

Vertical translation k units up

$$y = x^2$$

$$y = x^2 + 3$$
 Vertical translation
3 units up

$$y = x^2 - 5$$

$$y = x^2 + |k|$$
 Vertical translation
5 units down
neg
 $k < 0$

$$y = x^2$$

$$y = (x - 4)^2$$

$$y = (x - h)^2 \quad h > 0$$

Horizontal translation
4 units right

$$y = (x - h)^2 \quad \begin{array}{l} \text{neg} \\ h < 0 \end{array}$$

$$y = (x - 3)^2$$

$$y = (x + 3)^2$$

Horizontal translation
3 units left

$$y = x^2$$

$$y = (x - 2)^2 + 7$$

Horizontal translation
2 units right

Vertical translation
7 units up

$$y = x^2 + 7$$

$$y = (x - 2)^2$$

$$y = |x| \quad \text{Absolute Value}$$

$$y = |x + 1| - 6$$

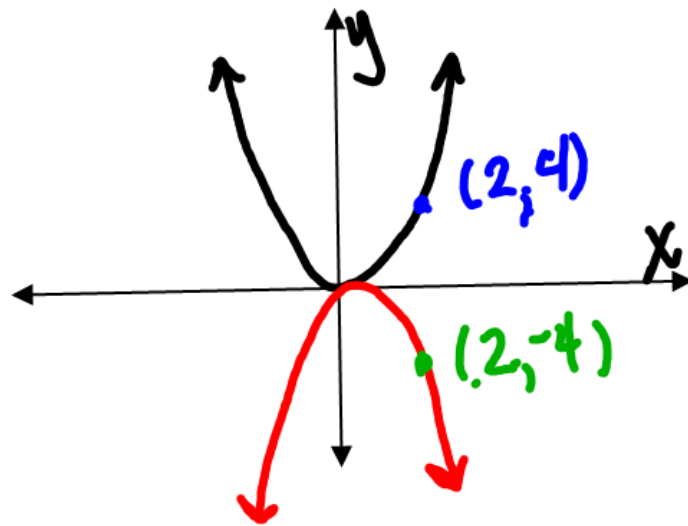
Vertical translation 6 units down
Horizontal translation 1 unit left

$$y = x^2$$

$$y = -(x^2)$$

$$y = -x^2$$

Reflection across x-axis



$$(x, f(x))$$

$$(x, y)$$

$$(x, y)$$

$$(x, -y)$$

$$(x, -f(x))$$

$$y = |x|$$

$$y = -|x|$$

$$y = \sqrt{x}$$

$$y = -\sqrt{x}$$

Reflection across the y-axis

$$y = x^2$$

$$y = (-x)^2$$

$$y = |-x|$$

$$y = x^3$$

$$y = -x^3$$

Reflection
across x-axis

$$y = (-x)^3$$

Reflection
across y-axis

Vertical Stretch

$$y = x^2$$

$$y = 3x^2$$

Vertical Stretch
by a factor of 3

$$y = a(f(x)) \quad a > 1$$

Vertical Compression

$$y = a(f(x)) \quad 0 < a < 1$$

fraction

$$y = \frac{1}{2}x^2$$

Vertical compression
by a factor of $\frac{1}{2}$

Horizontal Stretch

$$y = f(bx) \quad 0 < b < 1$$

fraction

$$y = x^2$$

$$y = \left(\frac{1}{2}x\right)^2 \quad \frac{1}{\frac{1}{2}} = 2$$

Horizontal stretch by a factor of 2

$$y = f(bx) \quad b > 1$$

$$y = (3x)^2$$

$$b = 3$$

$$\frac{1}{b} = \frac{1}{3}$$

Horizontal compression by a factor of $\frac{1}{3}$

$$y = \sqrt[3]{x}$$

$$y = \sqrt[3]{x}$$

$$y = -\sqrt[3]{x+1} - 5$$

Reflect x-axis
 Horiz trans 1 left
 Vert trans 5 down

$$y = b - \sqrt[3]{x}$$

$$y = -\sqrt[3]{x} + b$$

$$y = 2\sqrt[3]{x-3} + 4$$

Vertical stretch 2
 Horiz trans 3 right
 Vertical trans 4 up