Factored Form of a Quadratic Function

Lesson by Chicago Teachers Union Quest Center;
Annotation by Student Achievement Partners

GRADE LEVEL High School

IN THE STANDARDS F-IF.B.4, F-IF.C.7

WHAT WE LIKE ABOUT THIS LESSON:

Mathematically:

- Promotes coherence by highlighting prior knowledge and pointing to the mathematics that will be built from these ideas
- Develops students' understanding of zeros and other key features from the factored form of a quadratic function (F-IF.B.4)
- Requires students to analyze and see the connection between quadratic functions represented graphically and algebraically
- Requires students' use of precise course-appropriate mathematical language (MP.6)

In the classroom:

- Offers an engaging activity that connects students' procedural skill and conceptual understanding of the key features of a quadratic function
- Allows for whole group, partner, and individual work in one lesson
- Provides entry points for student discussion through suggested dialogue for teachers
- Encourages students to share their developing thinking
- Uses explanations and representations to make the mathematics of the lesson explicit

MAKING THE SHIFTS[1]

Focus	Belongs to the Widely Applicable Prerequisites for College and Careers[2]
Coherence	Builds on many key understandings from grade 8, expanding from linear to quadratic functions, and specifically calls out how this lesson falls within the progression of learning
Rigor[3]	Conceptual Understanding: primary in this lesson (F-IF.B.4)
	Procedural Skill and Fluency: primary in this lesson (F-IF.C.7)
	Application: not addressed in this lesson

[1] For more information read Shifts for Mathematics.
[2] For more information, see Widely Applicable Prerequisites for College and Careers.
[3] Lessons may target one or more aspect(s) of rigor.

ADDITIONAL THOUGHTS

It's important to note that this sample lesson is intended to span multiple class periods, and is the second lesson in an eight-lesson unit on "Quadratics for Career and College Readiness." All other lessons in this unit can be viewed here. It is not intended for the students to meet the full expectations of the course-level standards addressed through only this lesson. For example, F-IF.B.4 requires that students also be able to interpret key features of functions in terms of their context, but this lesson addresses only the key features of the functions without context. This is something that should be addressed in later lessons.

The stations activity at the end of the lesson provides a powerful way to understand function behavior. It allows students to look at functions with the same algebraic format to understand how the changing values affect the graph, and to look at a group of graphed functions with the same zeros to see how their algebraic representations are different.

For more insight on the course-level concepts addressed in this lesson, read pages 7–9 of the progression document, Grade 8, High School, Functions.

Factored Form of a Quadratic Function

Lesson Summary

Students develop an understanding of maximum/minimum, axis of symmetry, zeros, and vertex of quadratic functions in factored form. They gain an understanding of how to graph functions in factored form and an ability to explain the key concepts, reinforcing their ability to attend to precision. This activity was designed to lead into a lesson on factoring that will enable students to solve quadratic equations. The lesson was designed to help students thoroughly understand factors and zeros and their relationship, analyzing them both abstractly and quantitatively.

Lesson Objectives

Students will be able to:

- Students will write zeros of a quadratic function in factored form.
- Graph a quadratic function in factored form.
- Identify maximum/minimum, axis of symmetry, vertex, zeros, of a quadratic function in factored form.

Common Core State Standards:

A-CED.1: Create equations that describe numbers or relationship. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*

F-IF.7a: Graph linear and quadratic functions and show intercepts, maxima, and minima.

Time Allotment - 3 class sessions of 50 minutes each

Lesson Resources:

- EL Objectives and Vocabulary
- Analysis of CCSS Implementation
- Learning Progressions
- Materials and Attachments List
- Answer Key

Standards for Mathematical Practice:

- **MP.2** Reason Abstractly and Quantitatively
- **MP.6** Attend to Precision.

Lesson Breakdown:

Day 1

- Guided notes to identify zeros of a quadratic function and how to write them as linear factors.

Day 2

- A small group discovery activity to assist students in learning about finding the vertex and the identifying the role of *a* in the factored form of a quadratic function.

Day 3

- Guided notes to graph quadratics in factored form, identifying maximums/minimums, axis of symmetry, vertex, and zeros.
- Exit Slip

Factored Form of a Quadratic Function

Steps and Learning Activities	Anticipated Student Responses and Teacher Support
Day 1 **Understanding Zeros Guided Notes:** (40-50 Minutes) • Give students 3 different parabolas and have them identify the zeros. • Discuss Zero Product Property walking them through the example given. • Discuss Linear Factors and their definition. • Have students use a Graphing Calculator to graph a Quadratic Function and identify the zeros, from the example that they just used. • Discuss Factored Form of a quadratic function. Have students write each quadratic function in factored form. • Ask students to explain their process for writing linear factors from the graph of a quadratic function. Discuss the students' responses. Explain how to write linear factors of polynomials: $(x-p)$, $(x-q)$. Then have students write the linear factors of the parabolas given at the beginning of the notes.	"Why are these zeros? Are these the only zeros of the graph?" [1] *"These are the zeros because this is where function is equal to zero. You can see this on the graph of the quadratic function, because the y-value of the graph is equal to zero."* *"By looking at this graph of the function, these are the only zeros of the graph within the system of real numbers that we are working with. As you continue into higher levels of math, you will learn about other systems of numbers, where other zeros may exist. [This may be a good answer to give to students, if this question arises, because they get so frustrated at higher levels when they think that these can be the ONLY zeros.]"* "Why is it $x-p$? or $x-q$?" *"The zero is a solution: $x=p$ or $x=q$. So, to set up the zero as a factor, we subtract the value from both sides of the equation: $x-p=0$ or $x-q=0$."*
Day 2 **Small Group Activity:** (40-50 min) Place students into small groups (2-3) and have them complete "**Comparing Quadratic Function in Factored Form**". This activity will allow them to discover finding the vertex of a quadratic function and to discover the role of *a* in the factored form of the quadratic equation, q q $\mathrm{a(x-p)(x-q)}$. When students have completed the activity, you may want to have a class discussion about their responses to the questions. This discussion should focus on questions 5-7.	Possible Student Questions: "What is a vertex?" *"Let's think about what we learned about the vertex. Where can you find it on the graph of a quadratic function?"* "I don't know." *"Look at each graph at the top of the page. Is there a point that stands out as being different from any other point?"* "Yes, they all have a point that is the smallest. Except for graph c, it has a highest point." *"So, that highest or lowest point is called what?"* "The vertex?" *"Right. The vertex is the maximum or minimum point of the graph of a quadratic function."*

[1]ELs modification and accommodation: If you have access to Sketchpad present the graph of a parabola. Move it around the coordinate plane. ELs can visualize the vertex and the zeros of the parabola at different places.

Factored Form of a Quadratic Function

Steps and Learning Activities	Anticipated Student Responses and Teacher Support
	"What do you mean by similar amongst the graphs? What do you mean by different?" *"What do you see that they all have in common?"* "All four graphs have the same zeros. *What do you see that is not in common?"* "They all have a different vertex." "What do you mean use (x,y) as the vertex? How do I find *a*?" *"If your vertex has coordinates that are (x,y), then what can you do with that in the factored form of the quadratic equation?"* "I'm not sure." *"Can you know what your zeros are? Can you substitute them into the factored form of the quadratic equation?"* "Yes." *"Can you also substitute the vertex into the factored form of the quadratic equation?* "Yes." *"If you substitute the zeros and the vertex into the factored form of the quadratic equation, then what variable(s) will be left?"* *"a."* *"Right. So, will you be able to solve for the value of a?"* "Yes." "I don't know what you mean by what the role that the value of *a* plays in the factored form of the quadratic function."[2] *"Look back at the differences and similarities of the four quadratic functions. What did you notice?"* "They all had the same zeros but a different vertex." *"Do you think that there is something that may be a reason for this? Do you think there is something that may be happening to the equation that is causing this?"* "Could *a* be the reason for this?" *"Let's think about this, if a were the same in each one, what do you think would happen?" "What if it were different? Why don't you see what happens on your calculator when you have different values of a with the zeros. What do you see?"*

[2] For ELs draw a parabola that opens up and another one that opens down and make distinction between the two. Then draw a narrow parabola and a wider one, pointing which is narrower and which one is wider.

