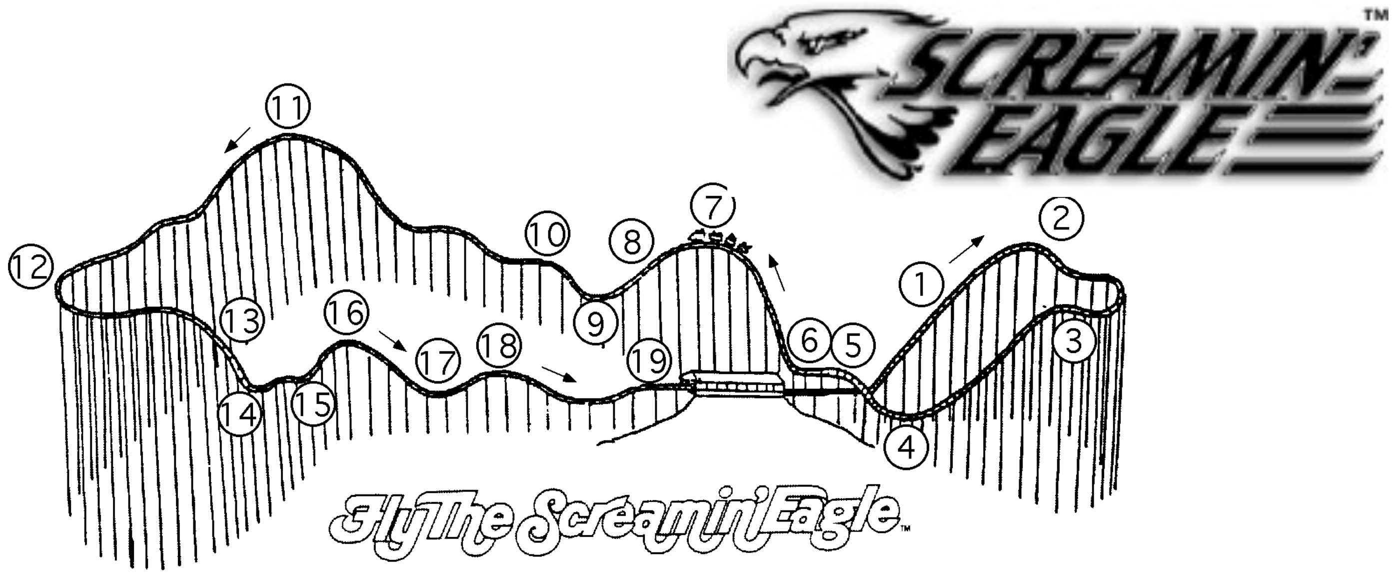
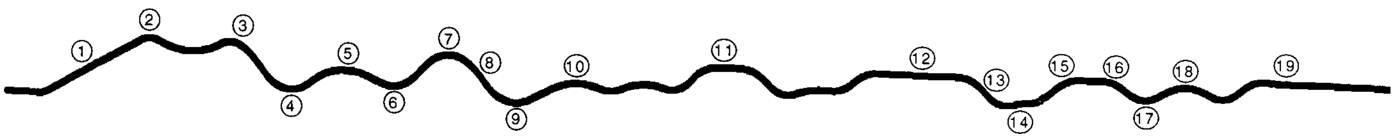
Name:	Partner:	Teacher:

Screamin' Eagle



QUALITATIVE QUESTIONS

If the track were stretch out so that it were entirely in a single plane, the profile would look like the diagram below.



Some of the numbered sections of the track are described to the right. The times correspond to a graph found on page 58.

Point	Description	Time (s)
1	Lift	
2	Top of lift	48
3	First hill	58
4	Bottom of first hill	63
5	First bump	65
7		70
9		73
11	Corner	83
12	180° turn	92
14		99
17	Valley	110
19	Brake shed	118

1. List the number or numbers from the track profile that best match the phrases below:

_____________ maximum velocity

_____________ maximum acceleration

_____________ maximum kinetic energy

_____________ maximum gravitational potential energy

_____________ greatest centripetal force

_____________ freefall area

_____________ weightless zone

_____________ where a machine makes the ride go instead of gravity

_____________ where the car moves with almost uniform velocity

_____________ where the coaster's velocity increases

_____________ high "g-force" zone

_____________ where friction has greatest effect

_____________ where riders slow down

QUALITATIVE QUESTIONS (continued)

2. At which point on the ride does the bottom seem to drop out from you as if the rails had come loose? Make a sketch of the wheels that contact the rails and explain which wheels were actually pressing against the rails at this point.

