

## Algebra II

### Lesson 5: Transformation Rules for Algebraic Equations

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When a number is added or changed in a function equation, a transformation will occur. The graph will be moved up or down, left or right, or be stretched or shrunk. These changes are known as **transformations**. When a parent function  $f(x)$  is transformed, it becomes a different function but, the graph of the new function will still possess the family resemblance of the parent function.

**Transformation function general equation:**

$t(x) = a \cdot f(b(x - h)) + k$ <p style="text-align: center;"><i>Where <math>t(x)</math> = transformed function.</i></p>		
$f(x + h)$	move the $x$ - value $h$ units left	graph will slide horizontally left
$f(x - h)$	move the $x$ - value $h$ units right	graph will slide horizontally right
$f(b(x))$	$x$ is multiplied by a value (the input is altered)	$0 < b < 1$ fraction horizontal stretch  $b > 0$ horizontal compression
$a(f(x))$	multiply the $y$ - value by $a$ (the output is altered)	$a > 0$ vertical stretch/ steeper or narrower  $0 < a < 1$ fraction vertical shrink/flatter or wider
$-f(x)$	graph will flip upside down the leading coefficient will be negative	<b>Reflection across x-axis</b>
$f(x) + k$	move $y$ - value $k$ units up	Vertical translation up $k$ units
$f(x) - k$	move $y$ - value $k$ units down	graph will slide vertically down $k$ units

**Observations:**

1. What happens to  $x$  has an effect that appears opposite of the mathematical operation.
2. The order of operations for transformations is similar to those of equations; we deal with the **multiplication before addition/subtraction**. For graphs of functions involving more than one transformation, apply each change in the following order:
  1. Horizontal Translation
  2. Stretching or shrinking
  3. Reflection
  4. Vertical shift up/down

