

Lesson Title: Graphing Quadratic Equations in Vertex Form

Unit Title: Quadratic Equation

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Subject, Grade Level, and Date: Algebra II, 9th-12th, February 5, 2016

Placement of Lesson in Sequence

The lesson is the third lesson of the sequence. The students' first lesson was how to graph points on an xy -coordinate plane by evaluating the x values. In the second lesson the students will have learned to graphing quadratic equations in standard form. The students be finding the vertex point and the axis of symmetry using the vertex and axis of symmetry formulas, respectively. The students will be learning the third lesson about how to graph quadratic equations in vertex form. The students will be using the vertex point and evaluating x values to graph the quadratic equation.

Central Focus and Essential Questions

The central focus of the third lesson is to teach students how to graph quadratic equations in vertex form using the vertex and the characteristics of the graph. The students will focus on the behavior of simple quadratic equations and how they differ from the parent function. One essential questions to ask are: What is the parent graph of $y = x^2$ look like? The students will then be introduced to the vertex form of a quadratic equation. The teacher will stress questions such as: What is the vertex form of a quadratic equation written as? What do the variables a , h , and k represent? What direction does h move? What direction does k move? What does the variable of a say about the equation? What if a is greater than 1? Less than 1? Which one is a vertical stretch and shrink? The essential questions will help the teacher focus on teaching the students the concept of how to graph a quadratic equation in vertex form. Moreover, the students need to be able to graph a quadratic equation in order to introduce the students to how they are used in real life.

Content Standards

The third lesson aligns with the Common Core standard is [CCSS.MATH.CONTENT.HSF.IF.C.7](#), which states: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

Learning Outcomes (Objectives)	Assessment
The students will be able to find and state the vertex form of a quadratic equation in vertex form. They will use the vertex form and find two points to graph the quadratic equation in vertex form. The students will also be able to describe the behavior of a quadratic equation in vertex form.	The students will be assessed by their participation in the class. They will have to present and describe their quadratic equation they have created to the classroom. The students will then be graded by points of the number of correct problems they do. The students will then be informally assessed using questions to check for their progression and understanding of the information. Once the students are working in groups, the teacher will go around to each group and make sure they know what they are doing and understand the process. The teacher will also help each student that needs help on the assignment.

Learning Targets	Student Voice
<p>There are three learning targets for the lesson. The first is: I will be able to state the vertex from a quadratic equation in vertex form. The second is: I will be able to graph a quadratic equation in vertex form using the vertex and two points. The third learning target is: I will be able to describe the behavior of the quadratic equation and be able to understand how they connect to the vertex form of a quadratic equation.</p> <p>The three learning target will be meet with 85% mastery.</p>	<p>The students will be able to write down what they have learned in the classroom. The learning targets will be written on the board throughout the classroom. They will be introduced to them in the beginning of the class and will be working on achieving the goals. The students will also be provided with times to express their understanding and questions during the class. The students will collaboratively be working in groups and have peer support to be able to mastery the learning targets.</p>

Prior Content Knowledge and Pre-Assessment

The students will have had previous knowledge about transformations of quadratic equations. The students will struggle on recalling how to write a quadratic equation based on the transformation the quadratic equation demonstrates. The students will be getting a pre-assessment as the entry task in lesson three. The entry task will help the teacher decide in the classroom whether the students need to recover transformations quickly. The students also have prior content knowledge about what the standard form of a quadratic equation is written as. The students know what the value of a does to the graph. Some students struggle on using the vertex formula and the axis of symmetry to find the vertex and axis of symmetry. Overall, the students will be able to graph a quadratic equation by evaluating the x values and plotting them. The students will be able to also plot the vertex, the axis of symmetry, and points to graph a quadratic equation in standard form.

Academic Language Demands		
Vocabulary & Symbols	Language Functions	Mathematical Precision, Syntax, & Discourse
<ul style="list-style-type: none"> • Quadratic equation in vertex form • Vertex • Axis of symmetry • Vertical shrink • Vertical stretch 	<p>Students will need to know what the vertex form of an equation looks like. The students will have to interpret what the variables of a, h, and k represent and how that affects the quadratic equation. Using the variables a, h, and k, the students will need to use that information in order to find the vertex and be able to graph the equation. The students need to understand the vocabulary of the lesson in order to be successful in meeting the learning targets for the lesson.</p>	<p>Mathematical Precision Students will use the x values that were computed in order to graph the quadratic equation in vertex form. The student will need to be precise because the values represent and model the quadratic equation.</p> <p>Syntax Students will learn to graph quadratic equations in vertex form. The students will need to correctly identify the vertex of the vertex form quadratic equation. The students must place the numbers in the</p>

