Lesson 1 - 3

The following exercise must be completed and submitted to your instructor for grading. Click here for directions on how to submit your assignment.

Introduction

What's your favorite ride at the Amusement Park? Maybe it's the Merry-Go-Round or perhaps the waterslide or bumper cars. Do you like roller coasters? Most teenagers love the thrill of roller coasters!

When the coaster is released at the top of the first hill, gravity takes over. Gravity applies a constant downward force on the cars. The coaster tracks serve to channel this force - they control the way the coaster cars fall. If the tracks slope down, gravity pulls the front of the car toward the ground, which makes it accelerate. If the tracks tilt up, gravity applies a downward force on the back of the coaster, causing it to decelerate. When the coaster ascends, one of the smaller hills that follow the initial lift hill makes the kinetic energy change back to potential energy. In this way, the course of the track is constantly converting energy from kinetic to potential and back again. This fluctuation in acceleration is what makes roller coasters so much fun.

In this project, called a Web Quest, you will dive into the World of Roller Coasters. You will learn about the history of coasters and research some found in the United States. Most importantly, you will use some of the mathematical skills you have just learned to help you better understand how roller coasters work.

The Task

Some of the fundamental properties that make roller coasters work, including hills and dips, acceleration, loops and centripetal force can be explained using mathematical models. Roller coasters are driven almost entirely by basic inertial, gravitational and centripetal forces. All of this is manipulated in order to create a great ride. Amusement parks keep building faster and more complex roller coasters, but the fundamental principles at work remain the same.

A roller coaster's energy is constantly changing between potential and kinetic energy. At the top of a first lift hill, there is maximum potential energy because the train is as high as it gets. As the train starts down the hill, this potential energy is converted into kinetic energy, so the train speeds up. At the bottom of a hill, there is maximum kinetic energy and little potential energy. The kinetic energy propels the train up the second hill, building up the potential-energy level. As the train enters a loop, it has a lot of kinetic energy and not much potential energy. The potential-energy level builds as the train speeds to the top of the loop, but it is soon converted back to kinetic energy as the train leaves the loop.

You are part of a team that is studying how mathematics and science influence how roller coasters work. You have been charged with making some mathematical justifications and explanations for the elementary physics behind roller coaster motion. You will use your

knowledge to make a recommendation for safe, yet fun roller coasters.

To complete this task, you must research the following questions:

- Historically speaking, what makes roller coasters so popular?
- How has roller coaster design evolved since the original coasters?
- What are some of the theme parks in the United States that have roller coasters? What are the popular roller coasters at these sites?
- What are the safety considerations when designing a roller coaster?
- What is the distance, rate of speed and time duration for different roller coasters?
- What is acceleration and how does it relate to roller coaster thrills?

The Process

1. Find the locations of at least three early roller coasters in the United States. Who were the designers? What material was used to build the coasters? Are those same materials used today? If not, what other materials are used?
2. Select five theme parks. Begin to complete the data collection sheet for five roller coasters at parks near your home or ones you have visited.
3. Calculate the time duration of the roller coaster rides. Use the formula ***d=rt***. Here ***d*** is distance or length of coaster. The variable ***r*** is rate or speed and ***t*** is time. Be careful with your unit conversions. Remember that 1.0 meter = 3.281 feet and 1 mile = 5280 feet. Add this data to your data collection sheet.
4. Calculate the average acceleration for the roller coasters you selected. The formula for finding average acceleration is: $s=(v_o)t + 1/2at^2$. Where ***s*** (Distance in meters - 1.0 meter = 3.281 feet) is equal to v_o (Initial Velocity - for coasters this is zero) multiplied by ***t*** (time in seconds) plus one-half ***a*** (Average Acceleration - what we are looking for) multiplied by ***t*** squared (time in seconds again). Add this data to your data collection sheet.
5. Complete three simulated roller coaster trials to determine combinations of factors that are useful for both safe and fun coasters. Go to the website http://www.learner.org/exhibits/parkphysics/coaster/ to perform the simulations. Write a detailed description of what you do at the website. This question is worth 20 points.

Name of Theme Park	Location in U.S.	Name of Roller Coaster	Height	Length	Speed (rate)	Duration of ride (time)	Average acceleration

	Height of the 1st Hill	Shape of the 1st Hill	The Exit Path	Height of the 2nd Hill	The Loo
Trial 1					
Trial 2					
Trial 3					

Web Resources

History of Roller Coasters
http://www.ultimaterollercoaster.com/coasters/history/

http://search.eb.com/coasters/

Roller Coaster Terminology
http://www.ultimaterollercoaster.com/coasters/glossary/

http://web.archive.org/web/20070203165930/http://www.cinternet.net/~bowersda/coasters.htm

Roller Coaster Locator
http://www.coaster-count.com/world.xhtml

http://web.archive.org/web/20070203142839/http://www.cinternet.net/~bowersda/glossary.htm

http://www.sixflags.com/pick_a_park1.asp

Ask a scientist and other basic physics
http://howthingswork.virginia.edu/

http://hyperphysics.phy-astr.gsu.edu/hbase/cf.html

http://www.phy.ntnu.edu.tw/java/circularMotion/circular3D_e.html

http://www.phys.virginia.edu/classes/605.ral5q.fall02/lectures/carousels_and_roller_coasters.pdf

Roller Coaster Statistics
http://www.sixflags.com/

http://www.rcdb.com/

http://www.learner.org/exhibits/parkphysics/coaster.html

http://www.adventureland-usa.com/attractions/rides

Create simulation
http://www.learner.org/exhibits/parkphysics/coaster/

Conclusions

Prepare a report of your findings, which should include your data sheet and an explanation of which roller coaster is the safest and most fun. If you can create a table to display your information, please do so. Otherwise, just list the answers with its corresponding heading. Use the data and results of your simulations to support your claim. Additionally, answer the questions mentioned earlier:

- Historically speaking, what makes roller coasters so popular?
- How has roller coaster design evolved since the original coasters?
- What are some of the theme parks in the United States that have roller coasters? What are the popular roller coasters at these sites?
- What are the safety considerations when designing a roller coaster?
- What is the distance, rate of speed and time duration for different roller coasters?
- Please find 2 more roller coaster's length, time duration and its rate of speed. DO NOT repeat the same roller coasters mentioned in the chart in Question 2 of the process for this question.
- What is acceleration and how does it relate to roller coaster thrills?