



Crazy About Coasters

6-12

Unit Overview

Materials

- laptops with Internet access and PowerPoint
- markers
- poster boards
- crayons
- plastic cups
- foam tubing insulators (swimming noodles cut in half will also work)
- lead ball
- measuring device
- stopwatch

Standards

Unit Content Standards	Unit Youth Development Standards
<ul style="list-style-type: none">• <i>LA.5.1.6.1: Use new vocabulary that is introduced and taught directly.</i>• SC.912.P.12.3: Interpret and apply Newton's three laws of motion.• SC.912.P.12.11: Describe phase transitions in terms of kinetic molecular theory• LA.910.2.2.3: The student will organize information to show understanding or relationships among facts, ideas, and events• LA.910.5.2.2: The student will research and organize information for oral communication appropriate for the occasion, audience, and purpose	<ul style="list-style-type: none">• 3.1.6 Youth participate in a variety of teamwork and networking experiences• 3.2.3 Youth demonstrate the ability to develop a plan

Extension Ideas

- Calculate who has the overall fastest roller coaster
- Modify roller coasters to make it faster/slower and explain
- Design safety cart to go with roller coaster
- Give a survey on favorite roller coasters

ELL Modifications

- Pre-teach vocabulary, cooperative learning experiences

Pre/Post-Assessment

- **(pre)** Have the students do a quickwrite on what they know about roller coasters and their relation to science
- **(post)** draw a cartoon to show the three laws of Newton as well as a roller coaster relating to science

Table of Contents

Lesson 1: Rolling and moving with Science	7
Lesson 2: Roller coasters, roller coasters, and more coasters.....	9
Lesson 3: Are you grounded	10
Lesson 4: Under construction	11
Lesson 5: Building a coaster.....	12
Lesson 6: Still hammering	13
Lesson 7: Wow, Look what I made	14
Lesson 8: Reflecting on all the good	15
Lesson 9: Selling your coaster.....	16
Lesson 10: Drawing conclusions about coasters	17
Appendix A: Teacher Background: Newton’s Law’s	18
Appendix B: Video Questions	19
Appendix C: Roller Coasters and Science?? PowerPoint	20
Appendix D: Student Roles	26
Engineer	26
Historian	28
Physicist.....	29
Safety Expert	31
Appendix E: Possible Answers to Student Roles.....	32
Appendix F: Roller Coaster Design Guide	34
Appendix G: Advertisement Rubric	35
Appendix H: Amusement Park Physics Screen Shot	36
Appendix I: Presentation Rubric	37
Appendix J: Mini-proposal for Rollercoaster Guide.....	38
Appendix K: 3 Box Comic Strip.....	40
Appendix L: 4 Box Comic Strip	41
Appendix M: Glossary of Terms.....	42

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Lesson 1: Rolling and moving with Science

Essential Question:

- How is science related to roller coasters?

Content Standards:

- SC.912.P.12.3: Interpret and apply Newton's three laws of motion.
- SC.912.P.12.11: Describe phase transitions in terms of kinetic molecular theory

Youth Development Standards:

- 3.1.6 Youth participate in a variety of teamwork and networking experiences

Teacher Background Knowledge:

- Know Newton's Laws (all three) – Appendix A
- How Stuff Works search for roller coasters
<http://www.howstuffworks.com/search.php?terms=roller+coaster>

Materials:

- Computer and a projector for video
- Computers/ laptops for student research
- Student job guides - will complete within 3 days then will use to construct and build roller coaster
- Copy of Video Questions for Teacher – Appendix B

Procedure:

1. Quick write: Have students write what they know about roller coasters and how roller coasters are connected to science.
2. Introduction, read questions (Appendix B) to students then tell them to think about it while you watch a clip <http://videos.howstuffworks.com/discovery-channel/396-build-it-bigger-kinetic-madness-video.htm>
3. If you have access to united streaming you could watch Roller coaster physics : (segments) The Ties that Bend: the Science of Roller Coasters, Galileo's "Stop Height": Gravity and Potential and Kinetic Energy at work, The Thrill of it all: G-forces, inertia, and Newton's first law of motion
4. After video, talk about roller coasters and have students start thinking about the questions.

Vocabulary

- inertia
- Newton's Laws
- potential energy
- Kinetic energy
- Velocity
- Friction

5. Then explain that students are going to design their own rollercoaster within their group and students pick roles and start exploring on the computer – save or write down data collected on paper
 - The four roles are :
 - **Historian** – history of roller coasters
 - **Engineer** – type and what keeps the coaster moving – work with physicist and safety after you looked at different types of coasters
 - **Physicist** – length, height, weight input
 - **Safety Expert** – safety check and loops

Formative Assessment:

- Student sheets are their exit slips to see if some have started thinking about their part or need help getting started.

