

Advanced Physics of Roller Coasters

Grade Levels: 9-12 | Duration: 90 min

Design a robust learning experience by selecting resources from this guide that fit the needs of your students. Reinforce learning before, after, and even during your visit by diving deeper into some of the science and engineering concepts.



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When to implement

The following icons indicate when resources should be implemented for the greatest benefit to your students' experience in the lab.



Grade Levels: 9-12

Duration: 90 min

Concepts/Skills

Gravity, potential energy, kinetic energy, velocity, engineering design

Objectives

Students will:

- Demonstrate that gravity is a naturally occurring force that pulls objects toward the center of the Earth.
- Calculate the velocity, potential energy and kinetic energy of their roller coaster prototypes.
- Work as a team to complete a given design challenge with constraints.

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Vocabulary



These are words and concepts that we will discuss in the lab. Your students' experience will be enhanced if they are familiar with these terms prior to your visit. If you need inspiration for vocabulary activities, please see our Vocabulary Choice Board activity.

Term	Definition
Energy	The ability to do work.
Force	An influence (push or pull) on a body or system, causing a change in movement or shape.
Gravity	A force that pulls objects toward the center of the Earth.
Acceleration	A change in velocity over a period of time. This includes a change in direction or a change in speed.
Position	A location in space, usually denoted by a set of coordinates relative to some arbitrary origin (i.e., x & y coordinates).
Velocity	A change in position over a period of time. Velocity includes not only the speed of an object, but what direction it moves in. $v = d/t$ (m/s): d = displacement or distance traveled (m), t = time elapsed (s)
Kinetic Energy (KE)	The energy of motion. An object in any form of motion has kinetic energy (e.g., running, walking, dancing, flying, etc.). $KE = \frac{1}{2}mv^2$ (J): m = mass (kg), v = velocity (m/s)
Potential Energy (PE)	The energy of position; energy that is stored and held in readiness, waiting to move (e.g., a ball held in the air, sitting still, waiting motionless). $PE = mgh$ (J): m = mass (kg), g = gravitational constant (m/s ²), h = height of object, height change (m)
Mechanical Energy	Energy possessed by an object due to its motion or its stored energy of position. Mechanical energy can be either kinetic (energy of motion) or potential (stored energy of position).

Related Texts



The following titles may provide students with a greater contextual understanding of the field of physics and give additional opportunities to incorporate science and engineering into Language Arts lessons. We are not endorsing the following authors but feel that the information presented in these texts may benefit your students and enhance their learning experience.

Age Range	Title and author	Text Type	Description
Grades 6-12	"Roller Coasters" by Robert Coker	Reference	Containing more than 150 images of the world's most terrifying rides, this book puts readers in the front seats of some of the largest coasters ever built. Spanning the whole history of roller coasters from the 15th century to 2002, this book offers an in-depth look at the evolving technology of coaster design and construction.
Grades 9-12	"Coasters 101: An Engineer's Guide to Roller Coaster Design" by Nick Weisenberger	Reference	An examination of the numerous and diverse aspects of roller coaster engineering. This book includes the science and mathematical formulas that engineers use when designing the technology of some of today's greatest coasters. A technical study.

Exhibit Connections



Make connections between learning from the lab and the exhibits and programs found in The Tech Interactive's galleries.



Science on a Roll

(found outside The Tech Interactive at the Park Ave. entrance)

Witness an elaborate demonstration of the transfer of potential and kinetic energy.



The Innovator

(Upper Level)

Students design their own roller coasters at a designated design station. Once tested and successful, students take their designs to the roller coaster simulator where they'll share the experience and thrills of their design first hand.



This exhibit makes a great accompaniment to Advanced Physics of Roller Coasters either before or after the lab!





Advanced Physics of Roller Coasters



Lab-Related Activities



The following activities can be implemented either before or after the lab and are meant to bridge the learning from the lab to the classroom.

Activity	Description	Time
Circle of Pong 	Students use their knowledge of energy and forces to place a ball in the center of a 6-foot diameter circle. As students iterate through this design challenge, they gain first hand experience in the Innovation Design Process.	 65 minutes
Exploring Chain Reactions 	Students will explore stored energy and energy transfer as they build a series of chain reactions.	 65 minutes



Looking for other hands-on activities and resources to use in your classroom? Check out our [education resources](#) page!

Next Generation Science Standards

Advanced Physics of Roller Coasters supports the following NGSS:

Grades	Engineering Design	Physical Science	Disciplinary Core Ideas	Crosscutting Concepts	Science and Engineering Practices
Grades 9-12	HS-ETS1-2 HS-ETS1-3	HS-PS2-1 HS-PS3-3	PS3.B ETS1.A ETS1.B ETS1.C	Energy and Matter Systems and System Models Structure and Function	1, 2, 3, 4, 5, 6



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The Tech Interactive

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