		<p>correct spot in the x, y coordinate point.</p> <p>Discourse Students will be writing the change in behavior the quadratic equation does from the parent function. The students must state the horizontal, vertical, and/or vertical shrink or stretch. Students will need to be able to identify the behaviors of the vertex form quadratic equation in order for the students to successfully understand the concept of graphing the quadratic equation in vertex form.</p>
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Language Target	Language Support	Assessment of Language Target
<p>The students will be able to communicate with their peers about the assignment in order to help each other learn. The students will also need to understand the language of the lesson in order to meet the standards for the lesson. Overall, the student's will need to use the language learned in the lesson to be able to describe the behavior of the quadratic equation.</p>	<p>The students will be collaboratively working together to complete the assignment. The students will be communicating with one another to understand the information. If a student is struggling to understand one of the vocabulary words, the students will be their support to be able to understand the word better. The teacher will also be walking around the room asking students if they need help and for checking for the student's comprehension.</p>	<p>The student will be working through a table with quadratic equations. The table will be scaffold in order to help the students ease in to graph a quadratic equation in vertex form is. The students will be informally assess by communicating out loud in the classroom. The teacher will either accept or not accept the student's response. If the response is approve, the student will be questioned on the response to further deeper learning. If the student does not have the appropriate response, the teacher will ask leading questions until the student is able to be on the right track to understanding the information.</p>

Lesson Rationale (Connection to previous instruction and Objective Standards)

The students know about the eight parent functions and will be using the quadratic equation to learn about the quadratic equation in vertex form. The students have previously learned how to graph quadratics in standard form in the second lesson. The students were able to find the vertex, axis of symmetry, and graph points on a graph. The students struggled to understand the information in the beginning of lesson two. Thus, the students will be working in groups to use theirs to help them learn deeper. The students are now ready to graph quadratic equations in vertex form. The students will work on the transformations of the parent function of $y = x^2$ and will be gradually moving closer to understanding how the transformations relate to the vertex form of a quadratic equation. The students will then use a table to help organize their thoughts and steps of each transformation. The students will then receive two problem assignment to complete in class or for homework if they do not finish. In addition, the students will be completing an exit task sheet before they leave the classroom. This allows for feedback of the students comprehension so that the teacher is able to structure the next day's lesson based off the students' mastery towards the learning targets. The unit is important to teach the students because they will need to be able to comprehend and gain knowledge on how quadratic equations are used in real life situations.

Differentiation, Cultural Responsiveness and/or Accommodation for Individual Differences

The students will have an equal opportunity to learn from their peers and have their support and they are learning the concept and procedural fluency of how to graph a quadratic equation in vertex form. The worksheet that will be the student's class work and homework, if students are finished, will be scaffold in order to accommodate to all the learners in the classroom. The students will be collaboratively learning as they work through the worksheets. The groups are also able to work at their own pace and ask for questions if they need a concept cleared up.

Materials – Instructional and Technological Needs (attach worksheets used)

The students will need a copy of the worksheets provided below. There will need to be 32 copies of each worksheet that will be given to the students. Access to a white board is very critical for the instruction to take place in the class. The students and teacher will be using the white board to instruct students. The students must come to class with a pen or paper to be able to begin the assignment in the classroom.

Teaching & Instructional Activities			
Time	Teacher Activity	Student Activity	Purpose
x min.			
Warm Up 5 mins.	The teacher will have the students split into groups of 5. Each group will be drawing and presenting their quadratic equation. The students will have to discuss about the behavior of the graph they drew. The students will have to describe whether the graph moves up, down, left, right,	Students will drawing quadratic equations and explaining the behavior of the quadratic equation. This allows the students to gain the concept of the transformations of quadratic equations.	This activity will allow the students to gain the concept of how the quadratic equations move. This will allow the notation to be presented. The students will be started off with a warm-up so they can progress to the vertex form notation of a quadratic equation.

