

Roller Coasters
Motion, Design, Forces
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South Carolina State Standards

Process skills and inquiries are not an isolated unit of instruction and should be embedded throughout the content areas. Safety issues should be addressed as developmentally appropriate.

A. Process Skills

- 1. Observe**
 - a. Use the senses and simple tools to gather information about objects or events such as size, shape, color, texture, sound, position, and change (qualitative observations).

- 4. Communicate**
 - a. Use drawings, tables, graphs, written and oral language to describe objects and explain ideas and actions.

- 5. Infer**
 - a. Explain or interpret an observation based on data and prior knowledge.
 - b. Discriminate between observations and inferences.

- 6. Predict**
 - a. Use prior knowledge and observations to identify and explain in advance what will happen.
 - b. Discriminate between inferences and predictions.

- 7. Hypothesize**
 - a. Devise a statement of assumption, based on observations, experiences, and research, that can be supported or refuted through experimentation.

- 8. Define variables**
 - a. Identify independent (manipulated), dependent (responding), and controlled variables in an experiment.

IV. Physical Science

Units of Study: Mixtures and Solutions
Forces, Motion, and Design

B. Motions and Forces

- 1. The motion of an object can be described by its position, direction of motion and speed.**
 - a. Investigate and describe the relative positions and movements of objects using points of reference.
 - b. Record and graph in metric units the distance vs. time of moving objects.
 - c. Investigate the variables that affect speed (e.g., ramp height/length/ surface, and mass of object).
- 2. If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another.**
 - a. Distinguish among gravity, friction, magnetism, drag, lift, and thrust.
 - b. Investigate and describe how forces affect the motion of objects.
 - c. Analyze a device with parts that move and determine the purpose of each moving part and the overall purpose of the device.
 - d. Design and construct a device that moves. (T)

Background Knowledge for Teacher:

Newton's Laws of Motion-

First Law:

1. An object will not move unless a force acts upon it.
2. If an object is moving it won't stop or slow down unless a force acts upon it.

Second Law:

1. An objects acceleration depends on the size and the direction of the force acting on it.

Size: The larger the force, the more acceleration.

Direction: A force that acts on an object can cause it to speed up, slow down, stop, or change direction.

Mass: Objects with less mass accelerate faster.

Third Law:

1. For every action (force), there is an equal and opposite reaction (force).

Action- first force Reaction- second force

Vocabulary:

Energy- The ability to do work.

Stored Energy or Potential Energy- Energy that has not been released.

Kinetic Energy- Energy in motion.

Force- Push or a pull.

Gravity- The force that pulls all objects to the ground.

Materials: (per group)

2 two-meter sections of $\frac{3}{4}$ inch pipe insulation

1 roll of masking tape

Assorted materials from classroom that students can use to support roller coaster such as books, chairs, boxes, etc

1 small marble

1 large marble

1 stopwatch

Poster board

Engage:

Explain to the students that they will be applying what they have learned about energy and the forces of motion to build roller coasters. In order to familiarize students with materials have the students carry out an investigation within their groups. In this investigation students will tape the ends of the track on opposing chairs so that the center hangs down to the floor like the letter u. They will use masking tape to secure the bottom of the track to the floor.

The groups will have a small marble and a large marble. They will place the marble on one end of the track and let it roll down. Students will count how many times the marble traveled back and forth across the masking tape (the center of the track). They will carry out this investigation for both the small marble and the large marble. They will record their data into a chart along with their observations.

Students will explain and record in their science notebooks how the small marble and the large marble move through Newton's Laws of Motion and potential and kinetic energy. As a class discuss their explanations.

Exploration:

Have students work in groups of 3-4. Provide students with the materials necessary to build their roller coasters. Give the students their challenge. Challenge: With your groups build a roller coaster with a hill, a loop, and a turn that your marble can travel through. Groups can use books, chairs, boxes, etc. in order to support your roller coaster.

Students need to test their roller coasters and make improvements if necessary. The marble should be able to travel the track successfully. Each team should use a stopwatch to measure the amount of time it takes for the marble to maneuver the track. Take a measurement of time three times to get an average.

Explication:

Each group will record their roller coaster on poster board along with any data that they have collected. Each group will give a presentation about their roller coaster. They will discuss any difficulties they had and the changes they made to overcome these difficulties. During their presentation they should explain how the marble moved through the science concepts they have learned about such as Newton's Laws of Motion and energy.

Elaboration:

After the groups have listened to each other's explanations, discuss as a class their findings about how roller coasters work. Write down findings on chart paper. Students will use their knowledge about how objects move to make predications about what would happen to the movement of the marble if we change the slope of the roller coaster. Discuss how to adjust the roller coaster to change the slope and have the students discuss how to investigate how the slope affects the movement of the marble. Allow students time to carryout their investigation and write their conclusions. Discuss their conclusions as a class.

Evaluation:

Students will write in their science notebooks about how the marbles moved throughout their investigations with roller coasters using terms such as slope, drag, force, friction, force, gravity, potential and kinetic energy.

Students will also take a quiz on roller coasters.