PGA STAY-HOME LAB
THE PHYSICS OF AMUSEMENT PARK RIDES

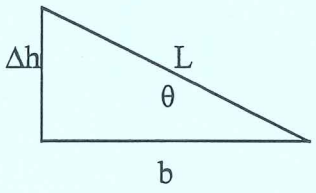
- **Purpose:** To apply the laws of physics to amusement park rides.

- **Research (5 points):**

  - On the Great America web site (www.sixflags.com) research American Eagle and Demon. This data will be used to answer the questions below. Be sure to convert all data to metric.

	American Eagle	Demon	
Max Velocity (m/s)			
Track length (m):			
Max height (m):			
Total time of ride (s):			

- **AMERICAN EAGLE wood coaster (8 points)**



1. View the roller coaster slide. The sloping track can be thought of as a vector triangle of vertical height Δh, base b, and hypotenuse length L. Measure any 2 sides between 2 points along the steepest part of the downhill track and calculate the slope angle θ. Show vector triangle and calculation in your report.
2. Count the number of coaster cars in the train. Assume the ride is full (6 passengers per car, averaging 65 kg each). If each car has a mass of 1050 kg (empty), calculate the work required to lift the train to the top of the hill. Assume no friction.
3. Again, assuming no friction, use the maximum height to calculate the maximum velocity of the train at the bottom of the hill. Compare to the advertised value.
4. Calculate the average velocity of the train over the entire ride. Compare this velocity to maximum velocity at the bottom of the first hill and explain why there is a difference.
5. Why is the first hill on a coaster always the highest?
6. If the train can just make it over the next hill which is 34 meters tall, what is its efficiency?

- **DEMON steel coaster (6 points)**

1. Using the maximum height from the website, calculate the maximum velocity of the ride. Where does this occur? Compare to the advertised value.
2. Calculate the average velocity of the train over the entire ride. Compare this velocity to maximum velocity and explain why there is a difference.
3. View the 2 slides of the Demon corkscrew, which occurs near the end of the ride, and estimate the radius of the corkscrew loops. Demon slows down before entering the corkscrew so as to not subject riders to more than 3 g's. Calculate the velocity of the train through the corkscrew.
4. How does the ride achieve this slower speed? View the short "Mantis" video to get the answer!

- **JEARL WALKER'S GRAVITRON RIDE (8 points)**

1. View the video of Jearl Walker riding the gravitron. Use a stopwatch to measure the period of rotation T after the floor drops away. Average the time over 5 revolutions if possible.
2. If the ride has a radius of 2.5 meters, calculate Jearl's velocity and centripetal acceleration as he rotates on the gravitron. How many "g's" does this represent?
3. What prevents Jearl from falling when the floor drops?
4. What 4 forces (horizontal and vertical, real and fictitious) act on Jearl as he rotates?
5. If Jearl's mass is 65 kg, how much centripetal force does he experience?
6. Jearl is in some discomfort during the ride. Why is the ride limited to a radius of 3 meters? What would the riders feel (in terms of "g's") if the ride had a radius of, say, 5 meters?

SIX FLAGS GREAT AMERICA SCAVENGER HUNT (10 pts)

Round off to nearest whole number. Think metric! Use www.sixflags.com/greatamerica/

1. Number of theme parks owned by Six Flags, Inc., in North America: _____
2. Price of online special single daily ticket (without tax): _____
3. Number of "Family Rides" listed on website: _____
4. Advertised approximate driving time (minutes) from Milwaukee to Six Flags: _____
5. Last 2 digits of zip code for Six Flags Great America location: _____
6. Maximum velocity (m/s) for Batman: _____
7. Minimum height (cm) required for a passenger to ride Iron Wolf: _____
8. Price of individual Six Flags ticket for groups of 20 or more (without tax): _____
9. Advertised ride duration for Raging Bull (sec): _____
10. Height of first drop on Superman (m): _____

Total: _____

LAB REPORT REQUIREMENT

- One report per group, worth 45 points, due Monday May 21
- Work in groups of 3-4
- All measurements and calculations are to be done in the metric system.
- Full group lab report, typed on unlined paper (calculations may be handwritten):
  - ▶ Cover page with student/hour and teacher names (2 points)
  - ▶ Purpose and procedure (2 points)
  - ▶ Research of rides (5 points)
  - ▶ Each ride's questions answered and calculations shown (8 + 6 + 8 points)
  - ▶ Scavenger Hunt tabulated (10 points)
  - ▶ Group conclusion/summary (4 points)