Parabolic Curves and Their Equations

Judy Johnson

CALCULATORS: Casio: *fx-9750G Plus* • Casio: *CFX-9850G Series*

Teaching Notes/Lesson Plan

Objective

The students will be able to determine the quadratic equation associated with a parabolic curve using the Conic and Statistics Functions of the Casio graphing calculator.

Engage

Discuss with students what a parabolic reflector is and how it is used. Give real-life examples of how it is used as a television dish, a microscope, and a solar heater/cooker.

Explore

1. Model creating an example of a parabolic reflector and determine the focus for the curve.
2. Demonstrate how to enter points into the STAT Menu and find the equation for the curve.
3. Demonstrate how to use the CONICS Menu to find the focus and other factors of a parabola.
4. Model comparing the equation found by the calculator to the equation found using algebraic means.

Explain

Students will create various parabolic reflector curves, find the equation for each curve using a graphing calculator and compare this result with the equation found algebraically. Students will then determine the amount of error between the created focus and the real focus.

Evaluate

The student will complete an activity sheet along with providing a brief written discussion of the findings in the activity.

Extension

1. Have the students create parabolic curves whose vertex is not on the axis and find their equations.
2. Have students research parabolic reflectors and bring in pictures or displays of how they are used in real-life situations.
3. Try to find the focus using sound waves instead of light waves.

Name _____ **Date** _____

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Student Worksheet

Objectives

The student will be able to:

1. Find the focus of a parabolic curve using the intersections of rays of light and
2. Find the equation for the curve of the parabolic reflector both using a calculator and algebraic formulas.

Introduction

Parabolic reflectors are used in real-life to collect, solar energy and provide electricity for people in remote areas where the use of light poles or underground cables is not feasible. In this activity, you will create three different parabolic reflector curves, determine the focus, and find the equation for the curve with a calculator, algebraically, and finally using the results of the flashlights. You will then compare the results.

Materials

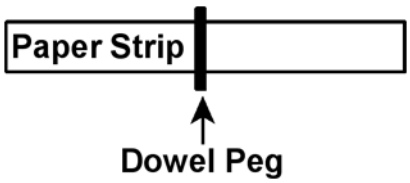
a. 12" x 16" Peg Board with the Axes Drawn as shown

b. Three 2" Dowel pegs that will fit into the holes of the Peg Board

c. One 18" x 1/2" Strip of Silver or Gold Poster Board

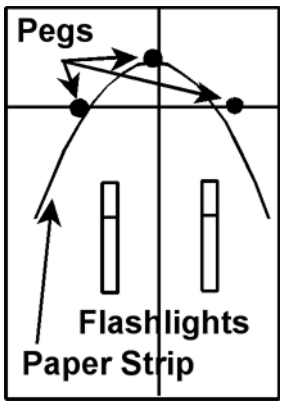
d. Two Mini Mag Lights and Strips of Plain Paper about 4" by 2" to wrap around the end of the Mag Lights Tape

e. Graphing Calculator



Instructions:

1. Attach one of the dowel pegs to the middle of the back of the strip of poster board so that approximately 1/4" of the peg is below the strip of paper as shown at the right.
2. Insert the peg attached to the paper strip into the given vertex so that the silver (or gold) side is facing the positive y-axis and the bottom of the strip touches the peg board. Put the other two pegs into the given x-intercepts as shown at the right.



3. Place each flashlight on the short end of one of the plain strips of paper so that the paper extends approximately 1" beyond the end of the flashlight and roll the paper around the flashlight. Secure this with a piece of tape. Turn on the flashlight so that when it is pointed at an object, the result is the smallest concentration of light. Place the flashlights onto the peg board so that they lie perpendicular to the *x*-axis and are equidistant from each other. Find where the two rays that are reflected intersect and determine the coordinates of this point. This is the focus for the parabolic reflector. Record this information on the activity sheet. Move the pegs to the next set of coordinates and record the coordinates of the next focus.

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Student Worksheet:

4. Using the Statistics Menu, find the equation of the curve using the vertex and the two *x*-intercepts. Using the Conics Menu, find the actual focus.
5. Find the equation of the curve algebraically.

Problems

Find each of the equations for each of the given curves.

Equation 1:

Use a vertex of (0, -2) and *x*-intercepts of (-3, 0) and (3, 0) to create a parabolic curve and determine the focus using the curve and flashlights.

a. Focus found using the flashlights and the parabolic curve. _____

b. Find the equation of the curve using the two intercepts and the graphing calculator.

Equation of the Curve Using the Calculator: _____

Focus: _____

c. Find the equation of the curve algebraically using the given vertex and *x*-intercepts.

d. Find the equation of the curve algebraically using the given vertex and experimental focus.