Lesson 2: Roller coasters, roller coasters, and more coasters

Essential Question:

- How is science related to roller coasters?

Content Standards:

- SC.912.P.12.3: Interpret and apply Newton's three laws of motion.
- SC.912.P.12.11: Describe phase transitions in terms of kinetic molecular theory
- LA.910.2.2.3: The student will organize information to show understanding or relationships among facts, ideas, and events
- LA.910.5.2.2: The student will research and organize information for oral communication appropriate for the occasion, audience, and purpose

Youth Development Standards:

- 3.1.6 Youth participate in a variety of teamwork and networking experiences

Teacher Background Knowledge:

- Know Newton's Laws (all three)

Materials:

- Teacher computer to display PowerPoint
- Power Point "Roller Coasters and Science??" – Appendix C
- Laptops for student research
- Student Role Sheets – Appendix D

Procedure:

1. Show PowerPoint "Roller Coasters and Science??" (Appendix C) and discuss the slides to get students thinking
2. Go over each role sheet (Appendix D) to ensure students understand what they have to complete and what is asked of them on the sheet. In addition to the sheets each team member will need to contribute towards building their coaster
3. Pass out their papers from previous days, along with the role sheets for each group and let them continue their own search.
4. Give exit slip last 5-10 minutes of class

Formative Assessment:

- Exit slip: What have they learned and how will they incorporate it into their rollercoaster design?

Vocabulary

- inertia
- Newton's Laws
- potential energy
- Kinetic energy
- Velocity
- Friction

Lesson 3: Are you grounded

Essential Question:

- How is science related to roller coasters?

Content Standards:

- LA.910.2.2.3: The student will organize information to show understanding or relationships among facts, ideas, and events
- LA.910.5.2.2: The student will research and organize information for oral communication appropriate for the occasion, audience, and purpose

Youth Development Standards:

- 3.1.6 Youth participate in a variety of teamwork and networking experiences

Teacher Background Knowledge:

- Know Newton's Laws (all three)

Materials:

- Laptop
- Projector
- paper

Procedure:

1. Show gravity clip and discuss and let them play with the Roller Coaster Simulation (<http://www.funderstanding.com/coaster>)
2. Continue collecting data – tell them this is the last day to collect any needed information so make sure they have some kind of notes
3. Exit slip

Formative Assessment:

- Exit slip: How will the gravity clip help me build my rollercoaster and what will I do with this new knowledge?

Vocabulary

- inertia
- Newton's Laws
- potential energy
- Kinetic energy
- Velocity
- Friction

Lesson 4: Under construction

Essential Question:

- How is science related to roller coasters?

Content Standards:

LA.910.2.2.3: The student will organize information to show understanding or relationships among facts, ideas, and events

Youth Development Standards:

- 3.1.6 Youth participate in a variety of teamwork and networking experiences
- 3.2.3 Youth demonstrate the ability to develop a plan

Teacher Background Knowledge:

- Know Newton's Laws (all three)

Materials:

- Poster paper
- Pencil, crayons
- Laptop
- rollercoaster guide (Appendix F)
- advertisement rubric (Appendix G)

Procedure:

1. Go over rollercoaster rubric and advertisement rubric – stress there are two rubrics
2. Within their groups, construct a rollercoaster plan according to findings and label loops– they may use internet sites for support – (<http://www.glencoe.com/sec/science/cgi-bin/splitwindow.cgi?top=http://www.glencoe.com/sec/science/top2.html&link=http://www.learner.org/exhibits/parkphysics/>) (Appendix H)

Formative Assessment:

- Student rollercoaster plans
- PowerPoint must contain words from the lesson

Vocabulary

- inertia
- Newton's Laws
- potential energy
- Kinetic energy
- Velocity
- Friction

Lesson 5: Building a coaster

Essential Question:

- How is science related to roller coasters?

Content Standards:

- SC.912.P.12.11: Describe phase transitions in terms of kinetic molecular theory
- LA.910.2.2.3: The student will organize information to show understanding or relationships among facts, ideas, and events

Youth Development Standards:

- 3.1.6 Youth participate in a variety of teamwork and networking experiences

Teacher Background Knowledge:

- Know Newton's Laws (all three)

Materials:

- Plastic drinking cups
- Masking tape
- Lead ball/marble – acts as rollercoaster
- Foam tubing or insulator – swimming noodles cut in half will also work

Procedure:

1. Students will start building their 3-D rollercoaster with group following their plan
2. Show the video at united streaming Engineering the Cutting Edge: Roller Coasters: segment roller coaster design (need to have access to united streaming) good model of what they will be building and why
3. Provide this site for the students as a resource for helping them with their coaster
<http://www.glencoe.com/sec/science/cgi-bin/splitwindow.cgi?top=http://www.glencoe.com/sec/science/top2.html&link=http://www.learner.org/exhibits/parkphysics/> (Appendix H)

Formative Assessment:

- Exit slip: reflection – What worked that day and what did not

Vocabulary

- inertia
- Newton's Laws
- potential energy
- Kinetic energy
- Velocity
- Friction

Lesson 6: Still hammering

Essential Question:

- How is science related to roller coasters?

