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AMUSEMENT PARK OF THE FUTURE LESSON PLANS

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Lesson Plan 1: The Thrill of the Ride—History and Psychology of Amusement Parks

This lesson launches the module by having the students examine photos, watch a video of an art project with extreme amusement rides, and view the accompanying website, which connects how particular characteristics of physics and engineering are used in amusements to generate emotions in people such as fear, excitement, and exhilaration. Students then elaborate on this baseline knowledge to investigate the history of amusements, note improvement to technologies and innovation, and connect the types of amusements with human psychological triggers.

ESSENTIAL QUESTIONS

- Why do people seek thrills in amusement parks?
- What kinds of characteristics do engineers, physicists, and mathematicians use in the design of amusement rides to make the largest impact on people?

ESTABLISHED GOALS AND OBJECTIVES

At the conclusion of this lesson, students will be able to do the following:

- Determine the types of physical characteristics (dropping, spinning, traveling at great heights) that amusement rides use to create thrills in people.
- Create a timeline of one type of amusement ride or game and document its history and how it has changed over time.
- Connect psychology research regarding what people experience on amusement rides with the history of amusement rides.

TIME REQUIRED

- 5 days (approximately 45 minutes each day; see Table 3.6, p. 37)

MATERIALS

- STEM Research Notebooks (1 per student; see p. 25 for STEM Research Notebook student handout)
- Computers with internet access
- Timeline creation software or paper, markers, and meter sticks
- Safety glasses or goggles
- Ball on a string
- Sturdy paper plate with a rim so that a marble can spin around the plate edge
- Scissors
- Marble

CONTENT STANDARDS AND KEY VOCABULARY

Table 4.1 lists the content standards from the *Next Generation Science Standards* (*NGSS*), *Common Core State Standards* (*CCSS*), and the Framework for 21st Century Learning that this lesson addresses, and Table 4.2 (p. 44) presents the key vocabulary. Vocabulary terms are provided for both teacher and student use. Teachers may choose to introduce some or all of the terms to students.

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Table 4.1. (*continued*)

FRAMEWORK FOR 21ST CENTURY LEARNING
Creativity and Innovation, Critical Thinking and Problem Solving, Communication and Collaboration, Information Literacy, Media Literacy, ICT Literacy, Flexibility and Adaptability, Initiative and Self-Direction, Social and Cross Cultural Skills, Productivity and Accountability, Leadership and Responsibility

Table 4.2. Key Vocabulary in Lesson 1

Key Vocabulary	Definition
acceleration	a change in an object's velocity, which could be a change in how fast it is moving or a change in direction
centrifuge	a machine that causes material (or a human) to travel in a circle
centripetal force	the force that keeps an object rotating in a circle
energy	the capacity for doing work; can be different types such as chemical, electric, mechanical; can also be kinetic or potential
force	a push or a pull on an object
gravity, or g-force	the force on an object as a result of acceleration or gravity measured in magnitude of Earth's gravity; the g-force increases when acceleration increases, which may be due to an increase in speed reached per unit of time or a decrease in the amount of time needed for the speed to be reached (g-force = acceleration from motion/acceleration from gravity)
mass	the amount of material in a body; it determines the amount of weight a body has due to the pull of gravity
psychology	the study of the human mind and behavior
speed	the rate at which something moves or covers distance; the distance a moving object travels per unit of time (if object 1 travels farther than object 2 over the same time, then object 1 has greater speed)
velocity	description of an object's motion that includes how fast it goes and the direction it is going
work	when force being applied to an object moves the object over a distance

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TEACHER BACKGROUND INFORMATION

The extreme g-forces proposed in the amusement rides in this lesson, such as 17 g, cannot be tolerated by humans. Astronauts who experience 3 g and changes in forces during launch and reentry must train for this experience for months in advance. This website provides real-life data on amusement park rides and g-forces, along with some explanation of physics experiments that can be done at the popular Physics Days at amusement parks: *http://physicsbuzz.physicscentral.com/2013/04/roller-coaster-g-forces-weve-got-data.html.* Teachers who have extra resources may want to consider organizing a Physics Day at a local amusement park. Table 4.3 gives some examples of g-forces.

Table 4.3. Typical Examples of G-Forces

Example	G-Force
Standing on Earth at sea level (standard)	1 g
Saturn V moon rocket just after launch	1.14 g
Going from 0 to 100 kilometers per hour in 2.4 seconds	1.55 g
Space Shuttle, maximum during launch and reentry	3 g

COMMON MISCONCEPTIONS

Students will have various types of prior knowledge about the concepts introduced in this lesson. Table 4.4 outlines some common misconceptions students may have concerning these concepts. Because of the breadth of students' experiences, it is not possible to anticipate every misconception that students may bring as they approach this lesson. Incorrect or inaccurate prior understanding of concepts can influence student learning in the future, however, so it is important to be alert to misconceptions such as those presented in the table.

Table 4.4. Common Misconceptions About the Concepts in Lesson 1

Topic	Student Misconception	Explanation
Motion: Speed, velocity, and acceleration are three concepts that describe the motion of an object.	Speed and velocity are the same.	Speed is a quantity (number) that only describes the distance traveled over time. Velocity is also a quantity, like speed, but also describes direction.
	Acceleration is defined only as an increase in speed or as a change in speed.	Acceleration is a change in velocity, so acceleration could be a change in the speed of an object or the change in direction of an object traveling at the same speed, or both.