Factored Form of a Quadratic Function

Steps and Learning Activities	Anticipated Student Responses and Teacher Support
Day 3 **Graphing Factored Form Guided Notes:** (20-30 min) • Have students determine the zeros of the quadratic equation that is given. • Explain how to find the axis of symmetry of the given quadratic equation. • Show students how to find the vertex of the given quadratic equation. • Demonstrate how to determine the maximum or minimum value of the quadratic equation. Assist students in discovering how to graph a parabola, identifying all of the information determined above. **Exit Slip:** (10-20 minutes) Give students exit slip to complete to show their understanding of the concepts learned in the lesson.	Possible Student Questions for the Guided Notes: "Why is the axis of symmetry of an equation and not just a number?" *"The axis of symmetry is a line, not a point. Therefore, in order to identify the axis of symmetry it needs to be written as the equation of that line, not just a number or x-value that that point goes through."* *Possible questions to help students to gain an understanding this:* *"What role does the axis of symmetry play in a quadratic function?"* *"What is the shape of an axis of symmetry?"*[3] *"Does the graph open to the side or does it open up/down? Will this allow for a an axis of symmetry this is vertical or horizontal"* *"If the axis of symmetry is vertical, how do you write the equation of the line" [x=b]* *"If the axis of symmetry is horizontal, how do you write the equation of the line" [y=b]* "How do you know if it's going to have a maximum or a minimum?" *"If the value of a is positive then the quadratic function will open up causing the parabola to have a lowest or minimum value. If the value of a is negative then the quadratic function will open down causing the parabola to have a largest or maximum value."* "Why is the minimum or maximum value just the y value of the vertex? Why not the entire vertex?" *"The maximum or minimum represents the upper or lower bound of a quadratic function. The bound is determined by a horizontal line which is determined by the y-value at the maximum or minimum point."* "Do I have to label my axes?" *"Not all axes are written the same way. For instance you may need each tic mark to go up by 2 instead of 1. What would happen if you did not label your axes?"*

[3]To help *ELs differentiate between horizontal and vertical lines you could refer to soccer. The majority of ELs have been exposed to soccer in their native countries. Ask them to draw the goals of soccer to point out the vertical posts and the horizontal post.*

Factored Form of a Quadratic Function

Resources for English Learners English
Language Objective(s):

- Students will make a list of the steps involved when graphing a quadratic function.

English Learners Unit Vocabulary:

Every Day Terms/ Phrases (Tier 1)	*General Academic Terms (Tier 2)*	*Content Specific Terms (Tier 3)*
direction	increasing / decreasing	linear factors
table / window	maximum / minimum	vertex
Upward/downward	symmetry	zeros/ roots / solutions
low / lower/ lowest		y-intercept
		axis of symmetry

ELs Strategies:
When working with small groups of EL of different levels, make sure you have an advanced English level student in each group who will be the language broker. Which means one of the students must speak the native language of the students with less English fluency, and also English, (The SIOP Model for Teaching Mathematics to English Learners) Jana Echevarria, Mary Vogt and Deborah Short.

Have ELs to write a list of all the steps involve in graphing parabolas. Suggested list: 1) Graph the zeros. 2) Find midpoint of the two zeros. 3) Substitute midpoint into original equation. 4) Find the coordinates of the y-intercept. 5) Sketch the graph and label all the information. Have ELs to practice the vocabulary for this lesson through sketches. You could have them draw two parabolas (upward and downward). Ask them to label all the vocabulary for this particular lesson in the graphs. Create index cards which have individual terms and ask the ELs to point out where that term is in the graph. For example: Show an index card with the word "zeros" x= 2 and x = -2 . The students then draw a parabola and label where the zeros are. Show them an index card with a parabola with labeled zeros; and write the word below "axis of symmetry." ELs then show the work to find the axis of symmetry. Etc.

Have ELs to sketch parabolas with a=2 and a=1/2. They will see the effect of the value "a" on the screen of the calculator. Repeat with a= 4 and a= ¼. Have ELs complete the sentences about the effect of "a" in the graph of the parabola: "When a=____ the graph of the parabola becomes ___________(wider/ more narrow)."

Analysis of CCSS Implementation

Students will identify zeros from given quadratic functions and explain how to write them as linear factors. Students will also identify zeros and vertices of quadratic functions. They will explain the role of *a* in the factored form of the quadratic equation. Additionally, they will write quadratic equations from given quadratic functions. Students will graph quadratic functions in factored form, identifying key concepts of the function. Students have to identify maximums/minimums, axis of symmetry, vertex, and zeros of quadratic functions, as well as properly write the quadratic equation of functions in factored form. Additionally they are challenged with understanding the meanings of these.

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Learning Progressions

Previous Knowledge

Functions 8.F: Define, evaluate and compare functions: 2: Compare properties of two functions each represented in a different way.
Students should be able to evaluate linear functions. This will be done at the 8th grade level.

F.IF: Analyze functions using different representations. 7: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
Students should be able to graph linear functions. This will be done earlier in an Algebra 1 course.

A-CED.1: Create equations that describe numbers or relationships. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*
Students will create linear equations given. This will be done earlier in an Algebra 1 course.

Current Knowledge

F.IF: Analyze functions using different representations. 7: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
Students will be able to graph a quadratic function in factored form.

A-CED.1: Create equations that describe numbers or relationships. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*
Students will create quadratic equations given zeros.

Next Knowledge

A.SSE: Write expressions in equivalent forms to solve problems: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. a: Factor a quadratic expression to reveal the zeros of the function it defines.
Students will be able to build upon their learning of the previous standard by solving quadratics by factoring at a later point in this same unit.

F.IF: Analyze functions using different representations. 7: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. c: Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
Students will be able to graph polynomials. This will be done in an Algebra 2 course.

F.IF: Analyze functions using different representations. 8: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
Students will be able to analyze various functions. This will be done in an Algebra 2 class.

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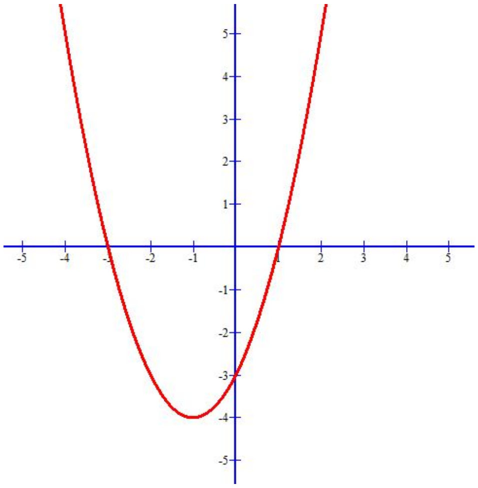
Materials and Attachments :

- Graphing Calculators
- Understanding Zeros Guided Notes
- Student Worksheet – Comparing Quadratic Functions in Factored Form
- Graphing Factored Form Guided Notes
- Exit Slip
- Supplemental Materials – Graphing Quadratics Stations Activity

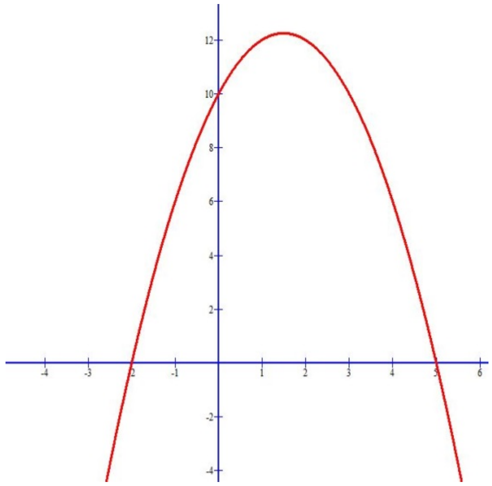
Understanding Zeros Guided Notes Name ________________________________

Refer to the graphs below to identify the zeros of each quadratic function.

