Egg Launch Contest

Students will represent quadratic functions as a table, with a graph, and with an equation. They will compare data and move between representations.

Learning Objectives

In this lesson, students will:

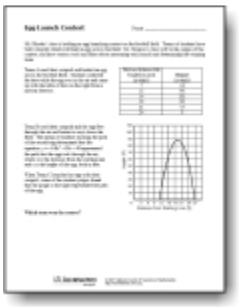
- Move between representations of a function as a table, a graph and an equation
- Determine the maximum value of a quadratic function
- Compare quadratic functions

Materials

- Egg Launch Activity Sheet
- Graphing Calculator

Instructional Plan

In this activity, students encounter data that comes in different forms in the context of the description of an egg launch contest. The data for team A are shown in a table, the data for team B are expressed by an equation, and the data for team C are displayed in a graph. The data are available to students on the activity sheet.



Egg Launch Activity Sheet

- Have students read the first two paragraphs on the activity sheet. Ask the class what they notice about the height of the egg as the distance from the starting line increases. If the data points are plotted on a coordinate plane and connected, what shape do students think the graph makes?

[Students should notice that the height increases, then decreases. The shape is a parabola.]

- Have students read the third paragraph. Ask the class to describe the shape described by the equation.

  [Students should recognize that this is a quadratic equation, whose graph is a parabola. The negative coefficient before the x^2 term means that the parabola opens down and has a maximum value.]

- Have students read the fourth paragraph. Ask them what they know about the flight path of Team C's egg by looking at the graph.
- After a discussion of the starting points, the heights, and the distances from the starting point for the three teams, ask students to spend a minute on recording which team they think won the contest and why.

Put students in groups or pairs to work through the second page of the activity sheet. They will need a calculator or some other tool for regression to find the equations for Team A and Team C.

If students are using a TI–83/84, you can post instructions for:

- Regression
- Finding the Maximum Value

Be sure to circulate around the classroom to help the students use the calculator effectively.

Team A

- Equation: $-1.3x^2 + 39.6x - 195.1$
- For the graph, see below.

Team B

- *Note that values are rounded and students may choose different points for their table.*

x	2	3	6	9	12	15	18	21	22
y	–5.2	9.8	45.2	66.2	72.8	65	42.8	6.2	–9.2

- For the graph, see below.

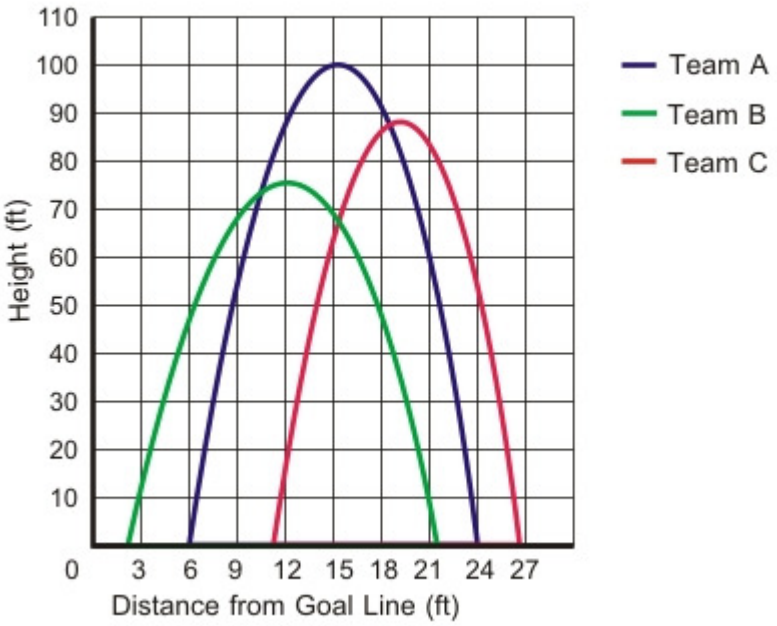
Team C

- *Note that values are rounded and students may choose different points for their table.*

x	11	12	15	18	19	21	24	27
y	0	19	65.5	86.5	88 (max)	82	53	0

- Equation: $-1.4x^2 + 53.2x - 417$

Graph of All Functions:

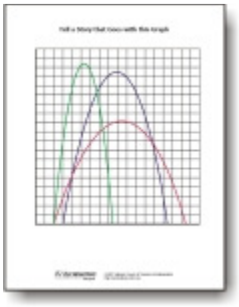


Questions for Students

1. Describe the usefulness of each representation (table, graph, equation) of the data.
2. What information about these egg launches can you infer from the tables, graphs, and equations?
3. What effect do the negative leading coefficients of the equations have on the graphs?
4. Explain different strategies that can be used to determne the maximum height reached by an egg on its flight path. What can you say about a minimum height reached by an egg on its flight path?
5. What can you say about any symmetry in these graphs?

