12 Days Task Name:

Learning Target: I can write quadratics using the three equations. I can identify the similarities and differences between the forms. I can use a graphing calculator to explore parabolas of quadratics.

Oh your true love sure has been busy! Fill in the chart below and determine how many of each type of gift you received over the 12 Days.

|  |  |  |  |
| --- | --- | --- | --- |
| Type of Item | **Number of items in the gift** | Number of days this gift was received | **Total number each type of gift received over the 12 days** |
| **Partridge in a Pear Tree** |  |  |  |
| **Turtle Doves** |  |  |  |
| **French Hens** |  |  |  |
| **Calling Birds**  |  |  |  |
| **Golden Rings** |  |  |  |
| **Geese a Laying** |  |  |  |
| **Swans a Swimming** |  |  |  |
| **Maids a Milking** |  |  |  |
| **Ladies Dancing** |  |  |  |
| **Lords a Leaping** |  |  |  |
| **Pipers Piping** |  |  |  |
| **Drummers Drumming** |  |  |  |
|  |  | TOTAL Number of Gifts received during the 12 Days! |  |

**Part I. Representing the Data Graphically**

![[image]]()Is this data discrete or continuous? \_\_\_\_\_\_\_\_\_\_\_\_\_

Domain: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Range: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Graph the data above on the graph to the left.

What is the name of the shape that the data forms?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Would a linear, exponential, or quadratic function would best model this data? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Equation for the Axis of Symmetry? \_\_\_\_\_\_\_\_\_\_

**Part II. Creating Equations that Model the Data**

The standard form of a quadratic is $y= ax^{2}+bx+c$. Using the first three ordered pairs (1, 12), (2, 22), and (3, 30) substitute the values for x and y into the standard form to create 3 equations in terms of a, b, and c. Use these three equations to solve a system of equations with 3 variables to determine an equation that models this data.

The quadratic equation that models this data is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Part III. Characteristics of the Function**

Using your equation and showing your work below, calculate the vertex (h, k). Vertex: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Solve the quadratic by factoring (Quadratic Formula may also be used) to determine the roots or x-intercepts of the quadratic.

 X-Intercepts: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add these two points to your graph. Do these points follow the pattern of the data? These are reasonable values because on the 0th day you got \_\_\_\_\_ gifts and on the 13th day you got \_\_\_\_\_ gifts because the 12 days of gift giving were OVER!

**Now that you have the intercepts, you can write a second form of a quadratic equation called the Intercept (or Factored) form. With intercepts of (p, 0) and (q, 0) Intercept Form is y = a (x – p)(x – q).**

From the Standard Form above, we know that a = \_\_\_\_\_\_\_, from the x-intercepts also above p = \_\_\_\_\_ and q = \_\_\_\_\_

 Intercept Form: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How does the **Intercept Form** compare to the quadratic when it is **factored**? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

If there is one x-intercept at 0 and the other is at 13, what is the x-value that is half way between the intercept values (the mean)?

P = 0 and q = 13 mean x-value of 0 and 13 is x = \_\_\_\_\_\_\_

Does that value look familiar? It is the \_\_\_\_\_\_\_\_\_\_ of the vertex and the number used in the equation for the \_\_\_\_\_\_\_\_ \_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

The third form of a quadratic equation is the Vertex Form, $y=a(x-h)^{2}+k$. Write the equation in Vertex Form using the $a$ from the Standard Form and the vertex you found at the beginning of Part III.

$a$ = \_\_\_\_\_\_\_ Vertex (h, k) :\_\_\_\_\_\_\_\_\_\_ Vertex Form: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

When an equation is in vertex form, it is easy to see the transformations on the parent graph.

$a $ indicates whether the graph is Looking at the Vertex Form above, describe

* **reflected over the x-axis** ($a$ is negative) the transformations on this graph.
* **same** width as the parent graph (|a| = 1) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **vertically stretched** (|a|> 1) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **vertically compressed** (|a|< 1) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

$h$ indicates whether the parent graph has been translated left or right, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

$k$ indicates whether the parent graph has been translated up or down.

**Part V. Exploring the Data on a Graphing Calculator**

Now we’ll explore how to put the data and equation into a graphing calculator!

* **Clearing the Home Screen, Data Lists, and Y =**

Once you turn on the calculator you should always [clear] the home screen.

Since data will need to be put into the calculator we’ll also want to clear the lists. [2nd] [catalog] [C] then arrow down until the arrow is pointing at ClrAllLists and press [enter]. The calculator will return to the home screen press [enter] once more and then you will see ‘Done’.

Press [y=] and clear out any equations on that screen by arrowing down to the equation and pressing [clear].

Turn off any scatter plots by pressing [2nd] [stat plot] [4]. PlotsOff will appear on the Home Screen press [enter] once more and then you will see ‘Done’,

* **Entering Data Points into the Lists**

Press [stat] [1] to edit the items in the lists.

Enter the domain values 1-12 in L1 pressing [enter] after each value to proceed to the next value.

Arrow right to L2 Enter the range values for the totals for each type of gift (see chart).

* **Graphing the Data**

To set up the parameters for the graph, press [2nd] [stat plot], 1: should be highlighted in black, press [enter] and ensure that ON is highlighted in black by arrowing over to On and pressing [enter]. Adjust the rest of the settings to those below.

Plot1 Plot 2 Plot3

On Off

Type: Scatter Plot

Xlist: L1

Ylist: L2

Mark: **□**

To graph the data, press [zoom] [9] ZoomStat.