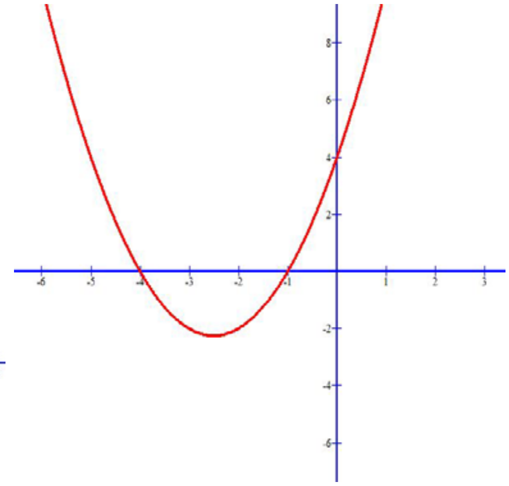
$y = f(x)$



$y = g(x)$



$y = h(x)$



List the zeros for each function

$f(x)$:____________________ $g(x)$:____________________ $h(x)$:____________________

The **Zero Product Property** states that: ____

____

For example: If $(x+1)(x-3)=0$, then

In the example above, $(x+1)$ and $(x-3)$ are called linear factors. **Linear Factors** are ________________

____

Using a graphing calculator, graph the quadratic function.
$k(x)=(x+1)(x-3)$. Sketch the graph to the right.

List the zeros of the function

$k(x)$:__________________________

What do you notice about the linear factors of $k(x)$ and the zeroes you identified from its graph?

____

____

Definition: $k(x)$ is a quadratic function written in **Factored Form**. Such that, $k(x) = a(x - p)(x - q)$. The values of *p* and *q* are the zeros for the function. For the functions $f(x)$, $g(x)$, and $h(x)$, *a* has a value of 1. We will take a look at how the value of *a* effects the graph of a quadratic function later in Lesson 2.

Looking back at the zeroes of quadratic functions $f(x)$, $g(x)$, and $h(x)$. Write two linear factors of each quadratic function to write the function in factored form with $a = 1$.

$f(x) =$ ______________________________

$g(x) =$ ______________________________

$h(x) =$ ______________________________

Now graph each function in your graphing calculator to confirm it is the same graph you were presented with for $f(x)$, $g(x)$, and $h(x)$.

In your own words, explain the process for writing linear factors from the graph of a quadratic function:

____

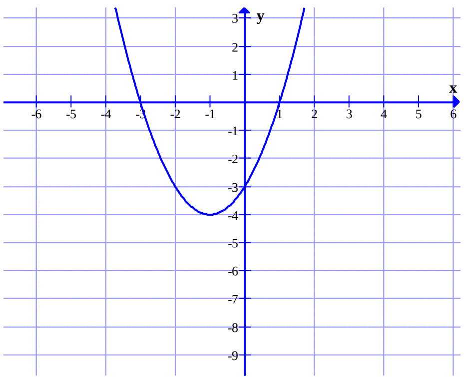
____

____

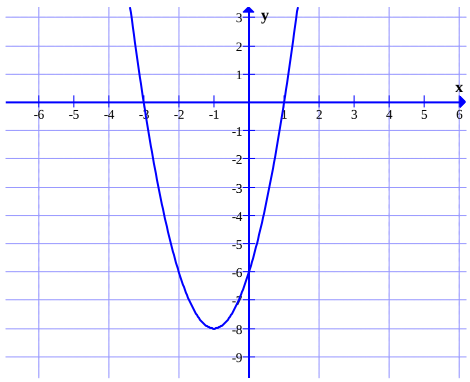
Comparing Quadratics Function in Factored Form Name ____

1. Let's take a look at the following three graphs of quadratic functions. Identify the functions zeros, linear factors, and vertex in the table below.

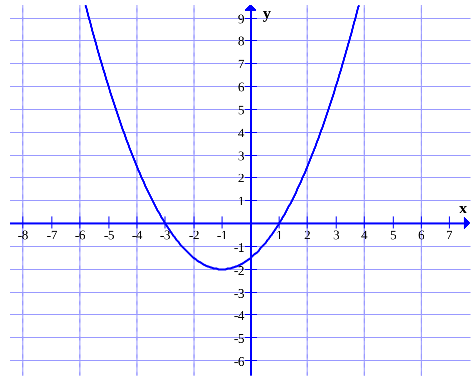
$y = b(x)$



$y = k(x)$



$y = r(x)$



Function	Zeros	Linear Factors	Vertex
$y = b(x)$			
$y = k(x)$			
$y = r(x)$			

2. What is similar amongst all three graphs?

3. What is different amongst all three graphs?

4. The factored form of a quadratic function is $y = a(x - p)(x - q)$. Using the vertex and the two linear factors that you discovered, find the value of *a* for $b(x)$, $k(x)$, and $r(x)$.

$b(x)$	$k(x)$	$r(x)$

5. Using the value of a, write the quadratic equation in factored form for the given graph of each quadratic function.

6. Explain the role that the value of "*a*" plays in the factored form of a quadratic function.

7. What do you think would happen to the graph of $b(x)$ if the value of *a* is less than zero?

Graphing Factored Form Guided Notes Name ____

A. $y = 2(x + 2)(x + 6)$

1. Identify the zeros of the quadratic equation: ____________________________

2. Identify the y-intercept of the quadratic equation: ___________________________________

3. Identify the axis of symmetry of the quadratic function: _______________________________

4. Identify the vertex of the quadratic function: _______________________________

5. Identify the maximum or minimum of the quadratic function: ______________________________

6. Graph the quadratic function:

B. $y = \frac{1}{2}(x-3)(x+4)$

1. Identify the zeros of the quadratic equation: ___________________________

2. Identify the y-intercept of the quadratic equation: _________________________________

3. Identify the axis of symmetry of the quadratic function: ______________________________

4. Identify the vertex of the quadratic function: ______________________________

5. Identify the maximum or minimum of the quadratic function: _____________________________

6. Graph the quadratic function:

C. $y = -3(x-3)(x-4)$

1. Identify the zeros of the quadratic equation: ___________________________

2. Identify the y-intercept of the quadratic equation: _________________________________

3. Identify the axis of symmetry of the quadratic function: ______________________________

4. Identify the vertex of the quadratic function: ______________________________

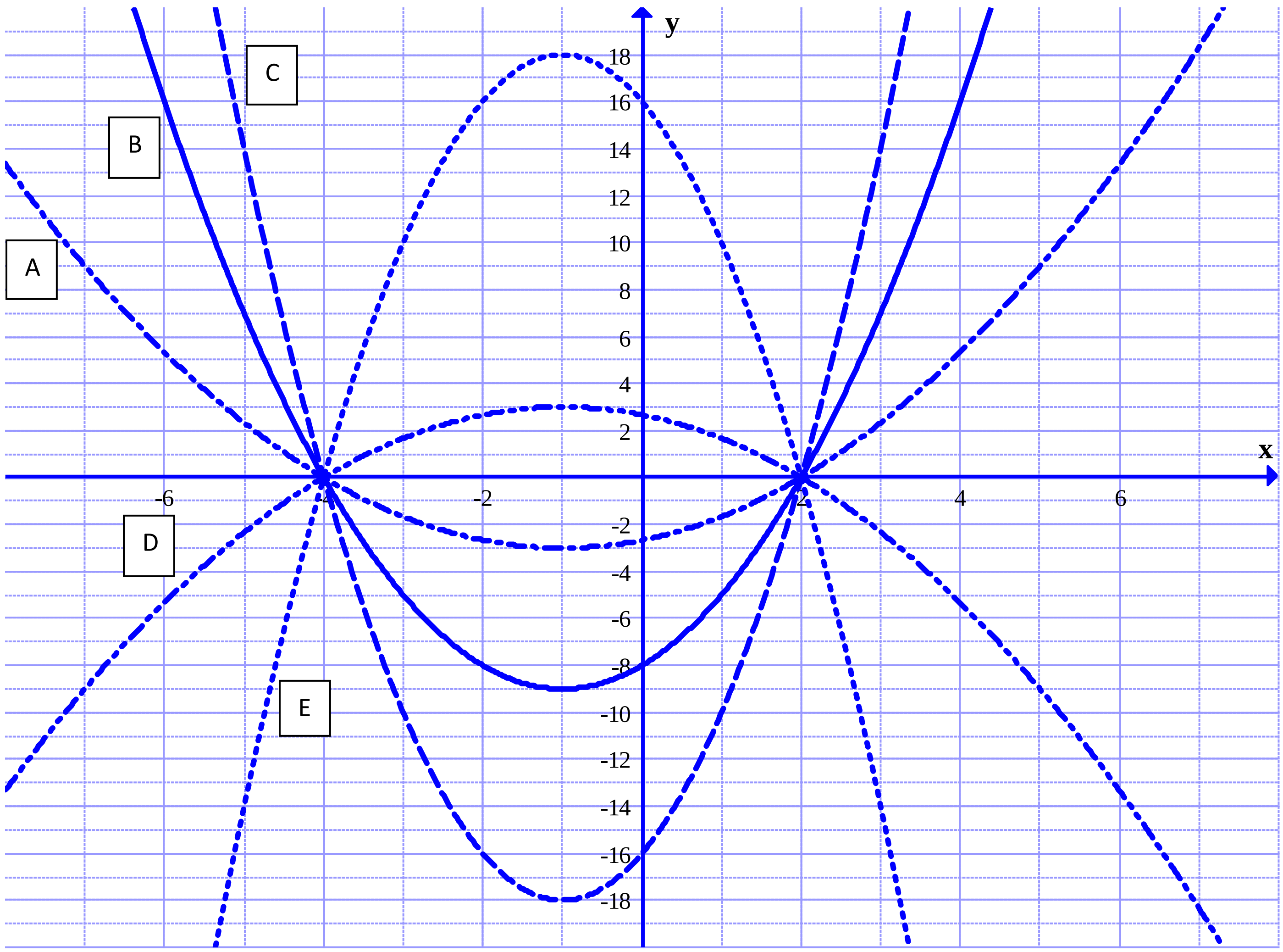
5. Identify the maximum or minimum of the quadratic function: _____________________________

