

Unit 8: Quadratic Functions

Learning Goal 8.1 – Transformations & Characteristics of Quadratic Functions

After completion of this unit, you will be able to...

- Identify transformations from an function or graph
- Create a function to describe given transformations
- Describe characteristics of a quadratic function on a graph (vertex, axis of symmetry, intercepts, zeros, intervals of increase/decrease, extrema, positive/negative areas, and end behavior)

Timeline for Unit 8

Monday	Tuesday	Wednesday	Thursday	Friday
20 <i>No School</i>	21 Day 1 – Transformations of Quadratic Functions	22 Day 2 – Characteristics of Quadratic Functions	23 Day 3 – Characteristics of Quadratic Functions	24 Day 4 – 8.1 Learning Assessment
27 Day 5 – Graphing in Vertex Form Graphing in Standard Form	28 Day 6 – Graphing in Factored Form Practice	29 Day 7 – Writing Equations of Parabolas	30 Day 8 – Comparing Different Forms of Quadratics	31 Day 9 – 8.2 Learning Assessment
3 Day 10 – Average Rate of Change	4 Day 11 – Applications of the Vertex	5 Day 12 – Comparing Different Quadratic Functions	6 Day 13 – Comparing Different Quadratic Functions	7 Day 14 – 8.3 Learning Assessment

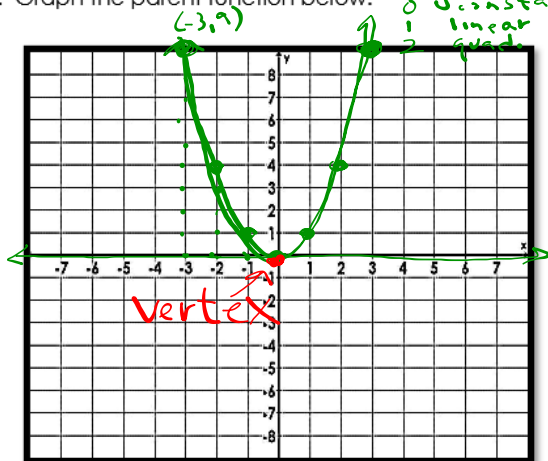
Tutoring Times

	Monday	Tuesday	Wednesday	Thursday	Friday
AM	Mrs. Jackson 7:45 – 8:15 Room 1210	Mr. Phillips 7:45 – 8:15 Room 1206	Mrs. Jackson & Mr. Webb 7:45 – 8:15 Room 1210 Room 1205	Mr. Watson & Mr. Phillips 7:45 – 8:15 Room 1208 Room 1206	Mr. Watson 7:45 – 8:15 Room 1208
PM	NONE	Mrs. Petersen 3:30 – 4:30 Room 1210	NONE	NONE	NONE

Day 1: Quadratic Transformations (H & K values)

The **parent function** of a function is the simplest form of a function. The parent function for a quadratic function is $y = x^2$ or $f(x) = x^2$. Graph the parent function below.

x	$y = x^2$
-3	$(-3)^2 = 9$
-2	$(-2)^2 = 4$
-1	$(-1)^2 = 1$
0	$(0)^2 = 0$
1	$(1)^2 = 1$
2	$(2)^2 = 4$
3	$(3)^2 = 9$



As you can see, the graph of a quadratic function is very different than the graph of a linear function.

The U-shaped graph of a quadratic function is called a parabola.

The highest or lowest point on a parabola is called the vertex.

One other characteristic of a quadratic equation is that one of the terms is always x^2 .

There are several different forms a quadratic function can be written in, but the one we are going to work with for today is called **vertex form**. In the following explorations below, you are going to learn the effect of a, h, and k values have on the parent graph.

Vertex Form

$$f(x) = a(x-h)^2 + k$$

Variable	Summary of the Effects of the Transformations		
a	Up:		Stretch:
	Down:		Shrink:
h	Left:		Right:
	Right:		
k	Up:		Down:
	Down:		

Vertex: _____

Go to: www.student.desmos.com

Enter the code: 2GR6FZ

Discovering Quadratic Transformations with Desmos

Slide 1 ~ The K Value ~ $y = x^2 + k$

a. What does the k value do to the blue graph? move \uparrow / \downarrow

b. What does a positive k value do to the blue graph? + \uparrow

c. What does a negative k value do to the blue graph? - \downarrow

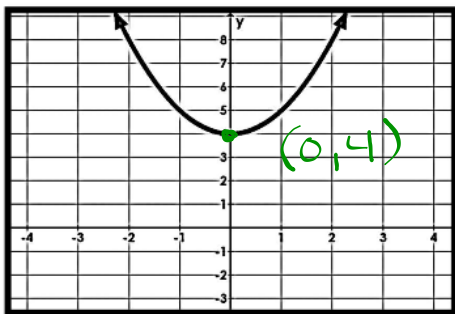
d. Which coordinate of the vertex changes when there is a k value present? y-coordinate (y-axis =) vert.

e. Name the transformations that would occur for the following equations (you may use the regular Desmos calculator for help). Then name the vertex.

