

Teacher's Guide: Energy Transfer in a Roller Coaster

Recommended Grade Level: 5-8

(also applicable to grades 9-12 for students requiring significant support in learning)

Suggested Time: About 50-60 minutes spread over one or more class periods, plus additional time to complete a writing assignment

Goals

Following are the big ideas that students should take away after completing this lesson:

- Energy can change from one form to another.
- The transfer of energy causes objects to move.
- Whenever energy decreases in one part of a system, it increases by the same amount in other parts of the system.

Vocabulary

(See definitions on page 6.)

- ascend
- descend
- friction
- gravity
- kinetic
- potential
- transfer

Key Literacy Strategies

Following are the primary literacy strategies students will use to complete this activity:

- Using background knowledge (screen 2; writing assignment 2)
- Determining important information (screens 4, 7, 8, and 10)
- Identifying and using text features (screen 6)
- Constructing summaries (writing assignment 1)

Note: In addition to the key literacy strategies listed above, students will also use each of these strategies to complete this lesson:

- Monitoring comprehension
- Synthesizing
- Making predictions
- Developing vocabulary
- Developing a topic in writing
- Identifying and using text features (photographs, captions, diagrams, and/or maps)

Overview

Energy Transfer in a Roller Coaster is a student-directed learning experience. However, while students are expected to work through the lesson on their own, teachers should be available to keep the lesson on track, organize groupings, facilitate discussions, answer questions, and ensure that students meet all learning goals.

The following is a summary of the lesson screens:

- Screen 1: Students are introduced to the excitement of roller coasters and the role energy plays in creating their movement.
- Screen 2: Students read about energy and the variety of forms it can take. They also read that they will be learning about mechanical energy, which pertains to moving objects and those raised above the ground. Students then name three other objects that have mechanical energy.
- Screen 3: Students learn what the goals are for the lesson, which strategies they will be using to complete the lesson, and the important vocabulary words they will use during the lesson.
- Screen 4: Students first read about gravity and the transfer of energy, two basic scientific principles that influence roller coaster movement. Students then watch a video that features roller coaster designer Chris Gray, who explains how changes in energy drive roller coasters along their tracks. After viewing the video, they write one to two sentences about what causes a roller coaster to move.
- Screen 5: Students read about the two types of mechanical energy—potential and kinetic energy—and learn that it is important to establish the highest amount of potential energy at the beginning of a roller coaster ride. They also read about how potential energy converts into kinetic energy, and back, during the ride. Then they read that the roller coaster cars, the track, the motor that pulls the cars uphill at the start, and Earth’s gravity work together as a system in which energy changes from one form to another.
- Screen 6: Students launch an interactive activity that uses a pie chart to clearly demonstrate how energy transfers back and forth between potential and kinetic energy throughout the ride. Students should click “Play” to watch the full ride once, then click “Step” to review each part of the ride. Students then write one to two sentences to answer two questions about potential and kinetic energy during a roller coaster ride.
- Screen 7: Students read a passage about some of the factors engineers must consider when designing a roller coaster track. After reading the passage, they name one factor that determines how much potential energy there is in a roller coaster ride and one factor that affects how much total energy roller coaster cars contain during a ride.
- Screen 8: Students answer three multiple-choice questions to show their comprehension of how energy transfers during a roller coaster ride, when kinetic energy is greatest, and how friction affects the amount of energy the cars have available to use.
- Screen 9: Students complete an interactive vocabulary activity, and then choose two words from the vocabulary list and write a new sentence for each word. These tasks demonstrate their understanding of the meanings of the words.

Screen 10: Students complete an interactive activity by highlighting text that answers two questions about how energy is measured and changes form during a roller coaster ride.

Final

Assignment: Students select and complete a writing assignment about the lesson topic.

