Pre-Calculus 2nd Quarter Project

ROLLER COASTER POLYNOMIALS
(PART 1: Roller Coaster Design – Math Application)
(PART 2: Roller Coaster Design – 3D Model)
DUE on TUESDAY, JANUARY 10, 2017

Purpose:
In real life, polynomial functions are used to design roller coaster rides. In this project, each team will apply skills acquired in Unit 2 to analyze roller coaster polynomial functions and to design a section of the team’s own roller coaster ride.

Objectives:
- Students will determine and analyze a polynomial model for a section of a roller coaster track.
- Students will construct a polynomial equation in factored form to fit given criteria.
- Students will apply mathematics to solve problems arising in everyday life, society, and the workplace (CCSS Mathematics Practice).
- Students will interpret mathematical results in the context of the situation and reflect on whether the results make sense, improving the model as necessary (CCSS Mathematics Practice).
- Students will use technological tools to explore and deepen understanding of concepts (CCSS Mathematics Practice).

Project Components:
1. Math Application – The team will have to answer questions and solve problems involving polynomial functions presented in real life scenarios. Through the team’s work, each is expected to gain an in depth understanding of real life application of concepts such as sketching and analyzing graphs of polynomial functions, dividing polynomials, determining zeros of a polynomial function, determining polynomial function behavior, etc.
2. 3D Model – The team will design a section of the team’s roller coaster polynomial using the skills learned during the small group application problems.

Project Evaluation Criteria:
The team’s project will be assessed based on the following general criteria:
- Math Application – POSTER BOARD
  - will be graded on correctness and accuracy of the answers.
  - Provide all answers in a full sentence form.
  - Make sure you clearly justify the team’s answers where required
  Possible points:
  - Answers based on accuracy 40 points
  - Professional appearance of the work (neatness, legibility) 10 points
    - TOTAL POINTS = 50 points

- 3D Model
  - Roller Coaster design clearly represents mathematical representation of team’s roller coaster 25 points
  - Scale of roller coaster is clearly labeled and accurate 15 points
  - Professional appearance of 3D model (neatness, creativity) 10 points
    - TOTAL POINTS = 50 points
• Individual Contribution
  o Each member must contribute to the team project.
  o A description of how each team member contributed to the project must be turned in with the poster board and model.
  o Members will have the opportunity to evaluate and grade each member based on his or her contributions to the project. This will be done in confidentiality. Mrs. Cook will be only one who will read evaluations.
  o Individual grades will be averaged.
  o Rubric attached.
    ▪ TOTAL POINTS = 28 points

Roller Coaster Design: POSTER BOARD:
• All information MUST be presented on a poster board. Dimensions are not to exceed: 24 in. x 36 in.
• All parts MUST be answered by showing all mathematical calculations, final answers clearly labeled, and justification written in complete sentences.
• The graph showing the final polynomial function MUST be printed from the calculator
  ▪ Use Desmos.com. Upload the team’s sketch onto Desmos.com. Then compare the team’s sketch with the graph the software provides.
  ▪ Graph print out MUST have
    • the x-axes and the y-axes labeled with zeroes and the y-intercept clearly labeled
    • you must show the polynomial function

Roller Coaster Design: 3D MODEL:
• The roller coaster MUST be built on a base. Dimensions are not to exceed: 20 in. by 30 in.
• The team will have to supply its own materials.
• The roller coaster MUST represent the team’s polynomial function. The team will have to decide how best to scale the coaster in relationship to the actual dimensions. Make sure the scale that is used is clearly labeled on the model.

Extra Credit

Each team can earn extra credit points that will be added to the project grade (3D model grade only). These items are to be ADDED to the original 3D model of the team’s polynomial function. To earn extra credit, the following must be met:

  o It needs to work without helping the marble along and by starting the marble from rest. (+3)
  o At least two loops (+2)
  o At least two funnels (+2)
  o Sturdy construction (+1)
You decided to become a structural engineer who specializes in roller coaster design. The team’s job is to design the team’s own roller coaster ride. To complete this task, please follow these steps:

The amusement park you are designing for, gave you the following coaster requirements:
- the team’s coaster ride must have at least 3 relative maxima and/or minima
- the ride length must be at least 6 minutes
- the coaster ride starts at 250 feet
- the ride dives below the ground into a tunnel at least once

Label each part clearly. The team’s work MUST be neat, organized and must appear professional.

1. Draw a rough sketch of the team’s "roller coaster" ride on a coordinate plane.
   Note: Be sure to illustrate the team’s x-axis and y-axis scale to identify the length of the ride and the height of the ride you are designing. Make sure the team’s design meets all the criteria listed above.

2. List ALL zeros or roots of the team’s polynomial; be sure to include at least one of each of the following on the team’s design: one double root (multiplicity of two), at least 2 real root, and imaginary roots. It might be necessary to go back to the team’s design and modify it according to these root requirements.

3. The “a” term in a polynomial function (or the leading coefficient) is a scaling factor which controls how fast the “arms” sweep up or down and thus the overall direction. Calculate and find the “a” term on the polynomial. Show all the team’s work.

4. Write the complete factored form of the team’s roller coaster polynomial.

5. Find the equation in standard form that represents the team’s roller coaster ride.

6. Perform long division and/or synthetic division to verify the correctness of the team’s equation.

7. Describe the end behavior of the team’s function and give a reason for this behavior. Write the end behavior using limits.

8. Include a graph from an online calculator (use Desmos.com).

9. State the practical domain and range of the team’s graph (that is, the actual ride).

10. Color the graph blue where the polynomial is increasing and red where the polynomial is decreasing and identify increasing, decreasing, and constant intervals. Identify these areas by using interval notation.