

A Wild Ride! Week 2: Grades 6-8

Day 3: Ramping it Up!

Teacher/Parent Background:

An object has different types of energy. Kinetic energy is the energy of motion, and depends on the mass and speed of the object. Gravitational potential energy is energy an object possesses based on its position. Gravitational potential energy depends on mass, height, and the strength of the gravitational field.

As an object falls through the air or rolls down a slope, it is accelerated by gravity. During this time, the gravitational potential energy of the object is converted to kinetic energy. This conversion follows the law of conservation of energy, which states that the total energy is constant in a closed system. If there is no friction, the kinetic energy of a freely-rolling car at the bottom of the hill is equal to the gravitational potential energy of the car at the top. If friction is present, some of the potential energy is converted to heat.

As long as there is no friction in the system, the conversion from potential to kinetic energy is the same whether the object is in free fall or is rolling down a ramp. Friction slows objects down and causes energy to be lost as heat. In a real roller coaster, the car gathers potential energy as it is pulled to the top of the first hill. For the remainder of the ride, the car coasts freely, rolling up and down hills and loops as energy is converted from potential to kinetic and back again. Due to conservation of energy, the car can never go higher than the initial hill without the input of additional energy.

Overview:

In this activity, students will explore and adjust incline planes in an online simulation and then design and test their own ramps as students enter the next phase of the engineering design process and start imagining their roller coaster solutions.

Related Standards:

Plan and carry out an investigation that can support an evidence-based explanation of how objects on Earth are affected by gravitational force.

Key Terms:

- Friction

- Gravitational Potential Energy
- Kinetic Energy
- Momentum

Materials List:

- Computer
- [Foam pipe insulation](#) or foam pool noodles cut in half, lengthwise
- Masking Tape
- Marbles
- Various objects such as blocks, boxes, chairs, etc. to use as support

Activity Description:

1. Launch the [Explore Learning Roller Coaster Physics Simulation](#).
2. Open the [Student Exploration Sheet](#).
3. Follow the instructions found on the Student Exploration sheet to complete the Gizmo Warm-Up, Activity A and Activity C.
4. Once the online simulation and accompanying handout is complete, use the foam pipe insulation to build a ramp that will allow a marble to jump off the ramp and into a cup.
5. Try at least 3 different iterations of the ramp and use the knowledge you gained to make the marble “fly” as far as you can.
6. Now that students have explored the materials they will be using in their roller coaster build, ask them to draw out 2 possible ideas of what their roller coaster could look like based on the challenge details in the Student Handout.

Closure:

Ask students the following questions:

- What factors seem to determine whether the car will break the egg?
 - *The mass and speed of the car (determined by the height of the hill)*
- When there is no friction, what is the only factor that affects the final speed of a roller coaster?
 - *The only factor that affects the final speed is the total height lost*

Extension:

Read and Learn: [Energy Screams](#)

Student Handouts

Challenge Details

Dear Student,

Arizona Science Center is interested in adding a new exhibit to its *Get Charged Up!* gallery. Since *Get Charged Up!* is all about force and motion, staff members would like to introduce guests to the science behind roller coasters! You have been tasked with designing a roller coaster to be reviewed by Arizona Science Center's Exhibit Technicians for their new exhibit. Please closely follow all details outlined below:

1. Use the steps of the Engineering Design Process to design the best possible roller coaster. This includes:

- a. Imagining possible solutions - there are many possible solutions to this one challenge; think big!
- b. Planning your chosen solution
- c. Creating and testing your solution
- d. Improving your solution to make it even better

2. You may only use the following materials:

- a. Foam tubes, paper plates, paper, etc. - for the roller coaster track
- b. Making tape - to secure parts of the track or to help create roller coaster design features
- c. Scissors - to cut the tape
- d. Marbles - for the roller coaster's train/cart
- e. Paper cups, blocks, boxes, books - to support the roller coaster and to catch rolling marbles
- f. Measuring tape/ruler - to measure the length of the track

3. Your roller coaster must include/stay within the following design requirements:

- a. At least one hill
- b. At least one vertical loop
- c. At least one turn

We eagerly await your design proposals. Best of luck!

Arizona Science Center, Head Exhibit Technician

Imagine

Possible Solution #1
(include a diagram with labels)

Possible Solution #2
(include a diagram with labels)