PREPARATION FOR LESSON 1

Review the Teacher Background Information provided, and preview the websites suggested in the Learning Plan Components section below to ensure that you have foundational knowledge in the ways that professional amusement designers use physics and psychology to create amusements. In this lesson, you will observe student interest to form groups for the design challenge. Teacher cues are given within the lesson plan to help you consider variables when forming groups. Ultimately, the challenge project groups should include students who have a variety of amusement interests within the same theme. For example, if students want to create a park with a haunted theme, the group should consist of students who want spooky-themed rides, with one or two students focusing on roller coasters, one or two on a height-related ride, one or two on spinning rides, and one or two on dart- or ball-throwing games. The final product will be a complete park with a full complement of amusements.

Have your students set up their STEM Research Notebooks (see pp. 24–25 for discussion and student instruction handout).

LEARNING PLAN COMPONENTS

Introductory Activity/Engagement

Connection to the Challenge: Begin each day of this lesson by directing students' attention to the driving question for the module and challenge: How can we use what we know about the development of amusements, the ways people experience thrills, and the laws of physics to propose new amusements that are both safe and extreme? Ask them why they think amusement parks are so popular. What makes them thrilling? Hold a brief student discussion of how their learning in the previous days' lessons contributed to their ability to create their plan for their innovation in the final challenge. You may wish to create a class list of key ideas on chart paper or the board or have students create a STEM Research Notebook entry with this information.

The introductory activity is multipronged. In science class, students watch an art video of a fictional research project that designs and creates extreme amusement rides. In mathematics, students examine the accompanying website. Although the actual research project is fictional, the extreme nature of the rides will engage students, and the discussion in the video pinpoints examples of physical principles that are key to designing successful amusement rides. In social studies class, students examine photos and use historical inquiry to make inferences about the emotions and motivation of people while riding amusements.

Science Class: Watch the 6½-minute video on the Centrifuge Brain Project (visit YouTube and search for "Centrifuge Brain Project" or access the video directly at *www.youtube.com/*

watch?v=RVeHxUVkW4w). As described earlier, this video is an art project that emphasizes important features of amusements and why people design them.

STEM Research Notebook Prompt

Ask students the following questions after they watch the video. Have them initially record their answers in their STEM Research Notebooks, then discuss as a class.

- What things do you think were the most important in this video?
- What characteristics did the researchers investigate? (Examples include acceleration, spinning, height, feeling of weightlessness, and speed.)
- What kinds of experiences did the designers try to simulate? What was their inspiration?
- The video mentions "6 g's." What do you think that means?
- What does the scientist mean by "gravity is a mistake"?
- Why do you think people go to amusement parks and ride the rides?
- Would you ride these rides? Why or why not?
- Do you think they are real? Why or why not?

Explain to the class that this video and accompanying website are actually an art project, but they are based on science, engineering, and mathematics.

Mathematics Connection: Have students investigate the website of the Institute for Centrifugal Research, creator of the Centrifuge Brain Project: *www.icr-science.org/index.htm.*

STEM Research Notebook Prompt

Students should respond to the following prompt in their Research Notebooks: Choose one of the rides and make estimates to determine the speed (distance divided by time) that the people are traveling. Record all ideas and research in your notebook.

Social Studies Class: Have students look at the pictures of roller coaster riders' faces on this website: *www.thisiscolossal.com/2010/10/magic-feelings-portraits-of-roller-coaster-riders.*

STEM Research Notebook Prompt

Ask students to write their responses to the following questions in their Research Notebook, and then discuss as a class:

- What do you think these people are feeling? Why?
- What do you think they are doing? Explain.

- Why do people seek thrills?
- Why are amusement parks popular ways to spend leisure time?
- In what ways do people connect to each other as a community at amusement parks?
- Is there a culture of amusement parks?
- How can science and engineering improve a person's experience in an amusement park?

Have a class discussion about the experiences that students have had in amusement parks, including both rides and games that they have played. Ask them to compare their experiences with what they thought the people in the photos were feeling and why people go to amusement parks.

English Language Arts (ELA) Connection: Ask students to interpret the technical information given in the video and on the websites that they explored in science, mathematics, and social studies class. Provide support in any areas of need, such as explaining technical language or clearing up any misinterpretations of the information communicated.

Activity/Exploration

Science Class: Use a jigsaw activity to have students investigate and elaborate on the physics involved in the project. In a jigsaw activity, students are grouped in two different ways. Here, they will be divided first into expert groups and then into home groups. Divide the class evenly into four expert groups that will research different types of motion of amusement rides: one group for spinning, one for height, one for feeling of weightlessness, and one for speed. Ask students to use the internet to investigate what concepts are involved in their group's assigned type of motion.

Once you have assessed that groups have compiled enough information, form home groups that each consist of one student who is a spinning expert, one height expert, one feeling of weightlessness expert, and one speed expert. Have these experts teach their groups about the key features of their concepts. You may wish to create an individual assessment of all four concepts to ensure interdependence in the group.

STEM Research Notebook Prompt

Students should record all information they researched for their expert portion of the jigsaw activity, as well as what they learn from their home group members, in their STEM Research Notebooks. Then, have students use the internet to investigate the history of amusements, beginning with the London World's Fair in 1851, Coney Island in the 1880s, and the New York World's Fair in 1939–1940, with a focus on the physics behind the