* **Constructing and Graphing a Quadratic Equation that Models the Data**

Press [stat], arrow right 🡪 to CALC and press [5] QuadReg for the Quadratic Regression Equation. If you see a list appear ensure that **Xlist: L1** and **Ylist: L2**. Arrow down until the word Calculate is highlighted and press [enter].

If you have a calculator that takes you to the Home Screen, you will need to add the following keys strokes after QuadReg [2nd] [1] [,] [2nd] [2] [enter]

QuadReg

y=ax2+bx+c

a= \_\_\_\_

b= \_\_\_\_

c= \_\_\_\_

 So the equation that represents this data in Standard Form is y = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Compare this equation to the one you found in Part II. What do you notice?

Press [y=] and in Y1= enter the standard form of the equation that models this data and press [enter]. What do you notice about the parabola and the data points?

* **Exploring the Table of Values Created by the Quadratic Equation**

To see the table of values for the equation graphed in the calculator, press [2nd] [table]

What are the function’s values for the 0th day? \_\_\_\_\_\_\_\_\_\_ 13th day? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

What are the function’s values for the 14th day? \_\_\_\_\_\_\_\_\_ 15th day? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ What other two x-values on this table have the same y-values? (\_\_\_\_, -14) and (\_\_\_\_, -30)

* **Modifying the Window for the Graph**

Often it is helpful to modify the ‘window’ of the graph. In this case, we will enlarge the window’s dimensions so that we can see more of the parabola. Press [window] and adjust the values according to the list below.

Window

Xmin= -5

Xmax= 14

Xscl=1

Ymin= -5

Ymax=45

Yscl= 5

When the window has been edited, press [graph] to see the graph.

* **Calculating the Maximum of the Parabola**

The maximum point of the parabola is the vertex and a very important point to the quadratic function.

1. To calculate the maximum value press [2nd] [calc] [4].
2. Now you are back to the graph and now you must set a left and right boundary for the calculator to look for the maximum that occurs between them.
3. Arrow left so that the curser goes ‘down the hill’ and away from where the vertex would be and press [enter] to set the left bound.
4. Once you see the vertical line or shaded in arrow on some models, that indicates the x-value of the Left Bound you need to arrow right past the maximum and over to the other ‘down hill’ side of the parabola and press [enter] to set the Right Bound.
5. There should be now two vertical lines indicating the x-values of the left and right bounds. The calculator asks you to Guess? You can move the cursor back to where you think the vertex is then press [enter].
6. Maximum X= \_\_\_\_\_\_ Y= \_\_\_\_\_\_

How do these values compare to the vertex you calculated in Part III?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* **Calculating the X-intercepts or Zero’s of the Parabola**

 The process to find the x-intercepts (also called a Zero because it is the x-value where the y-value is 0) is similar as you will have to set a right and left bound around the spot where the parabola crosses over the x-axis.

1. Press [2nd] [calc] [2]
2. Press and hold the left arrow until the cursor following the parabola dips below the x-axis.
3. Press [enter] to set the Left Bound.
4. Press and hold the right arrow until the cursor crosses over the x-axis and is now above the axis.
5. Press [enter] to set the Right Bound.
6. There should be now two vertical lines with two small arrows, or just two small shaded arrows on some graphing calculators, pointing toward each other indicating the x-values of the left and right bounds. The calculator asks you to Guess? You can move the cursor back to where you think the vertex is then press [enter].
7. Zero X= \_\_\_\_\_\_ Y= \_\_\_\_\_\_
8. Repeat this process on the other side of the parabola but the Left Bound will be on the side that is above the x-axis and the Right Bound will need to be set at a point below the x-axis.
9. Zero X= \_\_\_\_\_\_ Y= \_\_\_\_\_\_
10. How do these values compare to the x-intercepts you calculated in Part III?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part VI. Using a Graphing Calculator**

Now you will use the graphing calculator to explore the data from a projectile launched by a catapult.

 A catapult launches a large boulder, the path of the boulder is demonstrated below.

|  |  |
| --- | --- |
| Seconds | Height |
|  |  |
| 0 |  |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |
| 7 |  |
|  |  |

 Fill in the chart with the data from the illustration.

 Would this be continuous or discrete? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Consider the flight time of the boulder what is the

 Domain: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Range: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Where do you think the Axis of Symmetry will be?

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Clear the **lists** and **y =** and then enter boulder’s data into the lists.

Calculate the Quadratic Regression Equation (Standard Form) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Enter the equation into the Y1 and graph the function that models this statistical data.

Use the [table] feature to determine the x-intercepts and add them to the top and bottom of your chart. What is the Intercept Form of the Equation for this parabola? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

One of these values is not a valid point when considering only the flight of the boulder. The other point is very significant. Verify these points using the graph. You might find that expanding the window might help you see the intercepts.

Window

Xmin= -2

Xmax= 10

Xscl=1

Ymin= -5

Ymax=25

Yscl= 1

Explain in words what the y-intercept represents. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Explain in words what the x-intercept included in the flight path of the boulder represents. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Use the calculator to compute the vertex of the parabola. Vertex: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Explain in words what each value of the vertex represents. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Write the Vertex Form of the parabola \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Describe all of the transformations to the parent graph y = x2 that resulted in this parabola. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Ticket Out the Door

Now that you’ve explored the different forms of the equations of Quadratics, match the following forms with their useful information below.

1. Standard Form \_\_\_\_\_ A. Vertex and transformations on the parent graph are easily determined

2. Vertex Form \_\_\_\_\_ B. Also known as Factored Form, Zeros/Solutions are easily determined

3. Intercept Form \_\_\_\_\_ C. With some calculations using formulas, vertex and solutions can be determined