

**QUALITATIVE QUESTIONS**

Observe the motion of the cars as they are pulled to the top of the tower and dropped. The labeled points in the diagram are X at the top, Y at the point braking begins when going down, and Z at the bottom.

1. At which of the following points is the ride's:

- a. speed the greatest? \_\_\_\_\_
- b. gravitational energy the greatest? \_\_\_\_
- c. gravitational energy the least? \_\_\_\_\_
- d. kinetic energy the greatest? \_\_\_\_\_

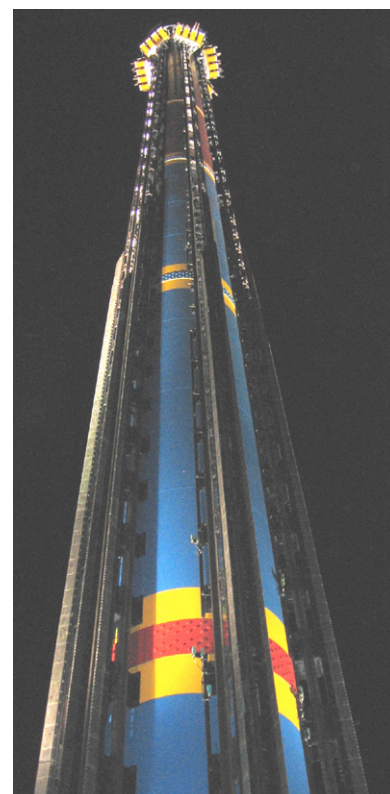
2. During which lettered section is the ride's:

- a. acceleration the greatest? \_\_\_\_\_
- b. normal force greater than the gravitational force on a rider? \_\_\_\_\_
- c. gravitational force greater than the normal force on a rider? \_\_\_\_\_

3. A foam ball has been attached to the restraint. Hold the ball in your hand as the car rises. When the ride falls, release the ball in front of you. Describe the behavior of the ball as you fall.

4. The braking system on Superman is passive and requires no friction or input of power. Long aluminum fins are attached to the lower portion of the tower. The back of each car has very strong magnets that straddle the aluminum fins and stop the falling car. How does this passive braking system work?

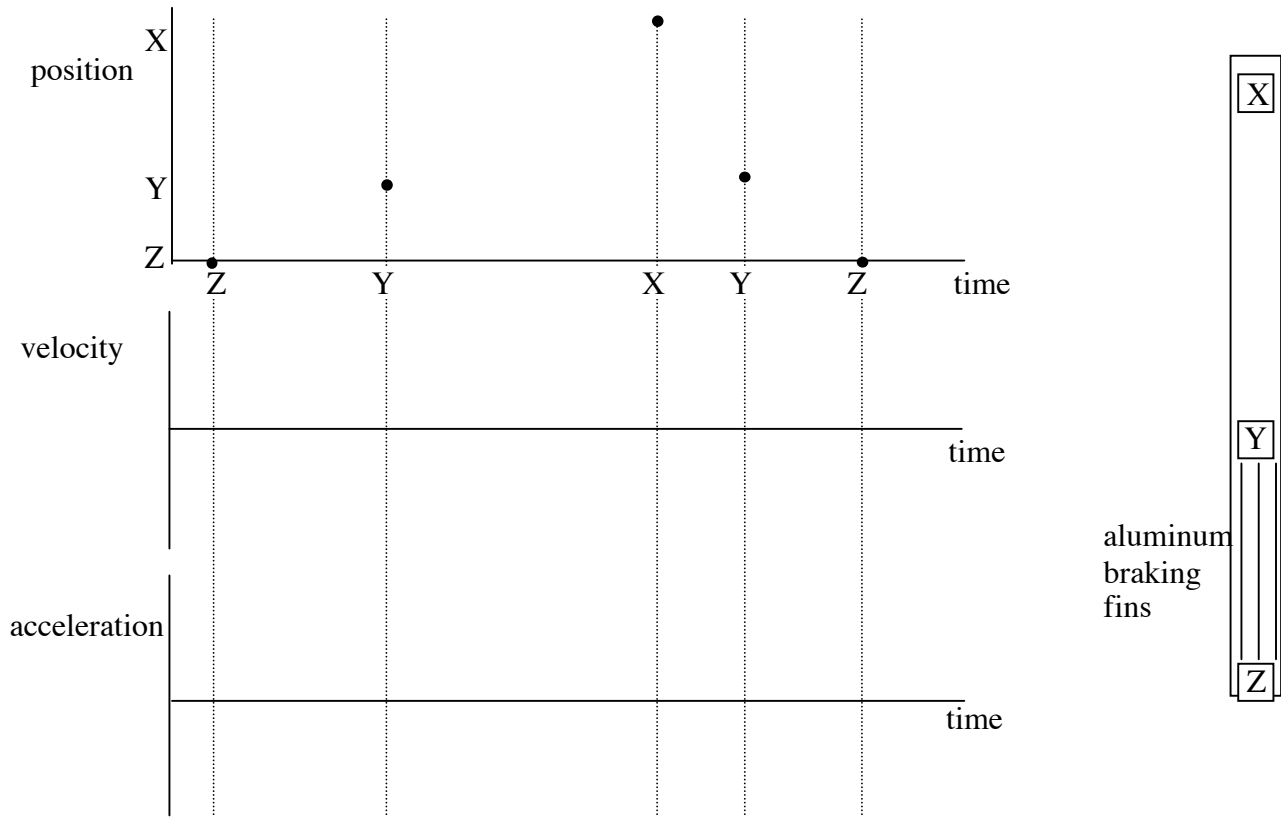
5. Carefully observe the motion of the car on the way up. Does the velocity increase, decrease, or stay the same when the car leaves the aluminum fin region of the tower? What would account for this change?



**SUPERMAN**  
Tower of Power

# Superman

6. Sketch qualitative position-time, velocity-time, and acceleration-time graphs for one complete cycle of the ride. The letters indicate the times the ride reaches the indicated positions. Treat upward as the positive direction.



7. Draw qualitative free body diagrams for a rider at each of the points indicated.

The figure shows a vertical schematic of the ride car on the left, labeled 'aluminum braking fins'. It has three points marked: X at the top, Y in the middle, and Z at the bottom. To the right of the schematic is a table with seven columns, each representing a different point in the ride cycle. The first column is labeled 'A' and contains the schematic. The other columns are labeled with points and conditions.

A	point Z $v=0\text{m/s}$	point B accel. upward	point A const. vel. up	slowing to pt. X	point A falling	point B braking
B						

**QUANTITATIVE QUESTIONS**

**Kinematics Analysis:**

1. Use the graph on the next page to find the maximum height the car reaches.
  
2. Find the height of the car when braking begins. (Use the graph on the following page.)
  
3. Determine the distance the car falls before braking.
  
4. With a stopwatch, measure the time the car falls freely before braking.
  
5. Based on your measurements, calculate the acceleration of the riders while falling.
  
6. Calculate the velocity of the car at the moment braking begins.
  
7. With a stopwatch, measure the time from the moment braking begins to the time the car stops at the bottom.
  
8. Calculate the average acceleration while braking.
  
9. Is the acceleration while braking uniform? How do you know?