Content Standards:

- LA.910.3.5.1: The student will prepare writing using technology in a format appropriate to the purpose (e.g., for display, multimedia)
- LA.910.1.6.1: The student will use new vocabulary that is introduced and taught directly

Youth Development Standards:

- 3.1.6 Youth participate in a variety of teamwork and networking experiences

Teacher Background Knowledge:

- Know Newton's Laws (all three)

Materials:

- Mini-proposal guide (Appendix J)
- Presentation rubric (Appendix I)
- Laptop
- Poster, pencil, markers, crayons
- Stopwatch
- Measuring device
- marble

Procedure:

1. Students will continue to build their rollercoaster with the given materials and calculate fastest speed, track length of coaster, highest hill
2. Students will make a PowerPoint/ visual aid to sell their rollercoaster – use rubric
3. Exit slip

Formative Assessment:

- Exit slip: What are some elements of a well presented presentation?

Vocabulary

- inertia
- Newton's Laws
- potential energy
- Kinetic energy
- Velocity
- Friction

Lesson 7: Wow, Look what I made

Essential Question:

- How is science related to roller coasters?

Content Standards:

- LA.910.3.5.1: The student will prepare writing using technology in a format appropriate to the purpose (e.g., for display, multimedia)
- LA.910.1.6.1: The student will use new vocabulary that is introduced and taught directly

Vocabulary

- inertia
- Newton's Laws
- potential energy
- Kinetic energy

Youth Development Standards:

- 3.1.6 Youth participate in a variety of teamwork and networking experiences

Teacher Background Knowledge:

- Know Newton's Laws (all three)

Materials:

- Laptops, print station
- Chart paper, markers, crayons

Procedure:

1. Students will finish PowerPoint/ visual aids to sell their rollercoaster – make sure the rubric is followed
2. Students will start writing a proposal (Appendix J) to give to the teacher to sell their coaster
3. Exit slip: 10 min.

Formative Assessment:

- Exit slip: What do students think will make their rollercoaster stand out and be the chosen coaster? How is their rollercoaster different/same from past coasters?

Lesson 8: Reflecting on all the good

Essential Question:

- How is science related to roller coasters?

Content Standards:

- LA.910.3.5.1: The student will prepare writing using technology in a format appropriate to the purpose (e.g., for display, multimedia)
- LA.910.1.6.1: The student will use new vocabulary that is introduced and taught directly

Youth Development Standards:

- 3.1.6 Youth participate in a variety of teamwork and networking experiences

Teacher Background Knowledge:

- Know Newton's Laws (all three)

Materials:

- Paper and pencil/ laptops

Procedure:

1. Students will finish their proposal and make revisions
2. Each student will write a personal reflection on the whole process and include group participation

Formative Assessment:

- Turn in completed proposal and reflection

Vocabulary

- inertia
- Newton's Laws
- potential energy
- Kinetic energy
- Velocity
- Friction

Lesson 9: Selling your coaster

Essential Question:

- How is science related to roller coasters?

Content Standards:

- LA.910.2.2.3: The student will organize information to show understanding or relationships among facts, ideas, and events

Youth Development Standards:

- 3.1.6 Youth participate in a variety of teamwork and networking experiences

Teacher Background Knowledge:

- Know Newton's Laws (all three)

Materials:

- Presentation Rubric (one per student)

Procedure:

1. Advertise roller coasters
2. Students will rate each group's rollercoaster using the presentation rubric.

Formative Assessment:

- PowerPoint/ visual aids and grade with given rubric

Vocabulary

- inertia
- Newton's Laws
- potential energy
- Kinetic energy
- Velocity
- Friction

Lesson 10: Drawing conclusions about coasters

Essential Question:

- How is science related to roller coasters?

Content Standards:

- SC.912.P.12.3: Interpret and apply Newton's three laws of motion.
- SC.912.P.12.11: Describe phase transitions in terms of kinetic molecular theory

Youth Development Standards:

- 3.2.3 Youth demonstrate the ability to develop a plan

Teacher Background Knowledge:

- Newton's three laws of motion

Materials:

- Cartoon Organizers (Appendix K & L)
- Pencil, crayons, and markers

Procedure:

1. Review with students Newton's Three Laws of Motion, and how they affect roller coaster design.
2. Have students make their own rollercoaster cartoon with captions showing the different phases the rollercoaster goes through and then make 3 different cartoons – 1 for each Newton's Law of Motion

Formative Assessment:

Collect cartoons and see if the pictures demonstrated Newton's three laws of motion and that their rollercoaster cartoon shows that they can see the relation between science and roller coasters.