Before the Lesson

- Go through each screen of the lesson, including all the interactive activities, so that you can experience ahead of time what students will be doing. As you go through each screen, jot down your own expectations for students' responses.
- Determine if students will be working individually or in pairs on the lesson. Some students may be able to work independently with little or no support. Students who are less familiar with the subject area or who struggle with literacy skills may benefit from working with another student. An effective way to do this is to pair a stronger student with a less able reader. You can also have students work individually on certain tasks and in pairs on others, depending on their experience and needs. If students will be working in pairs on any portion of the lesson, let them know if they will be expected to type in their notes individually or together.
- Provide instruction on key vocabulary (vocabulary words are defined in the lesson on screen 3, and on page 6 of this guide).
- Determine what students already know about energy, its different forms, and roller coaster design. You may want to start the discussion with questions such as: Who has been on a roller coaster? How do roller coasters work? What similarities do roller coasters share? Record their ideas on a chart. This will give you a sense of the background knowledge and possible misconceptions that students have before beginning this lesson. If time allows, return to the chart after students have completed the lesson to add new learning and correct misconceptions. Note: You may want to record their new learning in a different-colored ink so they can see how much they've learned.
- Arrange computers with Internet access so students can work individually or in pairs.
- Before students begin, suggest a timeline for completing the lesson, mention the different types of media they will encounter, and let them know how you expect them to submit their work. You may want to provide an outline of this information on a chart, chalkboard, or whiteboard, or as a handout.

Lesson Assessments

The following are descriptions of the lesson features that will be part of the packet of materials that students will submit. Students will use the packet for reference when writing their final assignment. It also serves as a formative assessment tool to monitor students' work as they are progressing through the lesson.

- **Notes** - Students take notes on screens 2, 4, 6, and 7. If time allows, review their notes before students begin their writing assignment.

- **Multiple-choice questions** - Students complete the three questions on screen 8. Walk around to make sure students answer all three questions before they continue. If students click to go to the next page before they finish, their work will not be saved.
- **Match It!** - Students complete an interactive vocabulary activity on screen 9. They begin by dragging the vocabulary terms into the correct sentences. After they finish and save their work, they will be able to check their answers against an answer key. When they are done, they will be asked to choose two vocabulary words and write a new sentence for each word. Sentences should demonstrate a clear understanding of the meaning of each word. An inappropriate response would be “The object has mechanical energy.” An appropriate response would be “The energy in moving objects is called mechanical energy.”
- **Highlight It!** - Students complete the comprehension activity Highlight It! on screen 10. Students will read a selection and then highlight specific information that answers two questions about the reading. Students will not be able to check their answers online, so you will need to provide them with correct answers when they are finished with the lesson. You can choose to review the answers as a class or return the corrected packet of materials to students before they begin the final assignment.

Following are some of the statements students may select to answer each question:

Question 1: How are the different types of energy present in a roller coaster ride measured?

Highlighted information to answer question 1 should include that kinetic energy is determined by the mass and speed of the object, and that potential energy is determined by the object’s mass, the force of gravity, and its height off the ground.

Question 2: How does energy change form during a roller coaster ride?

Highlighted information to answer question 2 should include that energy changes from potential to kinetic energy and back again many times over the course of a ride. As the cars ascend (the first hill), they gain potential energy. At the top of the hill, the cars have a great deal of potential energy. When the cars are released from the chain and begin coasting down the hill, potential energy transforms into kinetic energy until they reach the bottom of the hill. This kinetic energy then moves the cars up the next hill, and most of it is transformed back into potential energy. Then, when the cars descend this hill, that potential energy is again changed to kinetic energy.

- **Final Assignment** - Students complete one final writing assignment. You can choose to let students make their own selection or assign one according to your goals for the lesson. Use the rubric on page 7 to assess the writing assignments.

Lesson Aids and Extensions

Use the following suggestions to help students if they are stuck on a particular screen, to prepare students for completing their writing assignments, or as follow-up discussions to reinforce learning.

- **Watching Videos** - Encourage students to watch the videos more than once. After the initial viewing, provide students with a specific content focus to frame their next viewing(s) of the video. This will help them draw connections between the main topic and the information that the videos have to offer.
- **Participating in Discussions** - Organize class discussions or encourage students to talk about their questions in pairs. You may want to use the following discussion starters:
 - o What are two types of mechanical energy?
 - o Provide some examples from everyday life in which potential energy is transformed into kinetic energy. Suggestions include an object falling from a tabletop or shelf and a skateboard starting down a hill.
 - o What are some other examples of potential energy changing into kinetic energy?
- **Reading the PDF text** - Before they read the PDF text on screen 7, ask students to describe what riders encounter along a roller coaster track (e.g., ascents and descents of differing degrees) and explain how they think the cars can make it through an entire ride on their own power.
- **Sharing Student Work** - It may be motivational, and a further learning opportunity, for students to post their final essays so that their classmates, peers, and/or parents can see them. This may also provide an opportunity for students to comment on and discuss each other's essays.

