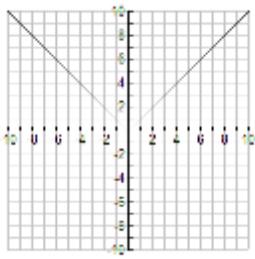
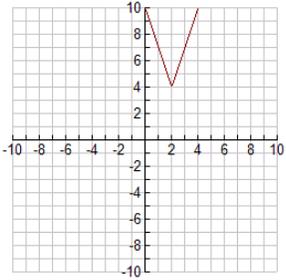


Lesson 1-7 – Graphing Absolute Value Functions

Objectives: In this activity, students will relate the piecewise function to the graph of the absolute value function and continue their development of translating functions based on constants.

Materials: paper, pencil, graphing calculator, Translating Absolute Value Functions Discovery Worksheet, graph paper (optional)

Time	Activity
	<p>Bellringer: Graph the following piecewise function without a calculator:</p> $f(x) = \begin{cases} x & \text{if } x \geq 0 \\ -x & \text{if } x < 0 \end{cases}$ <p style="text-align: right;"><i>Solution:</i></p>  <p>Activity: <i>Teacher Note: The Bellringer and following discussion are included on the Graphing Absolute Value Functions Discovery Worksheet.</i></p> <ul style="list-style-type: none"> Discuss whether the Bellringer is a function and find the domain and range of $f(x)$. <i>Solution: Yes, it is a function with D: all reals and R: $y \geq 0$</i> Have students graph $y = x$ on their graphing calculators and discuss its relationship to Bellringer #1 and the definition of absolute value from Activity 2. Discuss the shape of the graph, slope of the two lines that create the graph, the vertex, the domain and range, and the axis of symmetry.
35 in	<p>Group Work Translating Absolute Value Functions Discovery Worksheet:</p> <ul style="list-style-type: none"> ➤ On this worksheet the students will analyze the characteristics of the absolute value function then translate the graph using the rules developed in Activity 6 for $f(x \pm h)$ and $f(x) \pm k$. Then they will discover how $\pm f(x)$ and $af(x)$ affect the graph. ➤ Arrange the students in groups to complete the first two sections of the BLM in which they create their own rules. Stop and draw conclusions from the students' answers. ➤ Have the students complete the Synthesis and Analysis sections of the BLM to apply the rules. Circulate to check answers. ➤ When the students finish the worksheet, assign the following problem to be worked individually. <ol style="list-style-type: none"> Graph the function $f(x) = 3 x - 2 + 4$ without your calculators and then check with your calculators. Adjust the window to find all intercepts. Locate the vertex and equation of the axis of symmetry. State the domain and range. Determine the slopes of the two lines that form the "V" and find the x- and y-intercept. How are the vertex and slopes related to the constants in the equation of an absolute value in the form $f(x) = a x - h + k$? <i>Solution: vertex: (2, 4), axis of sym. $x = 2$, domain: all reals, range: $y \geq 4$, slopes = ± 3, no x-intercept, y-intercept (0, 10), (h, k) is the vertex, $\pm a$ are the slopes</i> 