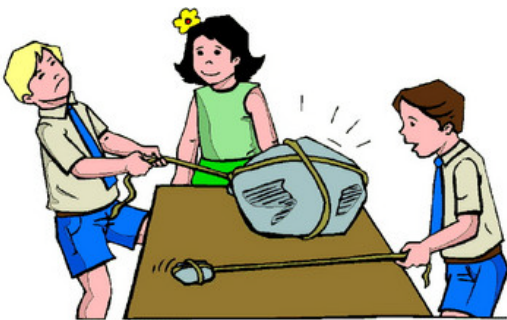
Vocabulary

- inertia
- Newton's Laws
- potential energy
- Kinetic energy
- Velocity
- Friction

Appendix A: Teacher Background: Newton's Law's

Newton's First Law of Motion

Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it.

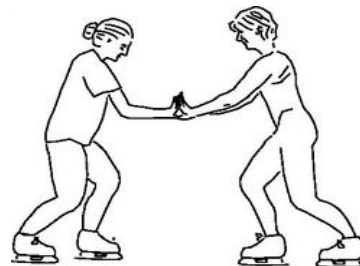


Newton's Second Law of Motion

The relationship between an object's mass m , its acceleration a , and the applied force F is $F = ma$. Acceleration and force are vectors; in this law the direction of the force vector is the same as the direction of the acceleration vector.

Newton's Third Law of Motion

For every action there is an equal and opposite reaction.



Additional Information in video form provided by the Science Channel can be found at <http://science.discovery.com/interactives/literacy/newton/newton.html>

Appendix B: Video Questions

The purpose of these questions is to gauge your student's background knowledge. You can either ask these questions of your students orally or you can combine these with the quick write. Examples of acceptable answers are highlighted in red.

1. What energy is building first? Do you know what this may be or do?

Potential

2. Roller coasters are designed to move themselves around the track without any form of fuel. How can the roller coaster get around all of those loops, turns, twists, without any assistance?

Energy from the first hill

3. The laws of physics help us explain how the roller coasters get around the track. What are some science words that you heard/saw in the video?

Potential energy

Gravity

Kinetic energy

Appendix C: Roller Coasters and Science?? PowerPoint

Roller Coasters and Science??

Newton's First Law

- An object at rest remains at rest and an object in motion maintains its velocity unless it experiences an unbalanced force.
- What does this mean?
- When the roller coaster is going it will keep going unless something stops it

inertia

- Inertia is where a state of rest or velocity along a straight line is maintained so long as it is not acted upon by an external force.
- How is inertia and a roller coaster related?
- Do I have to think about safety?

Newton's Second Law

- The unbalanced force acting on an object equals the object's mass times its acceleration.
- $F=ma$
- A small force on an object will cause a small acceleration and larger force will cause a larger acceleration.

Gravity

- feelings of weightlessness and heaviness experienced is contributed to forces acted upon them
- Pretend that there are small amounts of air resistance acting upon the riders. Thus, the only forces exerted upon the riders are the force of gravity and the normal force (the force of the seat pushing up on the rider). The force of gravity is at all times directed downwards.
-

Gravity

- A person who feels weightless has not lost weight.
- The force of gravity is the same magnitude
- The normal force however has a small magnitude at the top of the loop (where the rider often feels weightless) and a large magnitude at the bottom of the loop (where the rider often feels heavy).

Gravity and roller coaster

- If the tracks slope down , gravity pulls the front of the car toward the ground, so it accelerates
- If the tracks tilt up, gravity applies a downward force on the back of the coaster, so it decelerates

Potential Energy

- Potential energy – the energy you stored before it is used (not moving)
- The coaster builds potential energy as it makes it way up the first hill
- Potential energy increases as you go up the hill and decreases as you go down since it is converted to kinetic energy

Kinetic energy

- The energy of a **moving** object due to its motion
- The higher the hill the coaster is coming down, the more kinetic energy is available to “push” the cars up the next hill, and the faster the train will go.

Friction

- Is a force that opposes motion
- Friction causes kinetic energy to be used up on the roller coaster and the energy is converted to heat
- Roller coasters reduce friction by using different kinds of wheels to make the ride smoother

Newton's Third Law

- For every action force, there is an equal and opposite reaction force
- Think about the turns on the coaster
- When the tracks push the coaster one way the whole coaster goes that way

No energy was lost during this PowerPoint, just converted

Appendix D: Student Roles

Engineer

You will examine a traditional roller coaster, where the cars are lifted to the top of only the *first* hill by a mechanical device under the cars; thereafter the cars move only under the influence of gravity and friction. You aren't being propelled around a track by a motor or pulled by a hitch. The conversion of potential energy to kinetic energy is what drives the roller coaster, and all of the kinetic energy you need for the ride is present once the coaster descends the first hill. Obviously for a coaster, the higher the first hill, the more action will be possible later in the ride. All the energy from the ride comes from the first hill. The total energy available to the cars is the potential energy given to them by lifting them to height **h**.