6. Graph the quadratic function:

Exit Slip Name ____

The following quadratic functions all have the same zeroes; however, they are not the same function.

1. Explain what is causing the difference in these functions.
2. For each quadratic function A-E, write the quadratic equation in factored form for the function that is graphed.



Graphing Quadratics Stations Activity

Station 1

Graph the following quadratic equations. Identify the axis of symmetry, maximum or minimum value, vertex, and zeros of each quadratic equation.

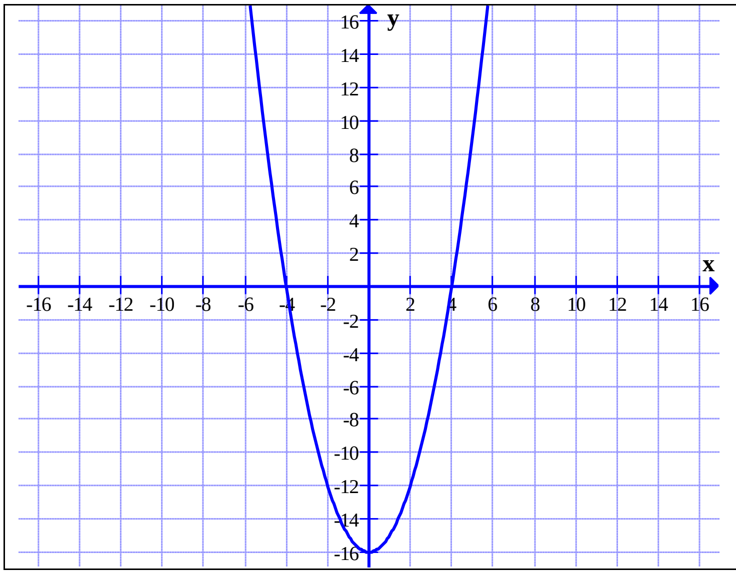
1. $y = 4(x - 3)(x + 5)$
2. $y = -(x - 4)(x + 6)$
3. $y = \frac{1}{2}(x - 6)(x + 4)$
4. $y = -2(x + 8)(x + 3)$

Station 2

Given the following quadratic functions, complete the following:

1. Identify the zeros.
2. Identify the vertex.
3. Write the quadratic equation in factored form for the function that is graphed.

a.



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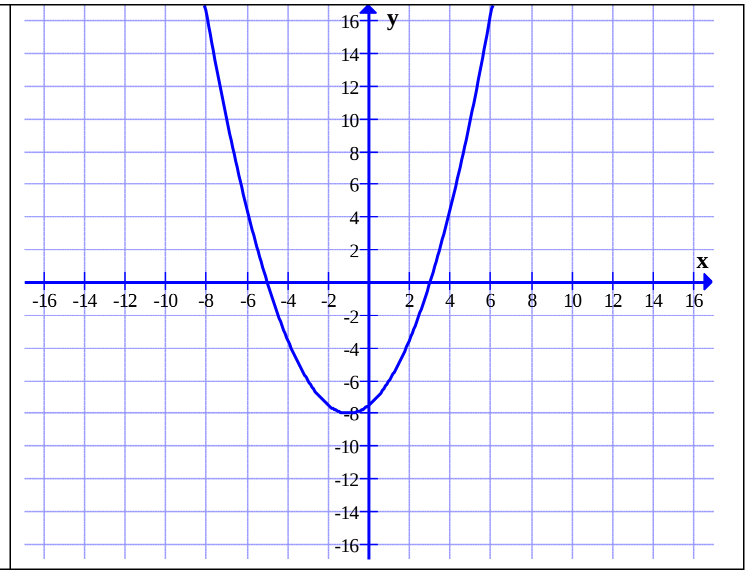

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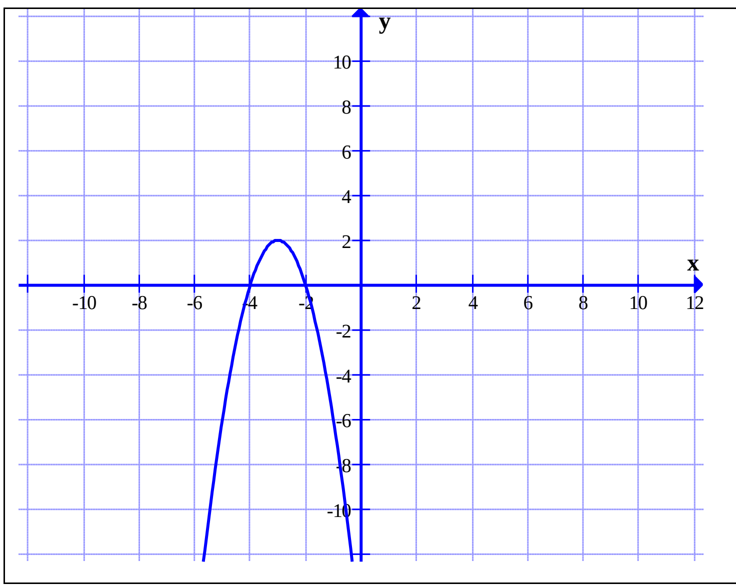

