Many of the questions asked on other non-looping roller coasters (Eagle®, Viper®, and Whizzer®) may be applied to this ride. The questions below are for use on this ride, and tend to be of a more advanced nature.

The first car has a mass of 1950 kg, and each car of the other of cars of the nine-car train has a mass of 1225 kg when empty.

1. The manufacturer of Raging Bull®, Bolliger and Mabillard, are Swiss. All of their measurements in metric. The design length of the train is 17000 mm, the width is 2210 mm, and the heart line is 1200 mm above the track. The Urethane® road wheels have a diameter of 354 mm. Measure the initial speed of the train at the top of the lift hill and the three succeeding hills.

2. Measure the height of the lift hill, and the next three hills. Draw a bar graph of gravitational potential energy plus kinetic energy, versus the hills. Discuss the significance of the trend of this graph. This is sometimes referred to as the friction profile.

3. Calculate the energy transfer from kinetic energy into thermal energy due to friction from the top of the lift hill to the top of the third successive hill.

4. The exit ramp from the Viper® crosses over the tunnel for Raging Bull®. Measure the speed of the train entering the tunnel, exiting the tunnel, and the average speed in the tunnel. Please show all of your work, and describe your methods of measurement.

5. The maximum banking angle on the first hill is 55^0.

   A. Draw a force diagram for the center of mass of the train as it is moving over the maximum-banked part of the curve (the center).
   B. Is this the optimal banking angle for the speed of the low friction train?

6. Draw energy bar graphs for each of the following seven positions: at the top of the lift hill, 1/3 the way down the lift hill, at the bottom of the lift hill, 1/2 way up to the next hill, and at the tops of the three successive hills. Be sure to include on each graph, quantitatively, total energy, kinetic energy, gravitational potential energy, and thermal energy. You may assume that since the wheel size is small, that the rotational energy is negligible. Write a paragraph discussing the changes in the different energies, and relate it to the total energy.

7. The tunnel at the bottom of the lift hill is 1.63 meters below grade at the base of the lift hill. Face to face distance of the tunnel is 38.7 meters. At the center of the tunnel, the circular section of track is 7.6 meters below the entrance and exit of the tunnel.

   A. Draw a force diagram of the train at the bottom of the tunnel.
   B. Calculate the centripetal force on the train at the bottom of the tunnel.
   C. Calculate the normal force (support force) of the track against the center of mass of a fully loaded train.
   D. Using your own mass, determine the force you feel on your seat as you round the bottom of the tunnel.

8. The cars roll on Urethane® wheels on a metal 1541 m track anchored to the ground. The train picks up a sizeable static electrical charge and is periodically discharged. How can this be?

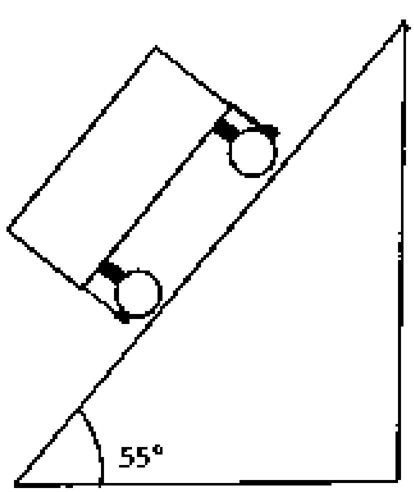

Diagram for #5