



Roller Coaster Science: *Discussion Guide*

Overview

Thrills, chills, and the fear of spills—they're all part of riding a roller coaster. And so is science. Depending on your tastes, a roller coaster ride can be the most exciting or the most harrowing way to encounter gravity, inertia, momentum, and other key scientific ideas. To take just one example, even the coolest, edgiest new coasters still obey the stop-height principle that Galileo formulated centuries ago.

Use these video segments and activities in your classroom to show students that physical science is truly a wild ride.

Student Glossaries

Remind the class that mastering specialized vocabulary is a key part of learning science. Have students use index cards to create individual glossaries. The activities for each video segment below will begin with a "Student Glossaries" assignment.

Using dictionaries, science books, and other classroom references, students should create a glossary card for every new scientific term. Each card should contain the term, phonetic spelling, part of speech, and definition. Encourage students to keep their cards in alphabetical order.

(Note: Students who created glossaries as part of the Human Body, Human Health Teacher Feature need simply add new cards to them.)

Classroom Activities

1. Show the segment "Rules of Physics" from the *Measure to Measure: Weight and Energy* video.
 - **Student Glossaries:** Give each student eleven index cards. Then write the following terms on the board. Direct students to research and write a glossary card for each term.
 - acceleration
 - direction
 - energy
 - force

- gravity
 - gravitational field
 - inertia
 - kinetic energy
 - mass
 - physics
 - potential energy
- **Scientific Inquiry:** “If you were blindfolded,” the narrator says, “you’d have a hard time telling when you were upside down.” Do students agree? Why or why not? Challenge the class to imagine how scientists might design an experiment to test that assertion. The following questions can help frame students’ thinking.
 - Is it reliable just to ask blindfold people after riding whether they could tell if they were upside down? *(Perhaps, but human memories can be tricky. Subjects may also be reluctant to admit that they “failed” to discern if they were upside down or not.)*
 - If not, how might we learn and record what blindfolded people are thinking during the ride? *(One approach might be to have a scientist ride next to each subject, who’d been instructed to say, “I feel upside down.”)*
 - How could we be sure that the results were true for more than one subject or roller coaster? *(By performing the experiment on various people and at different places. If possible, scientists might test some of the same subjects on different roller coasters.)*
 - Even if blindfolded people have a harder time telling when they’re upside down, how can we be sure that it was the blindfold that made the difference? *(By identifying and removing as many other variables as possible. For instance, scientists might notice that other riders scream while upside down. That could lead subjects to think they “feel” upside down. In that case, the scientists would try to arrange for the subject and experimenter to ride alone.)*
2. Show the segment “Galileo’s ‘Stop Height’: Gravity and Potential and Kinetic Energy at Work” from the *Roller Coaster Physics* video. (Access to *unitedstreaming* is required.)
- **Student Glossaries:** Give each student six index cards. Then write the following terms on the board. Direct students to research and write a glossary card for each term.
 - displacement
 - friction
 - hypothesize
 - stop height
 - work (in a scientific sense)

- **Pre-Video Discussion:** Ask students what makes roller coasters move. Record their answers on the board to review later.
 - **Post-Video Discussion:** “Most of these extreme machines,” the narrator begins, “don’t use engines or motors after the initial ascent.” Were students surprised to learn this? Challenge them to state in their own words what does make a roller coaster move.
 - **Scientific Inquiry:** Invite student groups to test Galileo’s stop-height hypothesis by rolling a marble or small ball over a track shaped like the one in the segment. Your building engineer might have materials that can be adapted to serve as tracks. Other items to try might include bendable plastic tracks for toy cars, the detachable rim of a springform pan, the rounded rim on the cover for a large pot, a U-shaped swing on the playground, or the inside of a bicycle tire.
3. Show the segment “The Thrill of It All: G-Forces, Inertia, and Newton's First Law of Motion” from the *Roller Coaster Physics* video. (Access to *unitedstreaming* is required.)
- **Student Glossaries:** Give each student five index cards. Then write the following terms on the board. Direct students to research and write a glossary card for each term.
 - blackout
 - g-forces
 - motion
 - redout
 - sensation
 - **Graphic Organizer:** Direct students to create Venn diagrams about the effects on roller coaster riders of positive and negative g-forces.
 - **Creative Writing:** Remind students that, according to the segment, a sense of danger is key to a roller coaster’s appeal. Tell students to keep that in mind while scripting a conversation in which a roller coaster fan tries to lure a wary friend onto the latest, scariest ride.
4. Show the segment “The Future of Roller Coaster Physics” from the *Roller Coaster Physics* video. (Access to *unitedstreaming* is required.)
- **Student Glossaries:** Give each student four index cards. Then write the following terms on the board. Direct students to research and write a glossary card for each term.
 - bearing (in terms of a wheel)
 - diameter
 - momentum
 - pulley

- **Discussion:** The Big Shot ride moves vertically but not horizontally, and it has no loops. So does it count as a true roller coaster? Invite students to weigh in with their views—and offer reasons for them.
- **Scientific Inquiry:** Form small groups. Direct each group to brainstorm, sketch, and describe a cool new roller coaster. After doing so, each group should answer the following physics questions about its design.
 - Does the design take Galileo’s stop-height principle into account?
 - Where would riders encounter positive g-forces?
 - Where would riders encounter negative g-forces?

Academic Standards

This discussion guide addresses the following national standards.

National Academy of Sciences

<http://books.nap.edu/html/nses/overview.html#content>

- Science as Inquiry: Designing and conducting scientific investigations
- Physical Science: Motions and forces
- Science and Technology: Problems and solutions in technological design

Mid-continent Research for Education and Learning

<http://www.mcrel.org/compendium/browse.asp>

Physical Science

- Understands the sources and properties of energy
- Understands forces and motion

Nature of Science

- Knows that investigations involve systematic observations, carefully collected, relevant evidence, logical reasoning, and some imagination in developing hypotheses and explanations
- Designs and conducts a scientific investigation