Extended HW	<p>Saga of the V-shaped Animal: Have the students demonstrate their understanding of the transformation of the absolute value graph by completing the following <i>RAFT writing</i>. <i>RAFT writing</i> gives students the freedom to project themselves into unique roles and look at content from unique perspectives. In this assignment, students are in the Role of a V-shaped animal of their choice in which the Audience is an Algebra II student. The Form of the writing is a story of the exploits of the Algebra II student and the Topic is transformations of the absolute value graph.</p> <p>Give each student the following directions: You are an animal of your choice, real or make-believe, in the shape of an absolute value function. Your owner is an Algebra II student who moves you, stretches you, hugs you, and turns you upside down. Using all you know about yourself, describe what is happening to you while the Algebra II student is playing with you. You must include at least <u>ten</u> facts or properties of the Absolute Value Function, $f(x) = a x - h + k$ in your story. Discuss all the changes in your shape as a, h, and k change from positive, negative, or zero and get smaller and larger. Discuss the vertex, the equation of the axis of symmetry, whether you open up or down, how to find the slope of the two lines that make your “V-shape,” and your domain and range. (<i>Write a small number (e.g., 1, 2, etc.) next to each property in the story to make sure you have covered ten properties.</i>)</p> <p>Have students share their stories with the class to review for the end-of-unit test. A sample story would go like this: “I am a beautiful black and gold Monarch butterfly named Abby flying around the bedroom of a young girl in Algebra II named Sue. Sue lies in bed and sees me light on the corner of her window sill, so my (h, k) must be $(0, 0)$ 1. I look like a “V” 2 with my vertex at my head and wings pointing at the ceiling at a 45° angle 3. My “a” must be positive one 4. I am trying to soak up the warm rays of the sun so I spread my wings making my “a” less than one 5. The sun seems to be coming in better in the middle of the window sill, so I carefully move three hops to my left so my “h” equals -3 6. My new equation is now $y = .5 x + 3$ 7. Sue decided to try to catch me, so I close my wings making my “a” greater than one 8. I begin to fly straight up five inches making my “k” positive five 9 and my new equation $y = 2 x + 3 + 5$ 10. Then I turned upside down trying to escape her making my “a” negative 11. Sue finally decided to just watch me and enjoy my beauty. ”</p>
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HW: 1-7

(I would not have the Saga and HW 1-7 due on the same day. I also make the Saga worth a quiz grade)

Pre-AP Algebra 2

Lesson 1-7 – Translating Absolute Value Functions Discovery Worksheet

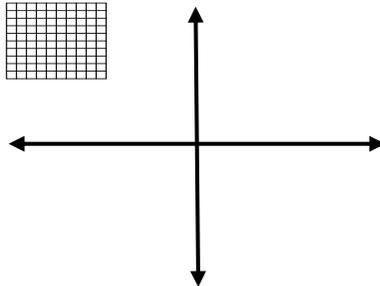
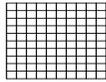
Name _____

Date _____

Graphing Absolute Value Functions

Graph the following piecewise function by hand:

$$(1) f(x) = \begin{cases} x & \text{if } x \geq 0 \\ -x & \text{if } x < 0 \end{cases}$$



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WINDOW
Xmin=-5
Xmax=5
Xscl=1
Ymin=-5
Ymax=5
Yscl=1
Xres=1
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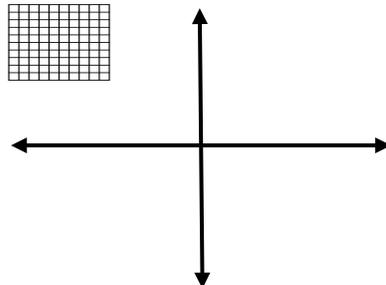
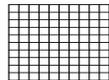
(2) On your graphing calculator graph the function $f(x) = |x|$ with this WINDOW and answer the following questions. (Note: Absolute value is under MATH > NUM > 1: abs(, so in your calculator you will type $y_1 = \text{abs}(x)$)

- Compare the graph to the graph in #1 above. What is the relationship between the two?
- What is the shape of the graph?
- What is the slope of the two lines that create the graph?
- What is the vertex of the graph?
- What is the domain and range?
- What is the axis of symmetry?

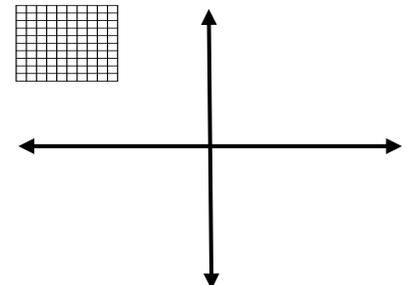
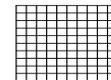
Translating Graphs of Absolute Value Functions

The following graphs are transformations of the parent function $f(x) = |x|$ in the form $f(x) = a|x - h| + k$. Graph each on your calculator and sketch below and observe the type of transformation.