3. Why is point 2 higher than point 7?

4. Identify at least three sources of friction, prior to point 19, in this ride.

   a.__________________________ b.__________________________
   c.__________________________

5. As compared to the beginning of the ride, do you expect friction and air resistance losses to be greater or less in the latter part of the ride? Why?

QUALITATIVE QUESTIONS (continued)

6. From a physics point of view, the passengers in the first car, middle car, and last car experience the ride differently. This is despite the fact that the whole train is being acted upon as a unit. Explain the differences in the experiences of the three passengers listed above between point 7 and point 10.

7. Describe your sensations of weight at the following points:
   a. at point 1

   b. at point 2

   c. at point 3.

   d. at point 4.

   e. between points 6 and 7.

Note: The questions that follow refer to a normal force/mass vs. time graph. This graph can be found on page 58 of this manual. An explanation of this graph is on page 57.

8. Describe and give reasons for the shape of the pressure and normal force/mass graphs when:

   a. The rollercoaster is in a valley.

   b. The rollercoaster passes over a hilltop.

QUALITATIVE QUESTIONS (continued)

9. As you go down the first large hill you are obviously speeding up. Should the accelerometer reading during this section account for this acceleration? Explain!

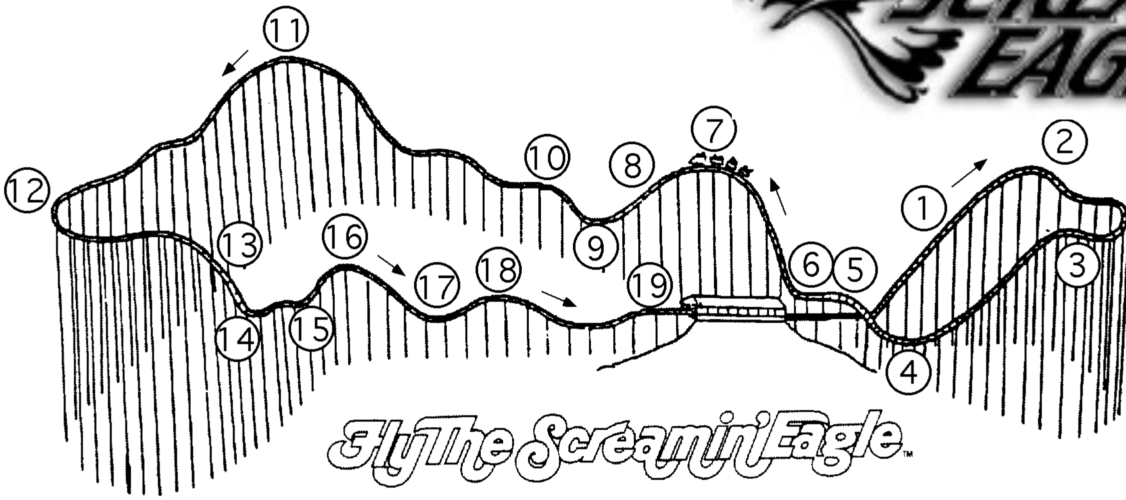
10. Is there any relationship between the shape of the profile of the track and your normal force/mass vs. time graph? Explain any similarities and differences you notice!

11. Analyze your normal force/mass vs. time graph. Explain points of
    a. greatest acceleration

    b. lowest acceleration

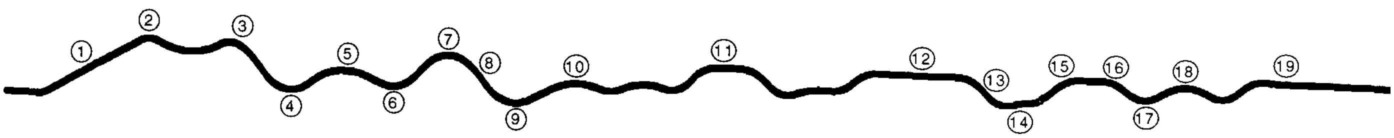
Name: Partner: Teacher:

Screamin' Eagle



QUANTITATIVE QUESTIONS

If the track were stretch out so that it were entirely in a single plane, the profile would look like the diagram below.



