

Algebra II

Lesson 3: Transformation Rules for Algebraic Equations

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When a number is added or changed in an algebraic 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. Let's use $t(x)$ for the transformed function.

$f(x + h)$	move the x - value h units <i>left</i>	graph will slide horizontally left
$f(x - h)$	move the x - value h units <i>right</i>	graph will slide horizontally right
$a(f(x))$	multiply the y - values by a	$a > 0$ <i>vertical stretch/ steeper or narrower</i> $0 < a < 1$ <i>fraction</i> <i>vertical shrink/flatter or wider</i>
$-f(x)$	graph will flip upside down	Reflection across x-axis
$f(x) + k$	move y - value k units <i>up</i>	Vertical translation up k units
$f(x) - k$	move y - value k units <i>down</i>	graph will slide vertically down k units
Put it all together	$t(x) = a \cdot f(x - h) + k$	

Enter parent function into calculator, and then enter equation below, what happened?

1. $t(x) = 2x^2$	$t(x) = \frac{1}{4}x^2$	$t(x) = x^2 + 3$	$t(x) = -x^2 + 3$
2. $t(x) = x^2 - 3$	$t(x) = (x - 3)^2$	$(x) = (x^2 + 3)$	$(x) = -(x^2 + 3)$
3. $t(x) = 2 x $	$t(x) = x + 2 $	$t(x) = x + 2$	$t(x) = - x + 2$
4. $t(x) = \frac{5}{x}$	$t(x) = \frac{1}{x + 4}$	$t(x) = \frac{1}{x} + 3$	$t(x) = -\left(\frac{1}{x} + 3\right)$

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. $f(x - 2) + 3$

b. $\frac{1}{2} g(x) + 3$

c. $-2g(x) - 7$

d. $3h(x - 4) + 1$

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 $h(x + 4) - 2$. Show each step.