	reflect across the x and y-axis.		
Part I	The teacher will then present a lecture. The students will be following along and be participating in lesson. Questions will be asked from both the teacher and the student. Questions such as: What does the h mean? What does the k mean? How do we find the vertex point?	The class will be working on a table of equations while looking at the behavior of the equations. This allows the students to progress gradually to the vertex form of a quadratic equation.	The students will be gradually exposed to the notation of the vertex form of a quadratic equation. The students will be lead from each equation until comprehension has been meet.
Part II	Once the teacher is finished with the lecture, the teacher will hand out the worksheets for the students to be working on. The teacher will be walking around helping the students if they need help.	The students will then work in groups of 5 on complete two problem. The students will need to complete those in class.	The purpose of this activity is for the students to demonstrate their ability in graphing quadratics in vertex form. This will also help the students in the class collaborate and work together as a team. This allows for the students to learn from their peers and communicate their thoughts about the assignment.
Exit Task	The teacher will then hand out the exit task in the last five minutes of class.	The students will then receive an exit task sheet that will allow them to reflect upon how well they learned and what they learned. The students will also have one main question that will allow the teacher to know whether the class can move on to the next topic or will need to review on the topic.	The purpose of this is to allow the students to reflect on their overall information they learned in class. This also allows for feedback to be given to the teacher so that the next lesson can be tailored to the student's level of comprehension.
Homework	The teacher will then present homework at the end of the class and will post it on Google Classroom.	The students will be assigned homework that will be posted on Google Classroom for all students to know what they need to do. The student's will have more homework to help them practice their ability	The purpose of this is for students to gain more practice in graphing quadratic equations in vertex form. This will help the student succeed in mastery the learning targets for the lesson.

		and skills to graph a quadratic equation in vertex form using the vertex point and two points on the side.	
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Entry Task, worksheet, exit slip are displayed below.

Entry Task is called: ***“I am very able to graphing quadratics in vertex form!”***

The worksheet is called: ***Graphing Quadratic Equations in Vertex Form***

The exit slip is called: ***“Don’t let it slip out of your brain!”***

“I am very able to graphing quadratics in vertex form!”

Instructions: Complete the problems below.

Equation	Describe the equation (Does it move left, right, up, down, reflect over the y or x-axis, open up or down, vertical shrink or vertical stretch?)	Sketch the graph	Vertex $(x, y) \rightarrow (h, k)$ & Axis of symmetry	Notation
$f(x) = x^2$ (Parent function)	Parent function			
$y = x^2 + 2$				
$y = x^2 - 3$				
$y = -1(x - 3)^2$				
$y = (x + 5)^2$				
$y = (x - 5)^2 + 1$				
$y = (x - 5)^2 - 1$				
$y = -x^2$				
$y = (-x)^2$				
$y = 2(x - 3)^2$				
$y = \frac{1}{2}(x - 3)^2$				
$y = (x + 3)^2 + 4$				
$y = (x - 3)^2 - 1$				

What is the vertex form of a quadratic equation?

Graphing Quadratic Equations in Vertex Form

Name: _____

Date: _____

Algebra II

Instructions: Collaboratively work with your group to complete the problems below.

First Problem:

1. Write the vertex form of a quadratic equation, $y = x^2$.
2. Given the equation $y = 2(x + 3)^2 + 2$, what is the value of:
 - $a = \underline{\hspace{2cm}}$ $h = \underline{\hspace{2cm}}$ $k = \underline{\hspace{2cm}}$
3. Describe what the equation, $y = 2(x + 3)^2 + 2$, is doing. Use complete sentence.
4. Does the graph open upward or down word? Does it vertical shrink or vertical stretch?
5. What is the vertex of $y = 2(x + 3)^2 + 2$?
6. What is the axis of symmetry of $y = 2(x + 3)^2 + 2$?
7. Using the information that you have found in questions 2-5, graph the equation $y = 2(x + 3)^2 + 2$ in the space below. Use can use the table to find the points of the graph. **Label** the vertex and the axis of symmetry.

x	y

Second Problem:

1. Write the vertex form of a quadratic equation, $y = x^2$.
2. Given the equation $y = -\frac{1}{2}(x - 2)^2 + 1$, what is the value of:
 - $a = \underline{\hspace{2cm}}$ $h = \underline{\hspace{2cm}}$ $k = \underline{\hspace{2cm}}$
3. Describe what the equation, $y = -\frac{1}{2}(x - 2)^2 + 1$, is doing. Use complete sentence.
4. Does the graph open upward or down word? Does it vertical shrink or vertical stretch?
5. What is the vertex of $y = -\frac{1}{2}(x - 2)^2 + 1$?
6. What is the axis of symmetry of $y = -\frac{1}{2}(x - 2)^2 + 1$?
7. Using the information that you have found in questions 2-5, graph the equation $y = -\frac{1}{2}(x - 2)^2 + 1$ in the space below. Use can use the table to find the points of the graph. **Label** the vertex and the axis of symmetry.

x	y

“Don’t let it slip out of your brain!”