Assessment Options

1. Ask students to write a news story that interprets the graphs of the flight paths of some of the other eggs in the contest such as the following:



Additional Graphs for Student Scenarios
(In color and black-and-white)

Extensions

1. Ask students to make colored posters of their graphs.
2. Ask students to explore this scenario: "You have been asked to find a quadratic function. When graphed on the coordinate plane, the maximum height attained by the egg on its flight path is equal to the distance the egg is hurled down the field. Write such a quadratic function as an equation.

Teacher Reflection

- How did students adjust to the 3 representations of the data?
- Do students have a data representation preference? If so, what is their preference and why?
- How well did students use technology (calculators) to do some of the work for them? Describe what students did with the calculators to help them interpret the data.
- How did students react to the idea that the launcher did not need to be on the goal line of the football field?

NCTM Standards and Expectations

Algebra 9-12

1. Analyze functions of one variable by investigating rates of change, intercepts, zeros, asymptotes, and local and global behavior.
2. Understand the meaning of equivalent forms of expressions, equations, inequalities, and relations.
3. Draw reasonable conclusions about a situation being modeled.

This lesson was written by Zoe Silver.

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unless otherwise noted, should not be interpreted as official positions of the Council.

Egg Launch Contest

NAME: _____

DATE: _____

Mr. Rhodes' class is holding an egg launching contest on the football field. Teams of students have built catapults that will hurl an egg down the field. Ms. Monroe's class will judge the contest. They have various tools and ideas for measuring each launch and how to determine which team wins.

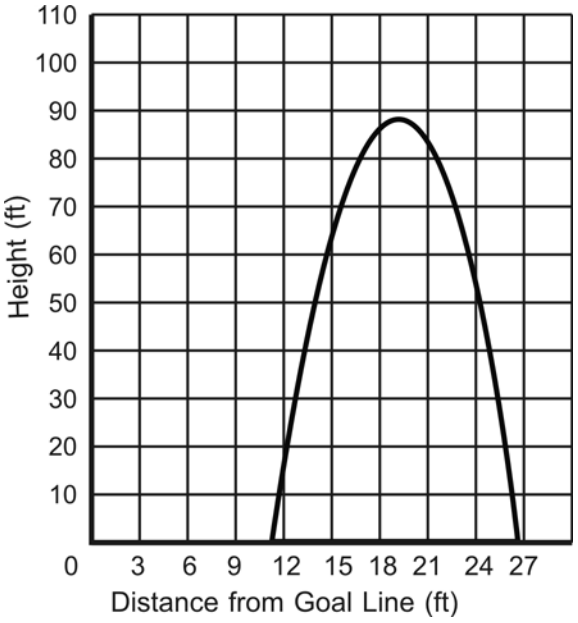
Team A used their catapult and hurled an egg down the football field. Students used a motion detector to collect data while the egg was in the air. They came up with the table of data below.

DISTANCE FROM THE GOAL LINE (IN FEET)	HEIGHT (IN FEET)
7	19
12	90
14	101
19	90
21	55
24	0

Team B's egg flew through the air and landed down the field. The group of students tracking the path of the egg determined that the equation $y = -0.8x^2 + 19x - 40$ represents the path the egg took through the air, where x is the distance from the goal line and y is the height of the egg from the ground. (Both measures are in feet.)

When **Team C** launched an egg with their catapult, some of the judges found that the graph to the right shows the path of the egg.

Which team do you think won the contest? Why?



Team A

1. Using the data from Team A, determine an equation that describes the path of the egg. Describe how you found your equation.

2. On the graph below, graph the path of Team A's egg.

3. What is the maximum height that the egg reached? How far was the egg hurled?

Team B

4. Using the equation from Team B, generate a table of values that shows different locations of the egg as it flew through the air.

