

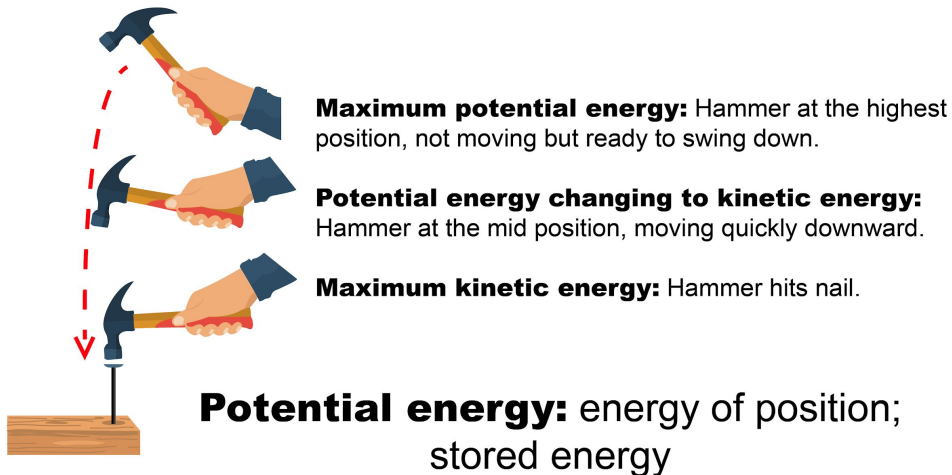
# Potential Energy

## Reflect

All types of energy can be sorted into one of two basic types of energy: kinetic energy and potential energy. One form often changes into the other. *Kinetic energy* is the energy of motion. *Potential energy* is the energy stored in an object because of its position. An object with potential energy has the potential to move because of its position.

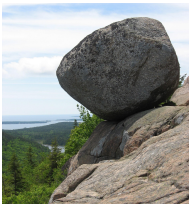


Look at the picture of the man about to hit a nail with a hammer. Which position of the hammer represents the greatest potential energy (stored energy), and which position represents the greatest kinetic energy: when he hits the nail or when he moves the hammer up, getting ready to swing down? The hammer held still in the position above the nail, right before the man swings, represents the highest potential energy. See the diagram below.



## Look Out!

**There are different types of potential energy.** Energy can be stored, ready for release into kinetic energy, in several common ways. Potential energy can be described as gravitational or chemical.



*Gravitational potential energy* is when objects have the potential to change their position due to the force of gravity (for example, a rock about to fall off a cliff). The height above the surface and the mass of the object affect the amount of potential energy. The higher or the more massive the object is, the greater the amount of potential energy is.



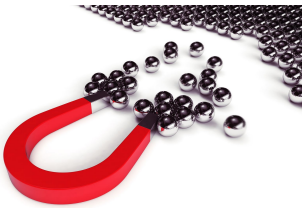
*Chemical potential energy* is when the energy is stored within the matter itself (for example, energy stored in a battery). When a battery is connected in a closed circuit to power an object, electricity can flow and potential energy is changed to the kinetic energy of an electric current.

# Potential Energy

Potential energy can be considered elastic, magnetic, or static.



*Elastic potential energy* is when it is stretched or compressed within the object (for example, a stretched string on a bow about to shoot an arrow).



*Magnetic potential energy* is when certain metal objects in a magnetic field have the potential of changing their position due to the force of magnetism.



*Static potential energy* is when charged particles in an electrostatic field have the potential of moving toward the opposite charge or away from the same charge.

In other words, any object inside a force field has potential energy. Just being inside the force field gives the object the potential of moving due to gravitational, electric, magnetic, electrostatic, chemical, or even nuclear forces.

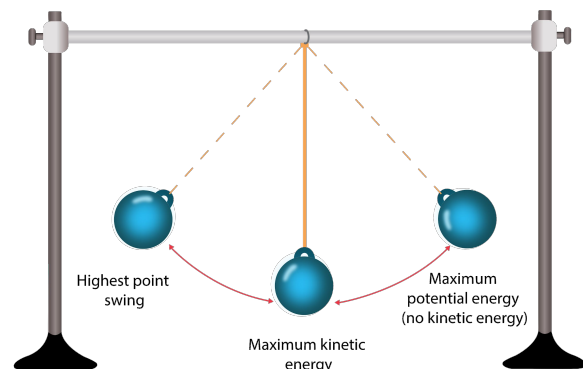
## What Do You Think?

According to the the law of the conservation of energy, energy can be neither created nor destroyed, but it can be transformed from one form to another. The total energy of a system remains constant.

What do you think happens to the energy of a ball in a pendulum that swings back and forth? The ball at the top of the swing is briefly motionless. It has the greatest potential energy, because it is highest above the surface.