This is given by the formula:

$$\text{P.E.} = m \cdot g \cdot h$$

Because some of this energy is converted to friction and heat, the cars can never return to this height. They can fall, converting some of this energy to kinetic energy (speed), and then rise again, losing speed and gaining back some of the potential energy, but none of the later hills on the roller coaster will be as high as the first one.

Most roller coasters have hills that decrease in height as you move along the track. This is necessary because the total energy reservoir built up in the hill is gradually lost to friction between the train and the track, as well as between the train and the air.

<http://www.ultimaterollercoaster.com/coasters/records/>

http://www.ehow.com/how_2084892_build-roller-coaster.html

Answer questions below:

- A. Why is the height and shape of the first hill important?

- B. Exit paths are paths out of a hill or loop. What should be considered when designing exit paths? Why?

- C. The second hill should help maintain the thrill. How should this hill be designed compared to the first hill? Why?

- D. Why is the teardrop, elliptical loop, a much better design for roller coasters than the circle loop design?
- E. Imagine that you and a group of passengers are testing out a newly constructed roller coaster. The slide down the first hill is thrilling, but before you get to the top of the second hill, you start sliding backward and get trapped between the first two hills. Using what you know about Newton's First Law of Motion, describe what the designer forgot to include in transforming his creation from his plan on paper to the real world.

Energy and friction: <http://www.funderstanding.com/help> and practice
<http://www.learner.org/interactives/parkphysics/coaster/>
<http://puzzling.caret.cam.ac.uk/game.php?game=roller>

Wooden or steel coaster: Does it make a difference?

Roller coasters can be wooden or steel, and can be looping or non-looping. You'll notice a big difference in the ride depending on the type of material used. In general, wooden coasters are non-looping. They're also not as tall and not as fast, and they don't feature very steep hills or as long a track as steel ones do. Wooden coasters do offer one advantage over steel coasters, assuming you're looking for palm-sweating thrills: they sway a lot more. Tubular steel coasters allow more looping, higher and steeper hills, greater drops and rolls, and faster speeds.

<http://adventure.howstuffworks.com/roller-coaster3.htm>

Historian

You are going to make a timeline about the history of roller coasters.

<http://www.ultimaterollercoaster.com/coasters/history/> Along the way you are going to make note of the good and bad so you can help your teammates design the roller coaster.

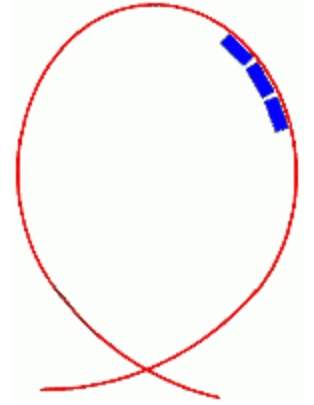
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Important information:

Physicist

Modern roller coasters are constructed of steel. The added strength of this material allows for twists and loops that weren't possible in older wooden coasters. Let's look at what happens in a loop.

A roller coaster loop is actually a teardrop shape called clothoid. A clothoid is a section of a spiral in which the radius is constantly changing. Unlike a circular loop in which the radius is constant, the radius at the bottom of a clothoid loop is much larger than the radius at the top. If roller coaster loops were perfect circles, the speed necessary to hold the cars to the track as they loop over the top would require 8 g's of acceleration going into the loop. This is much more than is tolerable by the human body ... fighter pilots often black out when experiencing 7 or more g's.



<http://adventure.howstuffworks.com/roller-coaster3.htm>

Visit <http://www.ultimaterollercoaster.com/coasters/records/> and complete the chart for 4 roller coasters to get an idea of what length, height, and speed you would want for your roller coaster.

Roller coaster name	height	length	speed

G-force or the force of gravity on roller coasters (<http://express.howstuffworks.com/feeling-loopy.htm>)

The G-force can be measured by direction: up and down, forward and backward, or left to right. Of concern is how long the forces last and how quickly and radically they change, and whether the ride jolts back and forth abruptly, or suddenly speeds up or slows down.

One G-force equals the normal tug of gravity on the body. Two G-forces make a person feel twice as heavy as normal. As the G-force increases, it becomes harder for the heart to pump blood to the brain.

Zero G is weightlessness -- the sensation of floating -- and negative G gives the sensation of being pulled upward out of the seat.

Explain the two types of energy work (potential and kinetic) in a roller coaster.

