Conservation of Energy

The Law of Conservation of Energy

- Energy can change from one form to another, but the total amount of energy never changes.
- Even when energy changes form, energy is never destroyed.

Conservation of Energy

The Law of Conservation of Energy

- This principle is recognized as a law of nature.
- The **law of conservation of energy** states that energy cannot be created or destroyed.

Conservation of Energy

Conserving Resources

- You might have heard about energy conservation or been asked to conserve energy.
- These ideas are related to reducing the demand for electricity and gasoline, which lowers the consumption of energy resources such as coal and fuel oil.

Conservation of Energy

Conserving Resources

- The law of conservation of energy, on the other hand, is a universal principle that describes what happens to energy as it is transferred from one object to another or as it is transformed.

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Energy Transformations

- You are more likely to think of energy as race cars roar past or as your body uses energy from food to help it move, or as the Sun warms your skin on a summer day.
- These situations involve energy changing from one form to another form.

Conservation of Energy

Mechanical Energy Transformations

- **Mechanical energy** is the sum of the kinetic energy and potential energy of the objects in a system.
- Often, the mechanical energy of a system remains constant or nearly constant.
- In these cases, energy is only converted between different forms of mechanical energy.

Conservation of Energy

Falling Objects

- An apple-Earth system on a tree has gravitational potential energy due to the gravitational force between apple and Earth.
- The instant the apple comes loose from the tree, it accelerates due to gravity.

Pixtal/age fotostock

Conservation of Energy

Falling Objects

- As the apple falls, it loses height so the gravitational potential energy decreases.
- This potential energy is transformed into kinetic energy as the speed of the apple increases.

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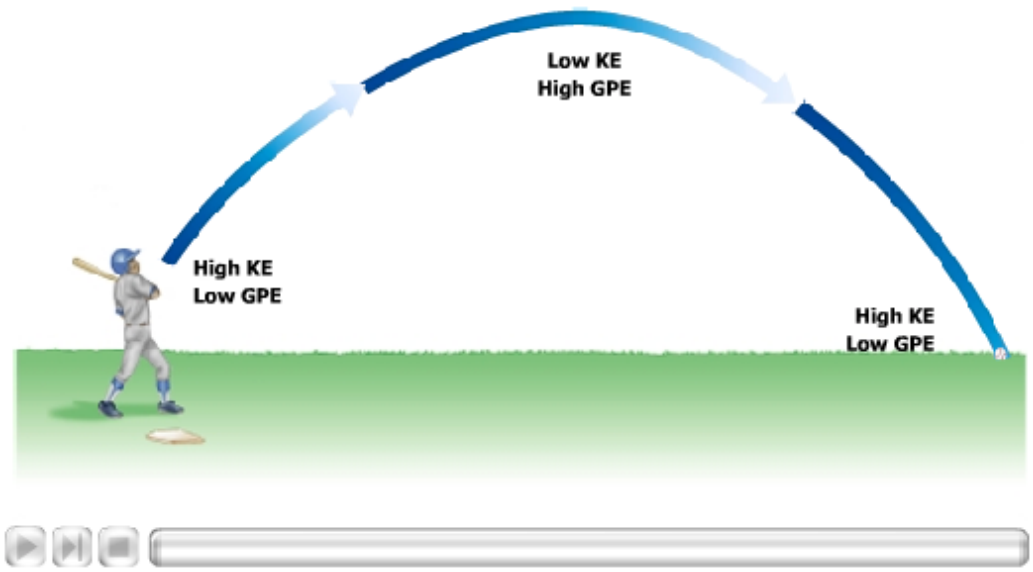
Falling Objects

- If the gravitational potential energy is being converted into completely into the kinetic energy of the apple falling, then the mechanical energy of the system does not change as the apple falls.
- The potential energy that the apple loses is gained back as kinetic energy.
- The form of energy changes, but the total amount of energy remains the same.

Conservation of Energy

Energy Transformations in Projectile Motion

- Energy transformations also occur during projectile motion when an object moves in a curved path.

