

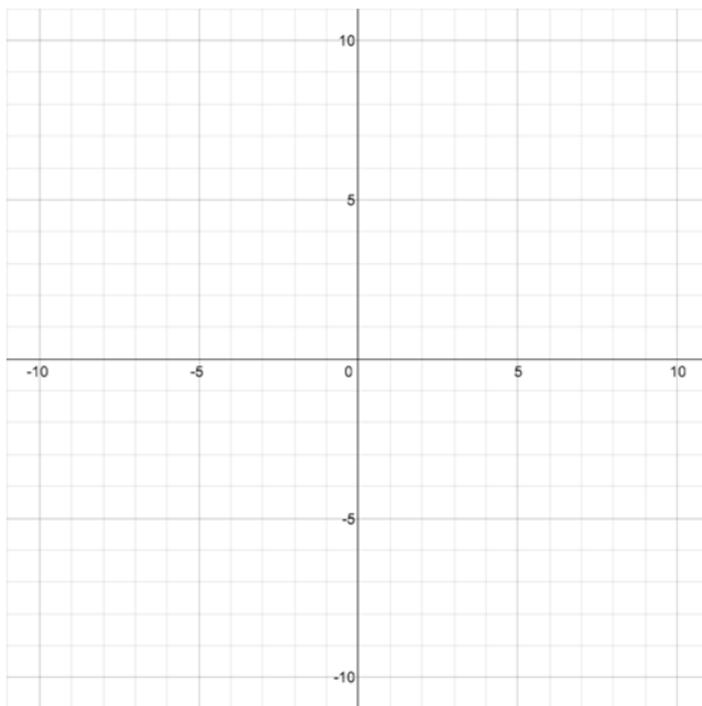
## Lesson 20: Stretching and Shrinking Graphs of Functions

### Classwork

#### Opening Exercise

The graph of a quadratic function defined by  $f(x) = x^2$  has been translated 5 units to the left and 3 units up. What is the formula for the function,  $g$ , depicted by the translated graph?

Sketch the graph of the equation  $y = g(x)$ .



#### Example



**Exploratory Challenge**

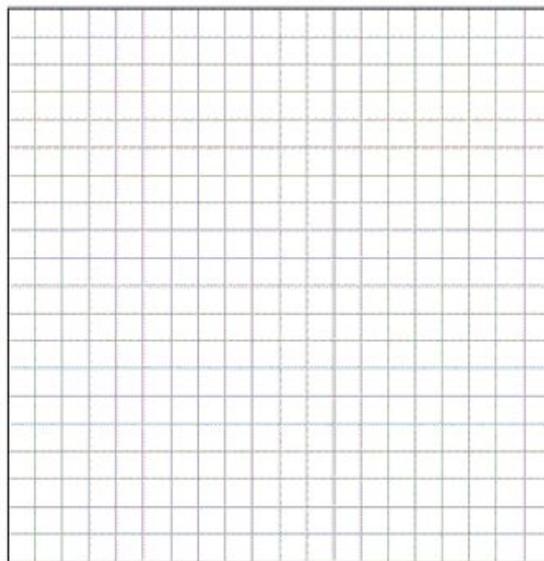
Complete the following to review Module 3 concepts:

- a. Consider the function  $f(x) = |x|$ . Complete the table of values for  $f(x)$ . Then, graph the equation  $y = f(x)$  on the coordinate plane provided for part (b).

$x$	$f(x)$
-4	
-2	
0	
2	
4	

- b. Complete the following table of values for each transformation of the function  $f$ . Then, graph the equations  $y = g(x)$ ,  $y = h(x)$ ,  $y = j(x)$ , and  $y = k(x)$  on the same coordinate plane as the graph of  $y = f(x)$ . Label each graph.