More practice: <http://puzzling.caret.cam.ac.uk/game.php?game=roller>

Safety Expert

You are in charge of making sure your rollercoaster is safety.

http://www.rollercoasterexpert.com/coaster_safety/coaster_safety.htm

<http://www.coasterforce.com/Accidents>

<http://www.coasterquest.com/coastersafety.htm>

<http://adventure.howstuffworks.com/roller-coaster9.htm>

Recent lawsuits have been brought by roller coaster riders who claim injuries such as brain damage. If the size and speed of a coaster doesn't necessarily make it more dangerous, what does? What facts, data, and/or statistics could you present to defend the building of your ultimate scream machine? (<http://www.time.com/time/nation/article/0,8599,165350,00.html>)

With this information you need to come up with a safety guideline for your roller coaster. Then help the engineer and physicist with the roller coaster elements (ex. Twists and turns). These are some possible elements (please define all and add a picture):

Batwing

Camel Back

Corkscrew

Double Loop

Inversion

Vertical Loop

Appendix E: Possible Answers to Student Roles

Safety question:

Recent lawsuits have been brought by roller coaster riders who claim injuries such as brain damage. If the size and speed of a coaster doesn't necessarily make it more dangerous, what does? What facts, data, and/or statistics could you present to defend the building of your ultimate scream machine?

The turns in different directions make it dangerous

Possible stats:

By the numbers, the biggest, baddest, thrilling-est roller coaster in North America is "Superman: The Escape" at Six Flags Magic Mountain — 415 feet high with a 328-foot drop and cars that travel as close as roller coasters get to a speeding bullet: 100 miles per hour. – no injuries reported

According to the CPSC, more people were injured in 1999 using trampolines (98,889) golf equipment (47,386) and bicycles (614,594) than the 7,260 injuries sustained at fixed-site U.S. parks and attractions (and that includes the go-karts). Only 138 required hospitalization — and that's out of 309 million people who attended amusement parks that year. The CPSC puts fatalities at two per year over the last two decades.

Engineer Questions:

- A.** Why is the height and shape of the first hill important?
The first hill is where the coaster gets all its energy to go around the whole track. The shape needs to be able to smoothly transition into the next piece of track so the riders will not be thrown, injured, or killed.
- B.** Exit paths are paths out of a hill or loop. What should be considered when designing exit paths? Why?
The exit path is the slope by which the roller coaster will maintain its velocity after traveling down the first hill. The exit path should have a low slope for a safe exit out of the first hill.
- C.** The second hill should help maintain the thrill. How should this hill be designed compared to the first hill? Why?

Calculate the height of the second hill; this calculation is as critical as the height of the first hill. The second hill maintains the velocity of the roller coaster, giving the riders a feeling of "weightlessness". The best height of the second hill is 230 feet.

- D. Why is the teardrop, elliptical loop, a much better design for roller coasters than the circle loop design?

A roller coaster loop is actually a teardrop shape called clothoid. A clothoid is a section of a spiral in which the radius is constantly changing. Unlike a circular loop in which the radius is constant, the radius at the bottom of a clothoid loop is much larger than the radius at the top. If roller coaster loops were perfect circles, the speed necessary to hold the cars to the track as they loop over the top would require 8 g's of acceleration going into the loop. This is much more than is tolerable by the human body

- E. Imagine that you and a group of passengers are testing out a newly constructed roller coaster. The slide down the first hill is thrilling, but before you get to the top of the second hill, you start sliding backward and get trapped between the first two hills. Using what you know about Newton's First Law of Motion, describe what the designer forgot to include in transforming his creation from his plan on paper to the real world.

The second hill could have been taller than the first hill and the coaster did not have enough energy especially with friction to make it over the second hill because Newton said that something in motion will stay in motion with a constant velocity unless acted upon by an external force and the external force is friction and gravity therefore stopping the coaster and transferring the energy into another form. (does not have to be exact if questionable ask them where they found their answer – prove it)

Appendix F: Roller Coaster Design Guide

✓Each member has to input their information into designing the coaster so make sure you know your material.

- Use the historical and safety details gathered
- Use the scientific facts gathered
- Use the coaster design facts gathered

✓Go back to other models to get ideas or suggestions

✓Draw first as a draft then revise as a team (you may go back and look at more roller coasters for ideas).