$$(3) f(x) = |x| - 4$$



$$(4) f(x) = |x| + 2$$



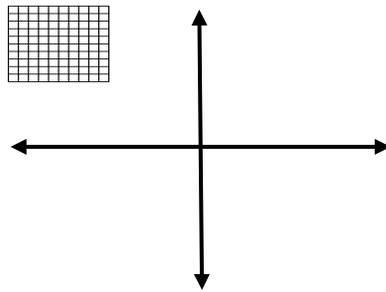
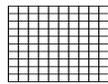
(5) What happens to the graph when you subtract a number from the function? (i.e. $f(x) - k$)

(6) What happens to the graph when you add a number to the function? (i.e. $f(x) + k$)

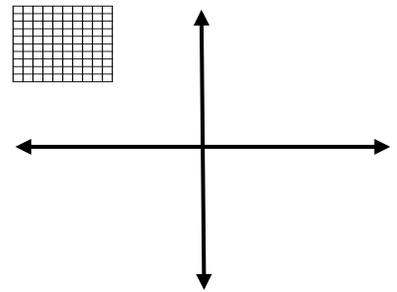
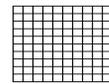
Pre-AP Algebra 2

Lesson 1-7 – Translating Absolute Value Functions Discovery Worksheet

(7) $f(x) = |x - 4|$
 $f(x) = |x + 2|$



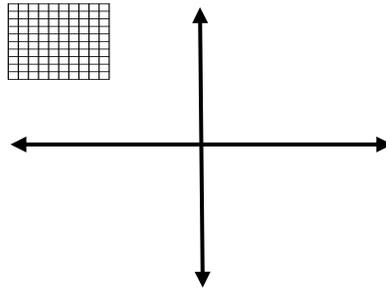
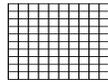
(8)



(9) What happens to the graph when you subtract a number in the function? (i.e. $f(x - h)$)

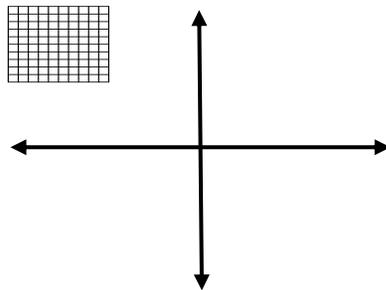
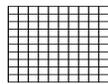
(10) What happens to the graph when you add a number in the function? (i.e. $f(x + h)$)

(11) $f(x) = -|x|$

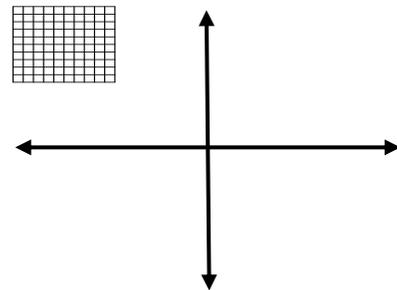
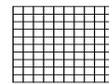


(12) What happens to the graph when you take the opposite of the function? (i.e. $-f(x)$)

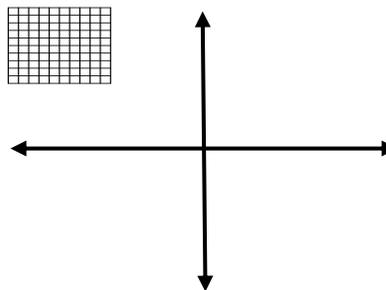
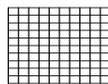
(13) $f(x) = 2|x|$
 $f(x) = \frac{5}{2}|x|$



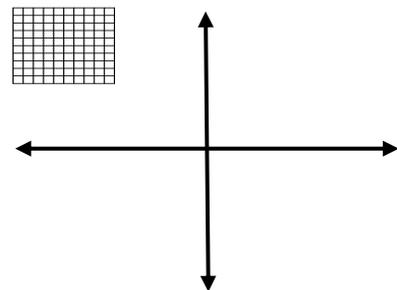
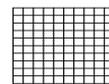
(14)



(15) $f(x) = \frac{1}{2}|x|$



(16) $f(x) = \frac{2}{5}|x|$



Pre-AP Algebra 2

Lesson 1-7 – Translating Absolute Value Functions Discovery Worksheet

- 17) What happens to the graph when the function is multiplied by a number greater than 1?
- (18) What happens to the graph when the function is multiplied by a number between 0 and 1?
- (19) These graphs are in the form $af(x)$. What does the “ a ” represent in these graphs?