Instructions: Use the information that you learned to help you complete the problems below.

1. What did you learn in class today?
2. What you still need help on:
 - a. Finding the vertex
 - b. Graphing the equation in vertex form
 - c. Finding the points of the equation
 - d. Describing the behavior of the graph
 - e. Other:
3. What could Ms. Kas do to help you learn easier? Circle that apply or write one in:
 - a. Use more examples
 - b. Work in groups
 - c. Need more time to understand the information
 - d. Nothing, she did great today!
 - e. Use simpler problems?
 - f. Other:

4. Circle below the level you are at:

2	1	0
I understand how to graph quadratic equations in vertex form. I am ready to move on.	I still need more time to practice how to graph quadratic equations in vertex form.	I do not understand at all how to graph quadratic equations in vertex form.

5. What is the vertex of $y = (x - 3)^2 + 4$?

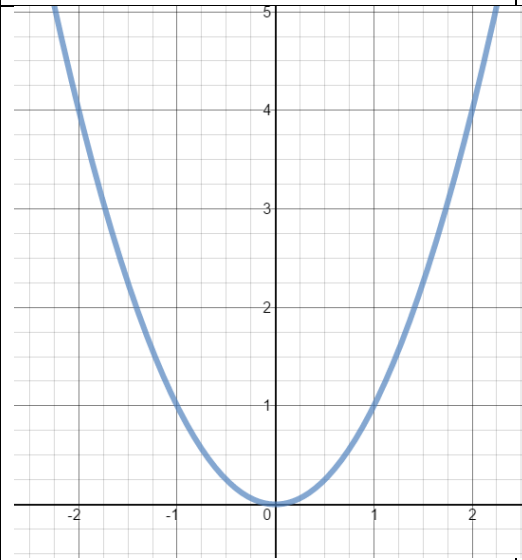
6. What is your attitude towards the math that was done in the class today?

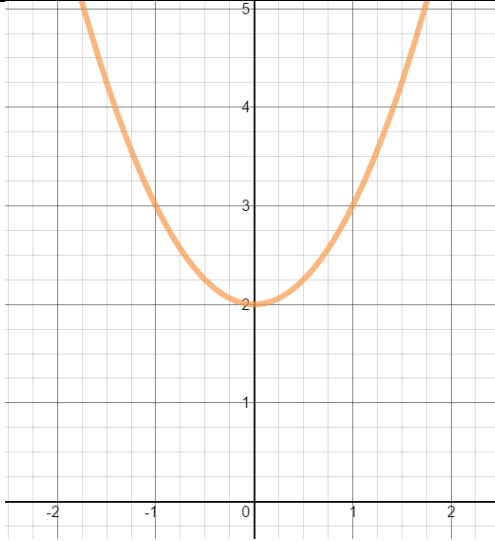
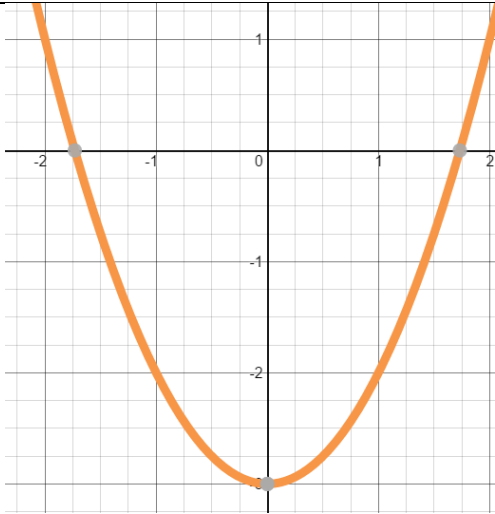
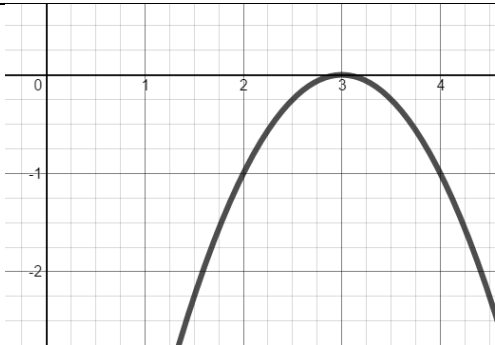
For example: *"I liked that math that we did today because I understand it!"*

