About the Lesson

In this activity, students will use the transformational graphing application to examine how the square root function is transformed on the coordinate plane. As an extension, students will examine similar transformations on a cube root function. As a result, students will:

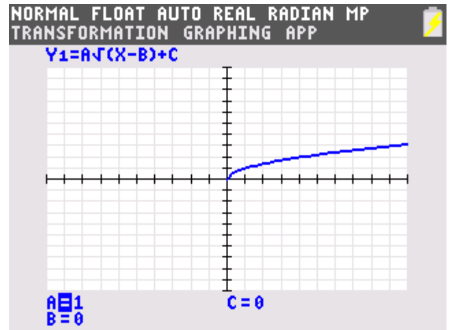
- Graph and explore the domain and range of a function.
- Analyze the shape and behavior of the square root and cube root functions.
- Understand the relationship of the terms of a function and the transformations on a graph.
- Look for and make use of patterns in graphs.

Vocabulary

- cube root
- domain
- function
- range
- square root

Teacher Preparation and Notes

- Students will need the Transformation Graphing application installed on their graphing calculators.



Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus C Silver Edition. It is also appropriate for use with the TI-84 Plus family with the latest TI-84 Plus operating system (2.55MP) featuring MathPrint ™ functionality. Slight variations to these directions given within may be required if using other calculator models.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

Compatible Devices:

- TI-84 Plus Family

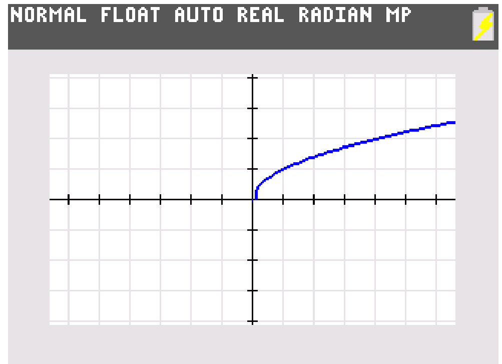
Software Application:

- Transformation Graphing

Associated Materials:

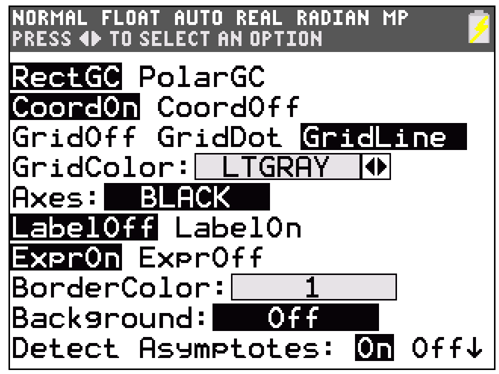
- RadicalTransformations_Student.pdf
- RadicalTransformations_Student.doc

Problem 1 – The General Radical Function



Students will examine the graph of $y = \sqrt{x}$ and determine the domain and range of the function. Students will also conjecture if the graph is always in the first quadrant.

Graph the equation $y = \sqrt{x}$. Once graphed, use TRACE to observe the coordinate values for points on the graph. This graph was created with the GridLine on and ZOOM ZDecimal . Press 2nd ZOOM for format to turn on GridLine.



1. What is the domain and range of the function?

   Answer: Domain: $x \geq 0$; Range: $y \geq 0$

2. Why does the graph "stop" at the origin?

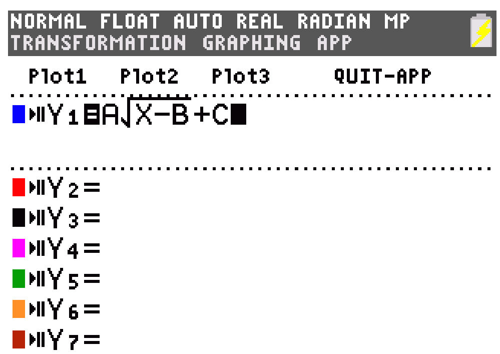
   Answer: The function is not defined for values less than zero because the square root becomes negative.

3. When is the following statement true? *The graph of the square root function is completely in the first quadrant.*

   Answer: Sometimes (This is a conjecture question, so an incorrect answer at this point is okay. Students will discover the truth soon.)