$y = x^2 + k$ (0,0)

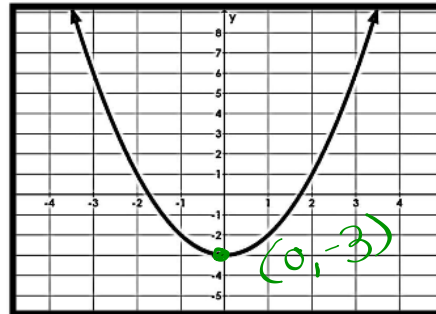
Equation	Transformations	Vertex
1. $y = x^2 + 5$	$k = +5$ up 5	(0, 5)
2. $y = x^2 - 3$	$k = -3$ down 3	(0, -3)
3. $y = x^2 + 7$	$k = +7$ up 7	(0, 7)
4. $y = x^2 - 4$	$k = -4$ down 4	(0, -4)

f. Describe the transformations and name the vertex. Create an equation for the graphs listed below.



$y = x^2$
 $k = +4$

$y = x^2 + 4$



$k = -3$

$y = x^2 - 3$

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g. Given the transformations listed below, create an equation that would represent the transformations.

1. Shifted up 8 units

$k = +8$
 $y = x^2 + 8$

2. Shifted up 20 units

$k = +20$
 $y = x^2 + 20$

3. Shifted down 5 units

$k = -5$
 $y = x^2 - 5$

Slide 2 ~ The H Value ~ $y = (x - h)^2$

- a. What does the h value do the blue graph? moves left / right
- b. What does a positive h value do to the blue graph? right
- c. What does a negative h value do the blue graph? left
- d. Which coordinate of the vertex changes when there is an h value present? x-coordinate (x-axis)

Slide 3 ~ The Tricky Part about the H Value

- e. Compare the blue graph to the black graph. How did the blue graph move? left 4
- f. What should be the h-value for the blue graph? $h = -4$
- g. However, when you look at the equation for the blue graph, what do you notice?
 $y = (x + 4)^2$ (plus sign)
- h. Compare the green graph to the black graph. How did the green move? right 2
- i. What should be the h-value for the green graph? $h = +2$
- j. However, when you look at the equation for the green graph, what do you notice?
 $y = (x - 2)^2$

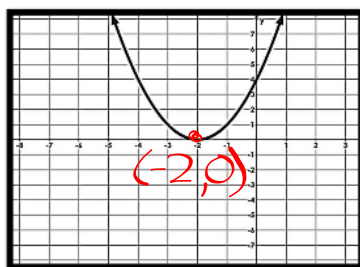
$h = \text{hypocrisy}$

HMMM.....Now read Slide 4!

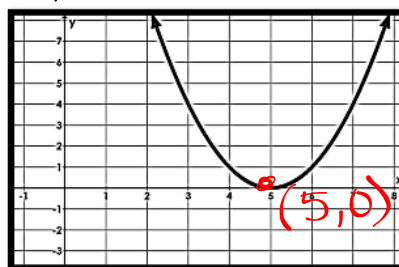
- k. Name the transformations that would occur for the following equations (you may use the regular Desmos calculator for help). Then name the vertex.

Equation	Transformations	Vertex
1. $y = (x - 4)^2$	<u>$h = +4$, right 4</u>	<u>$(4, 0)$</u>
2. $y = (x + 6)^2$	<u>$h = -6$, left 6</u>	<u>$(-6, 0)$</u>
3. $y = (x - 7)^2$	<u>$h = +7$, right 7</u>	<u>$(7, 0)$</u>
4. $y = (x + 3)^2$	<u>$h = -3$, left 3</u>	<u>$(-3, 0)$</u>

- l. Describe the transformations and name the vertex. Create an equation for the graphs listed below.



$y = (x - h)^2$
 $y = (x + 2)^2$
 $y = (x + 2)^2$



$y = (x - 5)^2$

- m. Given the transformations listed below, create an equation that would represent the transformations.