Synthesis Write an equation for each described transformation.

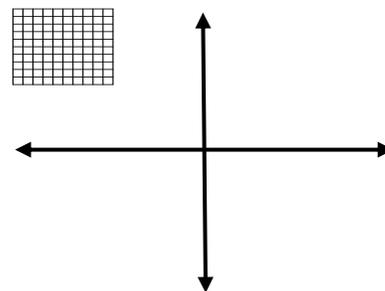
- (20) a V-shape shifted down 4 units: $f(x) =$ _____
- (21) a V-shape shifted left 6 units: $f(x) =$ _____
- (22) a V-shape shifted right 2 units and up 1 unit: $f(x) =$ _____
- (23) a V-shape flipped upside down and shifted left 5 units: $f(x) =$ _____

Analysis Describe the transformation that has taken place for the parent function $f(x) = |x|$.

- (24) $f(x) = |x| - 5$ _____
- (25) $f(x) = 5|x + 7|$ _____
- (26) $f(x) = -\frac{1}{4}|x|$ _____
- (27) $f(x) = |x - 4| + 3$ _____

(28) Graph the function $f(x) = 2|x - 1| - 3$ without a calculator and answer the following questions:

- a. What is the shape of the graph?
- b. What is the vertex of the graph and how do you know?
- c. Does it open up or down and how do you know?
- d. What are the slopes of the two lines that create the graph?
- e. What is the domain and range?
- f. What is the axis of symmetry?



Pre-AP Algebra 2

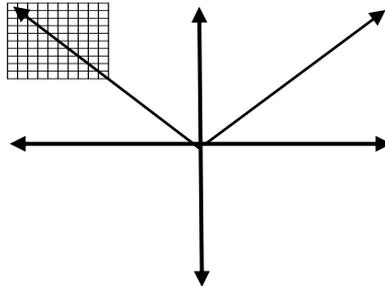
Lesson 1-7 – Translating Absolute Value Functions Discovery Worksheet (with answers)

Name _____

Date _____

Graphing Absolute Value Functions Graph the following piecewise function by hand:

$$(1) f(x) = \begin{cases} x & \text{if } x \geq 0 \\ -x & \text{if } x < 0 \end{cases}$$



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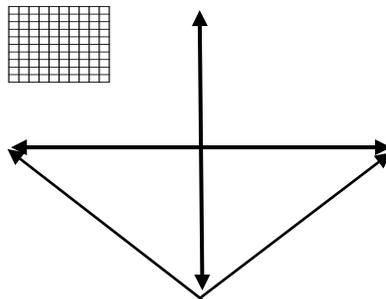
WINDOW
Xmin=-5
Xmax=5
Xscl=1
Ymin=-5
Ymax=5
Yscl=1
Xres=1
    