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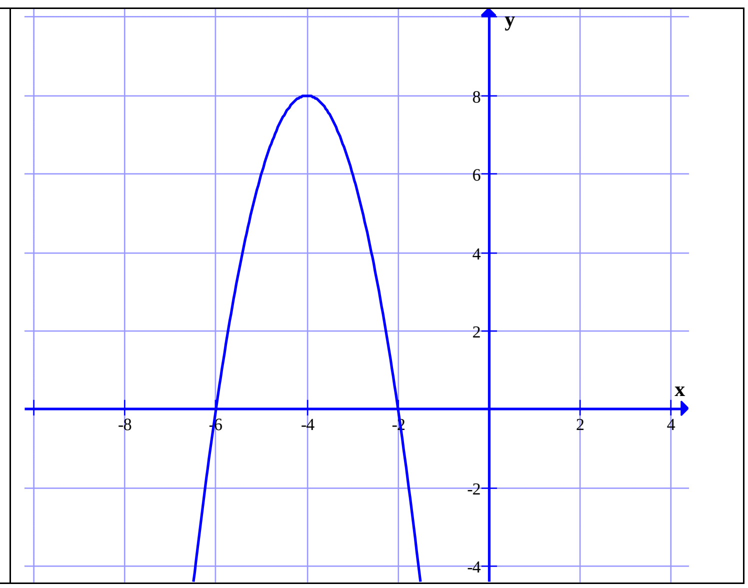
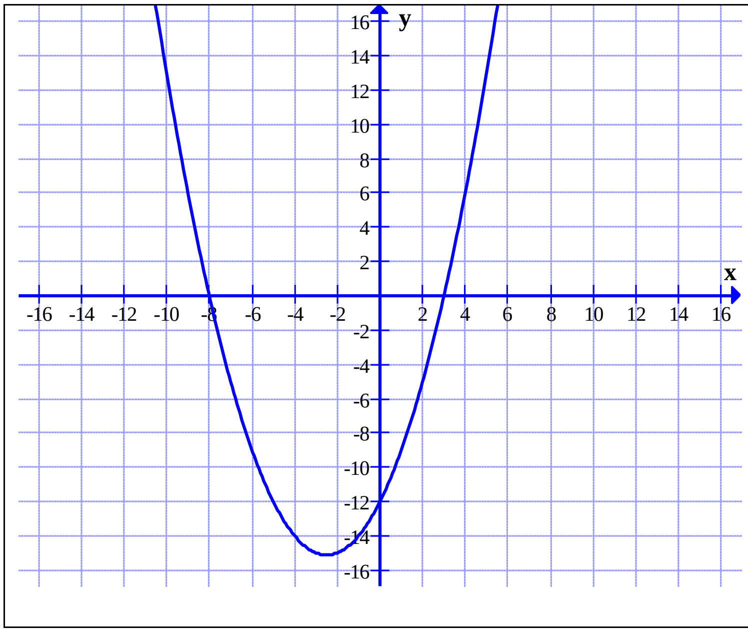


Station 3

Match each quadratic equation with the appropriate quadratic function.

1. $y = \frac{1}{3}(x-3)(x+3)$
2. $y = (x-3)(x+3)$
3. $y = -2(x+3)(x-2)$
4. $y = \frac{1}{2}(x-3)(x+8)$
5. $y = -2(x-3)(x+2)$
6. $y = \frac{1}{4}(x-6)(x+5)$
7. $y = 3(x-3)(x+3)$
8. $y = 2(x-3)(x+2)$

a.



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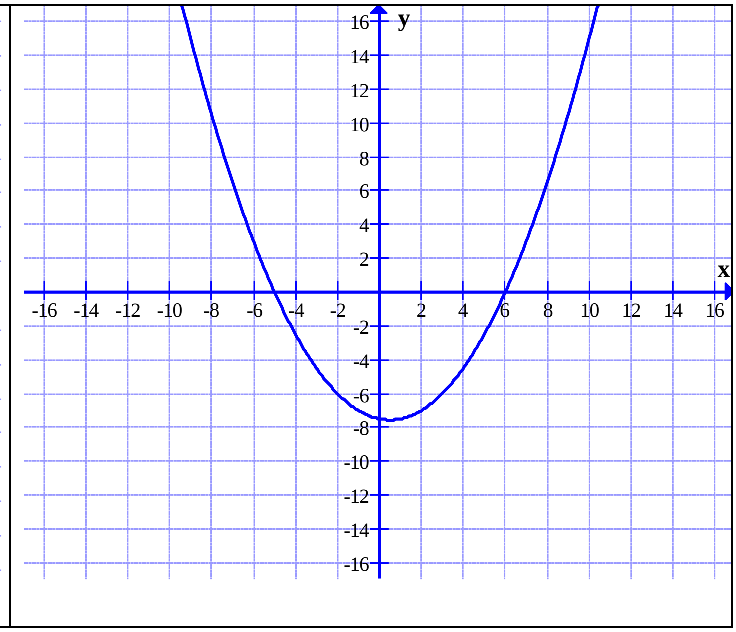

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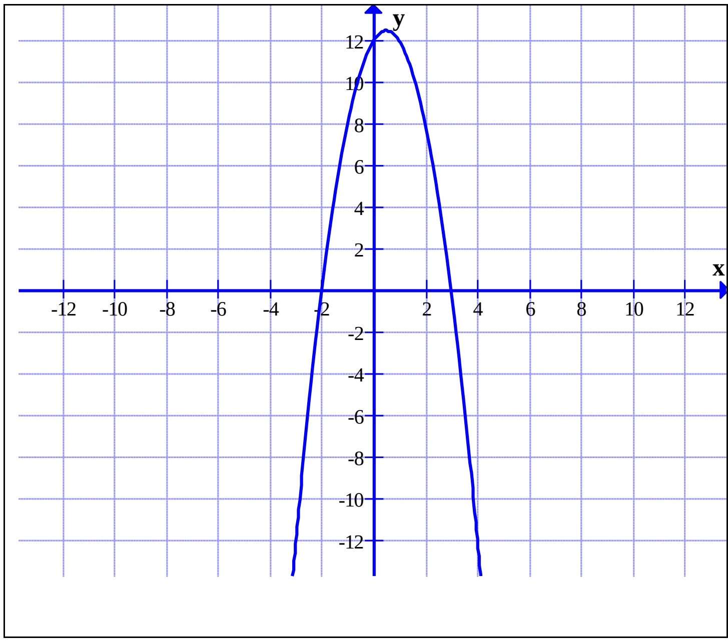

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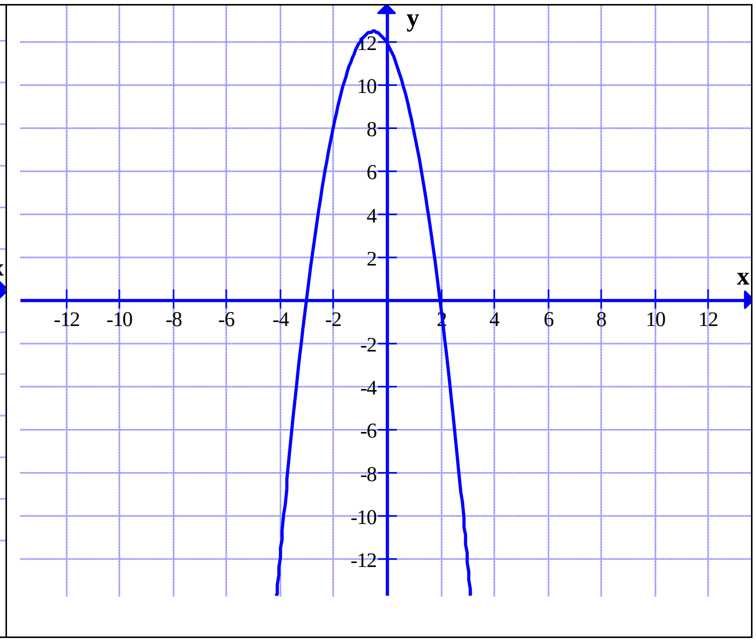