If you do not already have access to an online writing community, Teaching Matters™ provides TeXT, free classroom publishing tools that allow teachers and students to create and publish their own online eZine. More information and a free signup are available at Teaching Matters: TeXT (<http://text.teachingmatters.org>).

- **Reflection and Self-Assessment** - After students have turned in their writing assignments, you can choose to have them assess their learning. Bring students together as a whole class or in small groups to discuss the questions below. You may want to return to the chart of their ideas developed before the lesson and record their new learning. You may also have students respond individually to the questions and then convene the class to discuss the chart.
 - o What did you learn?
 - o What was surprising?
 - o What questions do you still have?
 - o What was the easiest for you to understand and do?
 - o What was the most difficult?

Vocabulary Definitions

ascend

To move upward, or climb.

descend

To move downward, or fall.

friction

A force that results when two objects touch as they move past each other.

gravity

The natural force of attraction by one body, such as Earth, upon objects at or near its surface. Gravity draws objects toward the center of the body.

kinetic

Relating to or caused by motion. An object has kinetic energy due to its motion.

potential

Having the ability to become something. Potential energy is stored in an object and waiting to be used.

transfer

To move from one place or thing to another. Energy transfer is the transfer of energy from one body to another.

Final Assignment Rubric Energy Transfer in a Roller Coaster

- Describe the transfer of energy within a roller coaster ride. Be sure to explain in your essay:
 - What types of energy are present during a roller coaster ride
 - How the changes in form of energy affect the roller coaster cars' movement
- Imagine you're on a roller coaster ride. Describe the changes in forces that happen during the course of the ride. Be sure to include in your essay:
 - Which part of the ride is the most exciting for you, and why
 - Where potential energy and kinetic energy must be greatest and least
 - How the design of a track makes this happen

4	3	2	1
<p>Provides a clear and accurate response to the question. Ideas are elaborated, with three or more relevant supporting details from the reading passage, video, and other materials in the lesson.</p>	<p>Provides an adequate response to the question. Topic and ideas are generally well organized, with two relevant supporting details from the reading passage, video, and other materials in the lesson.</p>	<p>Provides a generally accurate response, with one supporting detail from the reading passage, video, and other materials in the lesson.</p>	<p>Provides an inaccurate response to the question or fails to address the question. May include misinterpretations. Understanding of the topic is not apparent.</p>
<p>Uses at least three vocabulary words (or a form of the vocabulary words) from the lesson, and uses them all correctly.</p>	<p>Uses two vocabulary words (or a form of the vocabulary words) from the lesson, and uses them both correctly.</p>	<p>Uses one vocabulary word (or a form of the vocabulary word) from the lesson, and uses it correctly.</p>	<p>Does not use any vocabulary words, or uses vocabulary words incorrectly.</p>

Scoring the Rubric

Here are two suggestions for scoring the final assignment rubric. Select the option that best meets your needs or develop your own grading system.

Option 1: This option provides one score for each submitted assignment.

Assign a score of 4 or below for the written response (first row of the rubric) and a score of 4 or below for the use of vocabulary (second row of the rubric), for a total maximum score of 8. The interpretation of scores is as follows:

Score	Grade	Narrative Interpretation
7-8	A	Excellent
5-6	B	Good
4	C	Adequate (Fair)
3 or below	D	Minimal

Option 2: This option provides two scores for each submitted assignment: one for written content and one for the use of key vocabulary. An advantage of separate scores is that you can weight students' comprehension and composition differently than you do their knowledge of vocabulary. It can also help you identify specific needs for future instruction.

Assign a score of 4 or below for the written response (first row of the rubric) and a score of 4 or below for the use of vocabulary (second row of the rubric) and then score them separately. The interpretation of scores is as follows:

Score	Grade	Narrative Interpretation
4	A	Excellent
3	B	Good
2	C	Adequate (Fair)
1	D	Minimal

The final grade may look like this: A/B (A for content and B for vocabulary use).