- 1. Shifted +8 units
 $h = +8$

$y = (x - 8)^2$

- 2. Shifted -20 units
 $h = -20$

$y = (x + 20)^2$

- 3. Shifted -5 units
 $h = -5$

$y = (x + 5)^2$

Putting It All Together with H and K

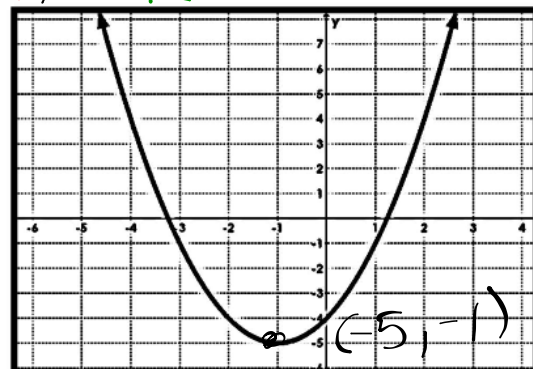
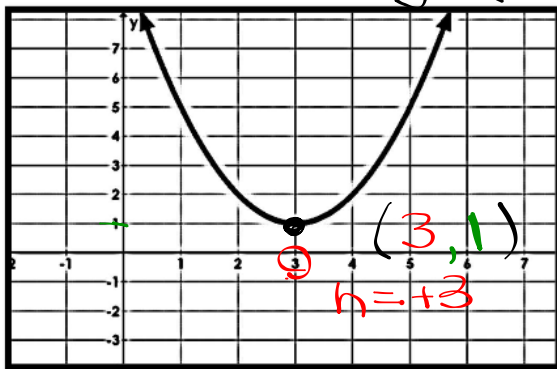
Practice: Identify the transformations and vertex from the equations below.

(h, k)

Equation	Transformations	Vertex
1. $y = (x - 2)^2 + 4$	$h = +2 \rightarrow$ right 2 $k = +4 \rightarrow$ up 4	$(2, 4)$
2. $y = (x + 3)^2 - 2$	$h = -3 \rightarrow$ left 3 $k = -2 \rightarrow$ down 2	$(-3, -2)$
3. $y = (x - 9)^2 - 5$	$h = +9 \rightarrow$ right 9 $k = -5 \rightarrow$ down 5	$(9, -5)$
4. $y = (x + 5)^2 + 6$	$h = -5 \rightarrow$ left 5 $k = +6 \rightarrow$ up 6	$(-5, 6)$

Practice: Describe the transformations and name the vertex. Create an equation for the graphs listed below.

$y = (x - h)^2 + k$



Transformations:	$h = +3 \rightarrow$ right 3 $k = +1 \rightarrow$ up 1	Transformations:	$h = -5 \rightarrow$ left 5 $k = -1 \rightarrow$ down 1
Vertex:	$(3, 1)$	Vertex:	$(-5, -1)$
Equation:	$y = (x - 3)^2 + 1$	Equation:	$y = (x + 5)^2 - 1$

Practice: Given the transformations listed below, create an equation that would represent the transformations.

1. Shifted up 4 units and left 3 units
 $h = -3$
 $k = +4$
 $y = (x + 3)^2 + 4$

2. Shifted right 5 units and down 2 units

3. Shifted left 8 units and down 1 unit
 $h = -8$
 $k = -1$
 $y = (x + 8)^2 - 1$

4. Shifted up 5 units and right 9 units

Algebra 1

Unit 8: Quadratic Functions

Notes

Slide 5 ~ The A Value, part 1 ~ $y = ax^2$

- a. What does the a value do the blue graph? wider / skinnier
- b. When a is greater than 1, what does it do to the blue graph? skinny (stretch)
- c. When a is between 0 and 1, what does it do to the blue graph? wider (shrink)
- d. If there is only an a value, what will the vertex always be? _____

Slide 6 ~ The A Value, part 2 ~ $y = ax^2$

- a. What does the a value do the blue graph? reflect (-)
- b. When a is less than 1, what does it do to the blue graph? _____

Practice: Describe the transformations from the given function to the transformed function.

- a. $f(x) = x^2 \rightarrow f(x) = 4x^2$
- b. $y = x^2 \rightarrow y = \frac{1}{4}x^2$
- c. $f(x) \rightarrow 6f(x)$
- d. $f(x) = x^2 \rightarrow f(x) = -x^2$
- f. $y = x^2 \rightarrow y = -\frac{1}{2}x^2$
- g. $f(x) \rightarrow -4f(x)$

Putting It All Together with A, H, and K

Practice: Given the equations below, name the vertex and describe the transformations:

Equation	Transformations	Vertex
1. $y = -(x - 4)^2 + 7$		
2. $y = -2(x + 2)^2 + 5$		
3. $y = \frac{1}{2}(x - 3)^2 - 8$		

Practice: Create an equation to represents the following transformations:

- a. Shifted down 4 units, right 1 unit, and reflected across the x-axis
- b. Shifted up 6 units, reflected across the x-axis, and stretch by a factor of 3
- c. Shifted up 2 units, left 4 units, reflected across the x-axis, and shrunk by a factor of $\frac{1}{4}$.