

Topic: Kinetic vs. Potential Energy

Grade Level: 6th Grade

Time: This lesson should take one week.

Science Standards:

MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Disciplinary Core Ideas:

PS3.B: Conservation of Energy and Energy Transfer

MS-PS3-5 When the motion energy of an object changes, there is inevitably some other change in energy at the same time.

PS3.C: Relationship Between Energy and Forces

MS-PS3-2 When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.

Science and Engineering Practices:

Developing and Using Models

Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems.

MS-PS3-2 Develop a model to describe unobservable mechanisms.

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

MS-PS3-3 Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system.

Crosscutting Concepts:

Energy and Matter

MS-PS3-3 The transfer of energy can be tracked as energy flows through a designed or natural system.

MS-PS3-5 Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).

Goals/Objectives

Students Will:

Define kinetic energy

Define potential energy

Compare and contrast kinetic and potential energy

Understand that energy is transferred when the kinetic energy of an object changes

Create a model demonstrating potential energy being transformed into kinetic energy

Justification:

This lesson will be part of a multi-week 6th grade unit focusing on energy. Throughout this unit, students will be learning about the various aspects of energy in all of its forms, ultimately working together to build a model roller coaster which will demonstrate various forms of energy. This is the third of six lessons which make up our energy unit.

In this lesson, students will investigate what kinetic and potential energy are, learning that everything actually has energy, even if it is sitting still. They will compare and contrast both forms of energy, looking for ways to describe each when building their own models in order to demonstrate energy transfer between potential and kinetic energy.

Engaging Contexts:

What has energy? Where can we find energy to help make something fly across the room? Can we create the energy we need in order to launch a model airplane with a rubber band? When the airplane lands is the energy gone? We've got a lot to learn about the way energy works. In this lesson we're going to talk about how things start and how they stop, or more accurately, where the energy is in things that move and things sitting still.

Required Materials:

Large Piece of Poster Paper Labeled with "Kinetic" on one side, a question mark in the middle, and "Potential" on the other side.

Disposable Plastic Drink Cups (2 per student)

Rubber Bands (2 per student, and extras for accidentally broken or lost bands)

Paper Clips (4 per student)

Single hole punch

Vocabulary:

Work - When a force is applied to an object and the object moves in the same direction

Energy - The capacity for doing work

Kinetic energy - The energy an object possesses by being in motion

Potential energy - The energy that is stored in an object due to its position relative to another object. It depends on the mass and height of the object.

Gravity - A force that pulls two objects together

Step 1 - Engage

Students will watch a short video about the story of Kinetic and Potential Energy. Following the video, students will be asked what they believe they know about both kinetic and potential energy. A large piece of poster paper will be taped up on the wall and students will write what they think they now know about both forms of energy on post-it notes and stick them to either side of the poster paper. If they have ideas they are unsure of, they can place them in the center under the question mark. As the class learns more about each form of energy we will move the notes around and add more notes to this paper.

<https://www.youtube.com/watch?v=7K4V0NvUxRg> (Unknown, 2009)

Step 2 - Explore

Students will watch a short video from Study Jams about energy and matter which also discusses the various forms of kinetic and potential energy.

<https://studyjams.scholastic.com/studyjams/jams/science/matter/energy-and-matter.htm>

(Scholastic, 2021)

As a class, discuss what energy is (the ability to do work and to move or cause change in matter), what the difference between potential and kinetic energy is (potential energy is stored energy while kinetic energy is energy in motion), and then ask for students to come up with examples in which energy is transformed from potential energy into kinetic energy. Now add, change, or remove post-it notes from the poster paper used previously, as our ideas of potential and kinetic energy are growing and changing.

As a class, read Kesler Science, Read It! (Kesler, 2021) Potential and Kinetic Energy together and then discuss the following questions:

1. What force acts on a roller coaster when it reaches the top of a hill but before it begins to descend?
 - a) Kinetic Energy
 - b) Mass
 - c) Potential Energy
 - d) Gravity
2. Where does the roller coaster have the most potential energy?
 - a) At the top of the hill before it begins to descend
 - b) In the middle of its descent down the hill
 - c) When it's close to the bottom of the hill
 - d) When it's reached the top of the next smaller hill
3. Another appropriate word for kinetic energy would be _____ energy.
 - a) Potential
 - b) Moving
 - c) Safe

d) Stored

4. Review the following vocabulary words and make notes or drawings to help you remember their meaning.

a) Work

b) Energy

c) Potential Energy

d) Kinetic Energy

e) Gravity

On the whiteboard, write Kinetic Energy on one side and Potential Energy on the other. You will discuss each of these items with the class and have them vote on each. It could be appropriate to add additional examples if it seems the class might benefit from a little bit more practice. It also might be fun to have students come up with their own examples (with the teacher's guidance) in order to make this into more of a game. :

- A box sitting on a table
- A rubber band stretched out and held tight
- Riding a skateboard down a ramp
- A fast running river
- A meteorite speeding toward the Earth's surface
- A pendulum held up high before it swings
- A mountain biker racing down a mountain

Class Discussion:

How does energy change between kinetic and potential?

