AP Calculus Final Project

(with special thanks to Mr. McLeod)

All projects can be presented as a poster board, booklet, PowerPoint, or video (more creative ideas are not only tolerated but encouraged). Grading will be based on accuracy and appearance.

Your final project has three parts:

1) The class will be taking a trip to Cedar Point. Attached is a packet to be filled out while in and after returning from the park. You may want to bring a measuring tape, a stop watch, a calculator, and a blank notebook. (Those unable to go to Cedar Point will receive a comparable make-up packet.)

2) A small group assignment will be handed out in class. You may choose your own groups (of no more than four people), but an applied problem will be chosen for your group. You may consult with other groups (whether they are working on the same problem or not), but the reasoning and final product should be that solely of your own group. Each problem is a practical application of Calculus and has no "answer" in mind. Rather, you are to apply what you have learned to propose a reasonable solution to the presented problem. Your audience will be a mostly college-educated group of professionals, some of whom have taken some Calculus and some who have not. You are the expert group, and your project should be written with as much confidence as you actually have in your recommendation without talking down to or offending anyone in your target audience. You are to create a ***TYPE-WRITTEN*** response to the letter you receive.

3) Write a ***TYPE-WRITTEN*** personal reflection of your year in AP Calculus. The two most common formats in the past have been a "suppose your best friend is taking the class next year" type of letter or a letter to Rausch, focusing on four components: What did you like this year that you hope is kept for next year? What did you not like this year that you hope is not repeated? What did we not do this year that you wish we had? What did we not do this year that you are glad we did not do? The focus of the reflection should be on strategies you found useful in being successful this year or mistakes you made and would avoid if you had to do it all over again. Other reflections can be included as well, but the paper should be school-appropriate. There is no requirement for length, but it should be as long as it needs to be. Ideas for keeping anonymity will be discussed in class.

The Virtual Roller Coaster

Name:____________________

Part I: The Roller Coaster Surf - You are going to surf the web in search of "good" Roller Coaster Sites that show you how physics is related to amusement park rides. It's not enough just to find them, make sure you record what information can be found there and what rides it describes. In your search, try to find sites that at least give you information about clothoid loops, banked turns, and g-forces.

Here is a link to get you started:

http://tqd.advanced.org/2745/data/ke.htm

1. List three good sites that you found with a short description of what information can be found on the site.

1. Address:____

Description:____

____

____

2. Address:____

Description:____

____

____

3. Address:____

Description:____

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<u>Part II: Design Your Own Roller Coaster -</u> Below are two sites that I found that have roller coaster design links. Go to each of the sites and design your virtual coaster.

4. *http://www.learner.org/exhibits/parkphysics/*

Click on the "roller coaster" link at the bottom of the page and design your own coaster. Record the parts that you chose below:

Type of…

1st Hill:__________________ 2nd Hill:______________________

Incline:__________________ Loop:________________________

What was your Thrill rating?__________________ Safety Rating:_______________

5. *http://www.funderstanding.com/k12/coaster/*

This takes a little while to load. BE PATIENT! On this applet, adjust the various knobs to change the characteristics of the coaster, then run it! A little car will run over your coaster and let you know how you did. In particular, record hoe each of the following affected your coaster:

speed:____

mass:____

gravity:____

hill1:____

hill2:____

loop:____

friction:____

What was your maximum speed:____________

OBJECT DROP

To explore the relationship between position, velocity, and acceleration, you will need a stop watch, a measuring tape, and an object with negligible air resistance (like a water balloon).

1. Find a safe spot some distance above the ground from which to drop your object (and an equally safe spot for your object to land).

2. Find the distance from which you will be dropping your object, either using direct measurement or using trigonometry.

3. Drop the object and time how long it takes for the object to reach the ground.

4. Repeat several times (at least until you get consistent results) and record the results below

Trial #1 _____ Trial #2 _____ Trial #3 _____ Trial #4 _____ Trial #5 _____ Trial #6 _____

How well did you do? Let's see.

