

# Project 1: 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 turn in a Maple worksheet as a complete report should be enough.

## 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  $y = f_1(x)$  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 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  $f_5(x) = mx^3 + nx^2 + ox + p$  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:** 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.