Extreme Punkin' Chunkin'

About the Lesson

In this activity, students will explore extrema, zeros, and other key values of quadratic functions in real-world contexts. As a result, students will:

- Use the calculator to find the maximum value of a quadratic function.
- Use the calculator to find roots (zeros) of a quadratic function.
- Apply the concepts of extrema and roots to solve problems in a real-world context.

Vocabulary

- roots and zeros
- extrema
- *y*-intercept

Teacher Preparation and Notes

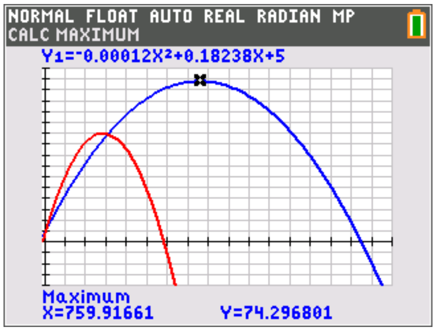
- There are four parts to this activity. Problems 1 and 2 go together and can be completed in class. Problems 3 and 4 may be used as either an extension or homework.
- To make the activity a bit more challenging, delete the instructions on the Student Activity that provide the window settings.
- Consider showing a video of the Punkin' Chunkin' contest or other pumpkin launches. Videos are available at a variety of websites, including YouTube and TeacherTube.

Activity Materials

- Compatible TI Technologies:

  TI-84 Plus*
  TI-84 Plus Silver Edition*
  TI-84 Plus C Silver Edition
  TI-84 Plus CE

** with the latest operating system (2.55MP) featuring MathPrint™ functionality.*



Tech Tips:

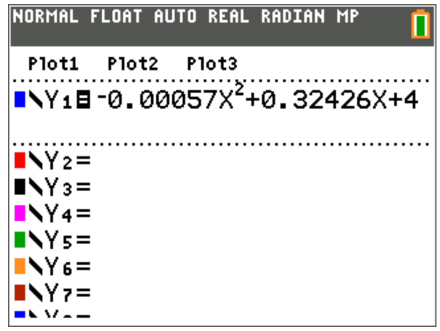
- This activity includes screen captures taken from the TI-84 Plus CE. It is also appropriate for use with the rest of the TI-84 Plus family. Slight variations to these directions may be required if using other calculator models.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

Lesson Files:

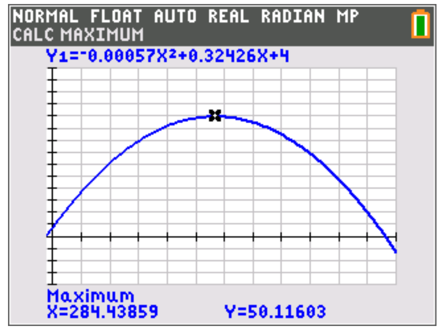
- Extreme_Punkin_Chunkin_Student.pdf
- Extreme_Punkin_Chunkin_Student.doc

Problem 1 – Punkin' Chunkin' Team 1

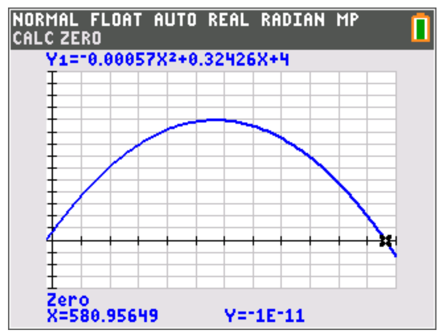
An equation is given to describe the motion of a pumpkin launched from a trebuchet. Students are instructed to graph the function. This graph is used to answer questions involving maximum height, horizontal distance, and the ability of the pumpkin to clear a fence.



Students will be using the **Calculate** menu to find the zeros, minimum, and maximum values for the various quadratics in this activity.



Remind students that when finding zeros, they must first choose a point to the left of the zero, press enter, then choose a point to the right of the zero and press enter. If it is done in reverse (a point on the right side, then a point on the left side), the calculator will encounter an error.



This same process is followed when calculating maximums or minimums.

Discuss with students the difference in domain and range in the context of the problem versus the graph of the function.

Also discuss how the zero, extrema, coordinates of the vertex, and *y*-intercept are represented in this problem.

1. What are the maximum height reached and the total horizontal distance traveled for the pumpkin? Round to the nearest foot.

Answer: The maximum height reached by the pumpkin is 50 feet. The total distance the pumpkin traveled is 581 feet.