At every point in the swing, the system of the ball on the pendulum string has the same total amount of energy. In other words, when the system has less potential energy, it has more kinetic energy. And when the system has more kinetic energy, it has less potential energy. At each moment, the system's kinetic energy and potential energy add up to the same value.

## Conservation of energy



# Potential Energy

## Look Out!

**Potential energy and kinetic energy are similar but not the same.**

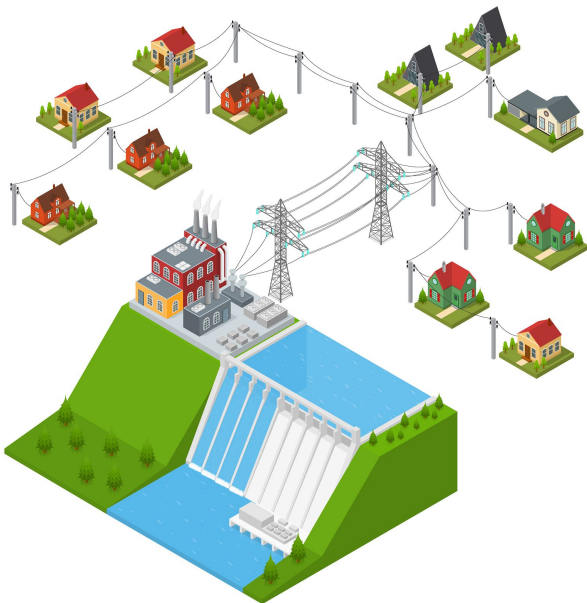
Scientists measure both potential and kinetic energy in joules (J). A joule describes the amount of energy needed to do a certain amount of work or cause a certain amount of change. The amount of potential energy depends on the mass and position of the object, whereas the amount of kinetic energy depends on the mass of the object and its velocity squared.

## Reflect

**Fuel energy is potential energy.** The chemicals in the food you eat, in batteries, and in fuel for vehicles all contain potential energy. When you eat food and it goes through your digestive system, your body converts the food's potential energy into kinetic energy that you use to move muscles.



When fuel such as gas is burned in an engine, the fuel's chemical potential energy is converted in the car's engine to kinetic energy that powers the vehicle.



**Potential energy becomes electrical energy.**

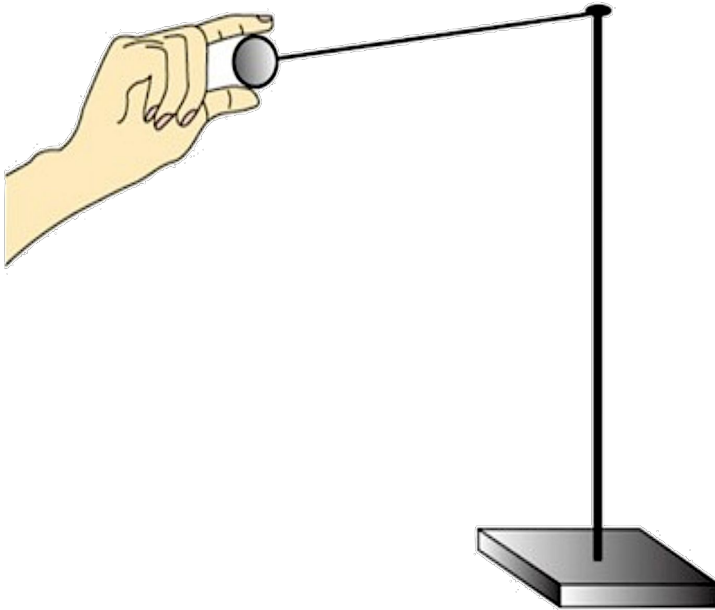
A hydroelectric dam keeps water held a certain height above Earth's surface. Gravitational potential energy builds in the water retained by the dam.

When the water is released, its potential energy is changed into the kinetic energy of moving water, which turns the blades of a water turbine generator.

The original potential energy stored in the dammed-up water becomes mechanical energy that is transformed into electrical energy.

## Try Now

A student sets up the pendulum system shown below. He holds the pendulum at the top of its arc.



Draw the path of the pendulum after the student releases it. Label the following points in the pendulum's path if the total mechanical energy of the system is 100 J.

Where does the pendulum have 100 J of kinetic energy? How many joules of potential energy does the pendulum have at this point?

Where does the pendulum have 100 J of potential energy?

How many joules of kinetic energy does the pendulum have when it has 100 J of potential energy?

Where does the pendulum have an equal amount of potential and kinetic energy?

How many joules of kinetic energy does the pendulum have at each of these points?