Some of the numbered sections of the track are described to the right. The times are approximate but should be fairly consistent with the graphs on the next page.

Point	Description	Time (s)
1	Lift	
2	Top of lift	48
3	First hill	58
4	Bottom of first hill	63
5	First bump	65
7		70
9		73
11	Corner	83
12	180˚ turn	92
14		99
17	Valley	110
19	Brake shed	118

About the graphs

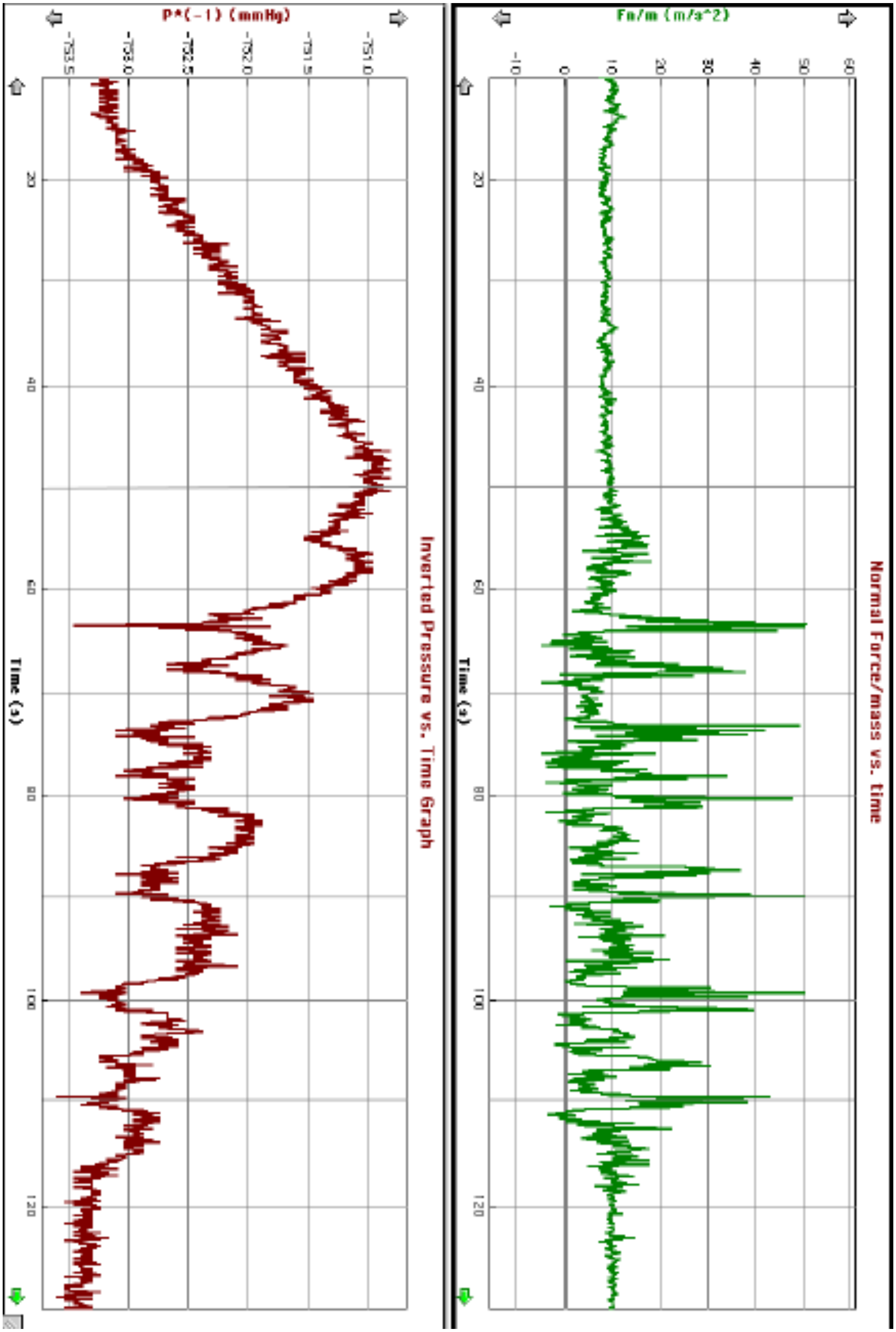
The graphs on the following page were produced by attaching a barometric pressure sensor and an electronic "accelerometer" to a portable electronic data collection device. The device collected data at a rate of 20 samples per second. These readings were plotted against time to yield the graphs.

