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Assume the original function is $f(x)$.

Vertical Transformations (y-values)

How is the original function changing? (What is the new function?)	How are the <u>points</u> of $f(x)$ affected?	What does this look like on the graph?
$f(x) + d$	$(x, y) \rightarrow (x, y + d)$	Vertical shift <u>UP</u> by d
$f(x) - d$	$(x, y) \rightarrow (x, y - d)$	Vertical shift <u>DOWN</u> by d
$(c)f(x)$ ex) $2f(x)$	$(x, y) \rightarrow (x, cy)$ $(x, 2y)$	Stretch vertically by (c)
$(\frac{1}{c})f(x)$ ex) $\frac{1}{3}f(x)$	$(x, y) \rightarrow (x, (\frac{1}{c})y)$ $(x, \frac{1}{3}y)$	Shrink vertically by $\frac{1}{c}$ (compression)
$-f(x)$	$(x, y) \rightarrow (x, -y)$ Switch the sign	Flip over the x-axis reflection

(7) $c < 1$

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Horizontal Transformations (x-values)

How is the original function changing? (What is the new function?)	How are the points of $f(x)$ affected?	What does this look like on the graph?
$f(x + d)$ ★	$(x, y) \rightarrow (x - d, y)$	Horizontal shift <u>LEFT</u> by d
$f(x - d)$ ★	$(x, y) \rightarrow (x + d, y)$	Horizontal shift <u>RIGHT</u> by d
$f(c \cdot x)$ ex) $f(2x)$	$(x, y) \rightarrow ((1/c)x, y)$ $(\frac{1}{2}x, y)$	^{compression} <u>Shrink horizontally</u> by $\frac{1}{c}$
$f(\frac{1}{c} \cdot x)$ ex) $f(\frac{1}{3}x)$	$(x, y) \rightarrow (cx, y)$ $(3x, y)$	Stretch horizontally by c
$f(-x)$	$(x, y) \rightarrow -x, y$ Switch sign of x	^{reflect} Flip over the y-axis

mult. by c ★
reciprocal ★

↑

↑ ↑ ↑

↑ ↑ $f(x+2)$
= $x^2 + 4x + 4$

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More Examples

$f(x)$
 $(2, 4)$

left + 3 $(2, 4) \rightarrow (2-3, 4) \rightarrow (-1, 4)$
 V.S. by 2 $(-1, 4) \rightarrow (-1, 4 \cdot 2) \rightarrow (-1, 8)$
 reflect $(-1, 8) \rightarrow (-1, -8)$
 X

$f(x+3)$
 $(-1, 4)$

left + 3

$2f(x+3)$
 $(-1, 8)$

vertical stretch by 2

$-2f(x+3)$

flip over x-axis
reflect

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$g(x)$
 $(4, 2)$

$H.S. (4, 2) \rightarrow (4 \cdot \frac{1}{3}, 2)$
 $\rightarrow (\frac{4}{3}, 2)$
 $V.S. (\frac{4}{3}, 2) \rightarrow (\frac{4}{3}, 2 \cdot 2)$
 $\rightarrow (\frac{4}{3}, 4)$

$g(3x)$
 $(\frac{4}{3}, 2)$

shrink horizontal by $\frac{1}{3}$

$2g(3x)$
 $(\frac{4}{3}, 4)$

stretch vertical by 2

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Part 1: For the given graphs below, provide the following information:

- Identify the given parent function: $f(x) = x$, $f(x) = x^2$, $f(x) = x^3$, $f(x) = b^x$, $f(x) = \sqrt{x}$, $f(x) = |x|$
- Describe using words, the transformation that occurred from the parent function.
- Write the transformation function represented by the given dotted graph.

1.	2.	3.
Parent fcn $f(x) = x$ left 4, up 1 $f(x) = x+4 + 1$		

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Part 2: Describe the transformations occurred from the given functions below.

7. What transformation converts the graph of $f(x) = -9(x - 7)^2 + 9$ to $g(x) = -9(x - 7)^2 + 6$?

8. What transformation converts the graph of $f(x) = -5|x + \underline{2}| + \underline{6}$ to $g(x) = -5|x + \underline{10}| + \underline{7}$?

$10 - 2 = 8$ spaces to the left $7 - 6 = 1$ space up

9. What transformation converts the graph of $f(x) = 3(x)^3 + 1$ into the graph of $g(x) = 6(x)^3 + 1$?