

Name:

Partner:

Teacher:

## Batman The Ride

### QUALITATIVE QUESTIONS

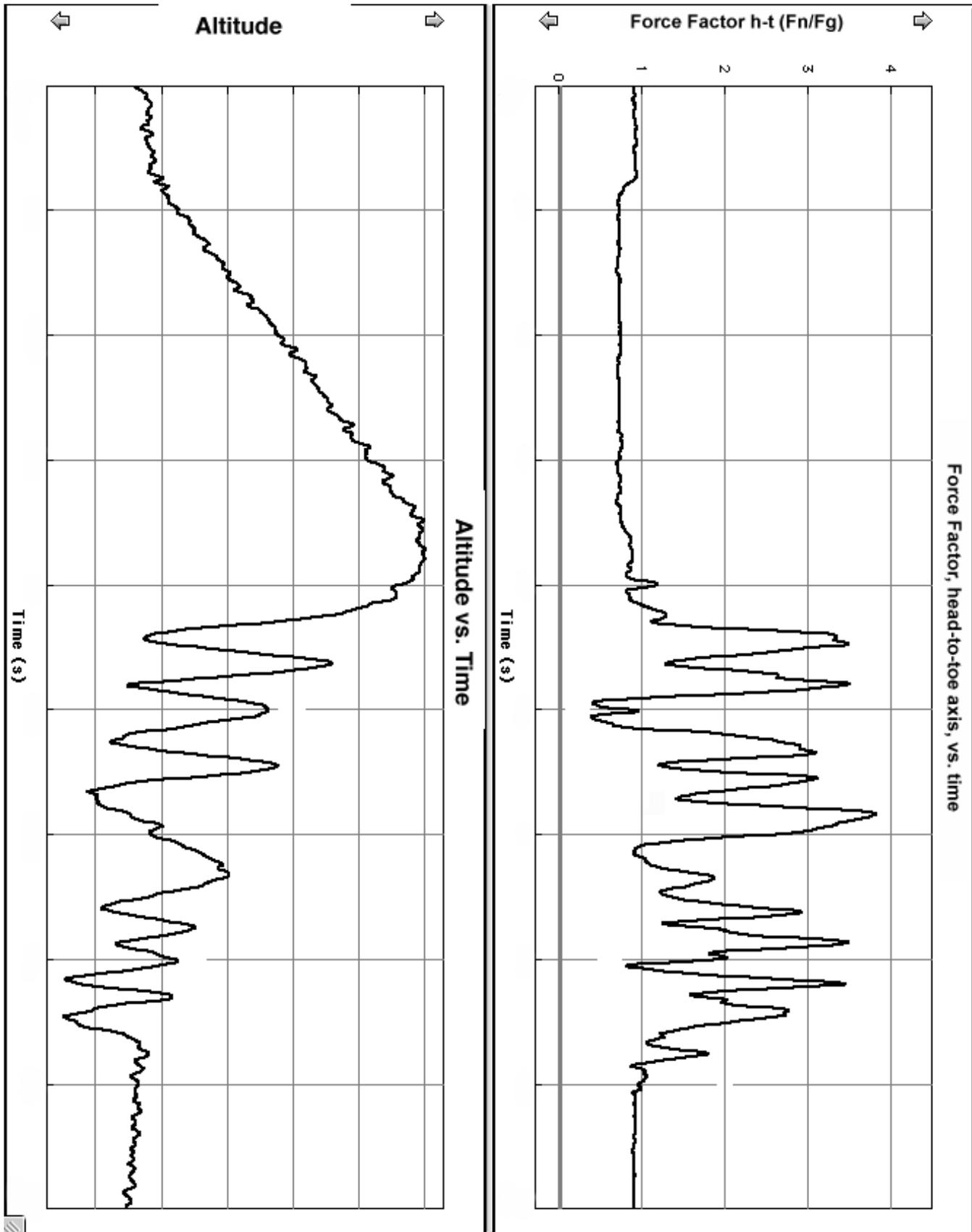


1. When you enter Batman The Ride, you walk the first 7.2 meters vertically to get on. What is the advantage to Six Flags St. Louis of having you do this?
2. In terms of forces, explain why Batman The Ride uses a long shallow climb up the first incline instead of a short steep one.
3. Why is the first hill of Batman The Ride the highest point on the ride?
4. Does each hill after the first hill have to be lower than the first hill? Explain.

