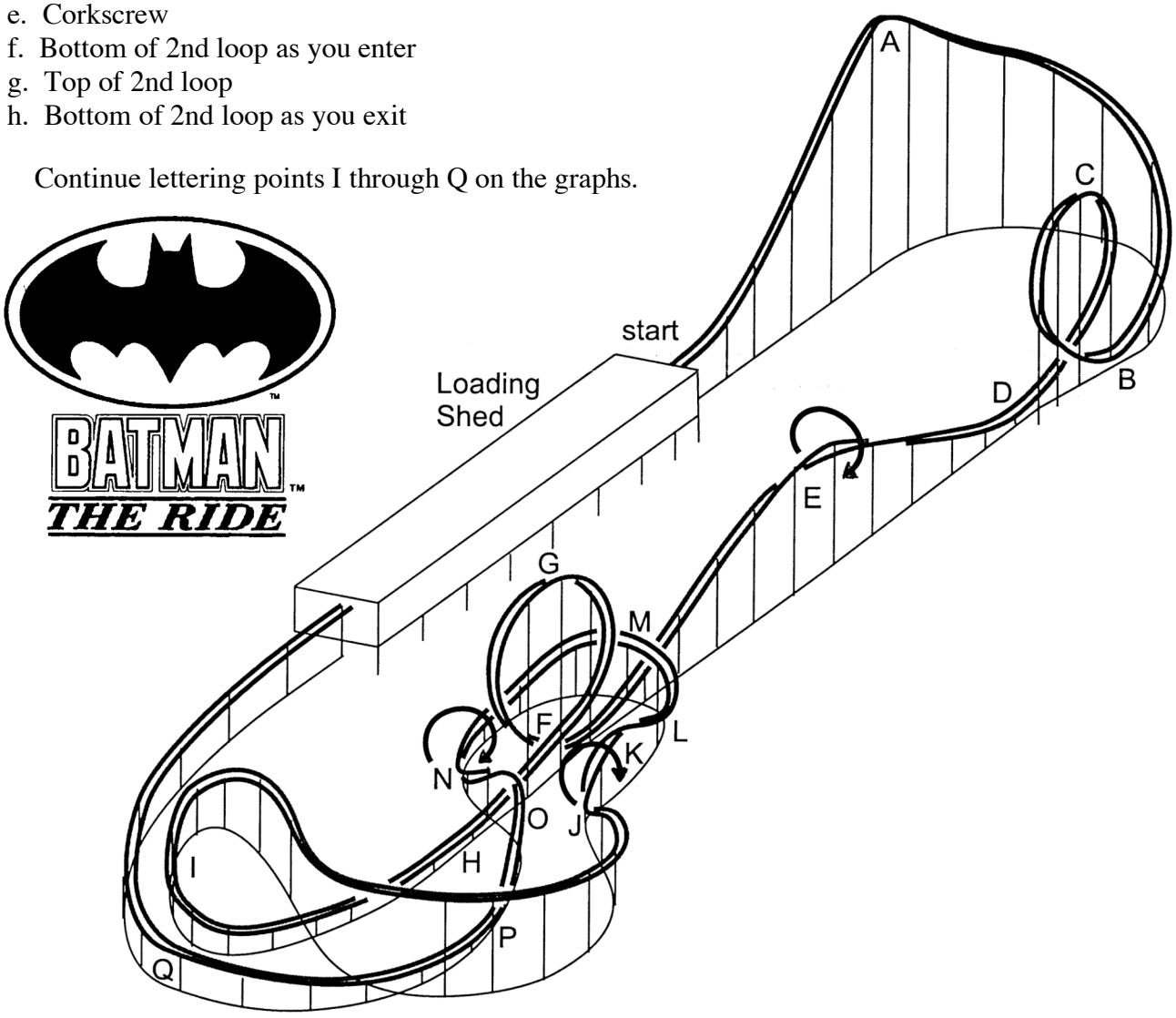
QUALITATIVE QUESTIONS

1. Label both graphs on the next page with the following positions along the ride:
   a. Top of incline
   b. Bottom of first drop
   c. Top of first loop
   d. Bottom of first loop as you exit
   e. Corkscrew
   f. Bottom of 2nd loop as you enter
   g. Top of 2nd loop
   h. Bottom of 2nd loop as you exit