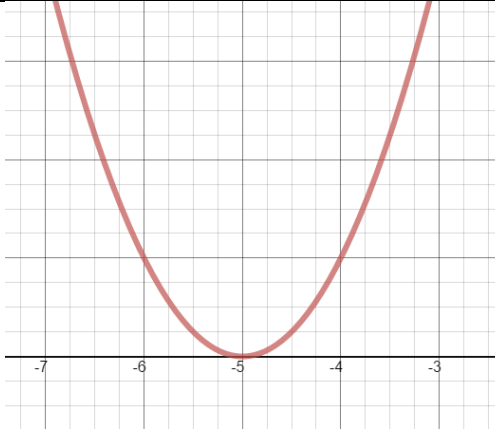
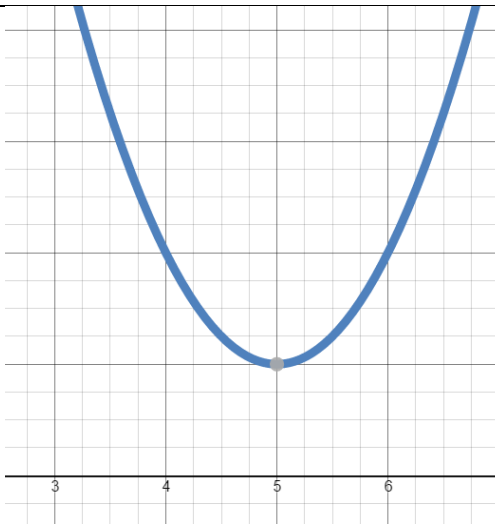
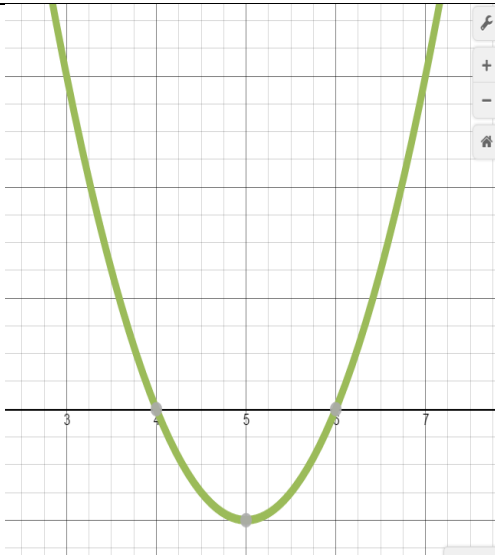
Answer key:

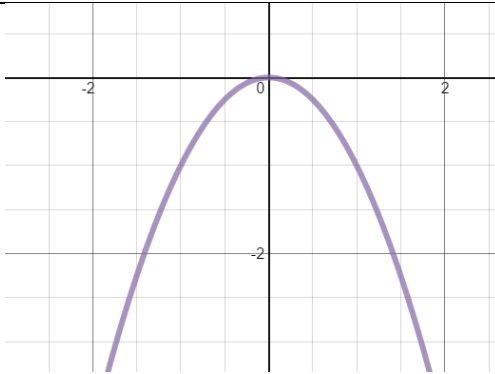
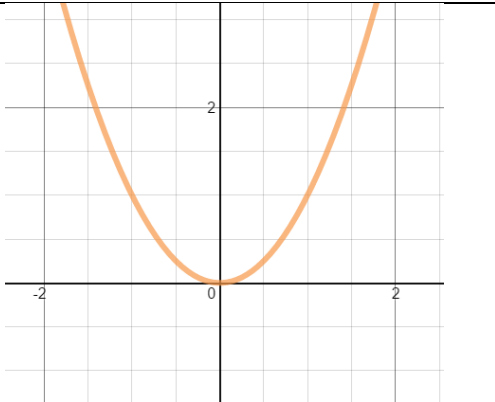
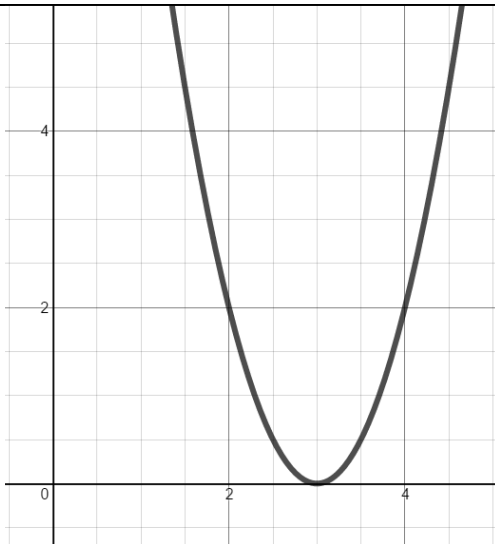
"I am very able to graphing quadratics in vertex form!"

