



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.

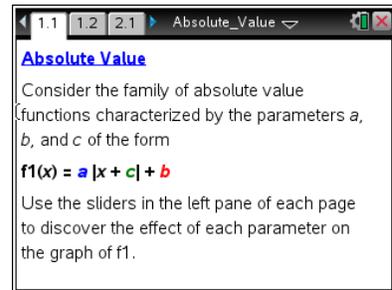


TI-Nspire™ Navigator™

- 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



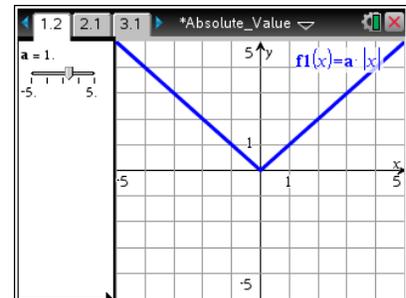
Tech Tip: To change a slider setting, right-click in a slider box and select option 1. Consider changing the minimum and/or maximum value, and the step size in order to help discover or confirm the effect of a specific parameter.



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)

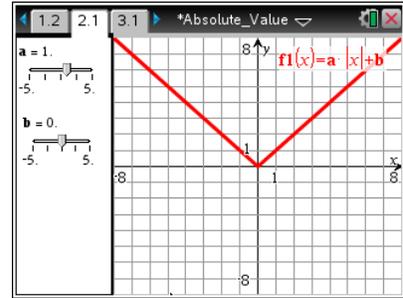
See Note 1 at the end of this lesson.

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.

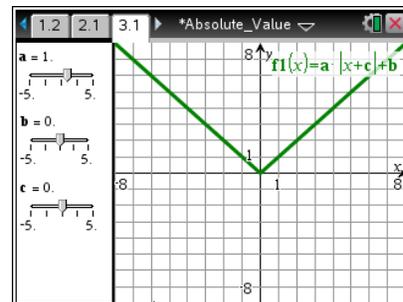


TI-Nspire Navigator Opportunity: **Quick Poll (Multiple Choice or Open Response)**

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

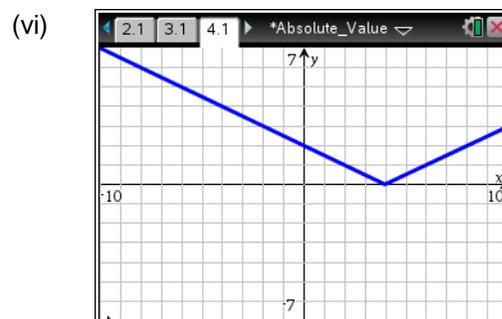
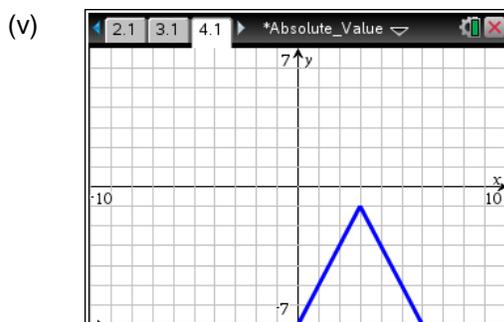
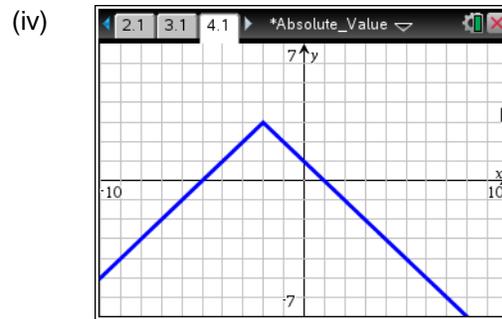
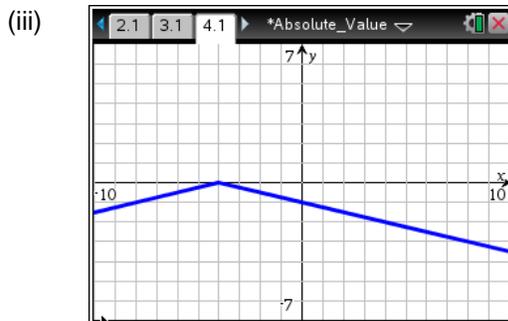
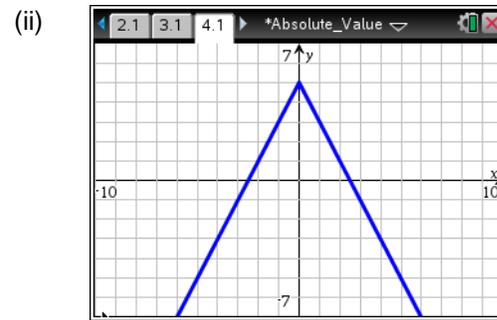
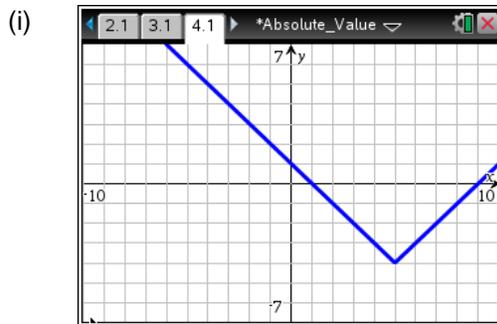
(c) $f(x) = 0.5|x - 4|$

(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.



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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