Focus found using the Model was _____.

Equation 2:

Use a vertex of (0, -2) and *x*-intercepts of (-4, 0) and (4, 0) to create a parabolic curve and determine the focus using the curve and flashlights.

a. Focus found using the flashlights and the parabolic curve. _____

b. Find the equation of the curve using the two intercepts and the graphing calculator.

Equation of the Curve Using the Calculator: _____

Focus: _____

c. Find the equation of the curve algebraically using the given vertex and *x*-intercepts.

d. Find the equation of the curve algebraically using the given vertex and experimental focus.

Focus found using the Model was _____.

Name _____ **Date** _____

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Student Worksheet:

Equation 3:

Use a vertex of (0, -3) and *x*-intercepts of (-5, 0) and (5, 0) to create a parabolic curve and determine the focus using the curve and flashlights.

- Find the equation of the curve using the two intercepts and the graphing calculator.
- Find the equation of the curve algebraically using the determined focus and given vertex.
- Determine the amount of error in the leading coefficient between the two equations.

a. Focus found using the flashlights and the parabolic curve. _____

b. Find the equation of the curve using the two intercepts and the graphing calculator.

Equation of the Curve Using the Calculator: _____

Focus: _____

c. Find the equation of the curve algebraically using the given vertex and x-intercepts.

d. Find the equation of the curve algebraically using the given vertex and experimental focus.

Focus found using the Model was _____.

Answer the questions.

1. Which of the experimental equations was closest to the actual equation of the curve?

_____

2. What was the difference between the leading coefficient of the actual equation and the leading coefficient of the experimental equation for each curve?

a. Equation 1: _____

b. Equation 2: _____

c. Equation 3: _____

3. What was the percent of change for each of the differences in Question 2?

a. Equation 1: _____

b. Equation 2: _____

c. Equation 3: _____

4. What would you do to reduce the percent of change in the experiment? Explain.

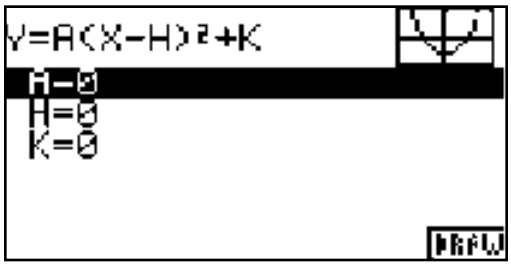
_____

_____

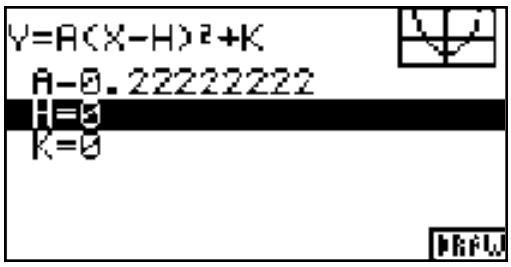
_____

Using the CONICS MENU

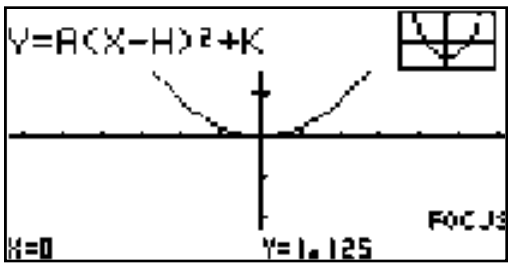
1. Turn on the calculator and highlight the **CONICS** Menu on the main screen and press **EXE**. Select **Y = A(X — H)^2 + K** by pressing the **Down Arrow** key twice. Then press **EXE**. You can now enter the values for the variables of the first equation which should be **y = 2/9 x^2**.



2. Enter 2/9 by pressing **2** **a^b/c** and **9** and then press **EXE**. Notice the screen shows the decimal equivalent of the fraction as shown on the right.



3. Press **F6** to draw the graph. Now press **SHIFT F5** and **F1**. The screen will show the graph and give the coordinates for the focus at the bottom as seen on the right.



4. Press **EXIT** and the **Up Arrow** key to enter the values for the next problem.

Using the STATISTICS Menu

1. Turn on the calculator and highlight the **STAT** Menu. Press **EXE** . Enter the *x* coordinate for the vertex and the two *x*-intercepts into List 1. Enter the y coordinate for the vertex and zero for the *y* values of the two *x*-intercepts into List 2. The screen will look like the one on the right.

2. Press **F1** and **F6** to be sure that the calculator is set up for a scatter plot. Press **EXE**. Press **F1** to get the graph. Now press **F3** to get the equation of of the parabola. The screen should look like the one on the right. Press **EXIT** to get back to the lists and enter the next set of coordinates.