Can anyone tell us a circumstance where a change between potential and kinetic energy (or vice versa) happens? Describe it please?

We've discussed a lot of different forms of potential and kinetic energy. We've all seen large and small windmills around our area which are used to produce energy. How is electrical energy produced from potential and kinetic energy?

Now look back on the poster paper. There should be a good bit of post-it notes. Ask the students if there's anything else they'd like to add, move, or remove from this display before we continue.

Step 3: Explanation

This section will begin as an overview of what we have learned so far and then continue into some of the mechanics of kinetic and potential energy.

We know that kinetic energy has to do with motion.

We know that potential energy has to do with what is stored but not yet used. (things which are still)

We know that gravity is a force which usually pulls things together, or in Earth's case, pulls things down (toward the center).

*There will be several drawings necessary in this part of the lesson which will require class discussion.

Review the definition of energy - the ability to do work or to move or cause change in matter.

Potential energy is found in all objects. It can be transformed into other forms of energy. Its height and mass determine its measure. It is measured in Joules.

Its potential energy is determined by its height and mass

The higher the object is, the greater its potential energy will be

*Draw a picture of two circles which are the same size but one is twice as high as the other. Draw arrows pointing down indicating that they are both falling. Ask which has the greater potential energy? The one falling from the higher position will have the higher potential energy.

The greater the mass is, the greater the potential energy will be

*Draw a picture of two circles which are at the same height but one is much larger than the other. Draw arrows pointing down indicating that they are both falling. Ask which has the greater potential energy? The larger one has the greatest potential energy as it has more mass.

Elastic Potential Energy

*Demonstrate this by stretching a few different rubber bands of differing sizes and widths. Ask students to determine which has the most potential elastic energy. (The one that can be stretched the furthest)

The amount of stretch you can achieve is the amount which can be released

The more you can stretch, the more you can store

*You will have students participate in a hands-on activity at this point. You will need the following materials

- 2 plastic disposable cups per student (it might be necessary to have many extras on hand just in case cups accidentally break or get lost in the rafters)
- 2 rubber bands per student
- 4 small paper clips per student

- 1 single hole punch to punch holes through the cups (four holes per cup)

Punch one hole equally distanced from each other around the top lip of one cup each student has. You will have four holes. Think of this as a north-south, east-west configuration. Once the holes are punched, students will feed one rubber band straight across from one hole to the other, threading it through a paper clip in order to hold it on the outside of the cup. Repeat this on the other side. This will result in one rubber band being suspended just beneath the lip of the cup, held in place by the paper clips. Repeat this process with another rubber band and two paper clips in a perpendicular direction. This will provide the appropriate cross section to create elastic potential energy in this experiment. Once the cup has all of its rubber bands secured in place, students can begin to attempt to stretch the modified cup over the non-modified cup and then release it in order to see if the potential energy will transform into kinetic energy, launching the modified cup into the air.

*As a final step in this part of the lesson, you will discuss what key points students have learned so far about potential and kinetic energy. Have them return to the poster paper with their post-it notes from before and add to them, re-arrange them, or remove their own if they've decided they no longer believe what they contributed was correct.

Step 4. Elaboration

Student Project

Find or create a toy that demonstrates both kinetic and potential energy.

- You will demonstrate this toy to the class, explaining how it uses both kinetic and potential energy.

- You will also explain how the transfer of energy between kinetic and potential or vice versa occurs with your toy.
- Provide a written summary of your toy's kinetic and potential energy capability, including examples.

*Have students return to the poster paper and add additional post-it notes, move post-it notes as necessary, or remove their own post-it notes as their understanding of potential and kinetic energy has grown.

Step 5. Evaluation

Provide students with the attached written evaluation, to be completed individually.

*Once the assessment is completed, go over the poster paper with all of the student's post-it notes as a class. Discuss each placement and decide if each is appropriate or not, or if it's unsure. Once the class has reviewed all of the notes, discuss how their understanding of potential and kinetic energy has grown as well as how it will help them understand the upcoming lessons in this, as well as other upcoming units.

References

Kesler. (2021). Potential and Kinetic Energy. Houston, Texas, United States of America.

Scholastic. (2021). *Energy and Matter*. Retrieved from Study Jams: <https://studyjams.scholastic.com/studyjams/jams/science/matter/energy-and-matter.htm>

Unknown. (2009, August 4). *The Story of Kinetic and Potential Energy*. Retrieved from YouTube: <https://www.youtube.com/watch?v=7K4V0NvUxRg>

