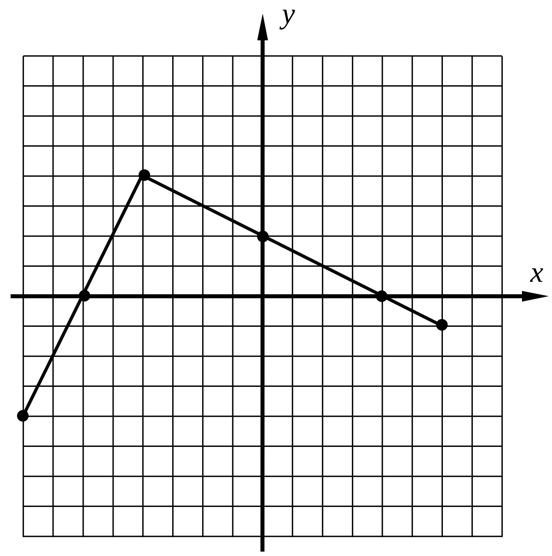
Name: ______________________________________ Date: ___________________

HORIZONTAL STRETCHING OF FUNCTIONS
COMMON CORE ALGEBRA I

In the last lesson we saw how multiplying a function by a constant stretched (or compressed) the function's outputs, and thus its graph. This was a **vertical stretch** because it only affected the vertical (output) component of the function for a given input. In today's lesson, we will see what happens to a function when you first manipulate its input.

***Exercise* #1:** The function $f(x)$ is shown on the graph below. Selected points are shown as reference. The function $g(x)$ is defined by $g(x) = f(2x)$. Notice that the multiplication by 2 happens **before** f is even evaluated. This is tricky!



(a) Find the values of each of the following. Carefully follow the rule for $g(x)$ and show your work.

$g(2) =$ $g(3) =$

$g(-2) =$ $g(-4) =$

$g(0) =$ $g(-3) =$

(b) Given the definition of $g(x)$, why can we **not** find a value for $g(4)$? Explain.

(c) State points that must lie on the graph of $g(x)$ based on your work in (a).

(d) Graph the function $g(x)$ based on your work from (b). Then, state the domain and range of both the original function, $f(x)$ and our new function $g(x)$. What remained the same? What changed?

Original Function: $f(x)$

Domain: Range:

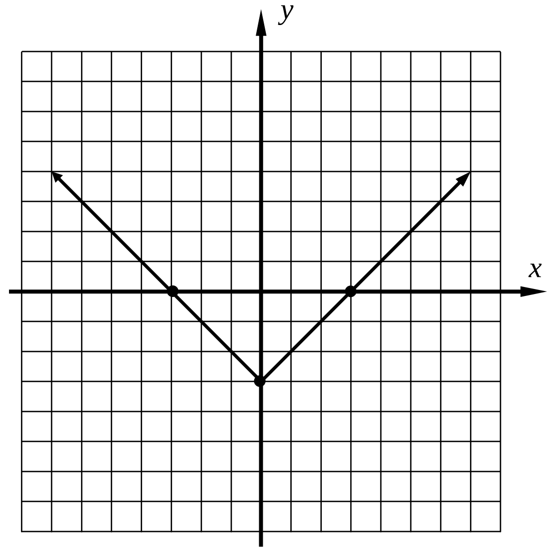
New Function: $g(x)$

Domain: Range:

(e) Describe what happened to the graph of $f(x)$ when we multiplied the function's input by 2.

Notice how the **horizontal stretch** worked almost counter to what we would have thought. In other words, when we multiplied the *x*-value by 2, it **compressed** our graph by a factor of 2. The opposite would also occur.

***Exercise* #2:** The function $f(x)=|x|-3$ is shown on the graph below. The function $g(x)$ is defined by the formula $g(x)=\left|\frac{1}{2}x\right|-3$.



(a) Use your graphing calculator to produce a table of values for $g(x)$ and graph it on the grid to the right.