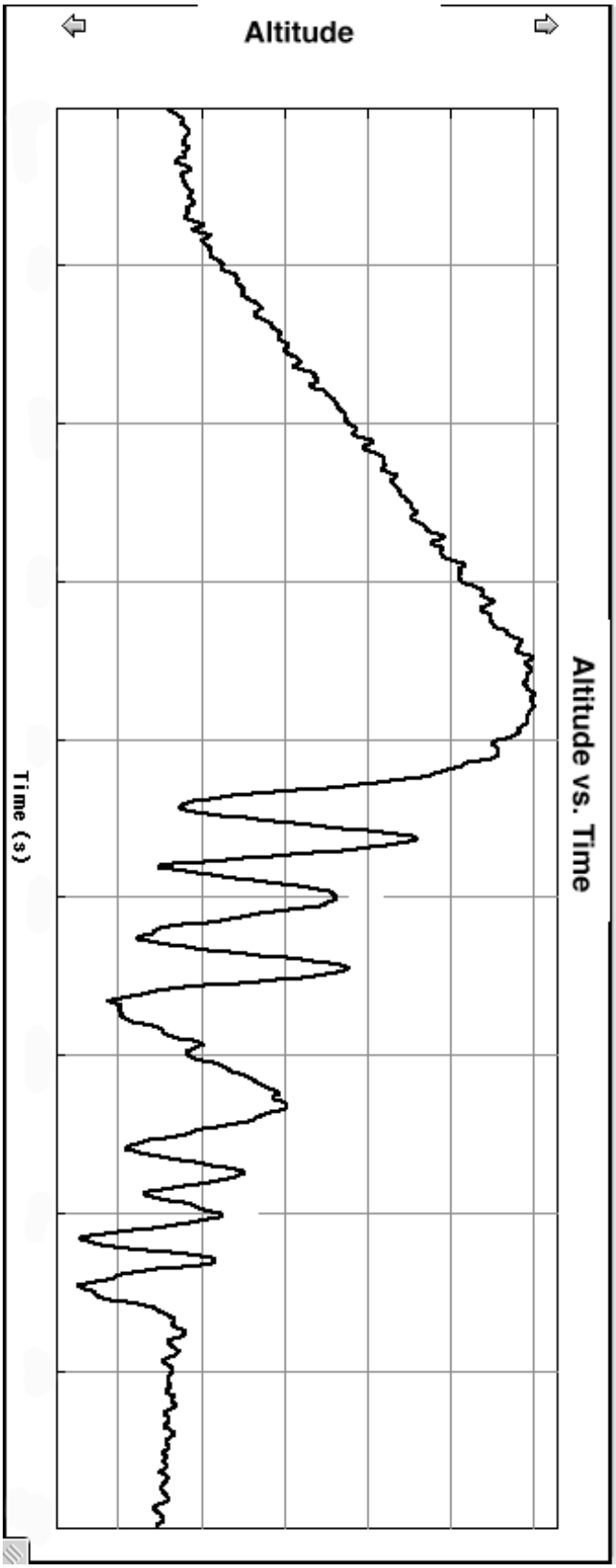
   Continue lettering points I through Q on the graphs.

