Name_____ Date_____

1.2 Transformations of Linear & Absolute Value Functions

Algebra 2 – Notes and Vocab

Core Concepts

Describe the transformations that occur when each value in the given function is added to the parent function.

$$f(x) = a|(x-h)| + k$$

a: Vertical stretch/shrink

$a > 1$ stretch

$0 < a < 1$ shrink

h: shift right/left

$(x+h)$ left

$(x-h)$ right

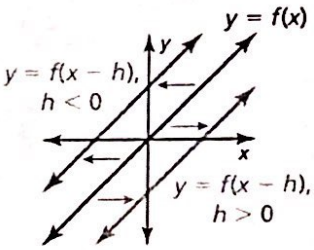
k: shift up/down

$+k$ up

$-k$ down

Horizontal Translations

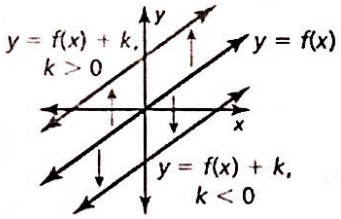
The graph of $y = f(x - h)$ is a horizontal translation of the graph of $y = f(x)$, where $h \neq 0$.



Subtracting h from the **inputs** before evaluating the function shifts the graph left when $h < 0$

Vertical Translations

The graph of $y = f(x) + k$ is a vertical translation of the graph of $y = f(x)$, where $k \neq 0$.



Adding k to the **outputs** shifts the graph down when $k < 0$ and up when $k > 0$.

Example 1: Writing Translations of Functions.

Let $f(x) = 2x + 1$

a. Write a function g whose graph is a translation 3 units down of the graph of f.

$g(x) = 2x + 1 - 3$

$\boxed{g(x) = 2x - 2}$

b. Write a function h whose graph is a translation 2 units to the left of the graph of f.

$h(x) = 2(x+2) + 1$ * now distribute *

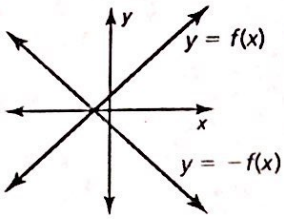
$h(x) = 2x + 4 + 1$

$\boxed{h(x) = 2x + 5}$

Core Concepts

Reflections in the *x*-axis

The graph of $y = -f(x)$ is a reflection in the x-axis of the graph of $y = f(x)$.

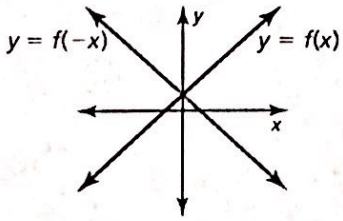


* makes the entire function negative *

Multiplying the **outputs** by −1 changes their signs.

Reflections in the *y*-axis

The graph of $y = f(-x)$ is a reflection in the y-axis of the graph of $y = f(x)$.



* negative only applies to the x inside the grouping symbols *

Multiplying the **inputs** by −1 changes their signs.

Example 2: Writing Reflections of Functions.

Let $f(x) = |x + 3| + 1$

a. Write a function g whose graph is a reflection in the x-axis of the graph of f.

$g(x) = -(|x+3| + 1)$

$g(x) = -|x+3| - 1$

* negative applies to the entire function. Distribute to each term but you cannot touch anything inside | |.

b. Write a function h whose graph is a reflection in the y-axis of the graph of f.

$h(x) = |-x+3| - 1$

* negative only applies to the x.

$h(x) = |-x+3| - 1$

You try!

Write a function g whose graph represents the indicated transformation of the graph of f. Use a graphing calculator to check your answer.

1. $f(x) = 3x$; translation 5 units up

2. $f(x) = |x| - 3$; translation 4 units to the right

3. $f(x) = -|x + 2| - 1$; reflection in the x-axis

4. $f(x) = \frac{1}{2}x + 1$; reflection in the y-axis

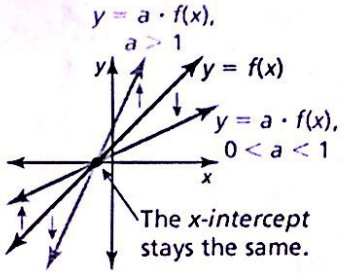
Core Concepts

* notice you multiply the entire function by a.

Vertical Stretches and Shrinks

The graph of $y = a \cdot f(x)$ is a vertical stretch or shrink by a factor of a of the graph of $y = f(x)$, where $a > 0$ and $a \neq 1$.

Multiplying the **outputs** by a stretches the graph vertically (away from the x-axis) when $a > 1$, and shrinks the graph vertically (toward the x-axis) when $0 < a < 1$.



Example 3: Writing Stretches and Shrinks of Functions.

Let $f(x) = |x - 3| - 5$

a. Write a function g whose graph is a vertical shrink of the graph of f by a factor of $\frac{1}{3}$.

$g(x) = \frac{1}{3}(|x-3| - 5)$

$\boxed{g(x) = \frac{1}{3}|x-3| - \frac{5}{3}}$

* again, distribute to each term but you cannot touch anything inside | |.

b. Write a function h whose graph is a vertical stretch of the graph of f by a factor of 2.

$h(x) = 2(|x-3| - 5)$

$\boxed{h(x) = 2|x-3| - 5}$

You try!

Write a function g whose graph represents the indicated transformation of the graph of f. Use a graphing calculator to check your answer.

5. $f(x) = 4x + 2$; vertical stretch by a factor of 2

6. $f(x) = |x| - 3$; vertical shrink by a factor of $\frac{1}{3}$

Example 4: Combining Transformations.

Let the graph of g be a vertical shrink by a factor of 0.25 followed by a translation 3 units up of the graph of f(x) = x. Write a rule for g.