1. What is your value of s_0 (the initial height)? _____

2. What is your value of v_0 (the initial velocity)? _____

3. Using the general form $s(t) = .5at^2 + v_0t + s_0$, write an equation for $s(t)$.

   ____

4. When does your equation predict the object should reach the ground? _____

Evaluate how close you feel your experimental results were to your theoretical ones. Discuss possible reasons for why your results are as good or poor as they are.

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Roller Coasters - Qualitative

Procedure

1. Gather materials:

- 2-meter (6 foot) long foam tube (1/2" pipe insulation) cut in half lengthwise
- glass marble
- wooden marble
- steel marble
- paper or plastic cup
- roll of masking tape

2. Cut each tube in half lengthwise, so each is channel-shaped to serve as the roller coaster track for the marbles (cars). Use scissors or a utility knife to cut through the perforated side of the tube to form two halves. This process is shown in Figures 1 and 2.

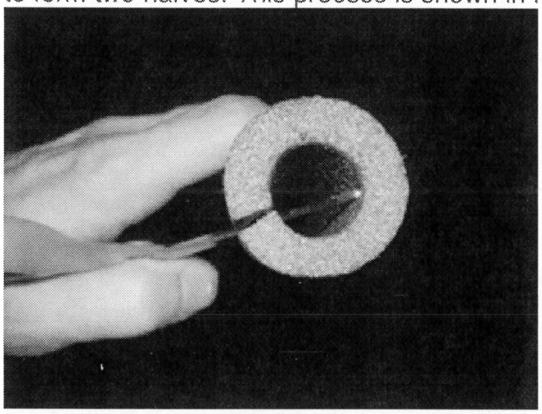


Figure 1. End view of cutting a tube of insulation lengthwise.

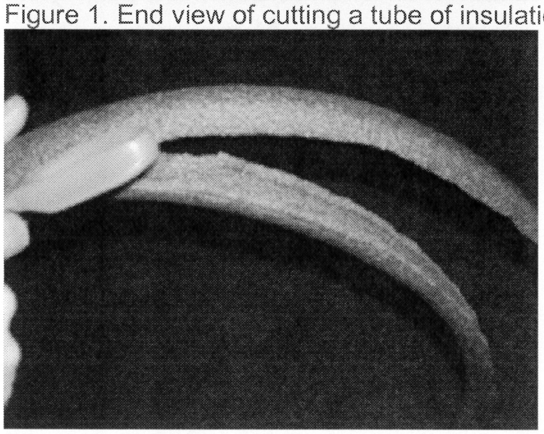


Figure 2. Side view of cutting a tube of insulation lengthwise.

3. In our roller coaster models, the glass marble simulates a normal car, the wooden marble represents an empty car, and a steel marble represents a full car. Experiment with different designs until you find one that works for all three marbles. Use the cup to catch the marble at the track end.

Draw a sketch of your roller coaster in the space below:

Height in cm: ______
# of Loops: ______
# of Corkscrews: ______
# of Turns ______

- Place a 1 next to a point on your roller coaster where the cars *accelerate*.
- Place a 2 at a point on your roller coaster where the cars *decelerate*.
- Place a 3 next to a point where cars are at a local maximum.
- Place a 4 next to a point where cars are at a local minimum.
- Place a 5 next to a point where cars are at an inflection point.
- What are the elements (in Calculus terms) that make a roller coaster "scary?"

RIEMANN SUMS AND THE TRAPEZOIDAL RULE

DATA

Numbers of "cars" in a "train": ________ or *Number of "track sections"* ________

Length of one "car" ________ *Length of "track section"* ________

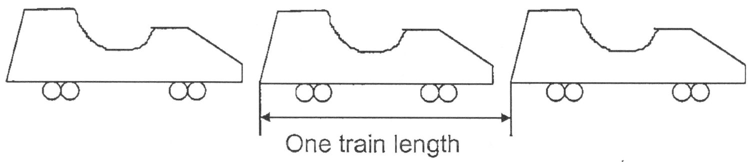
Now we will estimate the length of a track using Calculus.