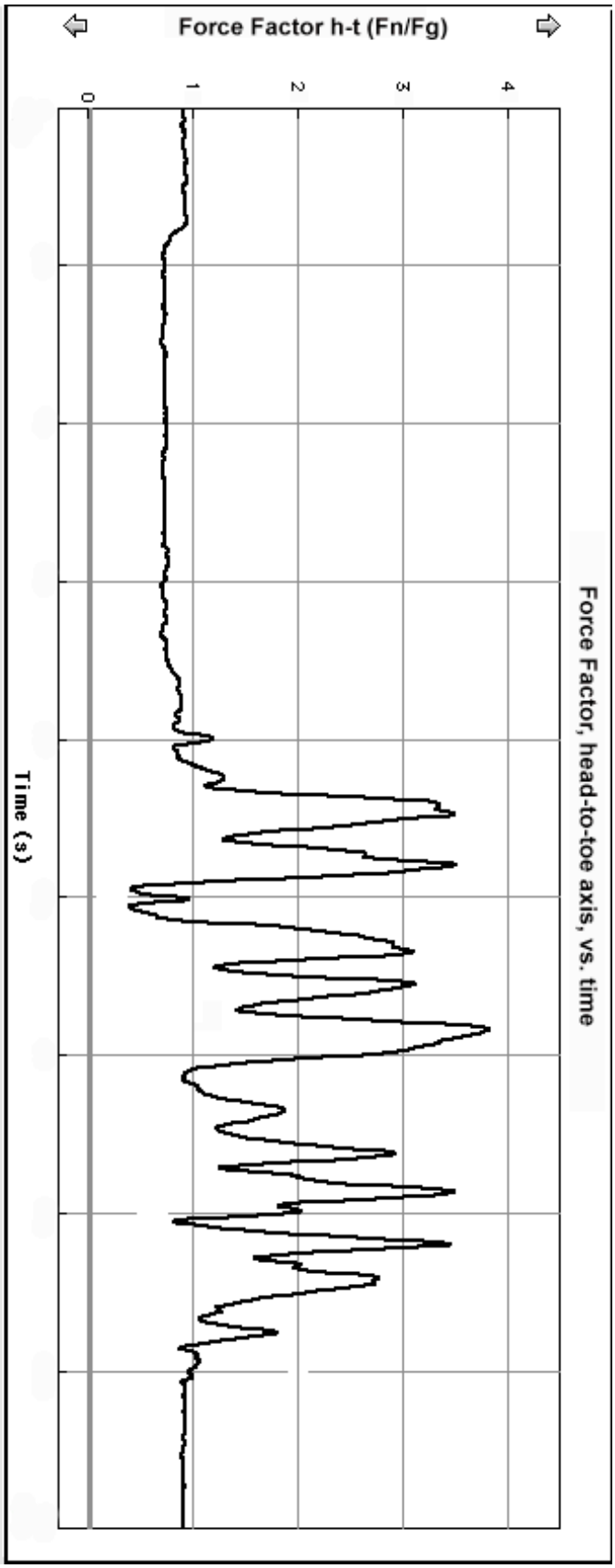


2. At what point on Batman The Ride does the Force Factor meter give its maximum reading? Why is it a maximum at that point?

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)

3. In terms of forces, explain why Batman The Ride uses a long shallow first incline.

4. 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?

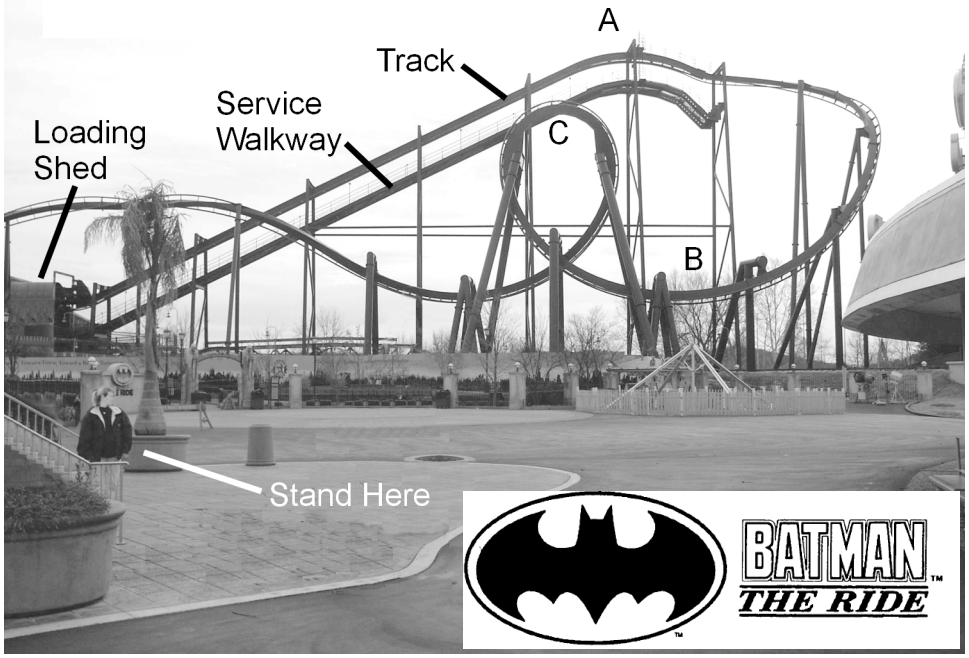
5. If the time to go uphill were shorter, what would happen to the power needed to move the train to the top of the first incline?

6. Why is the first hill of Batman The Ride the highest point on the ride?

7. Does each hill after the first hill have to be lower than the first hill? 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 it takes for the train to be pulled from the station to the top of the incline (point A).

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

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

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

e. How much gravitational potential energy does the loaded train have at the top of the incline. (Point A is 28 m above the ground.)

QUANTITATIVE QUESTIONS (continued)

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

a. Use conservation of energy to determine the speed of the train at the bottom of the first drop (point B is 6 meters above the ground) assuming no frictional losses.

b. Use the Force Factor vs. time graph to determine the **normal** force on a 60.0 kg person at the bottom of the first drop (point B).

c. In the margin to the right, draw and label a quantitative free body diagram for a 60.0 kg rider at point B. What is the value of the **net** force on the rider?

3. **Analysis of the motion of the train while upside down at the top of the loop, point C.**

a. Use conservation of energy to determine the speed of the train at the top of the first loop. (Point C is 20 m above the ground.) Assume no frictional losses.

b. Use the Force Factor vs. time graph to determine the normal force on a 60.0 kg person at the top of the first loop.

c. In the margin to the right, draw and label a free body diagram for a rider at the top of the first loop.