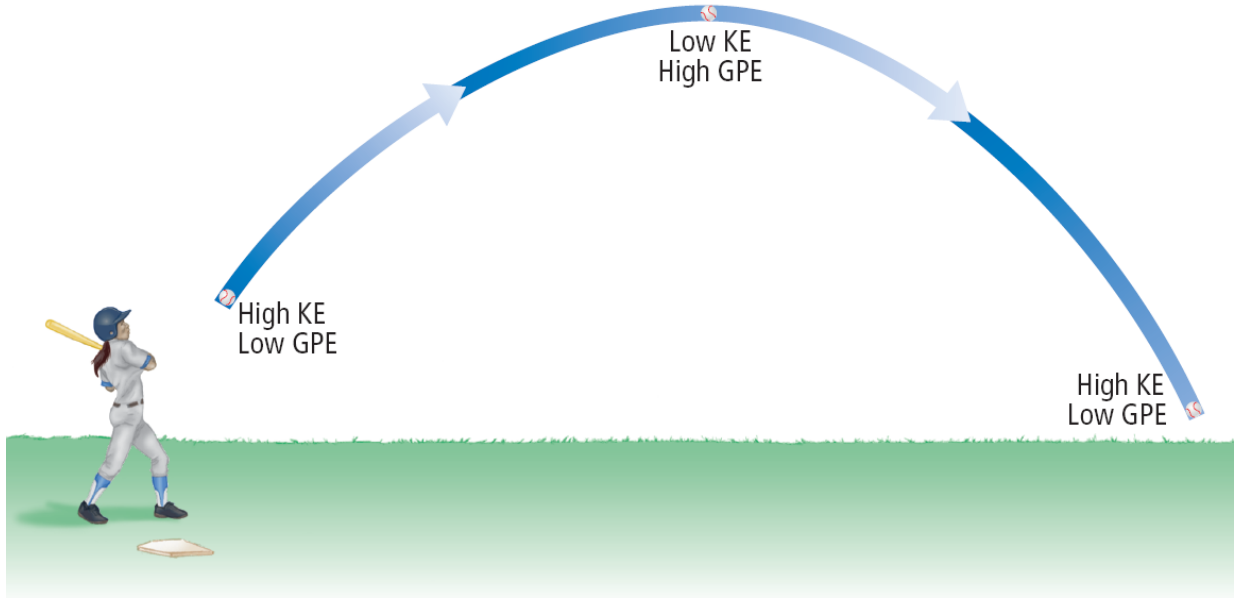


MAC OSX users click here to view.

Conservation of Energy

Energy Transformations in Projectile Motion

- However, the mechanical energy of the ball-Earth system remains constant as it rises and falls.



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Energy Transformations in a Swing

- When you ride on a swing part of the fun is the feeling of almost falling as you drop from the highest point to the lowest point of the swing's path.

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Energy Transformations in a Swing

- The ride starts with a push that gets you moving, giving you kinetic energy.
- As the swing rises, you lose speed but gain height.
- In energy terms, kinetic energy changes to gravitational potential energy.

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Energy Transformations in a Swing

- At the top of your path, potential energy is at its greatest.
- Then, as the swing accelerates downward, potential energy changes to kinetic energy.

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Is energy always conserved?

- While coasting along a flat road on a bicycle, you know that you will eventually stop if you don't pedal.
- If energy is conserved, why wouldn't your kinetic energy stay constant so that you would coast forever?

Conservation of Energy

The Effect of Friction

- You know from experience that if you don't continue to pump a swing or get a push from somebody else, your arcs will become lower and you eventually will stop swinging.

Conservation of Energy

The Effect of Friction

- In other words, the mechanical (kinetic and potential) energy of the swing decreases, as if the energy were being destroyed. Is this a violation of the law of conservation of energy?

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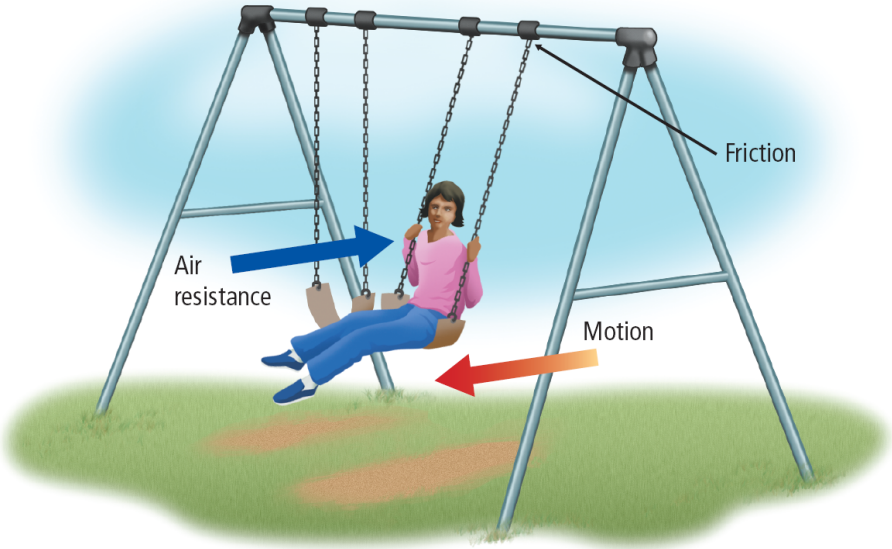
The Effect of Friction

- With every movement, the swing's ropes or chains rub on their hooks and air pushes on the rider.
- Friction and air resistance cause some of the mechanical energy of the swing to change to thermal energy.



