**Roller Coaster Engineering Lab**

(Topics: Newton’s Laws, Circular Motion, Work & Energy)

Problem statement

You will design a Roller Coaster with at least one hill and one loop, and present it at a future class via PowerPoint, Prezi, etc. In your presentation, you will analyze your roller coaster to determine the physical properties of the ride at various points. This exercise combines what we have learned in Newton’s Laws, Circular Motion, and Work & Energy.

Address the following items in your 5-minute presentation

1. Briefly explain your design philosophy
   1. What do you think a roller coaster type ride should accomplish to be successful?
   2. Do you like low or high, slow or fast? Why did you choose your particular layout?
   3. Do you have a favorite ride that actually exists at a park somewhere? Briefly explain and show picture if you want.
2. Side-view sketch, drawn to scale
3. The ride should have at least one hill and one loop. You can make it more complicated if you want.
4. Label the height and horizontal position in meters at key locations on your sketch.
5. The sketch should take up an entire PowerPoint slide. Take pride in your drawing.
6. Ride technical details

Note: Assume zero friction and zero wind resistance.

SHOW ALL CALCULATIONS on your slides.

You need to have an initial source of energy. In the case of most roller coasters, the energy of the ride comes from a chain lift that builds up potential energy by lifting the ride to the top of the first hill. This potential energy is then converted to kinetic energy as the cart goes down the hill.

1. Chain Lift Specifications: State how much time in seconds to get to the top of your hill. Use a maximum speed of 8 m/s. You can use a slower speed if you want.
2. Calculate the mass in kg of the loaded cart. If you want a reference, you can use 5,000 kg for the basic cart, plus 75 kg per person.
3. Once you have the mass, then calculate the potential energy in Joules gained by the cart once it reaches the top of the hill.
4. Once you have the potential energy, then determine the power in Watts required for the chain lift engine based on this energy and the time it takes to reach the top.

Assume that at the top of the first hill your cart starts from rest before it rolls down through the rest of the ride. Show the following calculations in your presentation.

1. The cart’s velocity in m/s at the bottom of the hill (if you have more than one hill, do this for each one)
2. Kinetic energy in Joules at the bottom of the hill (or hills).
3. The cart’s velocity in m/s at exactly the top of the loop (or loops).
4. The cart’s velocity in m/s when it exits the loop (or loops).

Safety Check: Your design must be safe to ride. This means that you should not have an acceleration that exceeds 6G’s (in other words, no more than 6 x 9.81m/s2) for any loop. In the real world, this could lead to your rider blacking out if it were sustained. If you choose to have a loop where the riders are on the outside of the loop, you must have a lower acceleration (4G’s at the most) since humans have a lower tolerance to the blood rushing to the head. In addition, your ride should not fall off the loop due to lack of velocity at the top of the loop. You must have a minimum of 1G of centripetal acceleration at the top of each loop.

1. Analyze the loop (or loops) in your ride. Assuming the cart travels around the inside of the loop, demonstrate that the acceleration in G’s falls within 1G and 6G’s as explained. If the cart travels on the outside, demonstrate that centripetal acceleration does not exceed 4G’s. SHOW your calculations and LABEL your sketch with the G’s so we can see it. (Obvious note: if your design isn’t safe, then you have to fix your design!)
2. End your fabulous presentation with some concluding remarks
3. How successful were you at creating the ride you envisioned?
4. Would you like to ride on this ride if it was created? Explain why or why not.
5. How would you change your process if you had to create another roller coaster?