We're On a Roll!

Skill Level

6th Grade

Learner Outcomes

Youth will be able to explain the difference between kinetic and potential energy.

Youth will be able to communicate the law of Conservation of Energy including that energy can be transformed between forms.

Education Standard(s)

CCSS.ELA-Literacy.SL.6.1
CCSS.ELA-Literacy.SL.6.4
CCSS.ELA-Literacy.L.6.3
GLE 0607.10.2
GLE 0607.10.3

Success Indicator

Design an experiment to observe potential and kinetic energy.

Life Skill(s)

Communication
Teamwork

Tags

Energy, physics, science, STEM

Time Needed

30-45 minutes

Materials (per group)

- Ramp (halved pool noodles or mini-blinds)
- Chair
- Marbles and rubber balls timer
- Tape measure
- Scale
- Additional manipulations to the experiment

Credits: Elizabeth Gall, University of Tennessee Extension

Background

Note: Background information is provided here; facilitators do not distribute to the learners. You won't want to introduce the terms of potential and kinetic energy until after the students have experienced the activity. At that point only mention the terms and move on.

Energy forms are either potential or kinetic. *Potential energy* comes in forms that are stored—including chemical, gravitational, mechanical, and nuclear. *Kinetic energy* forms are doing work—like electrical, heat, light, motion, and sound.

We use energy every day to do things for us. It makes change possible. Energy also helps cars move down the road and our body to lift things. Scientists define energy as the ability to do work. We have found a way to make energy work for us by converting it into different types and using it to make our lives more comfortable.

Energy is able to change between potential and kinetic forms in what is referred to as *energy conversion.* Within this energy conversion you end up with equal amounts of energy before and after the conversion but heat is transferred to the surrounding environment during energy conversions. Maintaining equal amounts of energy before and after a conversion is referred to as the *first law of thermodynamics*– that energy can be neither created nor destroyed. It is simply transferred or converted into different forms.

Introduction and Opening Questions

Script: Today we are going to learn about how roller coasters work. If any of you have gotten to ride on a roller coaster, you know it goes through many ups and downs, and twists and turns, and all of this movement is in response to the energy the car has.

What does it mean that an object has energy? Does an object at rest have energy? Through changes to an object, what happens to the energy? Does energy take on different forms? Think about when you are on that slide at camp. Think about when you are at rest and when you are moving the fastest.

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Experience *(use the Experiential Learning Model and encourage critical thinking and the use of science abilities and skills)*

Preparation:

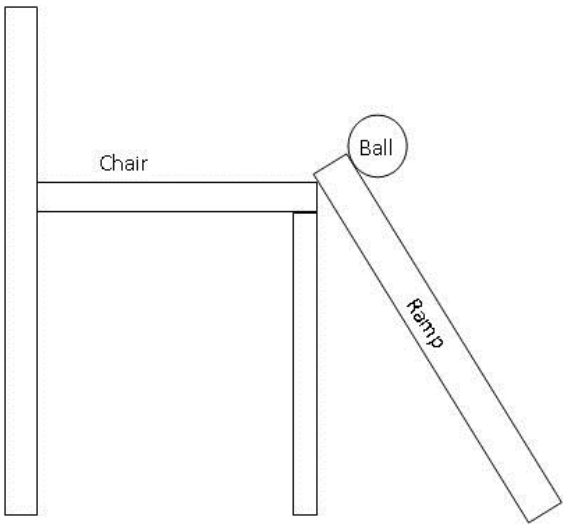
Find an appropriate current news article on energy (or use the attached article) to begin the Experience.

Activity:

1) Begin the activity with the Introduction and Opening Questions.
2) Have youth take about 5-10 minutes to read the article. To find the attached article (also found at the end of the activity): http://www.learner.org/interactives/parkphysics/coaster.html
3) Ask one or two questions to help youth to critically analyze what they read.

- If a roller coaster doesn't have a motor, how does it keep going along the track?
- When you are on a roller coaster, why does it seem like the higher you go up, the faster the coaster comes down?

4) After youth have read the informational text, they should have an idea formulating about what potential and kinetic energy is and how energy is transferred between potential and kinetic energy and back again.
5) Divide the class into groups of three. Have each group set-up an experiment using the wooden ramps and a ball to show the changes in position and energy of the object. The initial set-up for each group should be the same. (For example, have all groups use a classroom chair which will be the same height as the chair used in other groups. Place the ramp at the same angle. In addition, each member of the group should have a role (ball roller, observer (tell timer start and stop), and timer)).