✓Make sure your design includes:

- A name for your coaster that reflects the theme
- At least 3 labeled design elements, not including first and second hill
- Labeling of energy transformations
- The top height of coaster, longest drop distance, top speed, and any other technical details for purpose of comparing to real world designs
- Wooden or steel
- Show your reinforcement (where the roller coaster is supported)

Helpful sites:

<http://www.glencoe.com/sec/science/cgi-bin/splitwindow.cgi?top=http://www.glencoe.com/sec/science/top2.html&link=http://www.learner.org/exhibits/parkphysics/http://www.roller-coaster-videos.com/>

Appendix G: Advertisement Rubric

Teacher Name: **Miracle 3**

Student Name: _____

CATEGORY	4	3	2	1
Content	Covers topic in-depth with details and examples. Subject knowledge (relation between science and roller coasters) is excellent.	Includes essential knowledge about the topic. Subject knowledge appears to be good (there are 2 to 3 science connections).	Includes essential information about roller coaster but there is no more than 1 science connection.	Content is minimal OR there is no mention on how science and the roller coaster are related.
Knowledge of subject matter	Product quality is explained in depth (3 or more roller coaster features) and shown in advertisement.	2 product qualities are discussed and shown in advertisement.	1 product quality is discussed and shown in advertisement.	No qualities of the roller coaster are discussed or shown in the advertisement.
Organization	Content is well organized using headings and bulleted lists to group related material.	Uses headings or bulleted lists to organize, but the overall organization of topics appears to be scattered	There was no clear or logical organizational structure, just cut and pasted facts.	No visual information is given.
Attractiveness	Makes excellent use of font, color, graphics, effects, etc. to enhance the presentation.	Makes good use of font, color, graphics, effects, etc. to enhance to presentation.	Makes use of font, color, graphics, effects, etc. but occasionally these detract from the presentation content.	Use of font, color, graphics, effects etc. but these often distract from the presentation content.
Requirements	Each team member has at least one visual in the presentation and talk about their part (ex. history, safety, make..)	3 team members have at least one visual in the presentation and talk about their part.	2 team members have at least one visual in the presentation and talk about their part.	1 team member has at least one visual in the presentation and talks about their part.
Oral Presentation	Interesting, well-rehearsed with smooth delivery that holds audience attention.	Relatively interesting, rehearsed with a fairly smooth delivery that usually holds audience attention.	Delivery not smooth, but able to hold audience attention most of the time.	Delivery not smooth and audience attention lost.

Appendix H: Amusement Park Physics Screen Shot

Home | FAQ | View Programs | Day Materials | Workshops & Courses

Interactives

Choose One

AMUSEMENT PARK PHYSICS

What are the forces behind the fun?

You've bought your ticket and boarded the roller coaster. Now you're barreling down the track at 60 miles per hour, taking hairpin turns and completing death-defying loops. Your heart is in your throat and your stomach is somewhere near your shoes. The only thing separating you from total disaster is a safety harness...but are you really in danger?

The designers of the roller coaster carefully crafted this thrilling ride to be just that, but you're actually in less danger than you think. You face a greater threat of injury playing sports or riding a bike than you do on a park ride. Amusement park rides use physics laws to simulate danger, while the rides themselves are typically very safe.

How do physics laws affect amusement park ride design? In this exhibit, you'll have a chance to find out by designing your own roller coaster. Plan it carefully—it has to pass a safety inspection. You can also experiment with bumper car collisions.

Check the physics glossary to find out more about the terms used in this exhibit. Just click on the glossary icon whenever you see it.

Ready to roll? Go on to the first ride: [The Roller Coaster](#).

INTRODUCTION CAROUSEL FREE FALL RIDE SAFETY
BUMPER COASTER BUMPER CARS PENDULUM RELATED RESOURCES

"Amusement Park Physics" is inspired by programs from [The Mechanical Universe...and Beyond](#).

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SHRE

<http://www.glencoe.com/sec/science/cgi-bin/splitwindow.cgi?top=http://www.glencoe.com/sec/science/top2.html&link=http://www.learner.org/exhibits/parkphysics/>

Appendix I: Presentation Rubric

Please rate each roller coaster presentation 1-4

1 = did not complete

2 = could improve

3 = good

4 = excellent

Coaster Name	Voice (could you hear them clearly)	Visuals (did the picture go with what they were saying)	Information (did they inform you all about their roller coaster)	Presentation (how was the overall presentation)	Persuasion (How good did they persuade that you should ride/buy their coaster)

Appendix J: Mini-proposal for Rollercoaster Guide

Mini-proposal for rollercoaster Guide

- Do not use vague languages like might, could, ought, should, hope, will, may, it appears, consider, maybe.
- Don't think that the reader is familiar with the subject.
- Prevent using unsupported arguments.
- Avoid impossible promises.
- Proofread and review proposal over and over again and let someone to proofread it to see opinion of others.
- Proposal should be organized, readable, grammar free and without missing pages and also consider overall appearance such as cleanliness.
- When possible use graphics or charts
- Make use of sidebars and descriptive headlines. Since your goal is to have it read, making it inviting is a definite plus.
- Review the language you have used and be sure your proposal contains a majority of active verbs as opposed to passive verbs.

for example, "our firm Produces results"

vs.

"results are **Produced** by our firm."

