# A Wild Ride! Week 2: Grades 6-8

## Day 4: Getting Loopy!

### Teacher/Parent Background:

Inertia is a property of objects and substances. Newton's first law of motion, also known as the law of inertia, tells us that due to inertia, an object at rest will remain at rest. Also, due to its inertia, an object will stay in motion with the same speed and direction if there are no unbalanced forces at work upon it. You have that experience when your car is moving forward and then slows down or stops suddenly. Your body continues to move with the same speed in the same direction, or keeps moving forward. The reason your body stops or slows down is due to the constraint of the seat belt. It gives the resisting force to prevent you from moving in the same direction and at the same speed.

Friction is another source of the resisting force. Newton's second law of motion, also known as the law of force and acceleration, gives us the mathematical expression of how force can influence an object's motion. Force is equal to the mass multiplied by the acceleration, or F = ma. If an equivalent force acts upon two objects, the acceleration will be less for the object with greater mass. In other words, more force is necessary to act upon heavier objects than upon lighter ones. If the mass is a constant, the bigger the force is, the higher the acceleration will be.

Finally, Newton's third law of motion, or the law of action-reaction, tells us that whenever a force acts, there is an equal and opposite reaction happening together on both sides of the objects. The launching of rockets makes use of the action-reaction principle. They utilize a downward stream of fast, hot gases. The force of the hot gases pushing out of the open end causes the rocket to move forward. The force of the escaping gases is the "action,and the motion of the rocket is the "reaction, illustrating Newton's third law of motion.

### Overview:

In this activity, students will explore the variables that affect kinetic and potential energy with an online simulation and then dive into the plan and the create phase of the engineering design process as they build a roller coaster with one complete vertical loop.

### Related Standards:

- Use non-algebraic mathematics and computational thinking to explain

Newton's laws of motion

## Key Terms:

- Friction
- Gravitational Potential Energy
- Kinetic Energy
- Momentum
- Inertia

## 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:

Have students do the following:

1. Download the Energy Skate Park: Basics PhET simulation.
2. Before beginning the simulation, think about some factors of a ramp's design that will have an effect on the speed and momentum of an object.
3. Select "Playground" and then check grid and speed.
4. Set the friction to zero and set the mass to the maximum amount.
5. Use the ramp generator at the bottom to create ramps of different shapes and heights.
6. Observe the maximum speed of the skater on each ramp design.
7. Record your ramp designs by drawing the shape of each ramp labeled with its starting height in the data table (on Student Handout).
8. Record the maximum speed of the rider on each ramp by drawing a line on the speedometer in the max speed column.
9. Record data on the three different designs.
10. After students complete the online simulation, they will use the materials to build a mini roller coaster with just a ramp and a vertical loop.
11. Once students make a successful mini roller coaster that keeps the marble on the track, direct them to the Plan instructions on the Student Handout.

## Closure:

Have students discuss the following question:

- What variables in a ramp's design have the most effect on the speed and hence momentum of a skateboarder on a ramp?
    - *Answers should include assertions about greater height and a steeper incline, causing greater speed hence greater momentum*

## Extension:

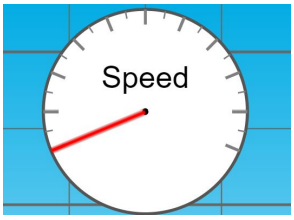
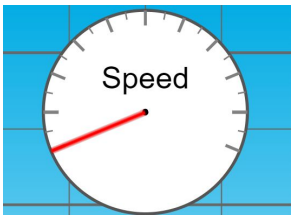
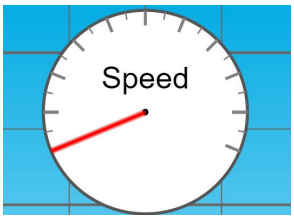
Watch & Learn: How do Roller Coasters Work?

Interesting Engineering!: Why don't Roller Coasters Fly off their Tracks?

ARIZONA SCIENCE CENTER
Never stop wondering.
Never stop imagining.™

# Student Handout

## Data Table 1:

| Ramp Design | Max Speed |
|---|---|
| |   |
| |   |
| |   |

ARIZONA SCIENCE CENTER
Never stop wondering.
Never stop imagining.

## Plan

After some experience building a ramp and a vertical loop go back to your 2 imagined solutions and choose the one you think is the best. You will build this design tomorrow.

| Chosen Solution |
| --- |
| |