Conservation of Energy

The Effect of Friction

- With every pass of the swing, the temperature of the hooks and the air increases a little, so the mechanical energy of the swing is not destroyed.
- Rather, it is transformed into thermal energy.

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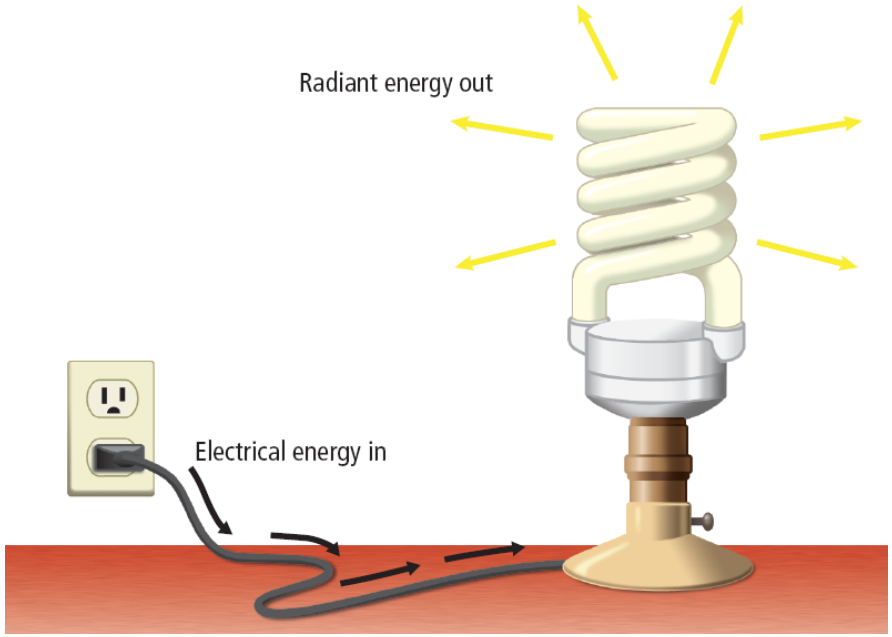
Transforming Electrical Energy

- Lightbulbs transform electrical energy into light so you can see.
- The warmth you feel around the bulb is evidence that some of that electrical energy is transformed into thermal energy.



Conservation of Energy

Transforming Chemical Energy

- Fuel stores chemical potential energy.
- The engine transforms the chemical potential energy of gasoline molecules into the kinetic energy of a moving car or bus.

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Transforming Chemical Energy

- Several energy conversions occur in this process.
- In a car, a spark plug fires, initiating the conversion of chemical potential energy into thermal energy.

Spark plug fires

Conservation of Energy

Transforming Chemical Energy

- As the hot gases expand, thermal energy is converted into kinetic energy.

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Transforming Chemical Energy

- Some energy transformations are less obvious because they do not result in visible motion, sound, heat or light.
- Every green plant you see converts the radiant energy from the Sun into the energy stored due to the chemical bonds in the plant.

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Power—how fast energy changes

- The rate at which energy is converted is the object's **power**.
- Power is measured in watts with 1 watt equaling 1 joule per second.

Power Equation

$$\text{Power (in watts)} = \frac{\text{Energy (in joules)}}{\text{time (in seconds)}}$$

$$P = \frac{E}{t}$$

Conservation of Energy

The Human Body—Balancing the Energy Equation

- What forms of energy can you find in the human body?
- With your right hand, reach up and feel your left shoulder.
- With that simple action, potential energy from your body was converted to the kinetic energy of your moving arm.

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The Human Body—Balancing the Energy Equation

- Some of your body's the chemical potential energy is used to maintain a nearly constant internal temperature.
- A portion of this energy also is converted to the excess thermal energy that your body gives off to its surroundings.

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Energy Conversions in Your Body

- Fat and other chemical compounds store energy for your body.
- This chemical potential energy is used to fuel the processes that keep you alive, such as making your heart beat and digesting the food you eat.

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Energy Conversions in Your Body

- You also use this energy to make your body move.

Table 1	Calories Used in 1 Hour		
Type of Activity	Body Frames		
	Small	Medium	Large
Sleeping	48	56	64
Sitting	72	84	96
Eating	84	98	112
Standing	96	112	123
Walking	180	210	240
Playing tennis	380	420	460
Bicycling (fast)	500	600	700
Running	700	850	1,000

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Food Energy

- The food Calorie (C) is a unit used by nutritionists to measure how much energy you get from various foods—1 C is equivalent to about 4,000 J.
- Every gram of fat a person consumes can supply about 10 C of energy.
- Carbohydrates and proteins each supply about 5 C of energy per gram.

Conservation of Energy

Conservation of Energy

- Energy can be converted between its many forms, including mechanical energy, thermal energy, electrical energy, and chemical energy.
- The law of conservation of energy states that energy never can be created or destroyed. The total amount of energy in the universe is constant.