Problem 2 – Transformations

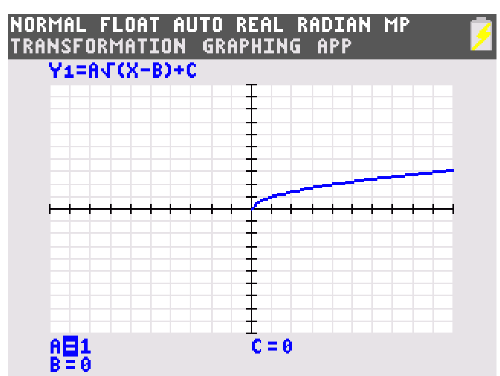
In Problem 2, students will change values in the general equation of a square root graph. Students will determine the domain and range of a square root function based on the general equation. They will revisit the question of where the graph lies in the plane. They will also describe the transformation performed on the graph by changing each variable.



Start the **Transformation Graphing** application by pressing APPS and selecting **Transfrm**.

Now, press Y= and enter **A√(X–B)+C** into **Y1**.

Press ZOOM, select **ZStandard**. Press WINDOW and change the **Xres** to 3 to make it graph faster. Press GRAPH. Notice the displayed equation. The values of **A**, **B** and **C** may be changed by using the arrow and number keys. Explore the transformations.



4. What does the graph look like when all three variables equal zero? Why?

   Answer: The graph is a straight line. The square root is multiplied by zero, making the function $y = 0$.

Discussion Questions:

- How does each variable affect the graph of the function?
- How can we algebraically show the domain and range of the function?
- Why does the graph “stop” (no longer exist) on the left side?
- How does the variable *a* affect the graph?

5. Based on your exploration, when is the following statement true? *The graph of the square root function is completely in the first quadrant.*

   Answer: Sometimes (Students should have the correct answer.)

Continue to manipulate the values of *A*, *B* and *C* on the calculator to help answer Questions 6–16.

6. Find two functions whose domain is $x \geq 3$.

   Answer: responses must have $\sqrt{x-3}$

7. What is the domain of the function $f(x) = 4\sqrt{x+2}-3$? Check using the graph.

   Answer: $x \geq -2$

8. Changing which variable will create a horizontal shift?

   Answer: *h*

9. Find two functions whose range is $y \geq -2$.

   Answer: Sample response must have –2 after square root

10. What is range of the function $f(x) = 4\sqrt{x+2}-3$? Check using the graph.

    Answer: $y \geq 3$

11. Changing which variable will create a vertical shift?

    Answer: *k*

12. What is the difference between the graphs of $f(x) = 4\sqrt{x+2}-3$ and $g(x) = -4\sqrt{x+2}-3$?

    Answer: Sample response: Positive 4 opens down (concave down); Negative 4 opens up (concave up).

13. What is the difference between the graphs of $f(x) = 4\sqrt{x+2}-3$ and $g(x) = 2\sqrt{x+2}-3$?

    Answer: Sample response: Positive 4 is steeper than positive 2.

14. What effect does the variable *a* have on the graph?

    Answer: Sample response: Flips the graph open up or open down. Makes the graph steeper as $|a|$ gets larger.

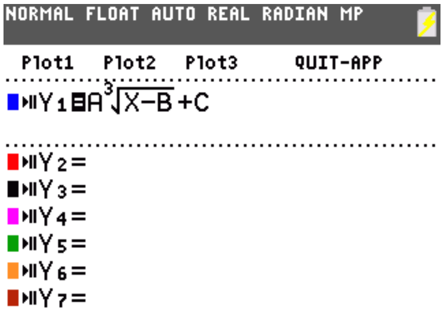
15. What is the domain of the function using the general equation $y = \sqrt{x-h}+k$?

    Answer: $x \geq h$

16. What is the range of the function using the general equation $y = \sqrt{x-h}+k$?

    Answer: $y \geq k$

Extension – Cube Root Functions



Press [Y=] and enter $A\sqrt[3]{(X-B)}+C$ into **Y1**.

Press [MATH] and select $\sqrt[3]{\ }$ for the cube root.

Change the values of the variables *A*, *B*, and *C,* and observe the effects of the changes on the graph.

17. What is the domain and range of the function in terms of the general equation?

    Answer: Domain and range: All real numbers

18. Describe the effects of changing each variable on the graph.

    Answer: *h* is a horizontal shift; *k* is a vertical shift; *a* makes the branches steeper and flips the graph.