```

(2) On your graphing calculator graph the function $f(x) = |x|$ with this WINDOW and answer the following questions. (Note: Absolute value is under MATH > NUM > 1: abs(so in your calculator you will type $y_1 = \text{abs}(x)$)

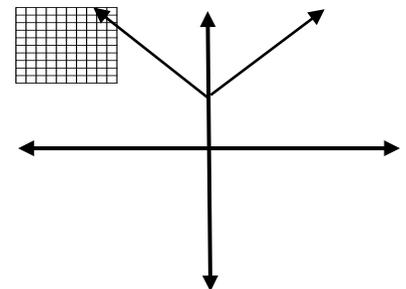
- Compare the graph to the graph in #1 above. What is the relationship between the two?
the graphs are the same
- What is the shape of the graph? *Two rays with a common endpoint that form a V.*
- What is the slope of the two lines that create the graph? *$m = \pm 1$*
- What is the vertex of the graph? *(0, 0)*
- What is the domain and range? *Domain: all reals, Range: $y \geq 0$*
- What is the axis of symmetry? *$x = 0$*

Translating Graphs of Absolute Value Functions The following graphs are transformations of the parent function $f(x) = |x|$ in the form $f(x) = a|x - h| + k$. Graph each on your calculator and sketch below and observe the type of transformation.

(3) $f(x) = |x| + 2$



(4) $f(x) = |x| - 4$

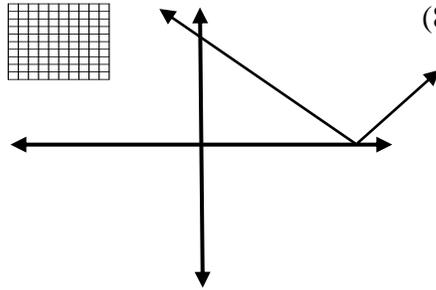
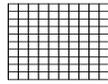


- What happens to the graph when you subtract a number from the function? (i.e. $f(x) - k$)
The graph shifts down.
- What happens to the graph when you add a number to the function? (i.e. $f(x) + k$)
The graph shifts up.

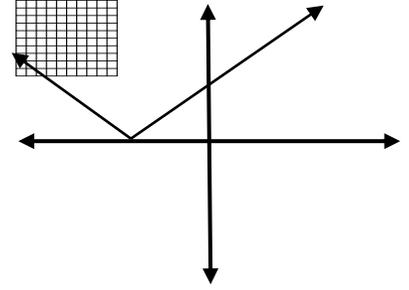
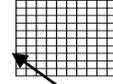
Pre-AP Algebra 2

Lesson 1-7 – Translating Absolute Value Functions Discovery Worksheet (with answers)

(7) $f(x) = |x - 4|$



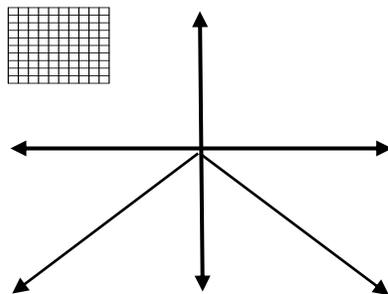
(8) $f(x) = |x + 2|$



(9) What happens to the graph when you subtract a number in the function? (i.e. $f(x - h)$)
The graph shifts to the right.

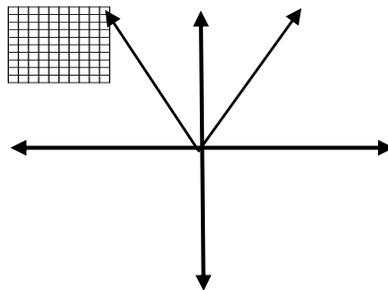
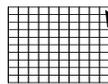
(10) What happens to the graph when you add a number in the function? (i.e. $f(x + h)$)
The graph shifts to the left.

(11) $f(x) = -|x|$



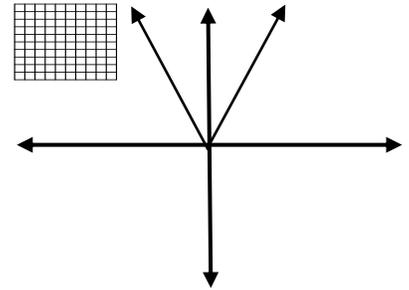
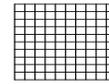
(12) What happens to the graph when you take the opposite of the function? (i.e. $-f(x)$)
The graph rotates on the x-axis.

(13) $f(x) = 2|x|$

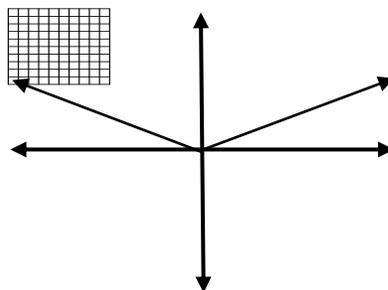
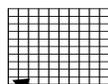


$f(x) = \frac{5}{2}|x|$

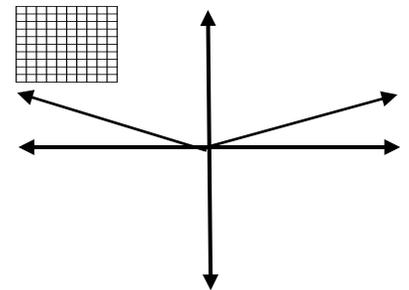
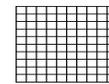
(14)



(15) $f(x) = \frac{1}{2}|x|$



(16) $f(x) = \frac{2}{5}|x|$



Pre-AP Algebra 2

Lesson 1-7 – Translating Graphs of Lines Discovery Worksheet (with Answers)

(17) What happens to the graph when the function is multiplied by a number greater than 1?

