Project: Designing a Roller Coaster

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Preparation

Be sure to read *Project Report/Grading Guideline* before beginning your project. Remember, you are to turn in a neat and complete project report. Any figures should have a title and a legend and be properly referenced in the report. Do not just turn in a Maple worksheet as a complete report in your own word is required.

The Problem

Suppose you are asked to build a roller coaster with an overall horizontal displacement of 400 feet. The coaster should ascend along a straight line $y = f1(x)$ of slope 2.5 for the first 20ft horizontally. We continue along three cubics, $f2(x) = ax^3 + bx^2 + cx + d$, $f3(x) = ex^3 + fx^2 + gx + h$, and $f4(x) = ix^3 + jx^2 + kx + l$ for 100ft each. In addition, the coaster should be 140ft above the ground at the 80ft mark, reach a bottom of 25ft above the ground at the 180ft mark, and reach a peak 65ft above the ground at the 260ft mark. Finally, the coaster should start a soft landing 30ft above the ground along a cubic $f5(x) = mx^3 + nx^2 + ox + p$ for the last 80ft.

Your Tasks

1. Write a system of 16 equations in 16 unknowns such that your track is both continuous and smooth throughout.
   Note: *Be sure to include your equations in your report and you must explain the reasoning for your equations within your report.*
2. Solve the equations in (1) with Maple to find values for *a-p*.
3. Define and plot a piecewise-defined function, $F(x)$, for your roller coaster.
   Note: *Include the equation for your completed piecewise-defined function (with all values a-p plugged in) as well as the graph of your roller coaster. Be sure to use the same scalar for both x and y.*
4. Find the maximum height of your roller coaster and the mark where it occurred.

Extra Credit

Design a more interesting roller coaster of your own.