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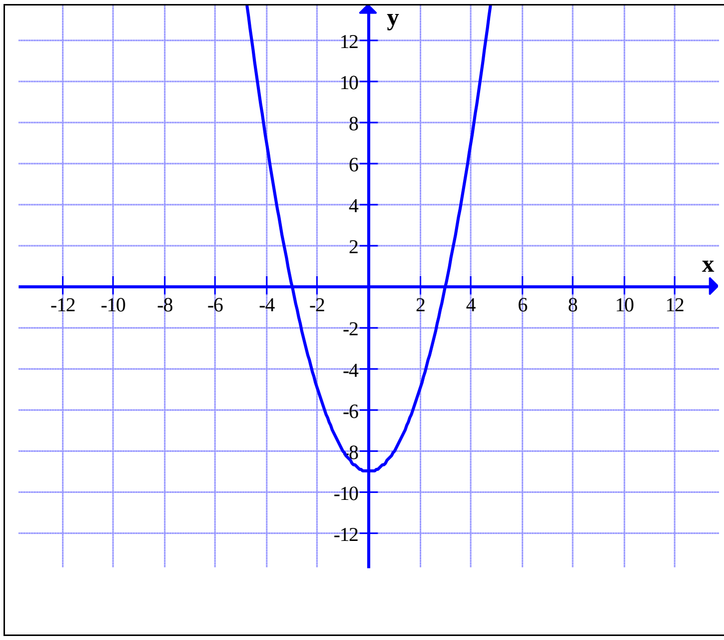
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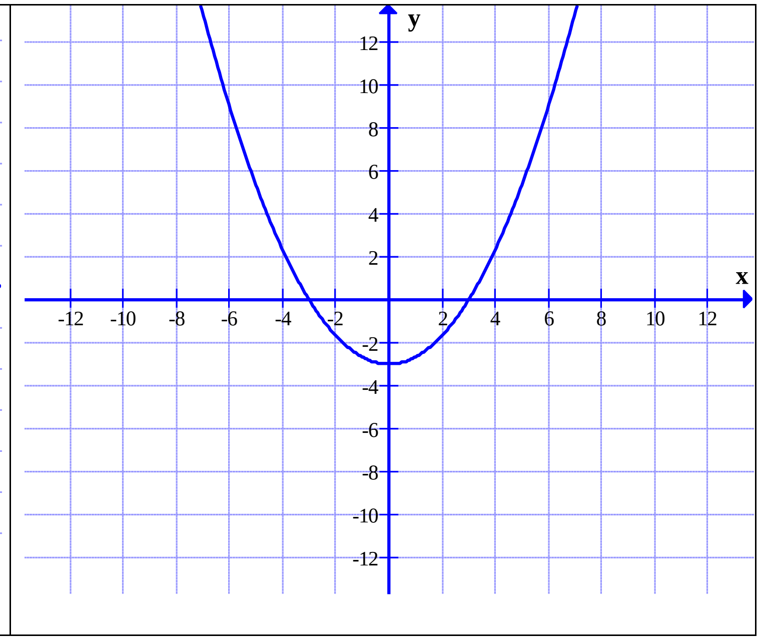
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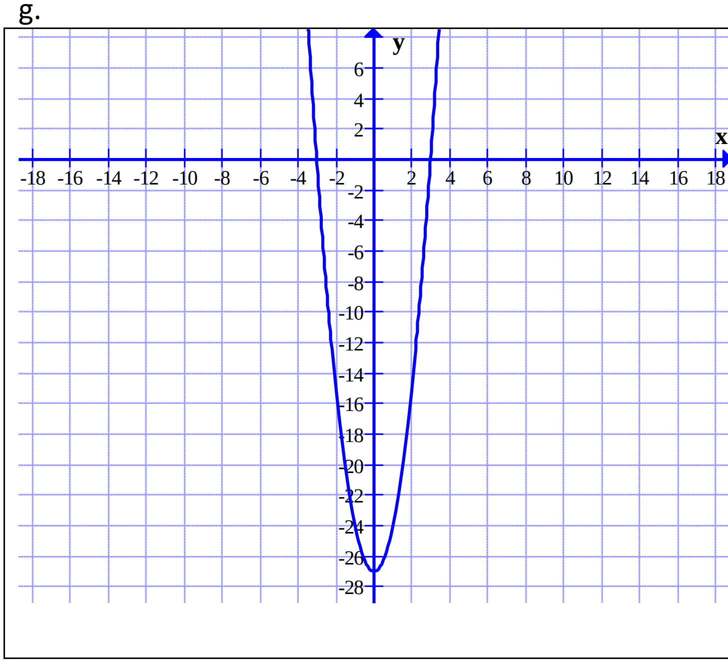
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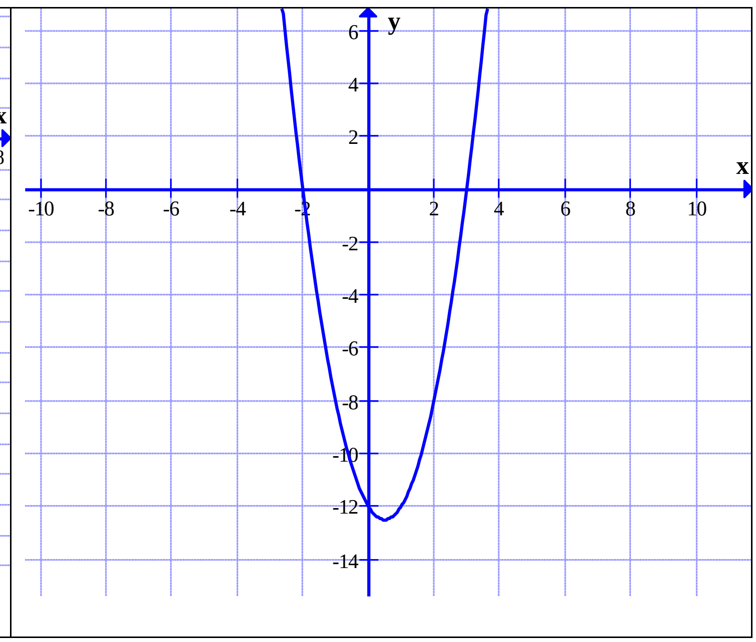
h.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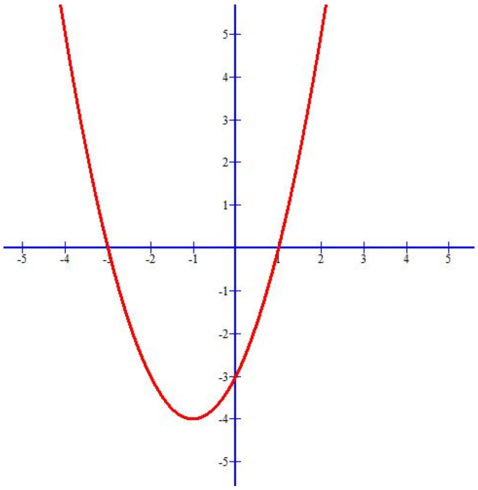
6
4
2
-2
-4
-6
-8
-10
-12
-14
-10 -8 -6 -4 -2 2 4 6 8 10

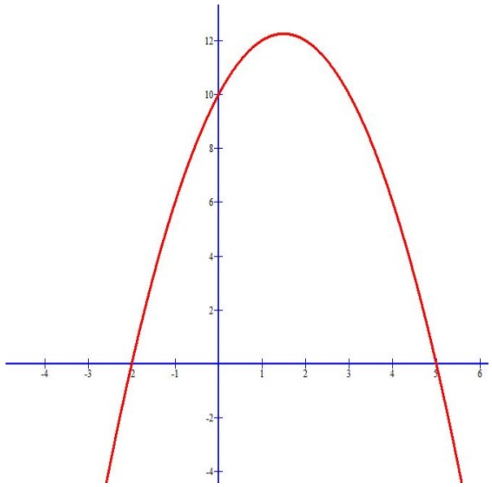
Understanding Zeros Guided Notes Name ____

Refer to the graphs below to identify the zeroes of each quadratic function.

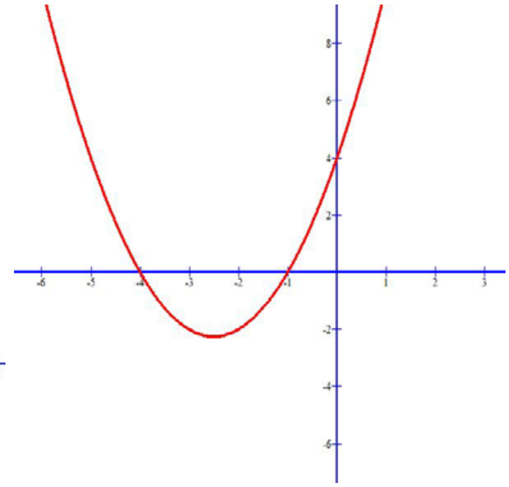
$y = f(x)$



$y = g(x)$



$y = h(x)$



List the zeros for each function

$f(x)$:____-4, 1_________ $g(x)$:____-2, 5_______________ $h(x)$:_____-4, -1 ______________

The **Zero Product Property** states that: _______If ab = 0, then a = 0 or b = 0 ____________________________

____

For example: If $(x+1)(x-3) = 0$, then

x + 1 = 0 or x – 3 = 0

In the example above, $(x+1)$ and $(x-3)$ are called linear factors. **Linear Factors** are ______

___________________________________ A linear factor is of the form ax + b_______________________________

Using a graphing calculator, graph the quadratic function.
$k(x) = (x+1)(x-3)$. Sketch the graph to the right.

