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.

KILLING TIME IN LINE

We are going to find out how fast a long line is moving and how many people were in line ahead of you.

1. Enter a long line (the longest line you anticipate waiting in today) and split your party into two groups.

2. Let some people get between your party's two groups and count this number of people. You want the number of people to be enough that a decent amount of time passes between the times your two groups pass the same point in line but not so long that the rear group would lose sight of the front group in your party (at least 20 people, probably more).

3. Note where the front group of your party is once you have your group successfully split in two and time how long it takes rear group of your party to reach the same point. Note where the front group is at that time and start timing again. Continue to do this until the rear party is about to enter the roller coaster. Record the time in line and not the length of time in a section.

4. Make a table showing the time in line vs. people/minute.

5. Use left-hand and right-hand Riemann Sums, as well as the Trapezoidal Rule, to estimate the total number of people who were ahead of you in line for your chosen roller coaster.

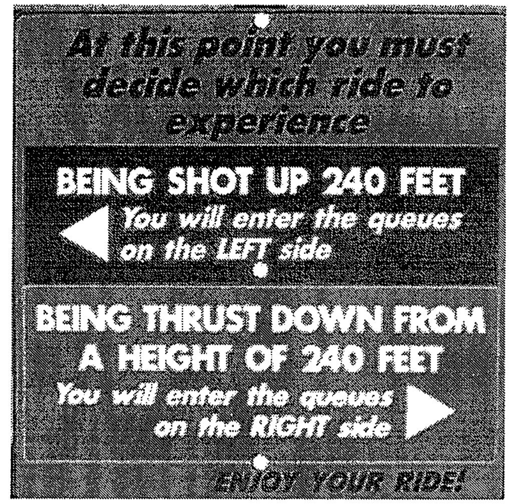
6. Find the average rate of change between every other (non-consecutive) entry in your table. When was the line's rate of change increasing the most (highest average acceleration)?

7. Find the average rate of change over your entire time in line. Describe what this number measures using correct units. What does the Mean Value Theorem say about this value?

POWER TOWER

Power Tower is a ride that features two different ride experiences. We will use both to look at the relationship between position, velocity, and acceleration that we studied in class.

GOING UP



1. If Power Tower starts on the ground, what is s_0? _____
2. If Power Tower starts at rest, what is v_0? _____
3. Using the general form $s(t) = .5at^2 + v_0t + s_0$, write an equation for $s(t)$. _______________
4. Time how long it takes the car to reach its maximum height. Power Tower is advertised as shooting you up 240 feet. If this is true, what acceleration is a rider being "shot" at? (Remember, gravity is acting AGAINST the car at 9.8 m/square second or 32 ft/square second). _____

FREE-FALLING?

If you ride the Power Tower going down, you feel as if you are simply let go to fall. Are you?

1. Using the same assumptions as above, what is s_0 now? _____
2. If you have been made to wait suspended above ground, what is v_0? _____
3. Using the same information in #3 and #4 above, write a general equation for the trip down.

   ____
4. According to your equation, when should the car reach the bottom? _____
5. Time the car for several "drops." Is it truly a free-fall? Defend your answer

____

____

____

____

____

ROLLER COASTERS – Qualitative

Ride a roller coaster. Pay attention to your height above the ground. Suppose you had a function $s(t)$ that gave your height above the ground t seconds into the ride and answer the following.

1. At what points of the ride you chose would you have a relative maximum in $s(t)$?

   ____

   ____

2. What sensation do you feel at a maximum point? ____________________

   ____

   ____

3. At what points of the ride you chose would you have a relative minimum in $s(t)$?

   ____

   ____

4. What sensation do you feel at a minimum point? ____________________

   ____

   ____

5. At what points of the ride you chose would you have an inflection point in $s(t)$?

   ____

   ____

6. What sensation do you feel at an inflection point? ____________________

   ____

   ____

7. What are the elements (in Calculus terms) that make a roller coaster "scary?"

   ____

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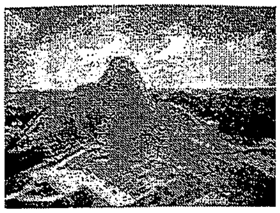


ROLLER COASTERS – Quantitative

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 roller coaster track using Calculus.

1. As well as possible, find a position where you can see an entire roller coaster track of your choosing. Divide the track into sections, preferably in either approximately equal lengths or by high and low points in the track. The places where the sections meet will be called "Checkpoints."

2. Time how long it takes the ride 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.

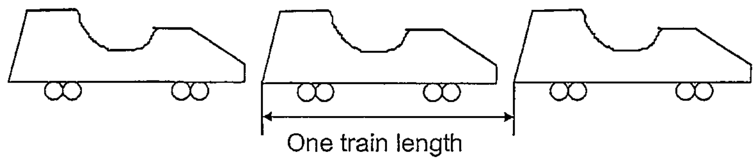
4. Make a table showing the time into ride vs. velocity data.

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.

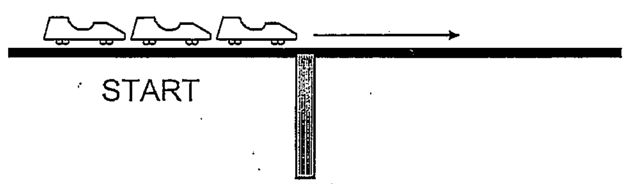
Velocity:

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

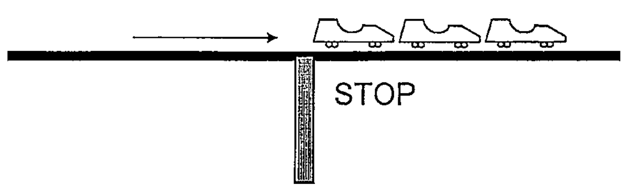
Length of Train Method: You need to measure the length of one car from the back of one car to the back of next adjacent car.



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

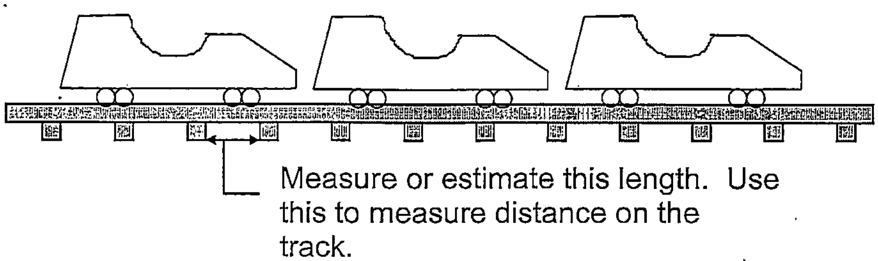


Time how long it takes for the front and the back of the train to pass the same point on the track. Pick a point that is in the very top of a hill or the very bottom of a dip in order to determine G-Force.



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

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**?