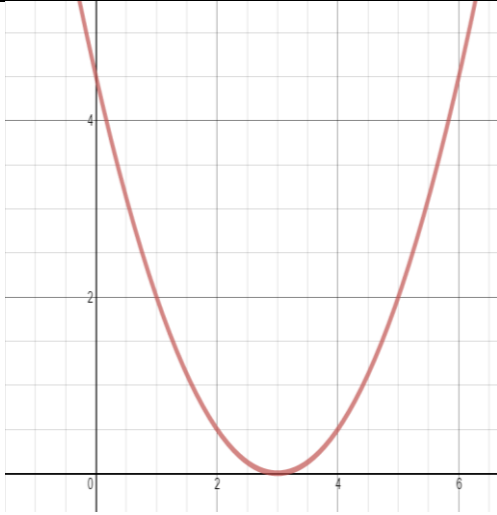
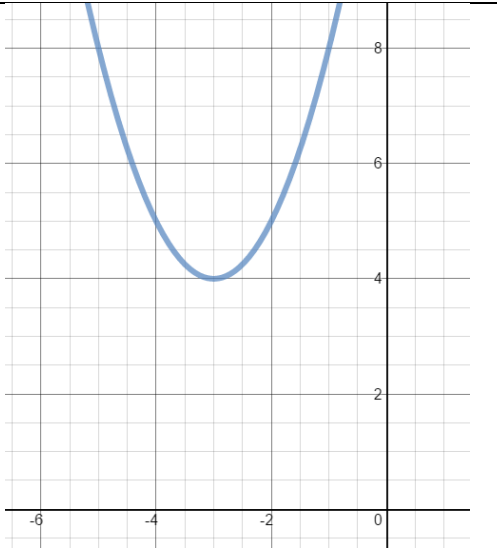
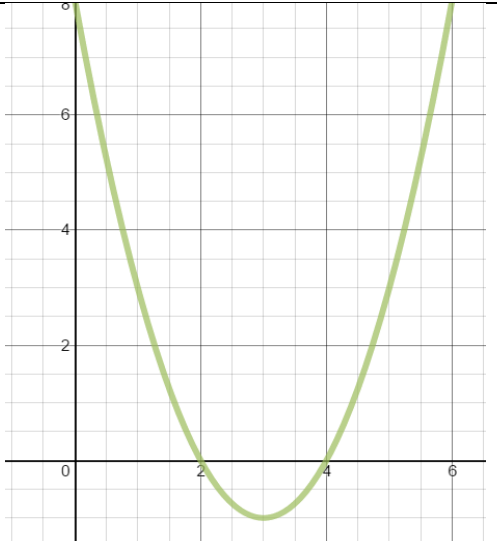
Instructions: Complete the problems below.

Equation	Describe the equation (Does it move left, right, up, down, reflect over the y or x-axis, open up or down, vertical shrink or vertical stretch?)	Sketch the graph	Vertex (x, y) $\rightarrow (h, k)$ & Axis of symmetry	Notation
$f(x) = x^2$ (Parent function)	Parent function Opens upward		(0,0) $x = 0$	$f(x)$

$y = x^2 + 2$	<p>Opens upward Moves up 2 units</p>		<p>(0,2) $x = 0$</p>	$f(x) + k$
$y = x^2 - 3$	<p>Opens upward Moves down 3 units</p>		<p>(0,3) $x = 0$</p>	$f(x) - k$
$y = -1(x - 3)^2$	<p>Opens downward Moves 3 units to the right</p>		<p>(3,0) $x = 3$</p>	$-f(x - h)$

$y = (x + 5)^2$	<p>Opens upward Moves 5 units to the left</p>		$(-5, 0)$ $x = -5$	$f(x - (-h))$
$y = (x - 5)^2 + 1$	<p>Opens upward Moves 1 unit upward Moves right 5 units.</p>		$(5, 1)$ $x = 5$	$f(x - h) + k$
$y = (x - 5)^2 - 1$	<p>Opens upward Moves 1 unit upward Moves 5 units to the right</p>		$(5, -1)$ $x = 5$	$(x - h)^2 - k$

