

Warm-Up

Conservation of Energy

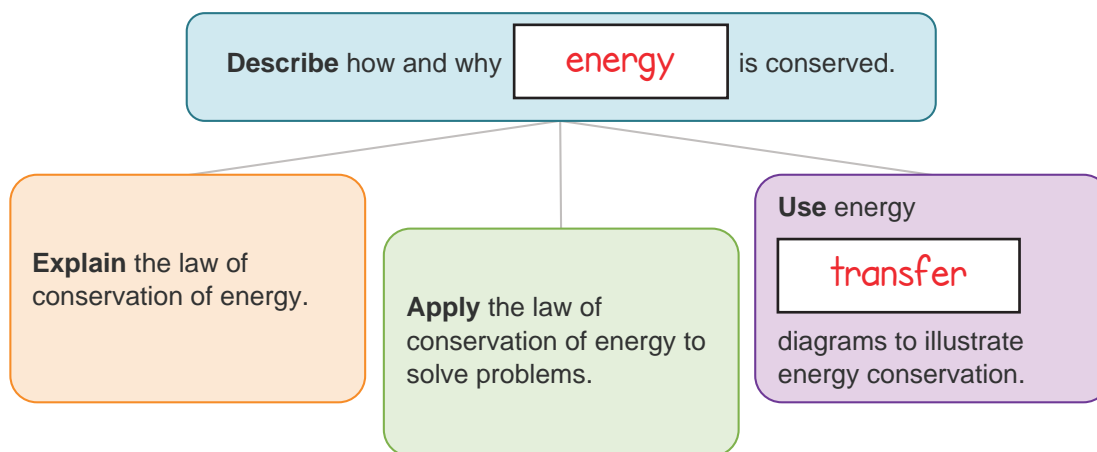


Lesson Question

How and why is energy conserved?



Lesson Goals



Words to Know

Fill in this table as you work through the lesson. You may also use the glossary to help you.

constant	staying the same ; unchanging
system	a group of related objects that interact and form a complex whole
efficiency	the ratio of output work to input work expressed as a percentage
law of conservation of energy	the law that states the total amount of energy in a system must remain constant , but can change form



Potential and Kinetic Energy

- Potential energy is the stored energy an object or particle has due to

its position.

- $PE_g = mgh$

- Kinetic energy is the energy an object or particle has due to its motion.

- KE = $\frac{1}{2}mv^2$

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The Law of Conservation of Energy

The law of conservation of energy states that:

- the total amount of energy in the universe remains **constant**.
- energy can change from one type to **another**.

Differentiating Systems

A **system** is a group of **related** objects that interact and form a complex whole.

- If all forms of matter and energy are not allowed in or out of a system, the system is closed. In a closed, **isolated** system, energy remains constant.
- An **open** system allows some forms of matter and energy to go either in or out of the system.

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Energy Transformations

- Any object moving through the air experiences the force of **air resistance**.
- **Friction** is usually involved when energy is converted from one type to another.

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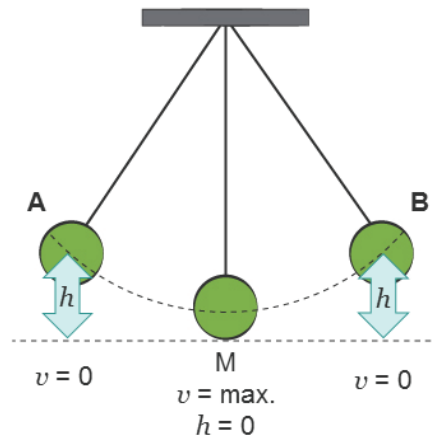
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Conservation of Energy Using a Pendulum

- As the pendulum swings downward, potential energy **decreases** and kinetic energy increases.
- As the pendulum swings upward, potential energy **increases** and kinetic energy decreases.
- The kinetic energy goes to zero at points A and B, where the pendulum **stops** and changes direction.

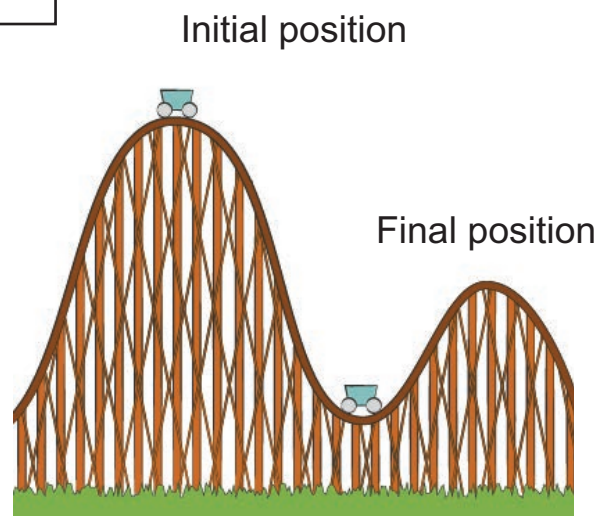


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Energy Transformation Formula

- $KE_i + PE_i = KE_f + PE_f$
- $\frac{1}{2}mv_i^2 + \boxed{mgh_i} = \frac{1}{2}mv_f^2 + mgh_f$
- $mgh_i = \boxed{\frac{1}{2}mv_f^2}$



All the energy at the top of the hill is **potential** energy, so $\frac{1}{2}mv_f^2$ initial squared can be eliminated. At the bottom of the hill, the opposite is true.