List the zeros of the function

$k(x)$:__________-1, 3___________________

What do you notice about the linear factors of $k(x)$ and the zeros you identified from its graph?

____

____

Definition: $k(x)$ is a quadratic function written in **Factored Form**. Such that, $\mathrm{k}(x)=a(x-p)(x-q)$. The values of *p* and *q* are the zeros for the function. For the functions $f(x)$, $g(x)$, and $h(x)$, *a* has a value of 1. We will take a look at how the value of *a* effects the graph of a quadratic function later in Lesson 2.

Looking back at the zeros of quadratic functions $f(x)$, $g(x)$, and $h(x)$. Write two linear factors of each quadratic function to write the function in factored form with $a=1$.

$f(x)=$ ______ (x+4)(x-1) ______________

$g(x)=$ _____ (x+2)(x-5) ______________

$h(x)=$ ______ (x+4)(x+1) ______________

Now graph each function in your graphing calculator to confirm it is the same graph you were presented with for $f(x)$, $g(x)$, and $h(x)$.

In your own words, explain the process for writing linear factors from the graph of a quadratic function:

____

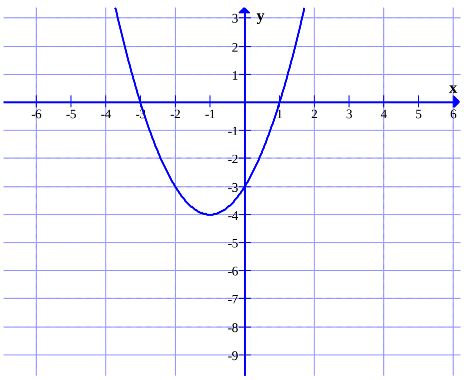
____

____

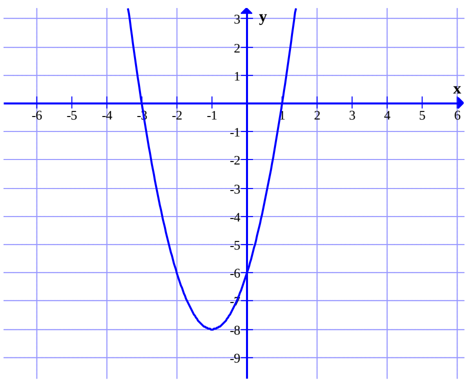
Comparing Quadratics Function in Factored Form Name ____

1. Let's take a look at the following three graphs of quadratic functions. Identify the functions zeroes, linear factors, and vertex in the table below.

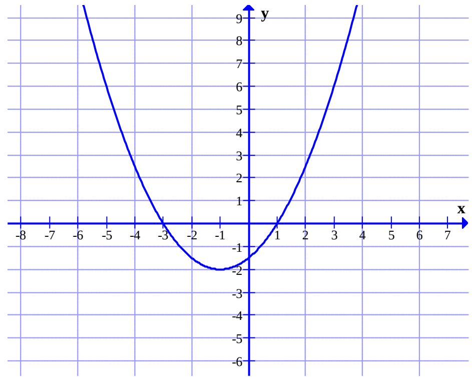
$y = b(x)$



$y = k(x)$



$y = r(x)$



Function	Zeroes	Linear Factors	Vertex
$y = b(x)$	x = -3, 1	(x+3)(x-1)	(-1, -4)
$y = k(x)$	x = -3, 1	(x+3)(x-1)	(-1, -8)
$y = r(x)$	x = -3, 1	(x+3)(x-1)	(-1, -2)

2. What is similar amongst all three graphs?

The quadratic functions all have the same zeroes and linear factors.

3. What is different amongst all three graphs?

The quadratic functions all have different vertices.

4. The factored form of a quadratic function is $y = a(x - p)(x - q)$. Using the vertex and the two linear factors that you discovered, find the value of *a* for $b(x)$, $k(x)$, and $r(x)$.

$b(x)$

$$y = a(x - p)(x - q)$$
$$y = a(x + 3)(x - 1)$$
$$-4 = a(-1 + 3)(-1 - 1)$$
$$-4 = a(2)(-2)$$
$$-4 = -4a$$
$$1 = a$$

$k(x)$

$$y = a(x - p)(x - q)$$
$$y = a(x + 3)(x - 1)$$
$$-8 = a(-1 + 3)(-1 - 1)$$
$$-8 = a(2)(-2)$$
$$-8 = -4a$$
$$2 = a$$

$r(x)$

$$y = a(x - p)(x - q)$$
$$y = a(x + 3)(x - 1)$$
$$-2 = a(-1 + 3)(-1 - 1)$$
$$-2 = a(2)(-2)$$
$$-2 = -4a$$
$$\frac{1}{2} = a$$

5. Using the value of a, write the quadratic equation in factored form for the given graph of each quadratic function.

$b(x) = (x + 3)(x - 1)$ $\quad$ $k(x) = 2(x + 3)(x - 1)$ $\quad$ $r(x) = \frac{1}{2}(x + 3)(x - 1)$

6. Explain the role that the value of "*a*" plays in the factored form of a quadratic function.

Possible Answer: The value of *a* stretches or shrinks the size of the graph.

7. What do you think would happen to the graph of $b(x)$ if the value of *a* is negative?

Possible Answer: The parabola would reflect about the x-axis. The graph would flip upside down.

Lesson 2: Graphing Factored Form Guided Notes (Answer Key)

A. $y = 2(x + 2)(x + 6)$

1. Identify the zeros of the quadratic equation: _________________________

$(x + 2) = 0 \quad \text{or} \quad (x + 6) = 0$

$x = -2 \quad \text{or} \quad x = -6$

2. Identify the y-intercept of the quadratic equation: _______________________________

$y = 2(0 + 2)(0 + 6)$

$y = 2(2)(6)$

$y = 24$

3. Identify the axis of symmetry of the quadratic function: ____________________________

[Show students that the axis of symmetry is the line that can be found by finding the *midpoint* between the zeros: $x = \frac{p+q}{2}$]

$x = \frac{p+q}{2}$

$x = \frac{(-2)+(-6)}{2}$

$x = \frac{-8}{2}$

$x = -4$

4. Identify the vertex of the quadratic function: ____________________________

[Discuss with students that the axis of symmetry is a line that goes through the vertex. Since the vertex is on that vertical line, the x-value of the vertex is $\frac{p+q}{2}$.]

$y = 2(x + 2)(x + 6)$

$y = 2(-4 + 2)(-4 + 6)$

$y = 2(-2)(2)$

$y = -8$

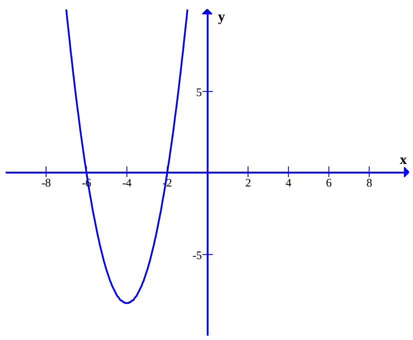
Vertex: $(-4, -8)$

5. Identify the maximum or minimum of the quadratic function: ___________________________

[Discuss with students that the maximum value or minimum value of a quadratic function is the highest or lowest point of the graph respectively.]