# Batman The Ride

## QUALITATIVE QUESTIONS (continued)

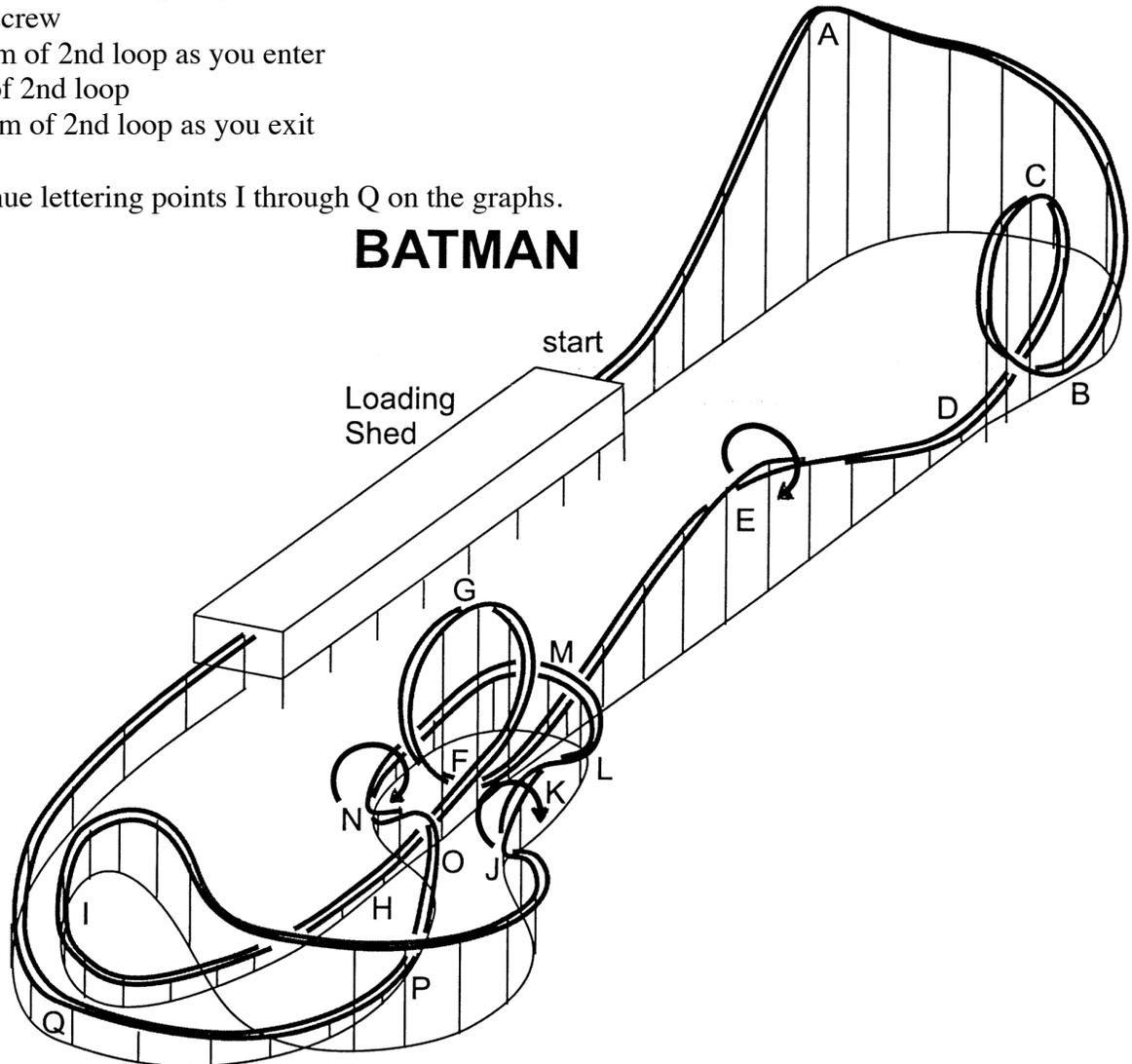
The graphs below were made from data collected by carrying a Force Factor meter and an altimeter on the ride.



**QUALITATIVE QUESTIONS (continued)**

5. Label both graphs on the previous page with the following positions along the ride.
- Top of incline
  - Bottom of first drop
  - Top of first loop
  - Bottom of first loop as you exit
  - Corkscrew
  - Bottom of 2nd loop as you enter
  - Top of 2nd loop
  - Bottom of 2nd loop as you exit

Continue lettering points I through Q on the graphs.



6. Justify your labeling choices for at least three of points A through H using only the data from the Force Factor vs. time graph.