	Excellent 3	Acceptable 2	Needs Work 1
1. Key Vocabulary - Using annotated observation, determine if student understands and can define all five vocabulary words provided in this unit.	Student easily discusses each of the five vocabulary words given at the beginning of this unit and can describe them when asked.	Student can discuss the vocabulary words provided in this unit with some difficulty and might have trouble describing what they mean or how they work.	Student does not have a clear understanding of the key vocabulary words provided in this unit. They are unable to discuss the terms when asked.
2. Engagement - Using annotated observation, determine if student is effectively participating in this lesson and following directions without causing disruption or losing focus to a degree that they are no longer participating effectively.	Student is completely engaged and making a valuable effort to learn as much as possible from the lesson. Behavior is appropriate during the experiment and helpful when asked. All tasks are completed appropriately with thoughtful answers and constructive feedback during group work/discussions.	Student is largely engaged and making a reasonable attempt to learn from the lesson. Behavior is acceptable with some intervention during the experiment. Student is generally helpful when asked. Tasks are completed with appropriate answers but not necessarily thoroughly thought out or considered. Feedback during group work and discussions can be constructive at times but might also be somewhat disruptive.	Student is generally not engaged or attempting to make a reasonable effort toward furthering the class goal. Behavior is disruptive or just disengaged entirely. Student causes trouble during the experiment. When asked, student chooses not to participate in various aspects of the lesson. Answers are short and poorly considered. Feedback is not given during group discussion or is disruptive in nature.
3. Experiment - Student must follow directions in order to create a specific device which can demonstrate the transfer of energy from potential energy into kinetic energy using rubber	Student watches demonstration closely and refers to displayed directions in order to re-create the experiment. Student is able to successfully demonstrate potential energy transferring to kinetic energy using elastic (rubber bands) and the two	Student watches demonstration and attempts to re-create the experiment, referring to the displayed directions occasionally. Student might break or lose components necessary to complete this activity, requiring extra parts. Student might also	Student fails to pay attention to the demonstration appropriately and/or doesn't follow the displayed instructions. They fail to use their materials appropriately, resulting in broken or lost parts. The student might also have missed explanations

<p>bands (elastic) and other supplies provided by the teacher.</p>	<p>plastic cups and four paper clips provided by the teacher without destroying or losing any of the provided pieces.</p>	<p>misunderstand steps, making mistakes requiring them to try another time.</p>	<p>about how certain steps are to be followed, creating various problems with the ability of their models to work appropriately.</p>
<p>4. Toy Model – Student is asked to provide a toy (either in person or one they can show online) which can demonstrate both potential and kinetic energy. They should explain how both work, how the transfer of energy takes place between the two, and provide a short, written summary of the toy and how these forces interact.</p>	<p>Student provides an appropriate toy, either in person or online, which can demonstrate both kinetic and potential energy. Student can describe how both forms of energy work. Student can describe how the transfer of energy takes place. Student has provided a short, written summary of the toy and how the forces of kinetic and potential energy interact.</p>	<p>Student has provided a toy, either in person, or online, which can demonstrate some form of either kinetic or potential energy, or possibly both, however the student does not show clear understanding when it comes to how these forces interact with this toy and/or how they transfer in order for the toy to operate. Student has provided a written summary of the toy and how it operates, however, it is not clear when explaining how the forces of potential and kinetic energy interact.</p>	<p>Student might have provided a toy either in person or online but is not clear about how it correlates to kinetic or mechanical energy. Student has difficulty explaining the example or the transfer of energy. Student either has not provided a short, written summary of the toy and how the forces of kinetic and potential energy interact, or what the student has provided is not clear due to a lack of understanding.</p>
<p>5. Assessment – Students will complete a 10 question assessment intended to gain an understanding of how much they have learned during this lesson. There are nine multiple choice questions and one short written answer question. Each question is equally scored leaving a possible total of 10 points</p>	<p>10/10 questions correct</p> <p>Short answer should be: Kinetic energy is energy in or of motion while potential energy is stored energy.</p> <p>Any answer resembling that is acceptable.</p>	<p>9-6 questions correct</p>	<p>Less than 6 questions correct</p>

Name: _____

Potential vs. Kinetic Energy Assessment

Multiple Choice:

1. When you do work you are exerting _____.

- A. Push
- B. Pull
- C. Energy
- D. Power

2. Stored energy within an object is called _____.

- A. Joule
- B. Kinetic
- C. Potential
- D. Transformed

3. Distance (height) and mass determine the amount of _____ energy in an object.

- A. Kinetic
- B. Potential
- C. Solar

D. Thermal

4. An object thrown from 50 feet will have _____ potential energy than an object thrown from 30 feet.

A. Greater

B. Less

C. Equal

D. Lower

5. Two objects are about to fall from the same height but with the same mass.

Which is going to have the most potential energy?

A. Smallest

B. Flattest

C. Largest

D. Roundest

6. We determine the amount of kinetic energy in an object by its

A. Speed and mass

B. Height and mass

C. Speed and velocity

D. Height and Velocity

7. What type of energy is caused by motion.

A. Kinetic

B. Potential

C. Solar

D. Electrical

8. When an object moves faster its _____ energy becomes greater.

A. Kinetic

B. Potential

C. Solar

D. Electrical

9. The potential energy of an object will become greater with:

A. Speed and mass

B. Height and mass

C. Speed and velocity

D. Height and Velocity

10. Briefly describe the difference between potential and kinetic energy.