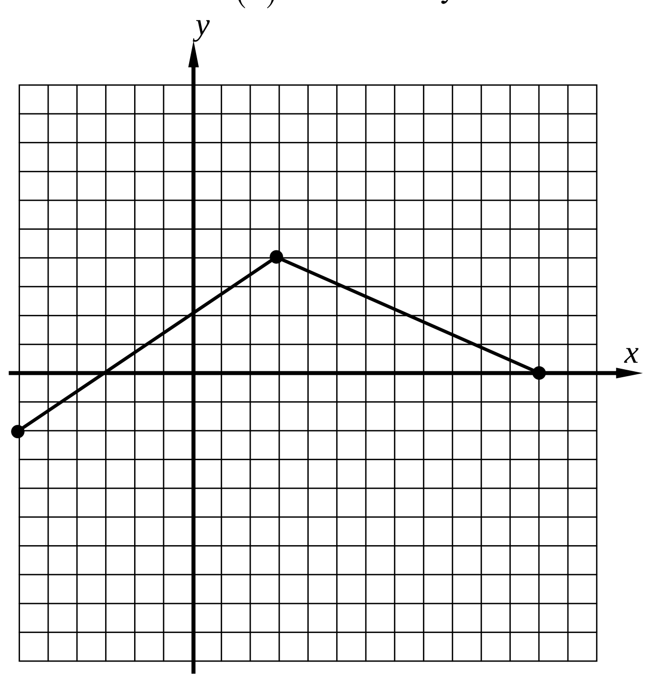
x									
y									

(b) What was the effect on the graph of $f(x)$ when we multiplied the input by $\frac{1}{2}$?

We can certainly combine the effects of both a vertical stretch and a horizontal stretch. This is harder, but if you can identify the various transformations, then the new function's graph can often be produced from the older function's fairly easily.

***Exercise* #3:** The graph of $f(x)$ is shown on the grid below. A new function $h(x)$ is defined by:

$$h(x)=2f(3x)$$



(a) Evaluate $h(1)$. What point must lie on the graph of $h(x)$ based on this calculation?

(b) Describe the transformations that must be done to the graph of $f(x)$ to produce the graph of $g(x)$.

(c) Graph $g(x)$ by plotting the three major points.

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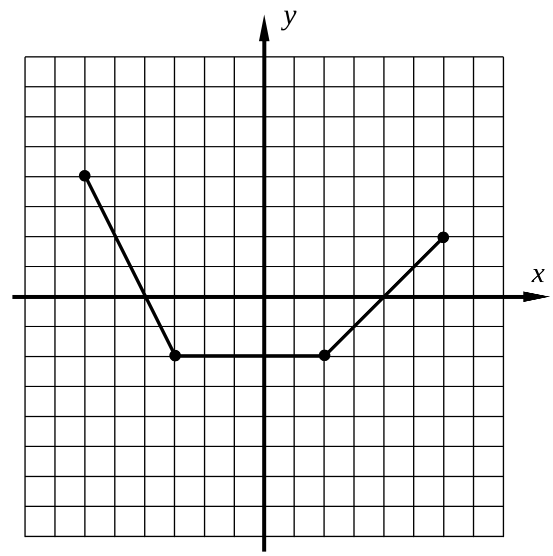
HORIZONTAL STRETCHING OF FUNCTIONS
COMMON CORE ALGEBRA I HOMEWORK

FLUENCY

1. The function $f(x)$ is shown graphed on the axes below with selected points highlighted. Two additional functions are defined as:

   $g(x)=f(2x)$ and $h(x)=2f(x)$

   Graph both $g(x)$ and $h(x)$ on the same grid and label them.



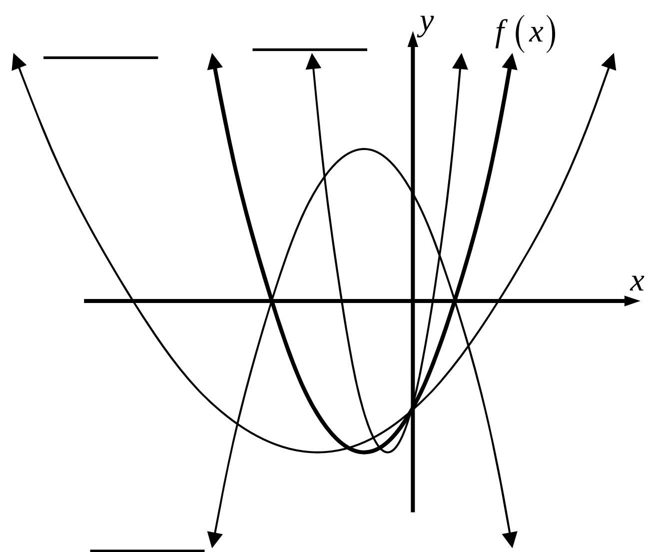
   State the domain of $g(x)$ only:

2. The quadratic function $f(x)$ is shown graphed to the right in bold. Three other functions are defined below with equations based on $f(x)$. Label each graph with its appropriate function.

