



### Math Objectives

- Students will explore the family of absolute value functions of the form  $f(x) = a|x + c| + b$  and discover the effect of each parameter on the graph of  $y = f(x)$ .
- Students will determine the equation that corresponds to the graph of an absolute value function.
- Look for and express regularity in repeated reasoning (CCSS Mathematical Practice).
- Look for and make use of structure (CCSS Mathematical Practice).

### Vocabulary

- absolute value function
- parameter
- vertex
- family of functions
- translation
- reflection

### About the Lesson

- This lesson involves the family of absolute value functions of the form  $f(x) = a|x + c| + b$
- As a result, students will:
  - Manipulate sliders, and observe the effect on the graph of the corresponding absolute value function.
  - Make a general statement about the effect of each parameter on the graph of the absolute value function.
  - Match specific absolute value functions with their corresponding graphs.

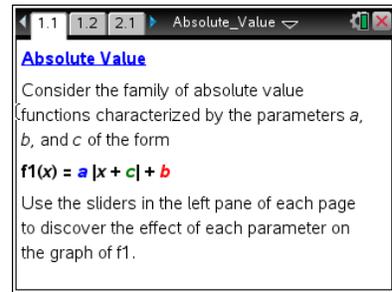


### TI-Nspire™ Navigator™

- Transfer a File.
- Use Class Capture to examine patterns that emerge.
- Use Live Presenter to demonstrate.
- Use Teacher Edition computer software to review student documents.
- Use Quick Poll to assess students' understanding.

### Activity Materials

- Compatible TI Technologies:  TI-Nspire™ CX Handhelds,  TI-Nspire™ Apps for iPad®,  TI-Nspire™ Software



### Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>

### Lesson Files:

#### Student Activity

- Absolute\_Value\_Student.pdf
- Absolute\_Value\_Student.doc

#### TI-Nspire document

- Absolute\_Value.tns



### Discussion Points and Possible Answers



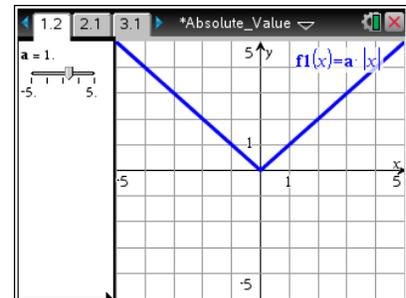
**Tech Tip:** To change a slider setting, right-click in a slider box and select option 1. Consider changing the minimum and/or maximum value, and the step size in order to help discover or confirm the effect of a specific parameter.



**Tech Tip:** To change a slider setting, touch and hold your finger anywhere along the slider bar to bring up a list of options. By choosing **Settings...**, the student can change the minimum and/or maximum value, and the step size in order to help discover or confirm the effect of a specific parameter.

### Move to page 1.2.

- The graph of  $y = f1(x) = a \cdot |x|$  is shown in the right panel. Describe the graph of  $y = |x|$ . Grab and move the slider in the left panel, and observe the changes in the graph of **f1**. Describe the effect of the parameter  $a$  on the graph of  $y = a \cdot |x|$ .



**Sample Answers:** The graph of  $y = |x|$  looks like a “V” and is made up of two straight line segments. The vertex, or lowest point on this graph, is at the origin, the point  $(0, 0)$ . For  $|a| > 1$ , the graph is stretched vertically and is narrower than the graph of  $y = |x|$ . For  $|a| < 1$ , the graph is contracted and opens wider than the graph of  $y = |x|$ . For  $a = 0$ , the graph is a horizontal line on the  $x$ -axis ( $y = 0$ ). If  $a < 0$ , the graph is reflected across the  $x$ -axis, or opens down.



**TI-Nspire Navigator Opportunity: Quick Poll (Multiple Choice or Open Response)**

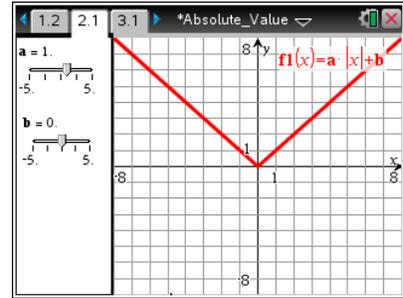
**See Note 1 at the end of this lesson.**

**Teacher Tip:** Some students might (incorrectly) associate the value of  $a$  with a horizontal stretch of the graph of  $y = |x|$  rather than a vertical stretch. To illustrate the vertical stretch, place a point at  $(1, 1)$  with  $a = 1$ . Use the slider to change the value of  $a$ . Ask students to observe the change in the value of the function and relate this to a vertical stretch.



Move to page 2.1.

- The graph of  $y = f1(x) = a|x| + b$  is shown in the right panel. Grab and move the slider for  $a$  to confirm your results in question 1. Grab and move the slider for  $b$ , and observe the changes in the graph of  $f1$ . Describe the effect of the parameter  $b$  on the graph of  $y = a|x| + b$ .



**Answer:** For  $b > 0$ , the graph is translated vertically, or moved, up  $b$  units. For  $b < 0$ , the graph is translated down  $b$  units.

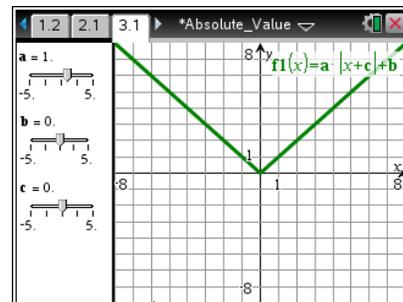


TI-Nspire Navigator Opportunity: **Quick Poll (Multiple Choice or Open Response)**

See Note 1 at the end of this lesson.

Move to page 3.1.

