Roller Coaster Physics

Introduction

You squeeze into the molded plastic seat and pull the padded bars down so they fit snug against your shoulders. The attendant comes by and pushes on the bars to make sure they are locked into place. Then the cars of the roller coaster begin to move out of the station, going up and up, until you feel that you can touch the sky. Suddenly, with a lurch, your car reaches the top. As it crests the hill and starts down the other side, you can feel it begin to pick up speed. Now you are flying down the track, up smaller hills, through loop-de-loops, upside down and twisting all around. You scream as the roller coaster rounds a curve in the track and you are pushed to one side. Finally, the coaster begins to slow down. It comes to a stop back at the station, and you are released. What a ride!

If you like to ride roller coasters, the description above probably sounds familiar. But did you know that roller coasters aren't just thrill rides? Actually, roller coasters are examples of the laws of physics in operation. Roller coasters are pulled to the top of the highest hill and released. A coaster has potential energy as it is pulled to the top, then changes to kinetic energy as the coaster begins its descent. Gravity and friction control the rest of the ride.

Why don't the cars of a roller coaster fly off the track? Why don't the passengers fly out of the cars? How high can the first hill of a roller coaster be? What laws of physics will determine how many hills, curves, and loops a roller coaster track can have? You can find answers to these questions in this WebQuest.

Task

Your job in this WebQuest is to find out how roller coasters work and use this information to build a simple model of a roller coaster. You will learn about roller coaster design, velocity and acceleration and the laws of motion. You will use the Web sites to design virtual roller coaster tracks and to see what happens to the roller coaster when you change variables such as height of hills, length of track, mass of the coaster, and speed of the coaster. Next you will collect simple materials to build a model of a roller coaster track. Finally, you will test your track with a model roller coaster and report on your results.

Process

Use the Web sites below to research roller coaster design and variables that affect their motion. Keep in mind that not all Web sites are written specifically for students. Some of what you read might be challenging. Look for information that will be useful in completing this WebQuest. After you have completed your research and experimented with the virtual roller coasters, decide what type of roller coaster model you want to build. Design the model, list the materials needed, then collect the materials and build your roller coaster track. What material are you going to use to simulate the roller coaster track? It should be flexible enough so that you can include loops in your design. What materials are you going to use for the roller coaster itself? Make sure that the item has enough mass to build up speed as it goes down the track.

Remember, a model doesn't always work exactly the same way as the real thing, so don't be discouraged if your design has some flaws. Also, you probably will not need to include the initial hill where the roller coaster is pulled up in your design. Assume that the coaster is already at the top of the first hill. Do not include any kind of motor in your design. When the track is finished, test your design by placing the coaster at the top of the first hill and letting go.

Also you must remember NOT to add any energy to the roller coaster by pushing it along the track. Did your coaster come out at the end of the track? If not, adjust the track and try again. When you have completed your trials, prepare a short report. In the report, draw the final design and write a paragraph describing your reasons for your design choice and how it worked when tested.

Resources

Look at the Web sites given here to find the information that will enable you to build a model of a roller coaster and test it. The last two sites allow you to build your own virtual roller coaster. Use these sites to get ideas for your model.

Kinetic and Potential Energy
http://library.thinkquest.org/2745/data/ke.htm

Amusement Park Physics: What are the forces behind the fun?
http://www.learner.org/interactives/parkphysics/

Roller Coaster
http://puzzling.caret.cam.ac.uk/game.php?game=roller

Evaluation

Read this rubric to determine how you will be scored in this WebQuest.

Criteria					Points
	1	2	3	4	
Task	The task was not completed.	It appears that some effort was made to complete the task, but major ideas are missing.	The task was completed as assigned, but some of the rationale for the design was faulty.	The task was completed with great attention to detail and thorough documentation.	
Process	The process was not followed.	The research was complete, but the model and report could have been better organized.	All the steps of the process were followed and the model was good.	It is clear that much effort went into the project. The ideas show a high degree of originality and imagination.	
Model	Model was not completed, or it appeared that little effort went into the project.	Model was well researched but lacked some key features needed for accomplishing the task.	Model was well thought out and included imaginative ideas.	Model was constructed with care and attention to detail. It is evident that much research went into the project.	
Report	The report was sloppy and not well prepared.	The report included key ideas but lacked general cohesiveness.	The report was well organized with only minor errors.	The report was well organized and steps were clearly documented.	

Conclusion

In the process of completing this WebQuest, you've become informed about the physical laws governing roller coaster design, the differences between potential and kinetic energy, and how different variables affect roller coaster design. You have developed critical thinking and problem-solving skills as you planned, designed, and built a model roller coaster. Finally, you have tested your design and reported on your experimental results.

How did your design work?
Did you have to make adjustments to the original design?
How did your model roller coaster compare to a real roller coaster?