



# ALGEBRA

# GRAPH TRANSFORMATIONS

## TRANSFORMATION RULES

Let  $f(x)$  be the original function and let  $c > 0$ ,  $k > 0$  be real numbers.

FUNCTION	TRANSFORMATION	EXAMPLE $f(x) = x^2$
$f(x) + k$	Vertical shift up $k$ units.	$f(x) + 5 = x^2 + 5$
$f(x) - k$	Vertical shift down $k$ units.	$f(x) - 4 = x^2 - 4$
$f(x + k)$	Horizontal shift $k$ units to the left.	$f(x + 3) = (x + 3)^2$
$f(x - k)$	Horizontal shift $k$ units to the right.	$f(x - 2) = (x - 2)^2$
$-f(x)$	Reflection across the $x$ -axis.	$-f(x) = -x^2$
$f(-x)$	Reflection across the $y$ -axis.	$f(-x) = (-x)^2$
$c \cdot f(x)$ , $c > 1$	Vertical stretch by a factor of $c$ units.	$2 \cdot f(x) = 2x^2$
$c \cdot f(x)$ , $0 < c < 1$	Vertical shrink by a factor of $c$ units.	$\frac{1}{3} \cdot f(x) = \frac{1}{3}x^2$

Notice that a **horizontal stretch** is the same as a **vertical shrink**, and a **horizontal shrink** is the same as a **vertical stretch**.

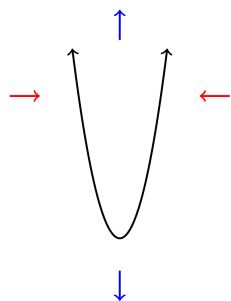


Figure 1: Vertical Stretch or Horizontal Shrink

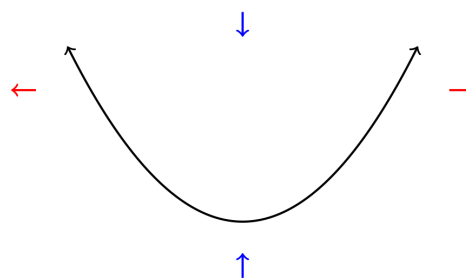


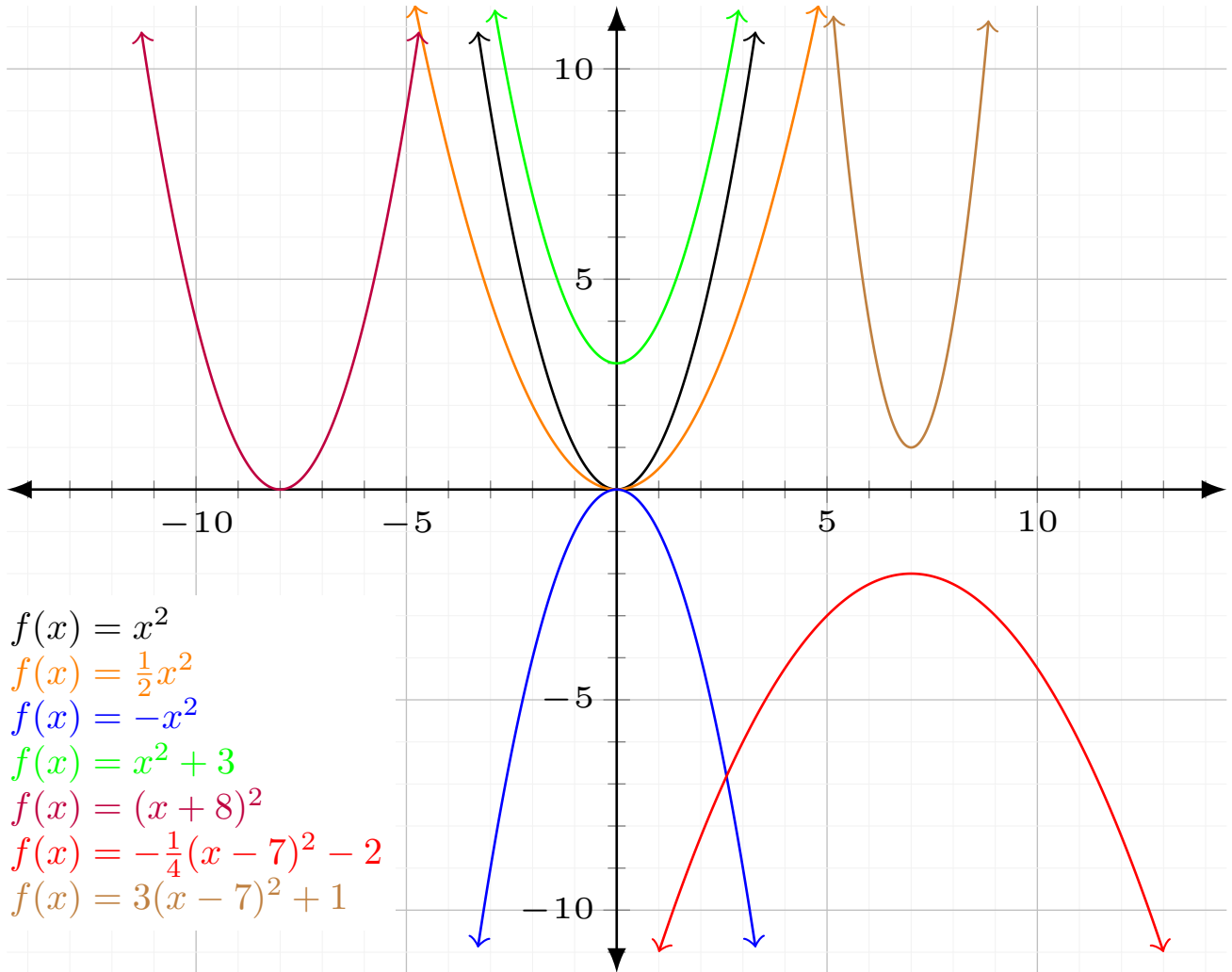
Figure 2: Vertical Shrink or Horizontal Stretch





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We can see that for the graphs of  $f(x) = 3(x - 7)^2 + 1$  and  $f(x) = -\frac{1}{4}(x - 7)^2 - 2$ , we have

horizontal shrink by 3

shift 1 up

$$f(x) = 3(x - 7)^2 + 1$$

shift 7 right

vertical shrink by 1/4

shift 7 right

$$f(x) = -\frac{1}{4}(x - 7)^2 - 2$$

shift 2 down

horizontal flip