It gets steeper.

(18) What happens to the graph when the function is multiplied by a number between 0 and 1?

It gets less steep.

(19) These graphs are in the form $af(x)$. What does the “a” represent in these graphs?

The slopes of the two rays are $\pm a$.

Synthesis Write an equation for each described transformation.

(20) a V-shape shifted down 4 units: $f(x) = |x| - 4$ _____

(21) a V-shape shifted left 6 units: $f(x) = |x + 6|$ _____

(22) a V-shape shifted right 2 units and up 1 unit: $f(x) = |x - 2| + 1$ _____

(23) a V-shape flipped upside down and shifted left 5 units: $f(x) = -|x + 5|$ _____

Analysis Describe the transformation that has taken place for the parent function $f(x) = |x|$.

(24) $f(x) = |x| - 5$ a V-shaped graph shifted down 5 units _____

(25) $f(x) = 5|x + 7|$ a steeper (slopes of ± 5) V-shaped graph shifted left 7 units _____

(26) $f(x) = -\frac{1}{4}|x|$ an upside down V-shaped graph not very steep – slopes of $\pm 1/4$ _____

(27) $f(x) = |x - 4| + 3$ a V-shaped graph shifted right 4 and up 3 _____

(28) Graph the function $f(x) = 2|x - 1| - 3$ without a calculator and answer the following questions:

a. What is the shape of the graph? *V-shaped*

b. What is the vertex of the graph and how do you know?

(1, -3) because it shifted right 1 and down 3.

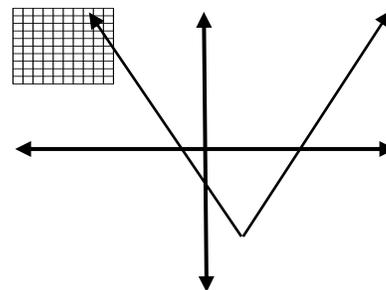
c. Does it open up or down and how do you know?

up because the leading coefficient is positive.

d. What are the slopes of the two lines that create the graph? $m = \pm 2$

e. What is the domain and range? *Domain: all reals, Range: $y > -3$*

f. What is the axis of symmetry? $x = 1$



Pre-AP Algebra 2

Lesson 1-7 – Saga of the V-Shaped Animal

Saga of the V-shaped Animal

You are an animal of your choice, real or make-believe, in the shape of an absolute value function. Your owner is an Algebra II student who moves you, stretches you, hugs you, and turns you upside down. Using all you know about yourself, describe what is happening to you while the Algebra II student is playing with you. You must include at least ten facts or properties of the Absolute Value Function, $f(x) = a|x - h| + k$ in your story. Discuss all the changes in your shape as a , h , and k change from positive, negative, or zero and get smaller and larger. Discuss the vertex, the equation of the axis of symmetry, whether you open up or down, how to find the slope of the two lines that make your “V-shape,” and your domain and range. (Write a small number (e.g., $\boxed{1}$, $\boxed{2}$, etc.) next to each property in the story to make sure you have covered ten properties.)

