**Activity 1.4.4 Stretch It! Part I**

Move it! Part I and Stretch it! Part I are both integral investigations that set the stage for all transformations to come. Doing you best to truly understand what is happening and how it is happening will certainly help to unlock some of the mysteries of mathematics.

Again, we will turn our attention to the **parent function** and the function reference sheet.

As stated in Move It!, the reference sheet is split into 3 columns. Column 1 represents the parent function; column 2 contains some basic (dare I say critical) sets of coordinate pairs (solutions); and column 3 is the graph (picture) of that parent function. For example, find the **absolute value function**. This will be the most referenced function in this investigation. Copy the information from the reference sheet onto this investigation.

**Absolute Value:**

Parent function: Basic set of solutions: Graph:



|  |  |
| --- | --- |
| -2 |  |
| -1 |  |
| 0 |  |
| 1 |  |
| 2 |  |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_

As stated above, transformations will continue to come up time and time again in your mathematics career, so let’s give it our full attention and do the best we can at understanding, not memorizing the relationships we observe. Understanding, not memorizing, what graphical changes are imposed on the **absolute value function** as we **“stretch”** the function will be a key to understanding transformations on **all families of functions**.

Our *goal* will be to understand the changes that take place with respect to absolute value, square root, cubic, quadratic and exponential functions. After that, you’ll be able to apply the concepts learned here to any parent function you bump into along your mathematical travels. ☺

1. Parent Function: Transformed Function:

Evaluate the functions using the given x-values. Then, graph the functions and label them f(x) and g(x) accordingly. Using the line below, describe the transformation that was applied to the parent function. (What happened to the parent to make it move to the new location?)



 Parent Transformed

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | x | g(x) |
| -2 |  | -2 |  |
| -1 |  | -1 |  |
| 0 |  | 0 |  |
| 1 |  | 1 |  |
| 2 |  | 2 |  |

Describe the transformation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

It’s at this point that we should point out how useful it is to have the parent solutions in a “handy-to-reference” location. Instead of relying on substitution, take a look at what happened to the y-values you were given. For example, in f(x) we started with (-2, 2) and g(x) we started with (-2, 6). How do you go from 2 to 6 mathematically?

Are the changes happening to x values or y values?

Does the same idea hold true for all of the other y values as you look from f(x) to g(x)?

Are you ready to apply a rule at this point?

Let’s try this again and see *what we see*…….

2. Parent Function: Transformed Function:

Evaluate the functions using the given x-values. Then, graph the functions and label them f(x) and g(x) accordingly. Using the line below, describe the transformation that was applied to the parent function. (What happened to the parent to make it move to the new location?)

 Parent Transformed

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | x | g(x) |
| -2 |  | -2 |  |
| -1 |  | -1 |  |
| 0 |  | 0 |  |
| 1 |  | 1 |  |
| 2 |  | 2 |  |

Describe the transformation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Again, it is useful have the parent solutions in a “handy-to-reference” location. Instead of relying on substitution, take a look at what happened to the y-values you were given. For example, in f(x) we started with (-2, 2) and g(x) we started with (-2, 8). How do you go from 2 to 8 mathematically?

Does the same idea hold true for all of the other x values as you look from f(x) to g(x)?

Are you ready to apply a rule at this point? The rule we’d like to write should include some formal discussion of notation such as *f(x)* and *k f(x)*, where *f(x)* is our original function and *k f(x)* is our transformed function and *k* is an ***outside*** value. Write down your rule.

Using your family of function reference sheet, try to see how this vertical transformation applies to other families.

3. Parent Function: Transformed Function: $g\left(x\right)=2x^{3}$

Evaluate the functions using the given x-values. Then, graph the functions and label them f(x) and g(x) accordingly. Using the line below, describe the transformation that was applied to the parent function. You’ll have to complete the x-values in the g(x) table as well. You may need to adjust the scale on the given graph to graph both functions.



 Parent Transformed

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | x | g(x) |
| -2 |  |  |  |
| -1 |  |  |  |
| 0 |  |  |  |
| 1 |  |  |  |
| 2 |  |  |  |

Describe the transformation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. Parent Function: Transformed Function: $g\left(x\right)=3x^{3}$

Evaluate the functions using the given x-values. Then, graph the functions and label them f(x) and g(x) accordingly. Using the line below, describe the transformation that was applied to the parent function. Again, you may need to adjust the scale on the given graph to graph both functions.