x											
y											

5. On the graph below, graph the path of Team B's egg.

6. What is the maximum height that the egg reached? How far was the egg hurled?

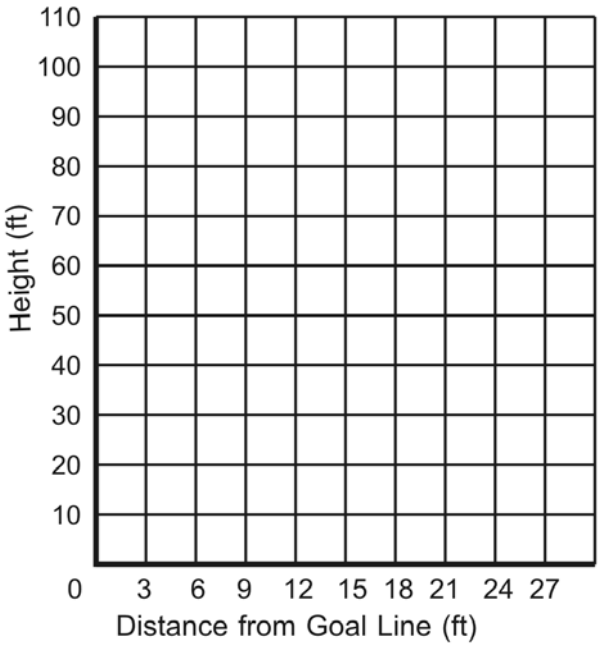
Team C

7. Using the data from Team C, generate a table of values that shows different locations of the egg as it flew through the air.