First Point \_\_\_\_\_

Second Point \_\_\_\_\_

Third Point \_\_\_\_\_

## **Batman The Ride**

### **QUALITATIVE QUESTIONS (continued)**

7. At what point on Batman The Ride does the Force Factor meter give its maximum reading? Why is it a maximum at that point?
  
8. Find the portion of the Force Factor vs. time graph that corresponds to the first loop (Points B, C, and D).
  - a. Does the sign of the reading change during any portion of the loop?
  
  - b. Does the direction of the normal force change during the loop? Explain.
  
  - c. What is the sign of the Force Factor when you are upside-down?
  
  - d. What is the direction of the normal force at that point?
  
  - e. Compare your answers for c and d and explain.

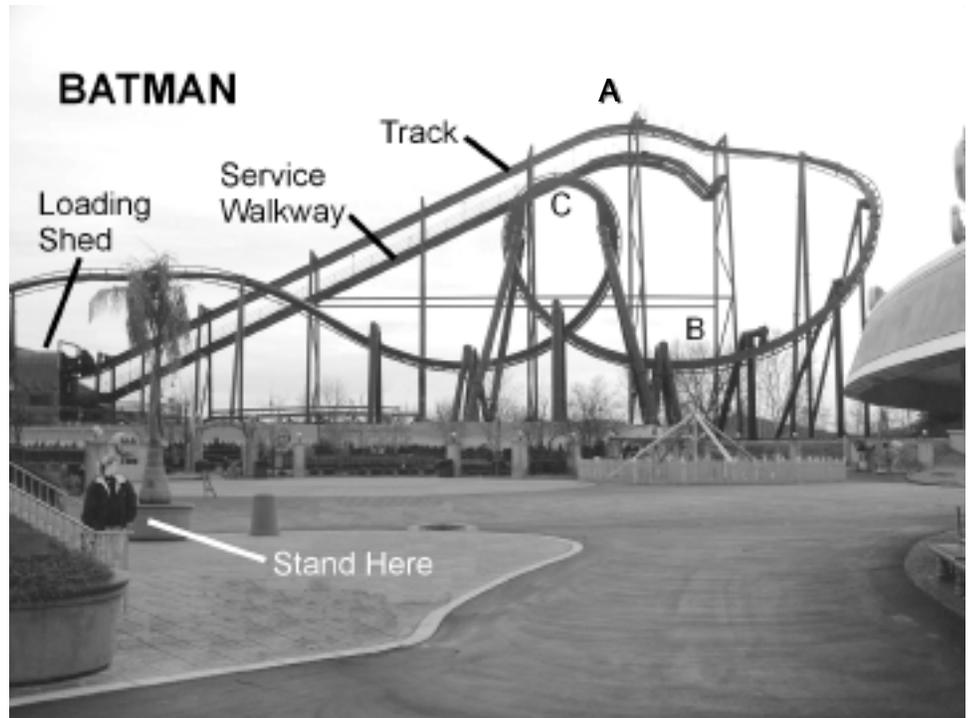
**QUANTITATIVE QUESTIONS**

For the questions that follow, refer to the photo below that shows the first incline, the first drop and the first loop of Batman The Ride. Point A in the diagram is at the top of the first incline after the train has been pulled to the top. Point B is at the bottom of the first drop as the train enters the first loop. Point C is at the highest point on the first loop.

- 1.. **Analysis of the train while being pulled from the station to the top of the first hill, point A.**

a. Measure the time for the train to pass any point on the incline.

b. Determine the speed of the train as it is lifted to the top of the incline. The train is 12.0 m long.



c. The mass of a fully loaded train is about 8,000 kg. How much kinetic energy does the train have at point A?

d. If point A is 30m higher than point B, how much gravitational potential energy does the loaded train have at the top of the incline (point A)?

e. What is the total energy stored in the system consisting of the train, the track, the earth and the surrounding air at point A?

## **Batman The Ride**

### **QUANTITATIVE QUESTIONS (Cont.)**

#### **2. Analysis of the train at the bottom of the first valley, point B.**

- a. What is the total energy stored in the track, train, earth and air system at point B?
  
  
  
  
  
  
  
  
  
  
- b. Use conservation of energy to determine the speed of the train at the bottom of the first drop (point B) assuming no frictional losses.
  
  
  
  
  
  
  
  
  
  
- c. Use a stopwatch to find the time that it takes for a 12m long train to pass by point B.
  
  
  
  
  
  
  
  
  
  
- d. Using your answer to 2c, find the speed of the train at the point B.
  
  
  
  
  
  
  
  
  
  
- e. Should your answers to 2b and 2c be the same? Are they?