

Project 1: Designing a Roller Coaster

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Preparation

Be sure to read the *Project Report Guidelines* 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 turn in a Maple worksheet. A complete project report should include all necessary equations and information.

The Problem

Suppose you are asked to build a larger roller coaster with an overall horizontal displacement of 400 feet. The coaster should ascend along a straight line $y = f_1(x)$ of slope 2.5 for the first 20ft horizontally. We continue along three cubics, $f_2(x) = ax^3 + bx^2 + cx + d$, $f_3(x) = ex^3 + fx^2 + gx + h$, and $f_4(x) = ix^3 + jx^2 + kx + l$ for 100ft each. In addition, the coaster should be 120ft above the ground at the 80ft mark, reach a bottom (local minimum) of 30ft above the ground at 180ft horizontally, and reach a peak (local maximum) of 55ft above the ground at 260ft horizontally. Finally, the coaster should start a soft landing 30ft above the ground along a cubic $f_5(x) = mx^3 + nx^2 + ox + p$ 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: You must explain the reasoning for your equations within your report. Be sure to include your equations in 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 scale for both x and y .
4. Find the maximum height of your roller coaster.