2. At what distance above the ground was the pumpkin launched?

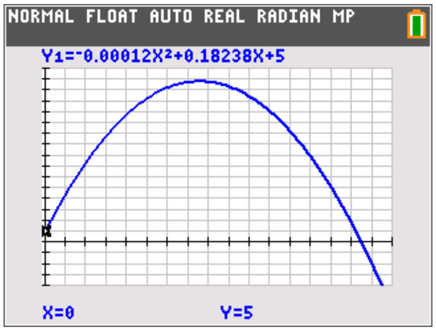
Answer: The pumpkin was launched from a height of 4 feet above the ground.

3. If a 10-foot high chain-linked fence is in the path of the pumpkin at a distance of 500 feet from where the pumpkin is released, will it pass over the fence? How high is the pumpkin when it reaches the fence? (Hint: Use the trace key and type 5 0 0.)

Answer: Yes; The pumpkin would be 23.63 feet above the ground at that point.

Problem 2 – Punkin' Chunkin' Team 2

Students use what they've learned in Problem 1 and apply it to the function representing the winning team in the Punkin' Chunkin' contest. Again, they will graph the function given and use the **Calculate** menu to find the values of interest.



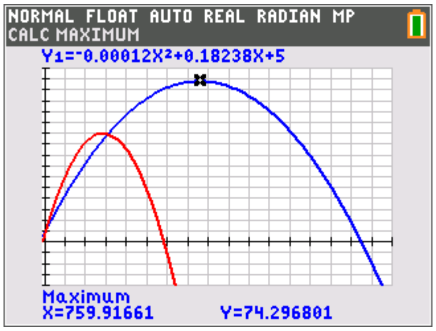
4. What are the maximum height reached and the total horizontal distance traveled for the pumpkin? Round to the nearest foot.

Answer: The maximum height reached by the pumpkin is 74 feet. The total distance the pumpkin traveled is 1547 feet.

5. At what distance above the ground was the winning pumpkin launched?

Answer: The pumpkin was launched from a height of 5 feet above the ground.

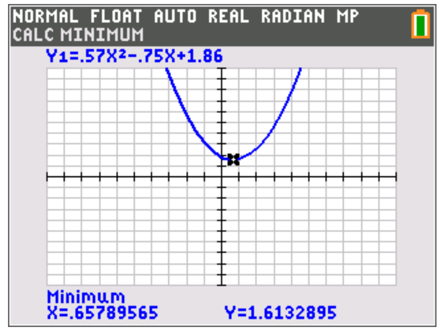
On the worksheet, students are to compare the trajectories of Team 1 and Team 2's pumpkins. They can do this by looking at the values they've recorded or graph Team 1's function along with Team 2's function using **Y1** and **Y2**.



6. Overall, how did the trajectory of Team 1's pumpkin compare to Team 2's pumpkin? Why do you think Teams 2's pumpkin went farther?

Answer: Team 2's maximum height was greater at a farther distance from the trebuchet.

Problem 3 – Cost of Kayaks



Students explore a problem that models the cost of production (*C*) for a kayak company. In this problem, they are asked to find the minimum cost and the associated number of kayaks produced.

Discuss with students what the *y*-intercept represents (fixed cost or cost when no kayaks are produced).

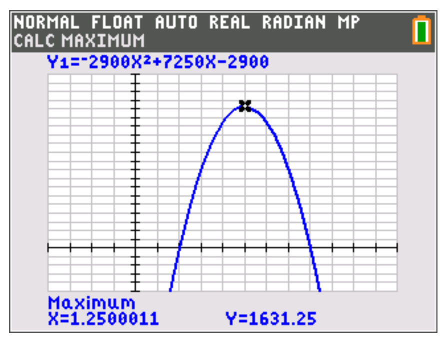
7. How many kayaks should the shop build to minimize the average cost per kayak?

Answer: They should build 65 kayaks to minimize the average cost per kayak.

8. What is the cost per kayak in the minimized cost situation?

Answer: The minimum cost per kayak would be \$161.

Problem 4 – Espresso Yourself



In this problem, students graph profit (*P*) for an espresso stand as a function of cups of espresso sold.

The *x*-axis represents the price per cup and the *y*-axis represents the profit.

Discuss with students why there is no *y*-intercept for this function (no profit if the price of a cup is \$0).

9. What are the maximum profit and the approximate price per cup of espresso that yields this maximum profit?

Answer: The maximum profit is \$1631.25 and the approximate price per cup of expresso would be \$1.25.

10. According to the given model, at what price per cup will sales be so low that the stand will not obtain any profit?

Answer: The expresso stand would yield no profit at a price of \$2 per cup.