x											
y											

8. On the graph below, re-graph the path of Team C's egg.

9. What is the maximum height that the egg reached? How far was the egg hurled?

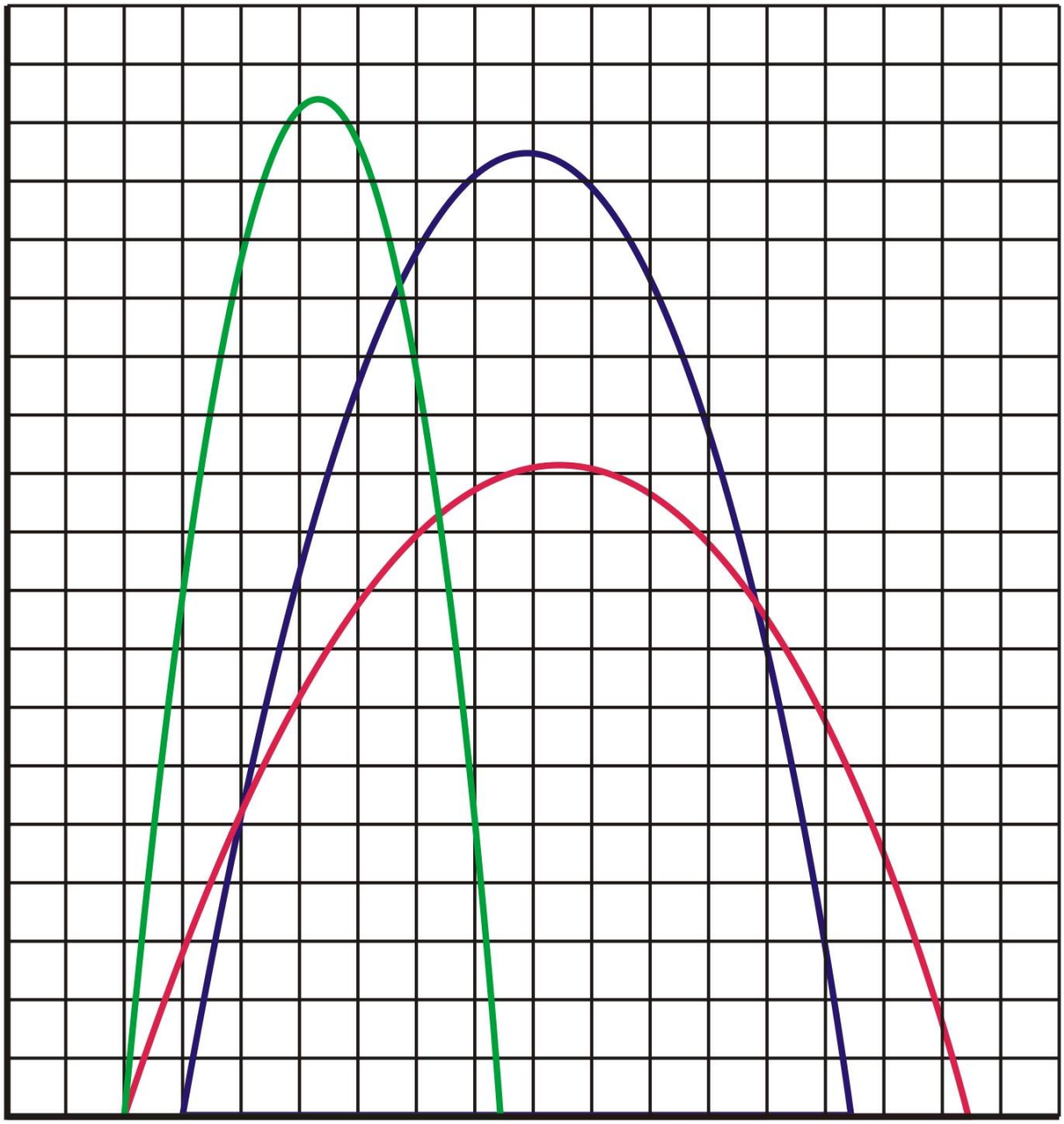


10. If it is a height contest, which team wins? How do you know?

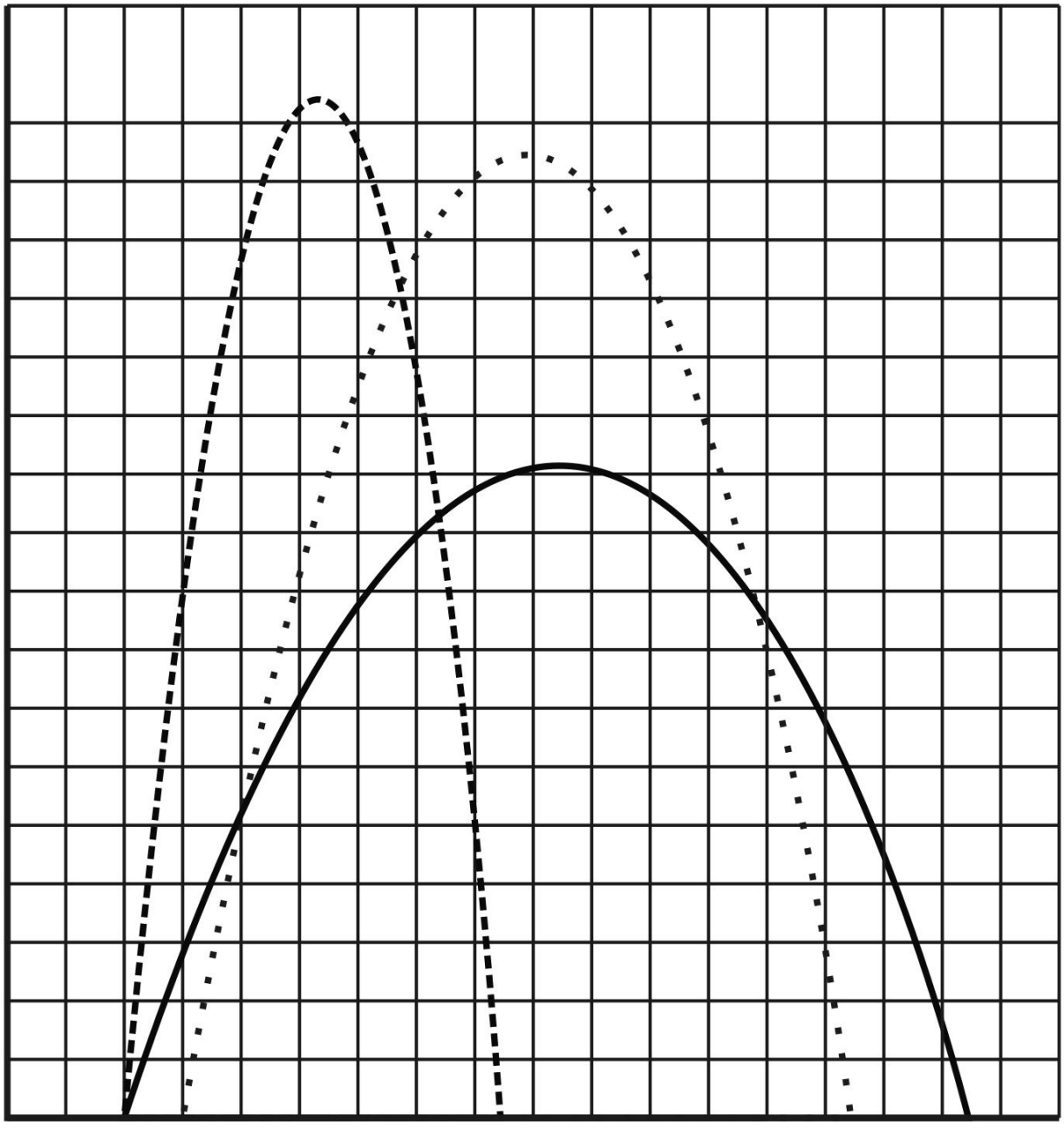
11. If it is a distance contest, which team wins? How do you know?