$y = -x^2$	<p>Opens downward Reflects over the $x - axis$</p>		<p>(0,0) $x = 0$</p>	$-f(x)$
$y = (-x)^2$	<p>Opens upward Reflects over the $y - axis$</p>		<p>(0,0) $x = 0$</p>	$f(-x)$
$y = 2(x - 3)^2$	<p>Opens upward Moves 3 units to the left Vertical shrink by 2 units</p>		<p>(3,0) $x = 3$</p>	$y = a(x - h)^2$

$y = \frac{1}{2}(x - 3)^2$	<p>Opens upward</p> <p>Moves 3 units to the left</p> <p>Vertical stretch by $\frac{1}{2}$ units</p>		$(3, 0)$ $x = 3$	$y = a(x - h)^2$
$y = (x + 3)^2 + 4$	<p>Opens upward</p> <p>Moves 4 units up</p> <p>Moves to the left 4 units.</p>		$(-3, 4)$ $x = -3$	$y = a(x - h)^2 + k$
$y = (x - 3)^2 - 1$	<p>Opens upward</p> <p>Moves 1 unit up</p> <p>Moves 3 units to the right</p>		$(3, -1)$ $x = 3$	$y = a(x - h)^2 + (-k)$

What is the vertex form of a quadratic equation?

The vertex form of a quadratic equation is $y = a(x - h)^2 + k$.

Graphing Quadratic Equations in Vertex Form

Name:

Date:

Algebra II

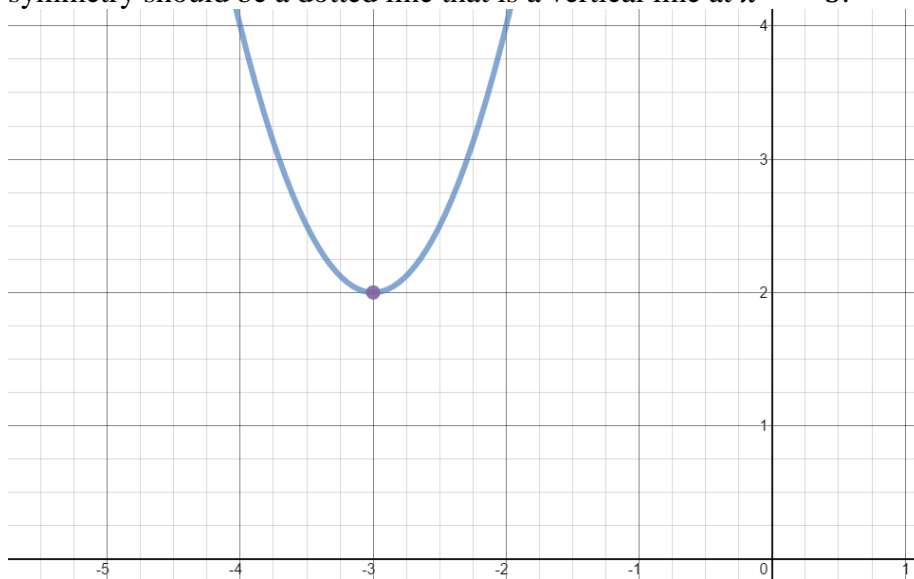
Instructions: Collaboratively work with your group to complete the problems below.

First Problem:

1. Write the vertex form of a quadratic equation, $y = x^2$.
 - a. $y = a(x - h)^2 + k$
2. Given the equation $y = 2(x + 3)^2 + 2$, what is the value of:
 - a. $a = 2$ $h = -3$ $k = 2$
3. Describe what the equation, $y = 2(x + 3)^2 + 2$, is doing. Use complete sentence.
The equation moves two units upwards and three units to the left.
4. Does the graph open upward or down word? Does it vertical shrink or vertical stretch?
The graph opens upward because the a value is a positive value and larger than 1.
5. What is the vertex of $y = 2(x + 3)^2 + 2$?
The vertex is $(-3, 2)$.
6. What is the axis of symmetry of $y = 2(x + 3)^2 + 2$?
The axis of symmetry is $x = -3$.
7. Using the information that you have found in questions 2-5, graph the equation $y = 2(x + 3)^2 + 2$ in the space below. Use can use the table to find the points of the graph.

Label the vertex and the axis of symmetry.

The purple dot is the vertex point. The equation is in the blue. The axis of symmetry should be a dotted line that is a vertical line at $x = -3$.