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Energy Transformation Formula

- Suppose a 125 kg roller coaster car is located at the top of a 40 m hill. What is the velocity when it reaches the bottom of the hill?

- Given:

- $m = 125 \text{ kg}$
- $h = 40 \text{ m}$
- $g = 9.8 \text{ m/s}^2$

$$(125 \text{ kg})(9.8 \text{ m/s}^2)(40 \text{ m}) = (125 \text{ kg})v^2$$

$$49,000 \text{ J} = 62.5 \text{ kg } v^2$$

$$784 \text{ J/kg} = v^2$$

$$\boxed{28\text{m/s}} = v$$

- Unknown: v

Formula: $\boxed{mgh} = \frac{1}{2}mv^2$

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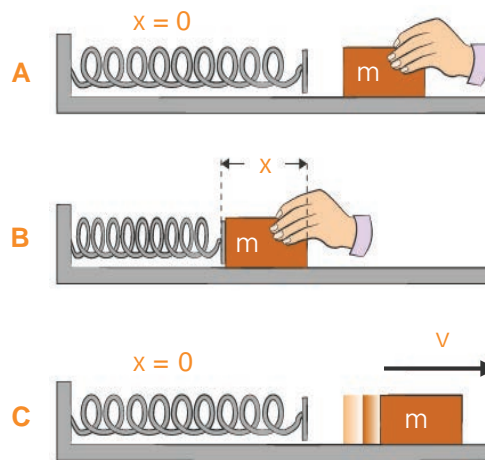
Conservation of Energy Using a Spring

- Elastic potential energy is determined by:

- the displacement, or the distance the spring is $\boxed{\text{compressed}}$, x .
- the compressibility of the spring, otherwise known as the $\boxed{\text{spring constant}}$, k .

- $PE_e = \frac{1}{2}kx^2$

- $KE_i + PE_i = \boxed{KE_f + PE_f}$



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Elastic Potential Energy

A compressed spring has potential energy of 10 J. If the spring constant is 100 N/m, what is the displacement of the spring?

- Given:
 - $PE_e = 10 \text{ J}$
 - $k = 100 \text{ N/m}$
- Unknown: X
- Formula: $PE_e = \frac{1}{2}kx^2$

$$\boxed{10\text{J}} = \frac{1}{2}(\boxed{100 \text{ N/m}})x^2$$

$$10 \text{ J} = (50 \text{ N/m})x^2$$

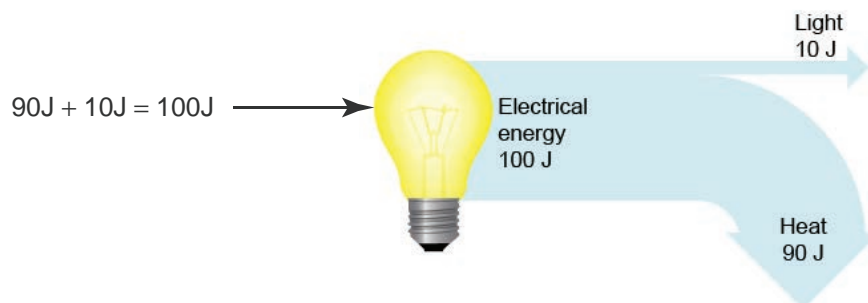
$$0.2 \text{ m}^2 = x^2$$

$$\boxed{0.4\text{m}} = x$$

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Energy Transfer Diagrams

Efficiency is the ratio of output work to input work expressed as a percentage.



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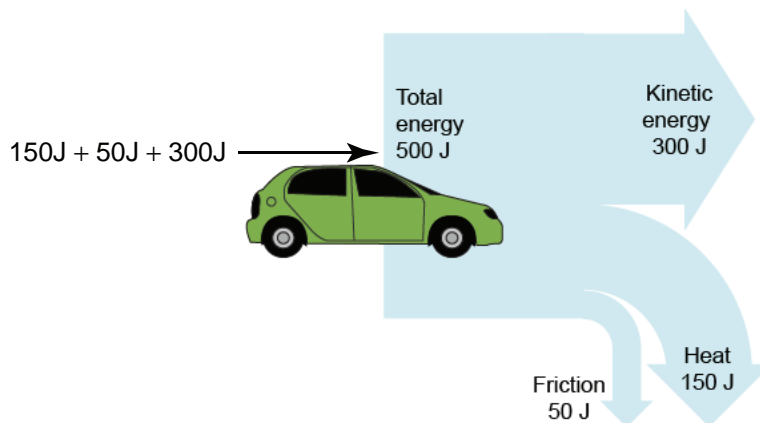
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As the car begins to move, some energy is converted into **friction** and

heat.



Summary

Conservation of Energy

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Lesson Question

How and why is energy conserved?

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Answer

(Sample answer) According to the law of conservation of energy, the total amount of energy in a system must remain constant, although it can change form. Energy can change from one type to another but cannot be created or destroyed. Therefore, in a closed, isolated system, the total amount of energy remains constant, or energy is conserved.

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Review: Key Concepts

- The law of conservation of energy states that the total amount of energy in a system must remain **constant** but can change form.
- According to the law of conservation of energy, initial energy is equal to final energy.
 - If friction is ignored, the equation can be simplified into $mgh_i = \frac{1}{2}mv_f^2$.
- **Elastic** potential energy is determined by the distance, x , the spring is compressed, and the spring constant, k .
 - $PE_e = \frac{1}{2}kx^2$
- Energy transfer diagrams illustrate the **efficiency** of a system and how energy is converted from one form to another.



Summary

Conservation of Energy

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