Pressure vs. Time Graph

Since the pressure in a fluid in a gravitational field changes with height, the atmospheric pressure as measured by a barometer can be used to gauge vertical position. In the pressure vs. time graph on the following page, the opposite (-) value of the atmospheric pressure was plotted against time. Since atmospheric pressure gets <u>smaller</u> as the height increases, the inverted pressure graph resembles the profile of the ride. This can be very helpful as you attempt to interpret the normal force/mass vs. time graph.

Normal Force/mass vs. Time Graph

When oriented vertically, "accelerometers" <u>do not</u> actually measure acceleration. They measure the Normal Force to Mass ratio rather than the Net Force to Mass ratio. Since gravity always acts downward on the object, the Normal Force will never be the **net** force in a vertical situation. Consequently, you will have to make appropriate adjustments to the graph readings in order to determine accelerations. This discrepancy between "accelerometer" readings and actual acceleration is explained in detail in the acceleration portion of the **Suggestions for Making Measurements** manual.


Inverted Pressure vs. Time Graph
P*(-1) (mmHg)
Time (s)
Normal Force/mass vs. time
Fn/m (m/s^2)
Time (s)

Name:	Partner:	Teacher: **Screamin' Eagle**

QUANTITATIVE QUESTIONS

1. If you stand by the restrooms near the Screamin' Eagle entrance, you can see points 3, 4, 5, 6, and 7 listed on the ride profile. Points 3 through 6 can also be seen from the ride queue line just before you enter the turnstile. Measure the time it takes the train to pass points 3, 4, 5, 6, and 7. Also measure the time it takes the train to move from point 3 to 4. .

2. If the train is 13 meters long, what is the speed of the train at points 3, 4, 5, 6, and 7?

3. Does each part of the train have the speed you calculated as it passes the point? Explain!

4. Determine the average acceleration of the train as it moves from point 3 to 4.

5. Compare your answer to question 4 to the reading on the graph between points 3 and 4. Try to explain any differences.

QUANTITATIVE QUESTIONS (continued)

6. Using the speed at point 5 and the fact that the first bump (point 5) has a radius of 21 m, find the acceleration of your body as you go over this bump. (Hint: you have a circular path at point 5.) What does your answer tell you about what you will feel as you go over the bump?

7. Use the pressure vs. time graph to locate point 5 from the profile. Determine the acceleration at that point using the normal force/mass vs. time graph.

8. Compare the measured acceleration values from questions 6 and 7. Think about significant figures!

9. What was the <u>direction</u> of your acceleration as you went over the first bump (point 5)?

10. Draw and label a free-body diagram for your body at the top of the first bump (point 5). Be sure the length of force vectors are representative of the relative sizes of the forces.

QUANTITATIVE QUESTIONS (continued)

11. A net force causes acceleration. Write an equation that describes the net force on you at point 5 in terms of the forces in your free body diagram from question 6.

12. Using your mass and the measured acceleration at point 5, calculate the net force on a 60.0 kg rider who is at point 5.

13. How much force does the seat exert on a 60.0 kg rider who is at point 5?

14. Using 60.0 kg for the mass of the rider and the measured acceleration at point 4, calculate the normal force the seat exerts on the rider at the bottom of the first large hill (point 4).

15. Draw and label a free body diagram for your body at the bottom of the first hill (point 4). Be sure the length of force vectors are representative of the relative sizes of the forces.

QUANTITATIVE QUESTIONS (continued)

16. Write an equation that describes the net force on a 60.0 kg rider at point 4 in terms of the forces in your force diagram from question 15.

17. Determine the net force on a 60.0 kg rider who is at point 4.