Experience *(use the Experiential Learning Model and encourage critical thinking and the use of science abilities and skills)*

Each group will let go of the ball from the top of the ramp and time how long it takes to reach the floor. Have youth record the results in the Student Handout. Measure the weight of the ball (can also do this in advance). Calculate potential gravitational energy of the object based on the following formula.

$$PE_{gravitational} = weight * height$$

6) Encourage youth to be creative after they have tested their original set-up. However, youth must use the Scientific Method and change only one factor in each successive trial. Encourage each group to do something a little bit different such as changing the angle of the ramp, letting go of the ball from different heights (the higher an object is, the more gravitational potential energy it has- think of a car on a hill or a tall roller coaster), using different objects, or even two wooden ramps back to back.

7) Throughout the activity ask youth what difference they see/ measure between successive trials.

8) Youth should share what they did with other members of the class in a way he or she feels most comfortable. The observations can be communicated in a number of different ways such as with words, a graphic, a mathematical equation, or table.

Talk It Over...

Share…

1) Where in your roller coaster is the greatest potential energy? The greatest kinetic energy?
2) What happened when you changed a factor (variable) in the experiment?
3) How did you feel about designing an experiment on your own?

Process…

1) Why did manipulating a variable in the experiment change the results?
2) From this experiment, explain the difference in potential and kinetic energy.
3) Did your group find it challenging to decide on an experiment design?

Generalize…

1) How have you experienced the transfer of energy observed in this activity?
2) What other types of transfer of energy do you experience on a daily basis?
3) What are other situations in which you have had to work as a team?

Apply…

1) How can the concept of *Conservation of Energy* be applied to issues in energy efficiency/energy conservation?
2) What are some other situations in which you will be asked to work as a team?

Term and Concept Discovery

Potential energy—stored energy and the energy of position

Kinetic energy—the energy of motion

Energy conversion– the transfer of energy from one form to another

Law of Energy Conservation– energy cannot be created or destroyed, it only changes form

Appendix

Standards:

6th grade

CCSS.ELA-Literacy.SL.6.1—Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 6 topics, texts, and issues*, building on others' ideas and expressing their own clearly.

CCSS.ELA-Literacy.SL.6.4—Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.

CCSS.ELA-Literacy.L.6.3—Use knowledge of language and its conventions when writing, speaking, reading, or listening.

GLE 0607.10.2—Analyze various types of energy transformations.

GLE 0607.10.3—Explain the principles underlying the Law of Conservation of Energy.

Resources:

NEED Curriculum, Intermediate Energy Infobook. (2013). Retrieved from: http://www.need.org/files/curriculum/guides/Intermediate%20Energy%20Infobook.pdf

Energy Article

http://www.learner.org/interactives/parkphysics/coaster.html

Roller Coaster

For many people, there is only one reason to go to an amusement park: the roller coaster. Some people call it the "scream machine," with good reason. The history of this ride reflects a constant search for greater and more death-defying thrills.

How does a roller coaster work?

What you may not realize as you're cruising down the track at 60 miles an hour is that the coaster has no engine. The car is pulled to the top of the first hill at the beginning of the ride, but after that the coaster must complete the ride on its own. You aren't being propelled around the track by a motor or pulled by a hitch. The conversion of potential energy to kinetic energy is what drives the roller coaster, and all of the kinetic energy you need for the ride is present once the coaster descends the first hill.

Once you're underway, different types of wheels help keep the ride smooth. Running wheels guide the coaster on the track. Friction wheels control lateral motion (movement to either side of the track). A final set of wheels keeps the coaster on the track even if it's inverted. Compressed air brakes stop the car as the ride ends.

Wooden or steel coaster: Does it make a difference?

Roller coasters can be wooden or steel, and can be looping or non-looping. You'll notice a big difference in the ride depending on the type of material used. In general, wooden coasters are non-looping. They're also not as tall and not as fast, and they don't feature very steep hills or as long a track as steel ones do. Wooden coasters do offer one advantage over steel coasters, assuming you're looking for palm-sweating thrills: they sway a lot more. Tubular steel coasters allow more looping, higher and steeper hills, greater drops and rolls, and faster speeds.

We're On a Roll!

Student Handout

Name: _____

Youth should record what they did in each trial of the experiment as well as their observations.

Condition/Factor	**Time**	**Observations**
Initial Condition		