The Plan of a Proposal

Before you begin writing any form of technical communication, there are three questions you should consider:

- **Who is my audience?** You need to decide to whom you are writing the proposal. You need to make sure that you think about your audience and what they might already know or not know about your topic.
- **What do I want my audience to get from my proposal?** The overall purpose of the proposal should be to get the readers' approval. Your main purpose should be clearly stated. The readers should not have to figure out what you are requesting in the proposal. The best advice is to state your purpose up front and then fill in details later in the proposal.
- **How can I make sure my audience understands what I want them to know?** You must put yourself in the shoes of your readers. Think about what they want to hear. Think about what they don't want to hear. Get someone else to read your proposal before you submit it. Make sure that his or her reaction is what you expected the reader's reaction to be.

Mini-Proposal Layout

Introduction: Identify the current opportunity or problem. Make sure you understand the situation clearly. Can you expand on the definition, demonstrating how you may add further value to the organization?

Example: (if you are a daycare center soliciting corporate accounts, your introduction may begin)

"In the past decade a trend has evolved where more and more mothers are returning to the workforce. However, not much has changed to provide these mothers with reliable and affordable child care. When Mom can't rely on suitable care for her child, your organization can't rely on Mom"

Next: Introduce the **Objectives And Scope Of Work That Your Prospect Can Expect.** Describe what you will do and give an accurate time-frame for delivery or completion of key items. Be aggressive, but realistic. This is not the time to make promises on which you can't deliver

Tell me about your roller coaster

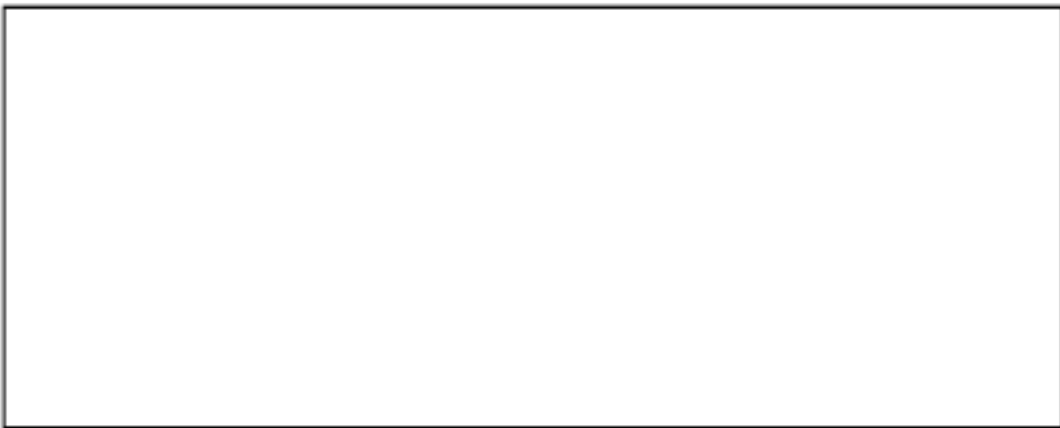
Then: **Describe The Benefits The Prospect Can Expect From Your Products Or Services.** This is a critical part of your sales proposal.

Benefits of adding the roller coaster to the park – (sales, profits, target different people, unique)

****For the sake of time you do not have to add in how much your coaster will cost. ****

Finally, You're At The End Of Your Proposal. Here, you want to remind the prospective buyer why you are the best choice for the job. This is your last time to convince me to buy your roller coaster design.

Appendix K: 3 Box Comic Strip



Appendix L: 4 Box Comic Strip

Appendix M: Glossary of Terms

- **Inertia:** Property of matter that states: an object at rest stays at rest and an object in motion stays in motion as long as it is not acted on by an outside force
- **Potential energy:** the energy of a body or a system with respect to the position of the body or the arrangement of the particles of the system (the build of energy stored before motion happens)
- **Kinetic energy:** the energy of a body or a system with respect to the motion of the body or of the particles in the system (movement – energy is being used)
- **Friction:** Friction is a force that resists the motion of an object. Friction results from the close interaction between two surfaces that are sliding across each other (rubbing).Friction can slow down an object and the greater the friction the more resistance therefore slowing it down more.
- **Speed** = distance/ time
- **Force** is anything that changes the state of rest or motion of an object
- **Velocity:** Velocity is a combination of speed and the direction in which an object travels
- **Free fall** = when gravity is the only force acting on an object (dropping an object and letting it hit the floor , on a coaster falling straight down)
- **Newton's Laws:** <http://teachertech.rice.edu/Participants/louviere/Newton/law1.html>
 - **Newton's First Law:** a body remains at rest or in motion with a constant velocity unless acted upon by an external force
 - **Newton's Second Law:** The relationship between an object's mass m , its acceleration a , and the applied force F is $F = ma$. Acceleration and force are vectors (as indicated by their symbols being displayed in slant bold font); in this law the direction of the force vector is the same as the direction of the acceleration vector
 - **Newton's Third Law:** For every action there is an equal and opposite reaction