

# 1<sup>st</sup> Annual Mathematics Olympiad

GROUP COMPETITION

*Barry University*

March 4, 2016

School Name: \_\_\_\_\_

## Designing a Roller Coaster

You have been hired to help with the design of the new roller coaster.

You are given a path design for a straight stretch (no turns) of a proposed roller coaster. The roller coaster has to start within first foot of the ground and finish on the ground at  $0^\circ$  angle. A safety rule is that a descent can be no steeper than  $80^\circ$  at any point. In addition each design starts with a  $45^\circ$  incline. (Angles refer to the angle that the path makes with a horizontal line and they are all considered to be positive.)

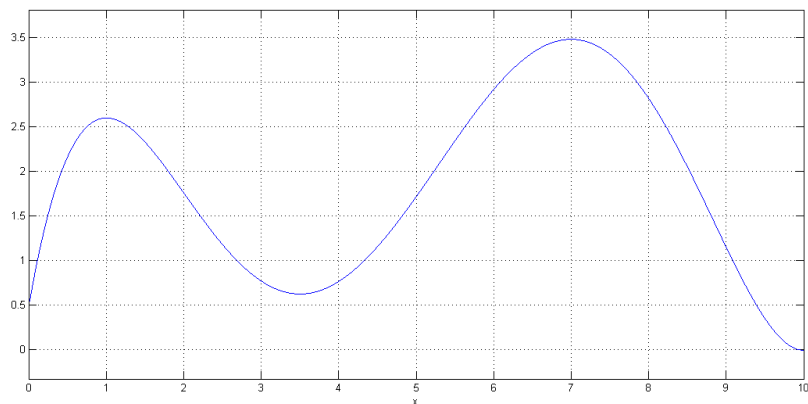


Figure 1: An example of a roller coaster prototype design

Design a prototype roller coaster that has the highest *thrill*. The thrill of the coaster is defined as the sum of the angle of steepest descent in each fall in radians + number of tops. The prototype should be between 9 and 11 ft long and the tallest point of the roller coaster should be between 3 and 4 ft. Your report should include:

1. Does your path satisfy the safety criterion? Explain why or why not.
2. For each fall, where is the steepest descent and how steep is the angle at that point?
3. Calculate the thrill of your path.

[Hint: Find a polynomial whose graph will represent roller coaster design.]  
Please justify all answers!