$x$	$f(x)$	$g(x) = 3f(x)$	$h(x) = 2f(x)$	$j(x) = 0.5f(x)$	$k(x) = -2f(x)$
-4					
-2					
0					
2					
4					



c. Describe how the graph of  $y = kf(x)$  relates to the graph of  $y = f(x)$  for each case.

i.  $k > 1$

ii.  $0 < k < 1$

iii.  $k = -1$

iv.  $-1 < k < 0$

v.  $k < -1$

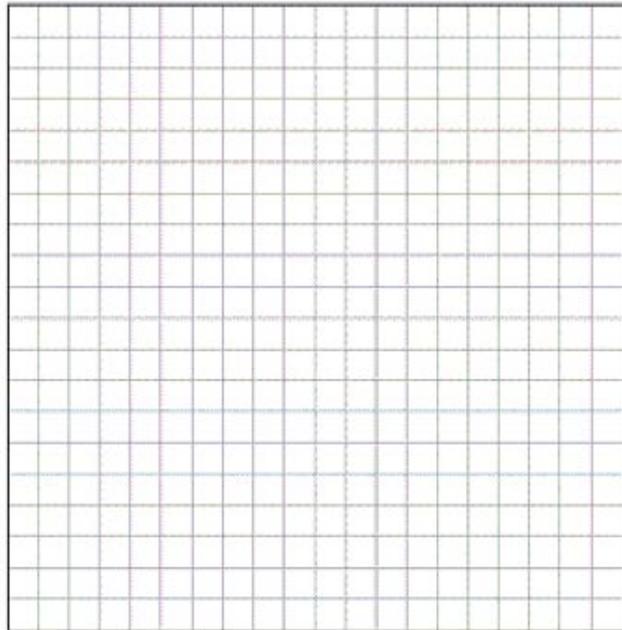
d. Describe the transformation of the graph of  $f$  that results in the graphs of  $g$ ,  $h$ , and  $k$  given the following formulas for each function. Then, graph each function and label each graph.

$$f(x) = x^3$$

$$g(x) = 2x^3$$

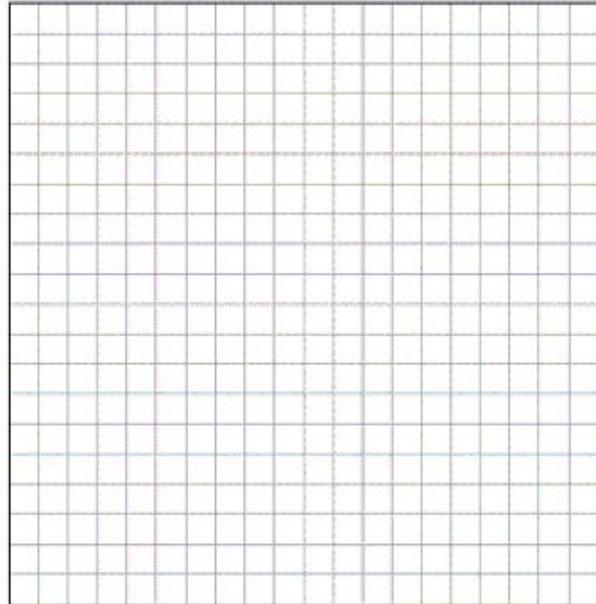
$$h(x) = 0.5x^3$$

$$k(x) = -3x^3$$



e. Consider the function  $f(x) = \sqrt[3]{x}$ . Complete the table of values, then graph the equation  $y = f(x)$ .

$x$	$f(x)$
-8	
-1	
0	
1	
8	



f. Complete the following table of values, rounding each value to the nearest hundredth. Graph the equations  $y = g(x)$ ,  $y = h(x)$ , and  $y = j(x)$  on the same coordinate plane as your graph of  $y = f(x)$  above. Label each graph.

$x$	$f(x)$	$g(x) = f(2x)$	$h(x) = f(0.5x)$	$j(x) = f(-2x)$
-8				
-1				
0				
1				
8				

g. Describe the transformations of the graph of  $f$  that result in the graphs of  $g$ ,  $h$ , and  $j$ .

- h. Describe how the graph of  $y = f\left(\frac{1}{k}x\right)$  relates to the graph of  $y = f(x)$  for each case.
- $k > 1$
  - $0 < k < 1$
  - $k = -1$
  - $-1 < k < 0$
  - $k < -1$

**Exercise 1**

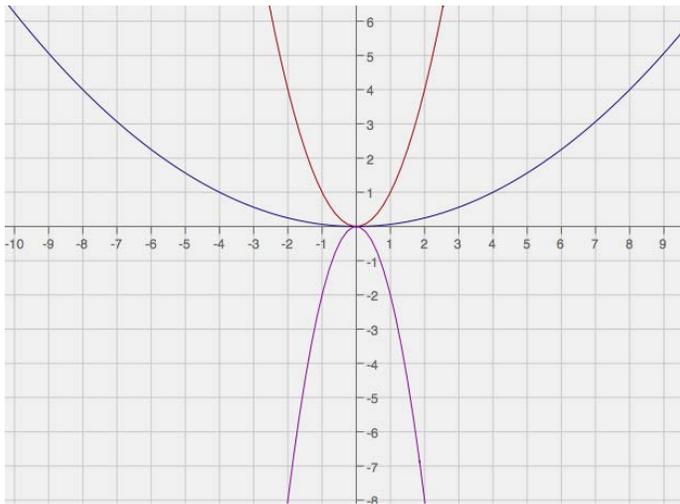
For each of the sets below, answer the following questions:

- What are the parent functions?
- How does the translated graph relate to the graph of the parent function?
- Write the formula for the function depicted by the translated graph.

a.



b.

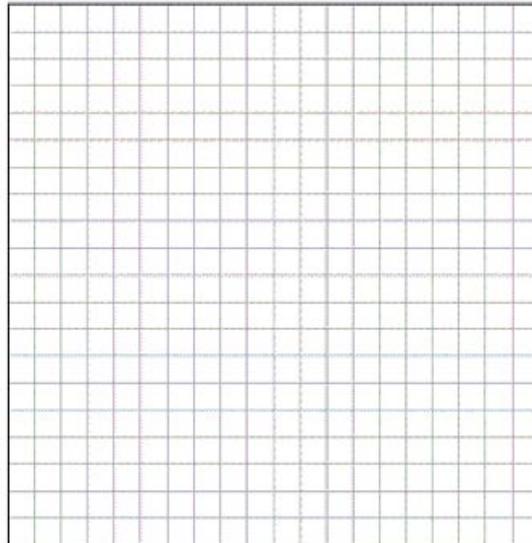
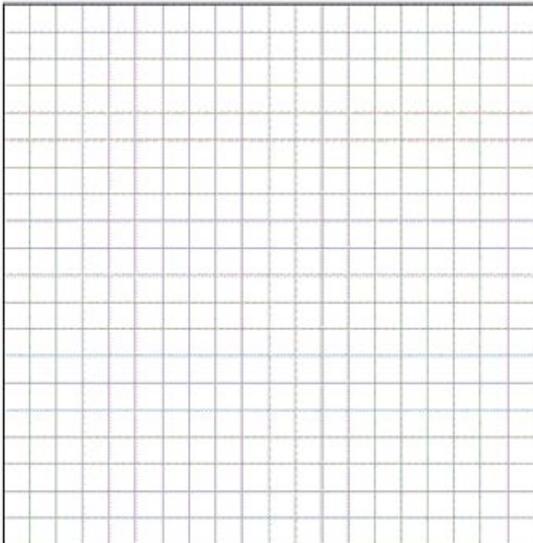


**Exercise 2**

Graph each set of functions in the same coordinate plane. Do not use a graphing calculator.

a.  $f(x) = |x|$   
 $g(x) = 4|x|$   
 $h(x) = |2x|$   
 $k(x) = -2|2x|$

b.  $g(x) = \sqrt[3]{x}$   
 $p(x) = 2\sqrt[3]{x}$   
 $q(x) = -2\sqrt[3]{2x}$



**Problem Set**

- Graph the functions in the same coordinate plane. Do not use a graphing calculator.  
 $f(x) = |x|$   
 $g(x) = 2|x|$   
 $h(x) = |3x|$   
 $k(x) = -3|3x|$
- Explain how the graphs of functions  $g(x) = 3|x|$  and  $h(x) = |3x|$  are related.
- Explain how the graphs of functions  $q(x) = -3|x|$  and  $r(x) = |-3x|$  are related.
- Write a function,  $g$  in terms of another function  $f$ , such that the graph of  $g$  is a vertical shrink of the graph  $f$  by a factor of 0.75.
- A teacher wants the students to write a function based on the parent function  $f(x) = \sqrt[3]{x}$ . The graph of  $f$  is stretched vertically by a factor of 4 and shrunk horizontally by a factor of  $\frac{1}{3}$ . Mike wrote  $g(x) = 4\sqrt[3]{3x}$  as the new function, while Lucy wrote  $h(x) = 3\sqrt[3]{4x}$ . Which one is correct? Justify your answer.
- Study the graphs of two different functions below. Which is a parent function? What is the constant value(s) multiplied to the parent function to arrive at the transformed graph? Now write the function defined by the transformed graph.

