NTTI Media-Rich Lesson

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NAME

Runaway Marbles
LESSON TITLE

Third –Sixth Grade
GRADE LEVELS

Three – 45 minute class periods
TIME ALLOTMENT

OVERVIEW
Students explore how the angle of the ramp and friction affect the speed of objects down a slope. They are given a challenge to create a roller coaster ride that will last the longest time and build a model for the ride using a marble as the passenger.

SUBJECT MATTER
Physical Science – Newton's Laws of Motion

LEARNING OBJECTIVES

- Identifies and demonstrates forces, such as push and pull.
- Differentiates between and demonstrates examples of potential and kinetic energy.
- Explains and infers with everyday examples that objects in motion stay in motion and those at rest stay at rest. Uses common objects such as balls or rolling cars to demonstrate.
- Explains and infers that objects at rest or in motion do not change their motion unless acted upon by an outside force. Using common objects like balls or rolling cars, infers that an outside force is necessary for a change in velocity to occur.
- Describes the relationship between movement and forces (e.g., inertia, acceleration, and velocity) quantitatively as a function of change in distance traveled over time. Picks a speed and uses it to predict the time required to travel the distance between two cities.

- Describes changes in rate of speed. Demonstrates that change in velocity is evidence that acceleration has occurred.

STANDARDS

POSITION AND MOTION OF OBJECTS

- The position of an object can be described by locating it relative to another object or the background.
- An object's motion can be described by tracing and measuring its position over time.
- The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.

Source: National Science Education Standards

MOTION / FORCES / MACHINES

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- Explains and infers that objects at rest or in motion do not change their motion unless acted upon by an outside force. Using common objects like balls or rolling cars, infers that an outside force is necessary for a change in velocity to occur.
- Describes the relationship between movement and forces (e.g., inertia, acceleration, and velocity) quantitatively as a function of change in distance traveled over time. Picks a speed and uses it to predict the time required to travel the distance between two cities.
- Describes changes in rate of speed. Demonstrates that change in velocity is evidence that acceleration has occurred.

Source: Georgia Learning Connection

MEDIA COMPONENTS

- www.discoverengineering.org/eweek/cool_things/rollercoaster/splash.htm
  This website offers insight into the careers of mechanical and industrial engineers that design amusement park rides. Users are also given the opportunity to design a roller coaster online and have it undergo inspections to determine if the ride is safe and enjoyable.

- www.learner.org/exhibits/parkphysics/coaster.html
  Users are able to use this website to view video clips of popular roller coaster rides in amusement parks from various areas of the country.

- http://search.eb.com/coasters/ride.html
  Students can use this website to explain the physics behind the amusement park roller coaster rides. Students are able to click on various parts of the roller coaster shown to learn about potential and kinetic energy, centrifugal force, acceleration, etc.

- www.rubistar.4teachers.org
  This website can be used as a tool to help teachers create rubrics for product-focused activities.

MATERIALS

For each team of students

1 cardboard ramp
2 marbles
5 runways (plastic foam)
Masking tape
Materials to increase friction (yarn, cloth, sandpaper, cotton balls, sponge, corrugated liners, etc.)
Stopwatch / team

PREP FOR TEACHERS

Teachers need to preview the Discover Engineering and Park Physics websites to familiarize themselves with the video clips and interactive activities. Teachers should select segments from the Discover Engineering website that show clips of roller coasters that are geographically near their area because students may be familiar with them.

INTRODUCTORY ACTIVITY: SETTING THE STAGE (Engage)

First Class Period

The teacher should introduce the activity and engage students by using the Discover Engineering website on roller coasters. "Today we're going to become mechanical engineers and go through some of the experiences that real mechanical engineers work through to build the rides we love to explore at amusement parks. While waiting in the line, you have probably had plenty of time to see people on the ride get flipped and corkscrewed through the ride. **(PROVIDE FOCUS FOR MEDIA INTERACTION)** Let's look at these video clips of different roller coasters in various parts of the country. We are looking at the differences in their designs." Teachers and students should view the video footage of roller coasters in action (www.discoverengineering.org/eweek/cool_things/rollercoaster/splash.htm) and if possible, discuss the movement of a popular ride in an amusement park in their city (For example, people living in Atlanta could discuss the design of the Ninja roller coaster at Six Flags over Georgia.) The teacher should first go to the website (www.discoverengineering.org/eweek/cool_things/rollercoaster/splash.htm), then click "Enter". Next, the teacher should scroll down to cue that says, "Check out these cool videos" and click on the picture of the curled up roller coaster. This will show various roller coasters in different areas of the country. The teacher should **PLAY** the clips of the roller coasters and the **STOP** and discuss with the students the design of the roller coasters and the effects or thrills that the riders experience.