1. As well as possible, find a position where you can see an entire roller coaster track (or race track, etc.) of your choosing. Divide the track into sections, preferably in either approximately equal lengths or by high and low points in the track (if track is not level). The places where the sections meet will be called "Checkpoints."
2. Time how long it takes the ride (race, etc.) to make it to each Checkpoint several times. Record the average time into ride, not the average length of time in a section, for each Checkpoint.
3. Use the next two pages in this packet to find the car's velocity at each Checkpoint.
4. Make a table showing the time into ride vs. velocity data.
5. Use left-hand and right-hand Riemann Sums, as well as the Trapezoidal Rule, to estimate the length of the track of your chosen roller coaster (race car, etc.).

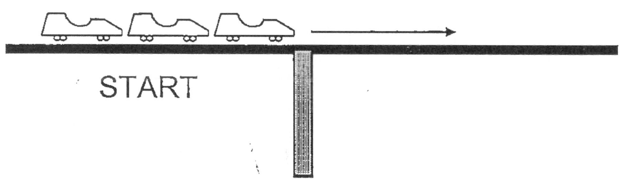
Velocity:

Here are two methods for measuring the velocity of a ride during a given part of the ride.

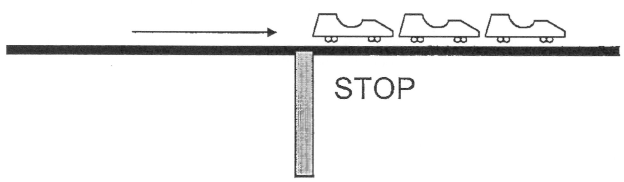
Length of Train Method: You need to measure the length of one car from the back of one car to the back of next adjacent car.



Then multiply this distance by the number of cars in the train.

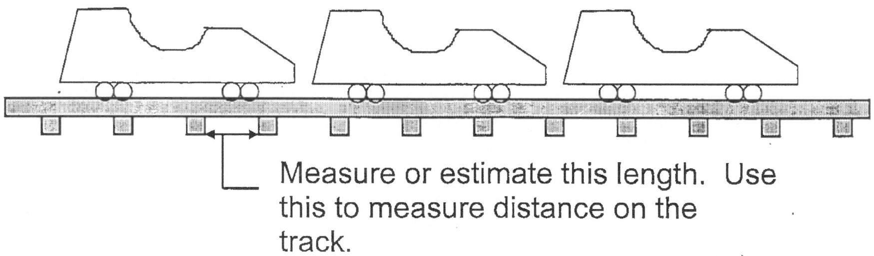


Time how long it takes for the front and the back of the train to pass the same point on the track. Pick a point that is in the very top of a hill or the very bottom of a dip in order to determine G-Force.



Use the following equation to determine the velocity: $v_{av} = \dfrac{\textbf{length of train}}{\textbf{time to pass}}$

Length of Track Method: You need to measure the length of a section of track. Most tracks are constructed with cross ties that are some equal distance apart from each other.



Multiply this length times a certain number of track sections. Then, time how long it takes the train to pass across that many sections. You may use any number of track sections, but make sure you choose an equal number on each side of a hilltop or dip. Also, the shape of the track should be fairly symmetrical.

Use the following equation to determine the velocity: $v_{av} = \frac{\text{length traveled}}{\text{time to pass}}$

NOTES:

Amusement Park Reflection

It has been said, "we don't learn from experiences, rather by reflecting on our experiences." This closing activity is meant to give you a chance to reflect on the learning that you had yesterday. Whether you went to the amusement park or completed the webquest in class, hopefully you realize some benefit.

Please write a reflection about your experience yesterday. Your teacher will give the guidelines that you should follow. The following are some prompts that you can use to focus your writing:

- What **new** knowledge did you obtain from your experience?
- Did you learn anything that **changed** your view on how something works?
- What was the **best** part of the experience?
- What would you like to learn **more** about?
- What prior knowledge was **reinforced** by your experience?
- What could have been done to make the experience more **valuable**?