 Parent Transformed

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | x | g(x) |
| -2 |  |  |  |
| -1 |  |  |  |
| 0 |  |  |  |
| 1 |  |  |  |
| 2 |  |  |  |

Describe the transformation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5. Parent Function: Transformed Function:

Notice the change for the value of *k* in this example! It is now a ***negative*** value. Evaluate the functions using the given x-values. Then, graph the functions and label them f(x) and g(x) accordingly. Using the line below, describe the transformation that was applied to the parent function.

 Parent Transformed

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | x | g(x) |
| -2 |  | -2 |  |
| -1 |  | -1 |  |
| 0 |  | 0 |  |
| 1 |  | 1 |  |
| 2 |  | 2 |  |

Describe the transformation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Instead of relying on substitution, take a look at what happened to the y-values you were given. How did they change differently from question #2?

6. Parent Function: Transformed Function:

Evaluate the functions using the given x-values. Then, graph the functions and label them f(x) and g(x) accordingly. Using the line below, describe the transformation that was applied to the parent function.



 Parent Transformed

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | x | g(x) |
| -2 |  | -2 |  |
| -1 |  | -1 |  |
| 0 |  | 0 |  |
| 1 |  | 1 |  |
| 2 |  | 2 |  |

Describe the transformation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

7. Parent Function: Transformed Function:

Evaluate the functions using the given x-values. Then, graph the functions and label them f(x) and g(x) accordingly. Using the line below, describe the transformation that was applied to the parent function.

 Parent Transformed

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | x | g(x) |
| 0 |  | 0 |  |
| 4 |  | 4 |  |
| 9 |  | 9 |  |
| 16 |  | 16 |  |
| 25 |  | 25 |  |

Describe the transformation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

8. Parent Function: Transformed Function:

Evaluate the functions using the given x-values. Then, graph the functions and label them f(x) and g(x) accordingly. Using the line below, describe the transformation that was applied to the parent function.



 Parent Transformed

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | x | g(x) |
| 0 |  | 0 |  |
| 4 |  | 4 |  |
| 9 |  | 9 |  |
| 16 |  | 16 |  |
| 25 |  | 25 |  |

Describe the transformation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Are you ready to apply an additional rule at this point? Again, the rule we’d like to write should include some formal discussion of notation such as *f(x)* and *k f(x)*, where *f(x)* is our original function and *k f(x)* is our transformed function and *k* is an ***outside*** value that might be either positive or negative. Write down your rule.

9. Parent Function: Transformed Function: $g\left(x\right)=\frac{1}{4}|x|$

Notice the change for the value of *k* in this example! It is now a ***fractional*** value between 0 and 1. Evaluate the functions using the given x-values. Then, graph the functions and label them f(x) and g(x) accordingly. Using the line below, describe the transformation that was applied to the parent function.

 Parent Transformed

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | x | g(x) |
| -2 |  | -8 |  |
| -1 |  | -4 |  |
| 0 |  | 0 |  |
| 1 |  | 4 |  |
| 2 |  | 8 |  |

Describe the transformation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

10. Parent Function: Transformed Function:$g\left(x\right)=\frac{1}{3}|x|$

Evaluate the functions using the given x-values. Then, graph the functions and label them f(x) and g(x) accordingly. Using the line below, describe the transformation that was applied to the parent function.

 Parent Transformed

|  |  |  |  |
| --- | --- | --- | --- |
| x | f(x) | x | g(x) |
| -2 |  | -6 |  |
| -1 |  | -3 |  |
| 0 |  | 0 |  |
| 1 |  | 3 |  |
| 2 |  | 6 |  |

Describe the transformation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Are you ready to apply an additional rule at this point? Again, the rule we’d like to write should include some formal discussion of notation such as *f(x)* and *k f(x)*, where *f(x)* is our original function and *k f(x)* is our transformed function and *k* is an ***outside*** value that might be either positive or negative and might be a fraction less than 1. Write down your rule.