12. Find a method of determining a winner so that the team that did not win in Question 10 or Question 11 would win using your method.

Tell a Story that Goes with this Graph



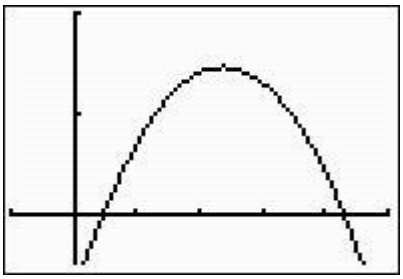
Tell a Story that Goes with this Graph



Using the TI-83 or TI-84 for Maximums, Minimums and Zeros

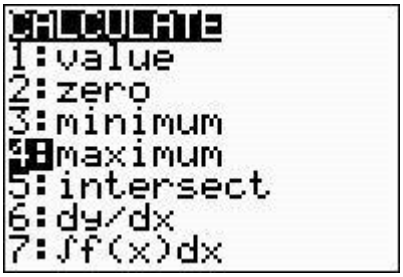
1. Enter and view the function:

- Choose the [Y=] key.
- Type in your function.
- Pick the best window and view the function.



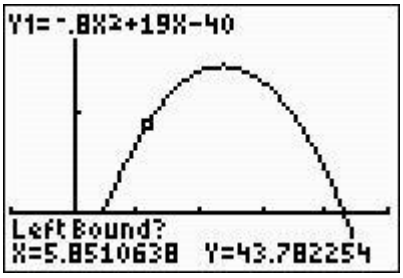
2. Choose the attribute for the calculator to find

- Press [2nd][CALC] for the list of options.
- Choose from the list by scrolling down or typing in the number.
- Then press [ENTER].

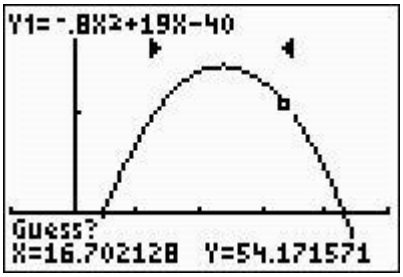


3. Define the bounds and get your answer

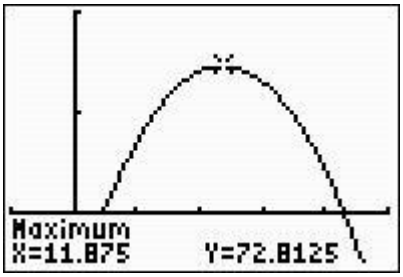
- The calculator will prompt you for a left (lower) bound for *x*. Use [◄] or [►] to move the cursor along the curve so you're clearly left of the maximum point. Press [ENTER].



- Next, use [►] to move to the right and determine a right (upper) bound for *x*.



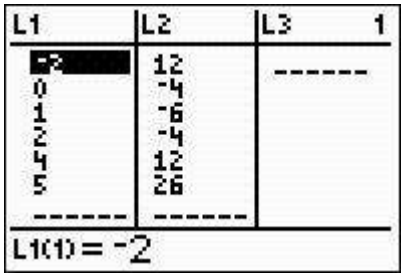
- Press [ENTER] once again for the calculator to find the maximum in the range you've provided.



Using the TI-83 or TI-84 for Regression

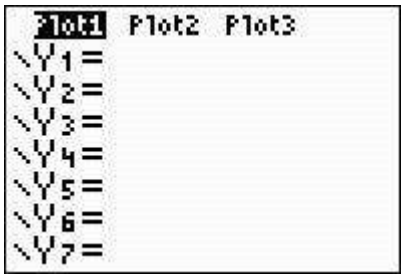
1. Enter the data into the calculator

- Choose the [STAT] key
- Choose [1.Edit] from the [EDIT] menu
- Enter the *x*-values into [L1]
- Enter the *y*-values into [L2]

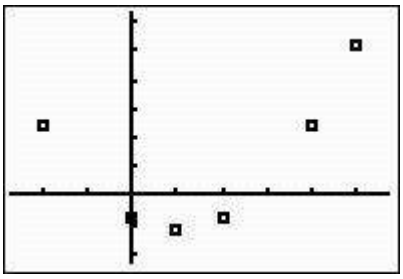


2. View the scatter plot

- Choose the [Y=] key
- Turn on [Plot1]



- View the graph with [GRAPH]
- If you don't see all the points, choose [ZOOM] then [9.ZoomStat]



3. Get the equation

- Choose the [STAT] key
- Select [CALC] from the menu across the top
- Choose a regression from the list
- Press [ENTER] twice