- The graph of  $y = f1(x) = a|x + c| + b$  is shown in the right panel. Grab and move the slider for  $a$  to confirm your results in question 1. Grab and move the slider for  $b$  to confirm your results in question 2. Grab and move the slider for  $c$ , and observe the changes in the graph of  $f1$ . Describe the effect of the parameter  $c$  on the graph of  $y = a|x + c| + b$ .



**Answer:** For  $c > 0$ , the graph is translated horizontally, or moved, left  $c$  units. For  $c < 0$ , the graph is translated right  $c$  units.



TI-Nspire Navigator Opportunity: **Quick Poll (Multiple Choice or Open Response)**

See Note 1 at the end of this lesson.

**Teacher Tip:** Some students might (incorrectly) reason that for  $c > 0$ , the graph is translated to the right.



4. Match each equation with its corresponding graph.

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

(b)  $f(x) = |x - 5| - 4$

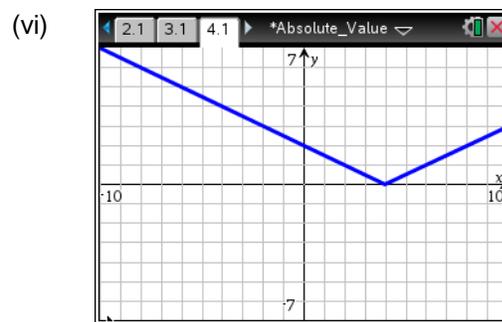
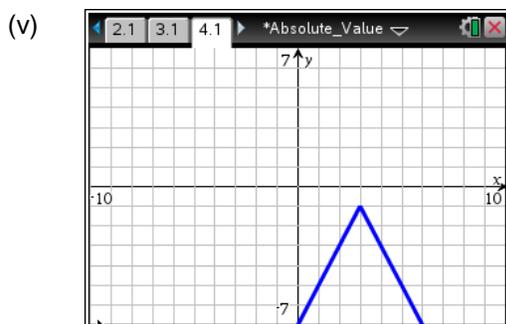
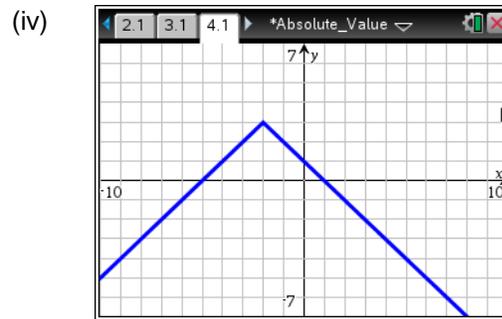
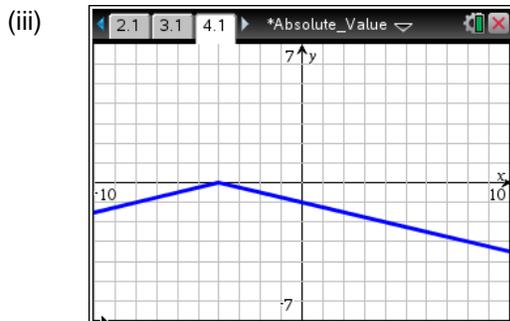
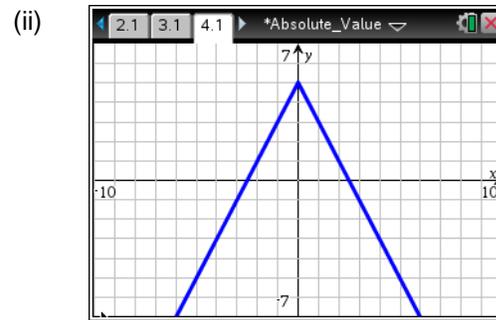
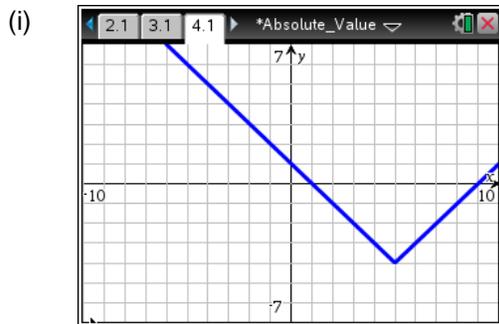
(c)  $f(x) = 0.5|x - 4|$

(d)  $f(x) = -2|x| + 5$

(e)  $f(x) = -2|x - 3| - 1$

(f)  $f(x) = -0.25|x + 4|$

**Answer:**



**Answer:** (a) → (iv) (b) → (i) (c) → (vi)  
 (d) → (ii) (e) → (v) (f) → (iii)



**Teacher Tip:** Ask students to graph both  $f_1(x) = a|x + c| + b$ ,  $f_2(x) = |ax + c| + b$ , and  $f_3(x) = |a(x + c)| + b$  on the same set of axes, on Page 3.1. Ask students, when are these graphs the same, when are they different, and how are they related?



**Tech Tip:** To graph another function, press **ctrl** **G** and Type the desired expression. Press **enter** to graph the function, or **▼** to add another function.



**Tech Tip:** To graph another function, double tap anywhere on the graphing window. Type the desired expression in the entry line at the top of the screen. Press **ENTER** to graph the function, or **↓** to add another function.

## Wrap Up

Upon completion of the discussion, the teacher should ensure that students are able to understand:

- How to graph an absolute value function of the form  $f(x) = a|x + c| + b$ .
- The concepts of reflection and translation.



## TI-Nspire Navigator

### Note 1

#### Name of Feature: Quick Poll

A Quick Poll can be given at several points during this lesson. It can be useful to save the results and show a Class Analysis.

A sample multiple choice question:

For  $a < 1$ , how does the graph of  $y = a|x|$  compare to the graph of  $y = |x|$

- (a) Wider
- (b) Stretched
- (c) Smaller
- (d) Same