Minimum: $y = -8$

6. Graph the quadratic function:



B. $y = \frac{1}{2}(x-3)(x+4)$

1. Identify the zeros of the quadratic equation: ___________________________

$(x-3) = 0 \quad \text{or} \quad (x+4) = 0$

$x = 3 \quad \text{or} \quad x = -4$

2. Identify the y-intercept of the quadratic equation: _________________________________

$y = \frac{1}{2}(0-3)(0+4)$

$y = \frac{1}{2}(-3)(4)$

$y = -6$

3. Identify the axis of symmetry of the quadratic function: ______________________________

$x = \frac{p+q}{2}$

$x = \frac{(3)+(-4)}{2}$

$x = \frac{-1}{2}$

4. Identify the vertex of the quadratic function: ______________________________

$y = \frac{1}{2}(x-3)(x+4)$

$y = \frac{1}{2}\left(-\frac{1}{2}-3\right)\left(-\frac{1}{2}+4\right)$

$y = \frac{1}{2}\left(-\frac{7}{2}\right)\left(\frac{7}{2}\right)$

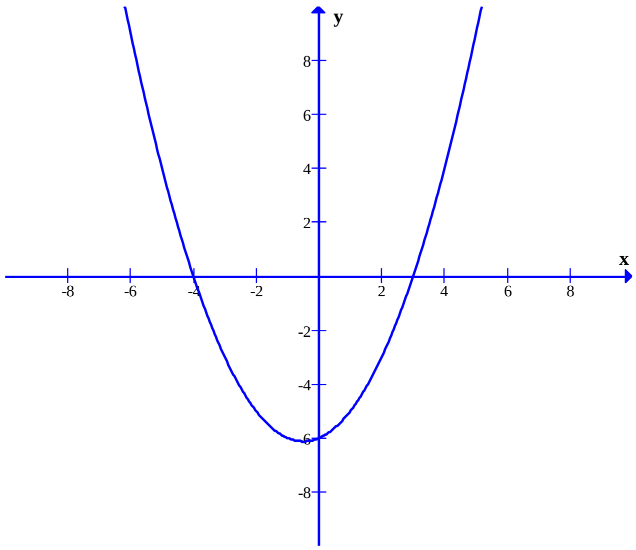
$y = -\frac{49}{8}$

Vertex: $\left(-\frac{1}{2}, -\frac{49}{8}\right)$

5. Identify the Maximum or Minimum of the quadratic function: _____________________________

Minimum: $y = -\frac{49}{8}$

6. Graph the quadratic function:



C. $y = -3(x - 3)(x - 4)$

1. Identify the zeros of the quadratic equation: ___________________________

$(x - 3) = 0 \quad \text{or} \quad (x - 4) = 0$

$x = 3 \quad \text{or} \quad x = 4$

2. Identify the y-intercept of the quadratic equation: _________________________________

$y = -3(0 - 3)(0 - 4)$

$y = -3(-3)(-4)$

$y = -36$

3. Identify the axis of symmetry of the quadratic function: ______________________________

$x = \frac{p+q}{2}$

$x = \frac{(3)+(4)}{2}$

$x = \frac{7}{2}$

4. Identify the vertex of the quadratic function: ______________________________

$y = -3(x - 3)(x - 4)$

$y = -3\left(\frac{7}{2} - 3\right)\left(\frac{7}{2} - 4\right)$

$y = -3\left(\frac{1}{2}\right)\left(-\frac{1}{2}\right)$

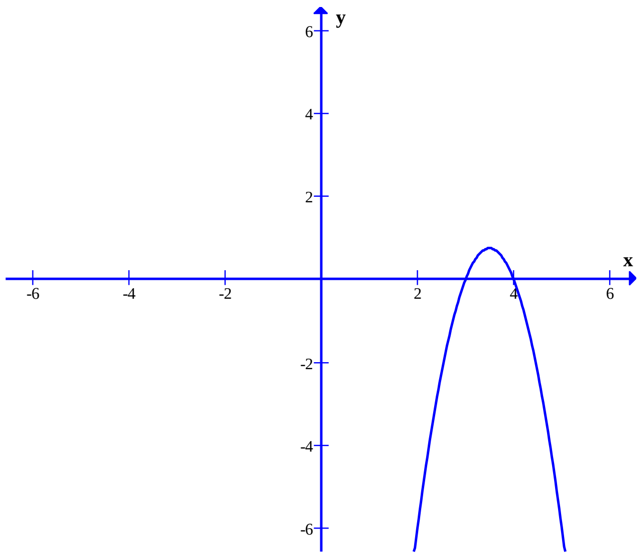
$y = \frac{3}{4}$

Vertex: $\left(\frac{7}{2}, \frac{3}{4}\right)$

5. Identify the Maximum or Minimum of the quadratic function: ___________________________

   Maximum: $y = \frac{3}{4}$

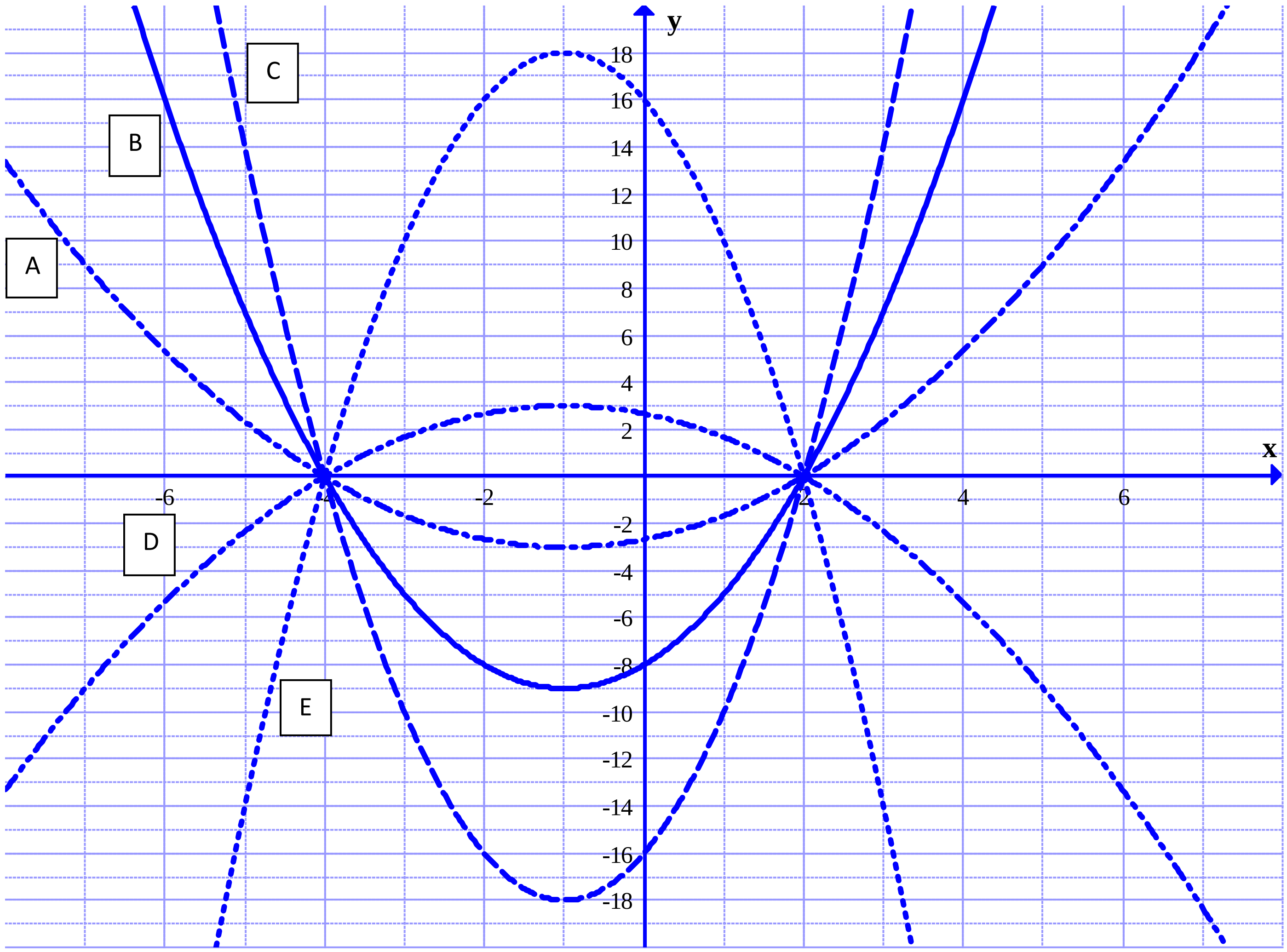
6. Graph the quadratic function:



Exit Slip Name ____

The following quadratic functions all have the same zeroes; however, they are not the same function.

1. Explain what is causing the difference in these functions.
2. For each quadratic function A-E, write the quadratic equation in factored form for the function that is graphed.



A = (1/3)(x+4)(x-2)

B = (x+4)(x-2)

C = 2(x+4)(x-2)

D = (-1/3)(x+4)(x-2)

E = -2(x+4)(x-2)