CALCULUS AT GREAT AMERICA

COASTER: Average and Instantaneous Velocities

Find a "straight" section of coaster track that has a profile approximating half a period of a sinusoidal curve, from maximum to minimum vertical height. Determine or approximate distances and write a simple 2D equation to represent this curve's profile. Identify your reference zeros for both axes. Use an integration technique to determine the length of this section of track.

Sketch the track outline from highest to lowest points. Take data to find the average velocity of the coaster along this section of track, noting reference positions of the coaster on your sketch.

On a second sketch of the track outline, mark at least 4 points along the curve (including highest and lowest). Compare in general terms the coaster's instantaneous velocity at these points, and compare instantaneous velocities to the average velocity found in prior work. Collect, if possible, position-vs-time data as the coaster travels through this part of the ride. Where data is available, support your comparison conclusions.

Describe the relative horizontal velocities of the front and back cars as each moves past the highest point on the curve. The front car moves past the peak, followed a short time later by the back car. Are the horizontal velocities the same for each car at that location on the track? Explain. Is that same horizontal velocity relationship maintained at the lowest point on the curve? Explain.

CAROUSEL: Finding Path Length

A rider sits on a horse that is moving vertically so that its position-vs-time graph approximates a sinusoidal curve. Meanwhile, the platform to which the horse is attached rotates about the ride's center. Goal: Find the total distance traveled by the horse and rider during one "full-speed" revolution of the carrousel, taking into account both circular and vertical motion. List data collected, include brief commentary as needed, and show work as appropriate in reaching your solution.

If all horses on the carrousel move up and down at the same rate, compare the distance traveled for a horse and rider located "*n*" distance units closer to the center of the ride. Include both circular and vertical motion in your description, and be as specific as possible in your conclusion.

STAR TOWER: 3-D Speed and Distance

On a 3-D grid, sketch the rider's path. Record "given," measured, calculated and/or estimated distances and times, and label axes appropriately.

Find the rider's speed as the ride is ascending. Is your answer an instantaneous or an average value? Explain.

Describe the vector components of the rider's velocity as the ride is ascending.

Write an integral representing the distance a rider travels on the ascent of Star Tower. DO NOT SOLVE.