   $g(x)=-f(x)$

   $h(x)=f(2x)$

   $k(x)=f\left(\frac{1}{2}x\right)$

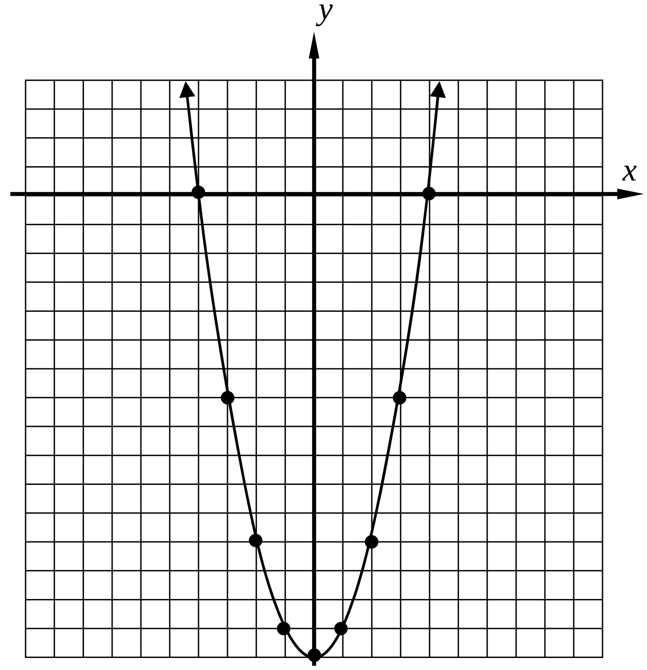


3. Which of the following formulas would indicate that the graph of $h(x)$ was stretched in the horizontal direction by a factor of 3?

   (1) $h(3x)$ (3) $h(x)+3$

   (2) $h\left(\frac{1}{3}x\right)$ (4) $3h(x)$

4. The parabola $f(x)=x^2-16$ is shown graphed on the grid below with certain points highlighted. The function $g(x)$ is given by $g(x)=f(2x)$.



(a) What is the range of the function $f(x)$?

(b) State the zeroes of $f(x)$.

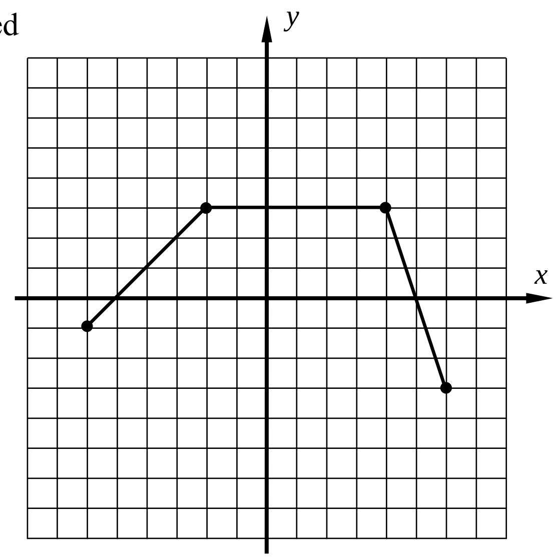
(c) The function $g(x)$ will have the equation $g(x)=(2x)^2-16$. Using your calculator, create a graph of $g(x)$ on the grid given.

(d) State the zeroes of $g(x)$. Why does this answer make sense in light of (b)?

Reasoning

5. The function $f(x)$ is shown below. Another function is defined by the formula:

$$g(x)=f(2x)+3$$



(a) Evaluate each of the following. Show your work.

$g(-3)=$ $g(-1)=$

$g(2)=$ $g(3)=$

(b) Plot a graph of $g(x)$ based on (a).

(c) What two transformations occurred to the graph of $f(x)$ to produce the graph of $g(x)$? State them and their order.