Teacher should then introduce the challenge letter from the amusement park owner asking the engineers to design a roller coaster ride that is thrilling and lasts the longest amount of time. Student engineers are to build a model of the roller coaster and use a marble for the passengers.

LEARNING ACTIVITIES

- Teachers and students should use RubiStar (www.rubistar.4teachers.org) to design a rubric to set the standard for what would qualify a roller coaster to win the challenge.

Students should explore using the cardboard ramp first. As students begin building, the teacher should ask questions that would help students infer that by changing the angle of the ramp or changing the type of surface, the speed would also be changed.

- How will you angle the ramp so the marble moves slowly but does not stop?
- What materials can you add to the ramp to make the marble travel more slowly?
- What other parts can you build to slow down the marble?
- After students have explored using the materials and the ramps, the teacher provide a **FOCUS FOR MEDIA INTERACTION** and use a destination station to have the entire group to test out their abilities as roller coaster designers and explain the physics behind the activity (use the park physics website -- www.learner.org/exhibits/parkphysics/coaster.html).

Second Class Period

Now have teams continue their explorations using the foam runways and the materials to increase the friction and slow the ride. Students should sketch a drawing of what the runways should look like. The runways built with foam will be the ones used for the test. Students should time three trials for each ride, then record and average the times. Students should then decide if they feel that their design should be restructured and then redesign if time allows. The teacher should facilitate this process by asking the teams the following questions:

- Are there any places where your marble gets stuck or falls off? How could you fix these areas?
- What could you add to slow down the marble?
- What's similar about some of the rides that last the longest?
- Why is it important to test each ride three times and find the average?

To help explain the principles of physics behind their designs, one team at a time should come to the teacher to explore the Amusement Park Physics website (http://search.eb.com/coasters/ride.html). The teacher should give the students a **FOCUS FOR MEDIA INTERACTION** by telling the students to look at the roller coaster shown, find elements of the roller coaster that are similar to their team's design, and click on the terms to read about the laws of physics that enable the roller coaster to work. Students will then work as a team along with the teacher to explore this website. The teacher should rotate the teams during this class period to allow them to review the website and alter their roller coaster designs as necessary.

CULMINATING ACTIVITY

Third Class Period

Have each team view the roller coaster designs for the final test. Use a stopwatch to time the designs. Run three trials and find the average time for each ride. The teacher should lead the students in a discussion about the final designs:

- What changes did you make to your final design? Why?
- How does your final time compare to your first time?
- If you could start over, how would you design your ride differently?

Each roller coaster design should be judged using the rubric developed as the standard.

CROSS-CURRICULAR EXTENSIONS

- Students could compose a letter to the owner of the amusement park in the challenge detailing their results. (Writing)

- Each team should compose an advertisement for their roller coaster design. The advertisements should be as creative as possible including music, art and technology components. (Music, Art, and Technology)

COMMUNITY CONNECTIONS

Students could take a field trip to their local or nearby amusement park and use their rubric to rate the rides there. The class could then email their comments and ratings to the owners of the amusement park.

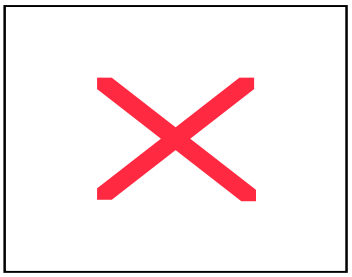
STUDENT MATERIALS

- **Challenge letter**
- **Sketch sheet for drawing hypothesis**
- **Record sheet**

Handout

Thriller-Chiller
Amusement Park

Handout



Runaway Marbles

Use the box below to sketch a drawing of what you think your roller coaster is going to look like.
Remember, in order to win the challenge, your roller coaster will be the longest and most thrilling ride!

(Draw and label the parts.)

1st Trial	2nd Trial	3rd Trial	Average Time