POLYNOMIAL ROLLER COASTERS
Teaching Guidelines

Subject: Mathematics

Topics: Algebra, Polynomial Equations and Functions

Grades: 9 - 12

Knowledge and Skills:

- Can relate aspects of the graph of a polynomial function to the coefficients

Materials: (for each team)

- Graphing calculator or spreadsheet program

Procedure: This activity is best done by students working individually or in teams of two.

Students will need to already understand how to enter a polynomial function into a graphing calculator or spreadsheet program.

You may wish to simplify the activity by restricting the investigation to third or fourth-order polynomials from the beginning.

Answers:

1. Change the "*f*" coefficient from "–10,000" to "–20,000." What is the effect on the roller coaster? Why? *The roller coaster drops to the right more steeply. "f" is the coefficient of the linear term, and when it has a negative value then that term imparts a negative slope to the graph. As f becomes more negative, that slope increases.*
2. What do you think would happen if you changed "*f*" to "-30,000"? Try it and explain what happened. *As above.*
3. What happens if you change "*f*" to "0"? Explain. *The graph climbs more strongly to the right.*

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4. Change all coefficients to "0" except for "*d*" (leave it at "20"). Describe the result. *The result is a standard cubic function graph, increasing from left to right.*

5. Now change "*d*" to "-20" (leaving all other coefficients equal to zero), and create the graph. Explain the results. *This inverts the graph, causing it to drop from left to right.*

6. Leave $d = -20$, and change "*f*" from "0" to "10000". Try several other values of "*f*", to see the effect. Describe the results. *This will cause "humps" to appear in the graph.*

7. Set "*a*" and "*b*" equal to zero, and see if you can find values for the other coefficients that produce a graph of this shape:

$$y = -14x^4 - 40x^3 + 10000x^2 + 10000x + 300000$$

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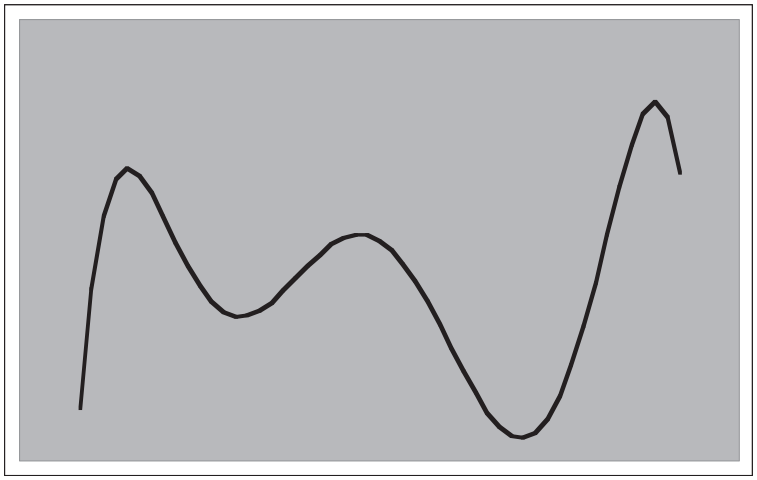
Polynomial Roller Coasters

The shape of a roller coaster could be modeled by a polynomial function, such as this one:

$$y = ax^6+bx^5+ cx^4+dx^3+ex^2+ fx + g.$$

Here is an example:



$$y =-.015x^6+.01x^5+ 14x^4+20x^3-3000x^2-10000x + 300000.$$

(Domain: $-25 \le x \le 25$)

Use a graphing calculator or spreadsheet program to investigate the effects of the coefficients on the shape of the roller coaster, as follows:

1. Change the "*f*" coefficient from "–10,000" to "–20,000." What is the effect on the roller coaster? Why?

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2. What do you think would happen if you changed "*f*" to "-30,000"? Try it and explain what happened.

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3. What happens if you change *"f"* to "0"? Explain.

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4. Change all coefficients to "0" except for *"d"* (leave it at "20"). Describe the result.

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5. Now change *"d"* to "-20" (leaving all other coefficients equal to zero), and create the graph. Explain the results.

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6. Leave *d = -20*, and change *"f"* from "0" to "10000." Try several other values of *"f"*, to see the effect. Describe the results.

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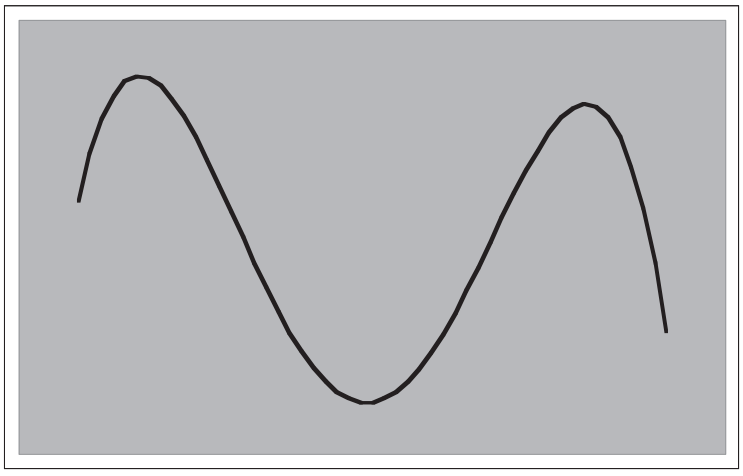
7. Set *"a"* and *"b"* equal to zero, and see if you can find values for the other coefficients that produce a graph of this shape:



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