Transformations

Operation	Transformation
Multiply/divide	Stretch/compress
Add/subtract	Shift
Multiply by -1	Reflect

If the changes are…	**then they affect..**	**and are implemented…**
"outside" $f(x)$	y	as written, following order of operations
"inside" $f(x)$	x	"backwards," in the "opposite" order (like solving for x).

Transformation		**Example**
Vertical…	*Outside*	
Stretch	$y = af(x)$ $a > 1$	$y = 2x^2$
Compress	$y = af(x)$ $0 < a < 1$	$y = \frac{1}{2}x^2$
Reflect over x-axis	$y = -f(x)$	$y = -x^2$
Shift up	$y = f(x) + k$ $k > 0$	$y = x^2 + 3$
Shift down	$y = f(x) - k$ $k > 0$	$y = x^2 - 3$
Horizontal…	*Inside*	
Stretch	$y = f(ax)$ $0 < a < 1$	$y = \left(\frac{1}{2}x\right)^2$
Compress	$y = f(ax)$ $a > 1$	$y = (2x)^2$
Reflect over y-axis	$y = f(-x)$	$y = (-x)^2$
Shift right	$y = f(x - h)$ $h > 0$	$y = (x - 3)^2$
Shift left	$y = f(x + h)$ $h > 0$	$y = (x + 3)^2$

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Example

The "parent function" is $y = \sqrt{x}$.

1. (Vertical) reflection over x-axis
2. Vertical stretch by a factor of 5
3. Shift down 4 units

$$f(x) = -5\sqrt{2x - 3} - 4$$

2. Horizontal compression by a factor of 2
1. Shift right 3 units.

[Old x]= 2[New x]−3		**[New y]= −5[Old y]−4**	
New x	Old x	Old y	New y
$0 = 2x - 3$ $x = 1.5$	0	0	$-5(0) - 4 = -4$
$1 = 2x - 3$ $x = 2$	1	1	$-5(1) - 4 = -9$
$4 = 2x - 3$ $x = 3.5$	4	2	$-5(2) - 4 = -14$
$9 = 2x - 3$ $x = 6$	9	3	$-5(3) - 4 = -19$