Check for Understanding

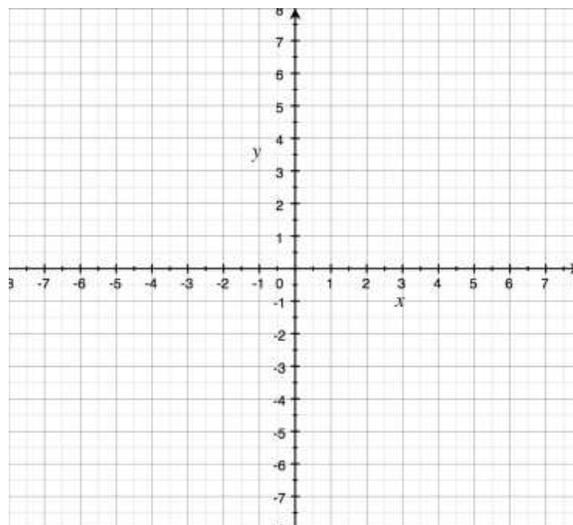
Can you complete these problems correctly by yourself?

1. Graph $f(x) = 2|x - 3| - 6$ and use the graph to answer the questions.
(1) Discuss what types of transformations were made to the parent graph.

(2) Give the Domain and Range.

(3) What value(s) of x make the following true?

- a. $f(x) = 0$
- b. $f(x) < 0$
- c. $f(x) \geq 0$
- d. $f(x) = -2$
- e. $f(x) \leq -2$
- f. $f(x) > -2$



(4) Use your answers to (3) to answer the following.

- a. $2|x - 3| - 6 = 0$
- b. $2|x - 3| - 6 < 0$
- c. $2|x - 3| - 6 \geq 0$
- d. $2|x - 3| - 6 = -2$
- e. $2|x - 3| - 6 \leq -2$
- f. $2|x - 3| - 6 > -2$

(5) Write the equation for each transformation of $f(x) = |x|$ described below.

- a. Shrank vertically by a factor of 2, translated right 7 units and translated up $\sqrt{5}$ units
- b. Reflected over the x-axis, stretched vertically by a factor of 5 and translated down 10 units
- c. Translated down 6 units, translated right 9 units

Spiral

What do you remember from Algebra 1? (these are skills we will need in Algebra 2) You also need to remember what we have already learned in this unit.

Linear Equations

1. Find the equation of the line with y-intercept 3 and a slope of $-\frac{2}{3}$, and graph it.
2. Find the equation of the line that passes through the point $(-2, 4)$ and has a slope of -1 . Then graph it.
3. Find the equation of the line that passes through the points $(2, -3)$ and $(-1, -4)$.
4. Graph the following equations on the same axes and find the point of intersection.
$$\begin{cases} y = -3x + 6 \\ y = -\frac{1}{3}x - 2 \end{cases}$$
5. Graph the following piecewise defined functions. Then identify the domain and range.

$$f(x) = \begin{cases} -3x - 4, & x < -1 \\ x, & x \geq -1 \end{cases}$$

Composition and Inverse of Functions

6. Let $f(x) = 5x + 2$, $g(x) = 3 - x$, $h(x) = x^2$. Find the following
 - a. $f(g(-1))$
 - b. $g(f(-1))$
 - c. $(f + g)(x)$
 - d. $(f - g)(x)$
 - e. $(f \cdot g)(x)$
 - f. $f(g(x))$
 - g. $g(f(x))$
 - h. $h(f(x))$
 - i. $f(g(h(x)))$
 - j. Find the inverse of $f(x)$.
7. Verify that $f(x) = 5x - 3$ and $g(x) = \frac{x}{5} + 3$ are inverses.
8. Verify that $f(x) = \frac{x}{2} + 3$ and $g(x) = 2x - 6$ are inverses.

Inequalities and Absolute Value

9. Solve the inequality, graph the solution on a number line, and then write the solution in interval notation.
 - a. $|2x - 3| = 7$
 - b. $|x + 5| < 12$
 - c. $|5x + 2| \geq 13$
 - d. $|10x - 12| + 9 \leq -1$