**Example 1...** Describe each combined transformation, *in the correct order*.

a.  $f(x - 2) + 1$

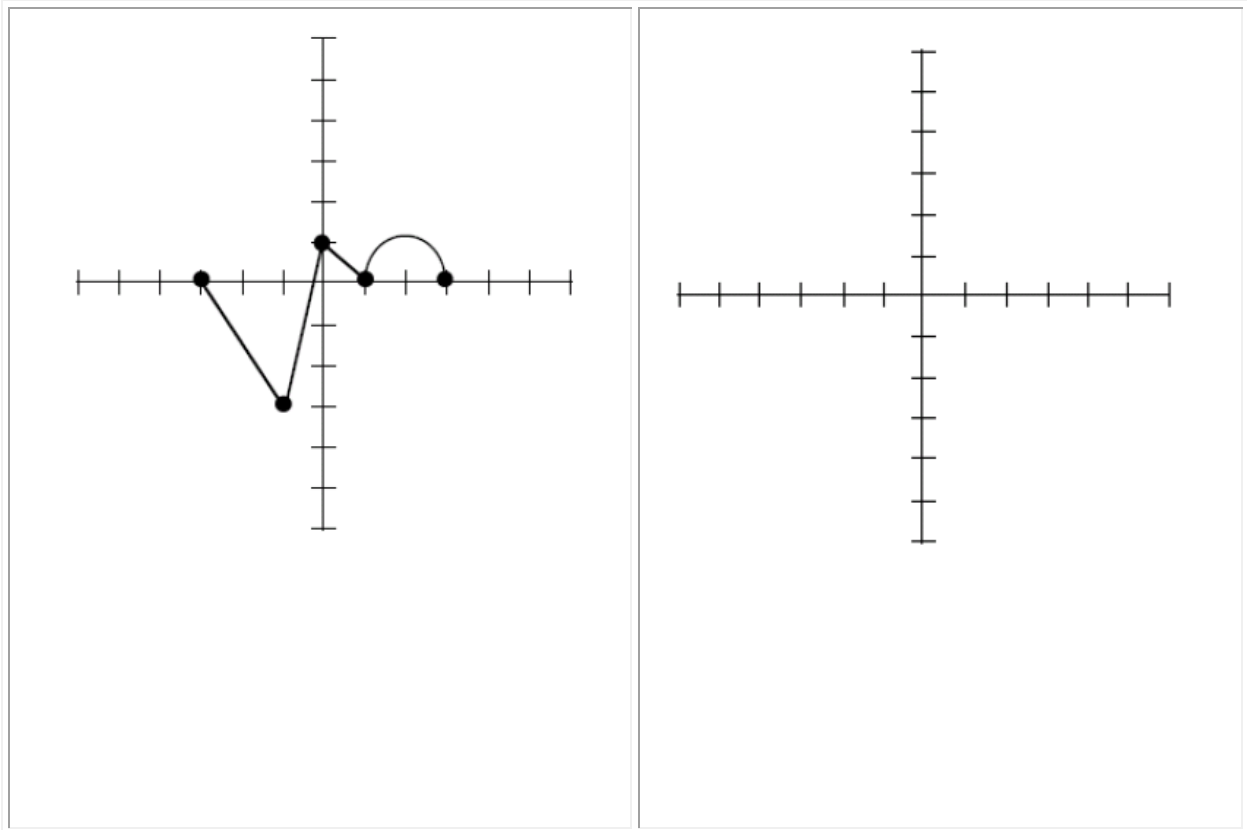
b.  $5g\left(\frac{1}{2}x\right) + 4$

c.  $f(x) = -2x^2 - 7$

d.  $h(x) = \frac{1}{3}|2(x + 1) - 3|$

When dealing with just a graph of a function, look at the x-y ordered pairs. For a horizontal shift, work with the x-value. For the stretch and vertical translations work with the y-value.

**Example 2** Transform the function below to  $3(f + 2) - 3$ . Show each step.



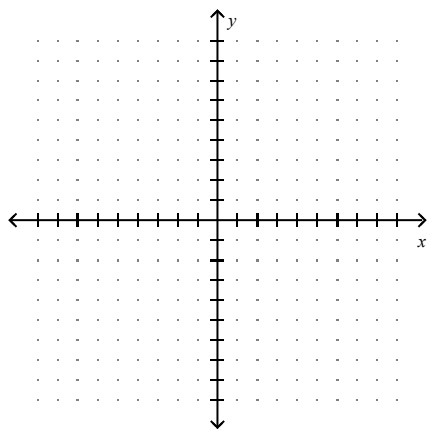
Use tables to graph the transformations of the following functions. Identify the domain and range

**a.**  $f(x) = (x - 2)^3 + 1$

	x	y	
	-2		
	-1		
	0		
	1		
	2		

Parent-

Transformations-

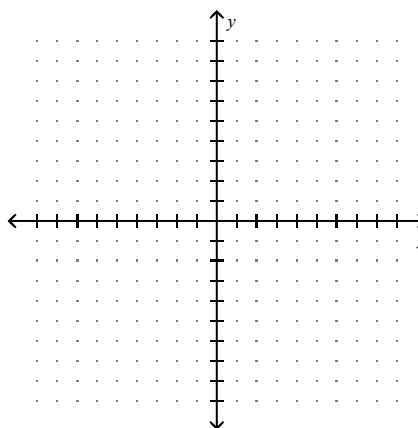


**b.**  $g(x) = 5\sqrt{\frac{1}{2}x} + 4$

	x	y	
	0		
	1		
	4		
	9		
	16		

Parent-

Transformations-

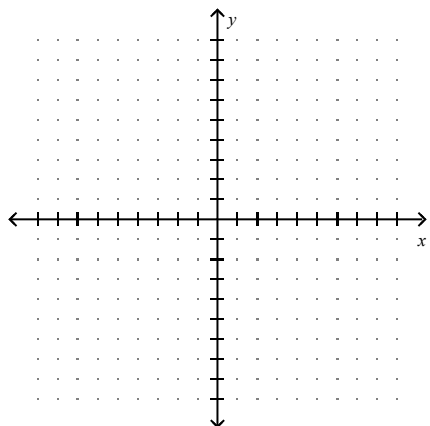


**c.**  $f(x) = -2x^2 - 7$

	x	y	
	-2		
	-1		
	0		
	1		
	2		

Parent-

Transformations-



**d.**  $h(x) = \frac{1}{3}|2(x + 1)| - 3$

	x	y	
	-2		
	-1		
	0		
	1		
	2		

Parent-

Transformations-