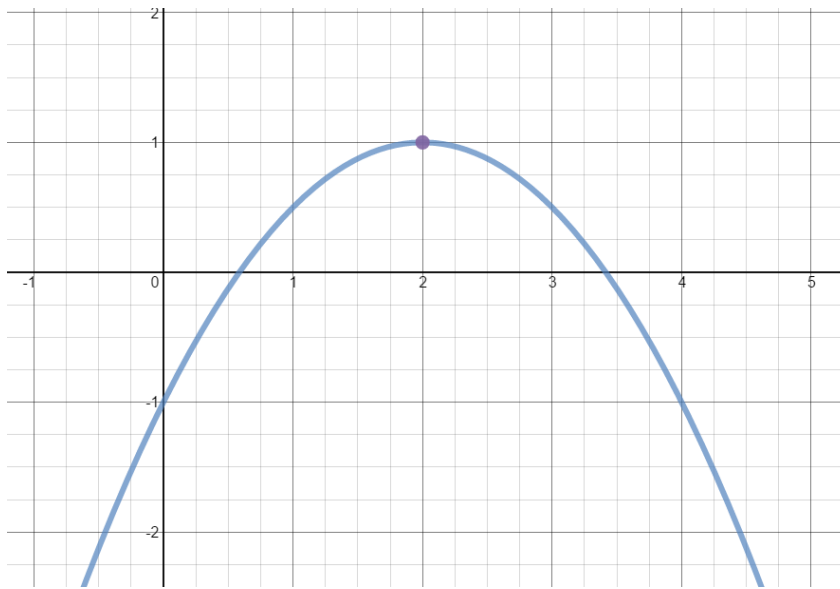
x	y
-2	4
-3	2
-4	4

Second Problem:

1. Write the vertex form of a quadratic equation, $y = x^2$.
 - a. $y = a(x - h)^2 + k$
2. Given the equation $y = -\frac{1}{2}(x - 2)^2 + 1$, what is the value of:
 - i. $a = -\frac{1}{2}$ $h = 2$ $k = 1$
3. Describe what the equation, $y = -\frac{1}{2}(x - 2)^2 + 1$, is doing. Use complete sentence.
 - a. The equation is moving up one unit and over to the right two units.
4. Does the graph open upward or down word? Does it vertical shrink or vertical stretch?

- a. The graph opens downward because the a value is negative. The equation also exhibits a vertical stretch by a factor of $\frac{1}{2}$.
5. What is the vertex of $y = -\frac{1}{2}(x - 2)^2 + 1$?
The vertex is (2,1).
6. What is the axis of symmetry of $y = -\frac{1}{2}(x - 2)^2 + 1$?
The axis of symmetry is $x = 2$.
7. Using the information that you have found in questions 2-5, graph the equation $y = -\frac{1}{2}(x - 2)^2 + 1$ in the space below. Use can use the table to find the points of the graph. **Label** the vertex and the axis of symmetry. The purple dot is the vertex point. The equation is in the blue. The axis of symmetry should be a dotted line that is a vertical line at $x = 2$.

x	y
0	-1
1	.5
2	1
3	.5
4	-1



“Don’t let it slip out of your brain!”

Instructions: Use the information that you learned to help you complete the problems below.

- What did you learn in class today?
The students should write around this idea, which is the learning target the students were going to complete for the lesson: I learned about how to graph quadratic equations in vertex form.
- What you still need help on:
 - Finding the vertex
 - Graphing the equation in vertex form
 - Finding the points of the equation
 - Describing the behavior of the graph
 - Other:

The student responses will vary based on student’s comprehension in graphing quadratic equations in vertex form.

- What could Ms. Kas do to help you learn easier? Circle that apply or write one in:
 - Use more examples

- b. Work in groups
- c. Need more time to understand the information
- d. Nothing, she did great today!
- e. Use simpler problems?
- f. Other:

The student responses will vary based on student's opinion on how Ms. Kass can help them learn.

4. Circle below the level you are at:

2	1	0
I understand how to graph quadratic equations in vertex form. I am ready to move on.	I still need more time to practice how to graph quadratic equations in vertex form.	I do not understand at all how to graph quadratic equations in vertex form.

- a. The student responses will vary based on student opinion on their comprehension.
5. What is the vertex of $y = (x - 3)^2 + 4$?
- a. The vertex is (3, 4).
6. What is your attitude towards the math that was done in the class today?
- a. For example: *"I liked that math that we did today because I understand it!"*
The student responses will vary based on their attitude towards the math learned in class.