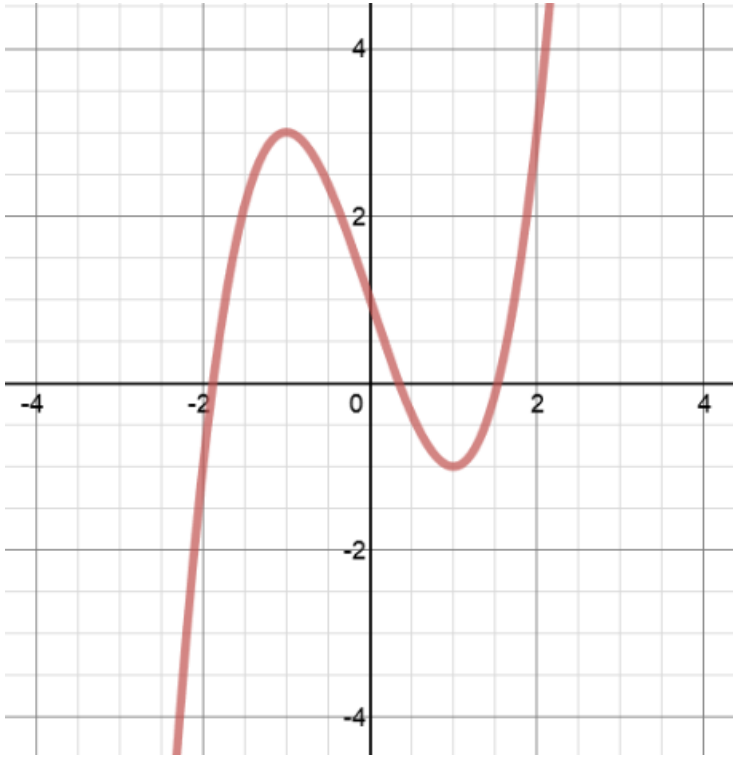
Warm - Up

Identify the following:

Intervals

Increasing: $(-\infty, -1), (1, \infty)$

Decreasing: $(-1,1)$



X Intercepts: $(-2,0)$, $(0.5,0)$, $(1.5,0)$

Y Intercepts: $(0,1)$

Relative Maximum(s): $(-1,3)$

Relative Minimum(s): $(1,-1)$

Domain: All Real Numbers

Range: All Real Numbers

End Behavior: $as\ x \to \infty, y \to \infty$

$as\ x \to -\infty, y \to -\infty$

So far…

Most confusing Function Characteristics	
Domain	Interval of X values
Range	Interval of Y values
Increasing Interval	Interval of X values
Decreasing Interval	Interval of X values
End Behavior	Look at the far ends of the graph. If it's pointing up, Y is approaching positive infinity. If it's pointing down, Y is approaching negative infinity.

Homework Questions?

Quiz on Friday

Objectives for today

Define Parent Functions and be able to associate the graph of a parent function with the correct name and function notation. (continued from yesterday)

Identify vertical and horizontal transformations from both a graph of a function and the function equation.

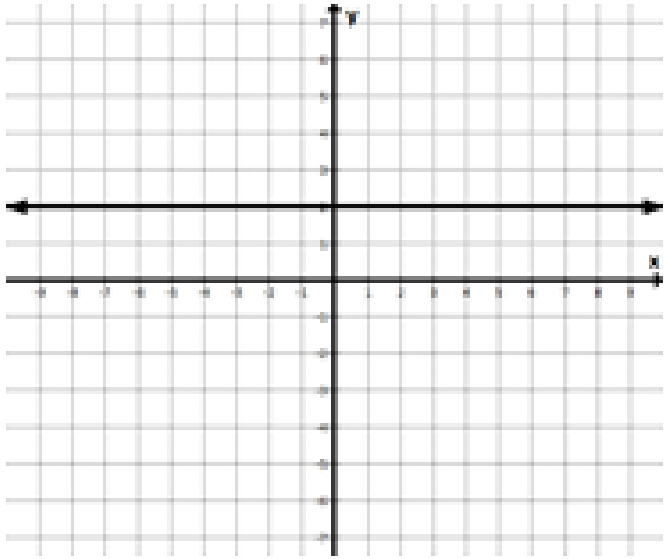
Parent Functions

Introducing PARENT FUNCTIONS!

Parent functions are the simplest form of families of functions.

Function	Parent Function
$g(x) = 2x^2 + 4$	$f(x) = x^2$
$g(x) = x - 7$	$f(x) = x$
$g(x) = \frac{1}{3}(x - 7)^3 - 1$	$f(x) = x^3$
$g(x) = \lvert x + 4 \rvert$	$f(x) = \lvert x \rvert$

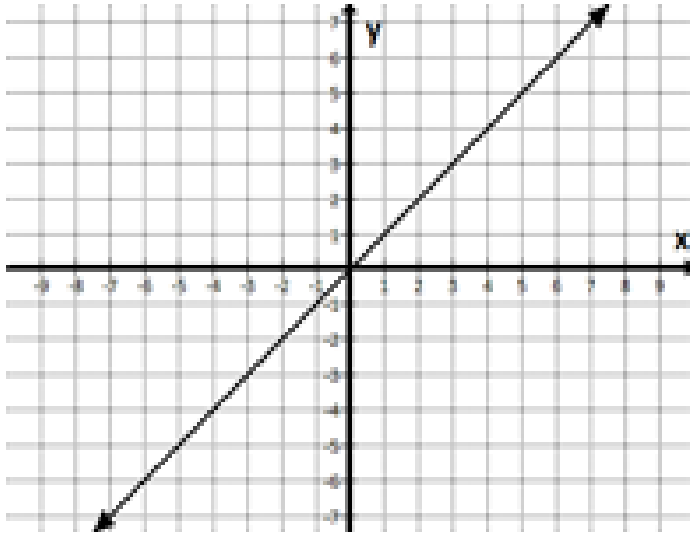
Parent Functions



Constant, f(x) = C

Domain		**Range**
	End Behavior	
$as\ x \to -\infty, y \to$		$as\ x \to \infty, y \to$
	Critical Points	
Vertex	**X intercepts**	**Y intercepts**

Parent Functions

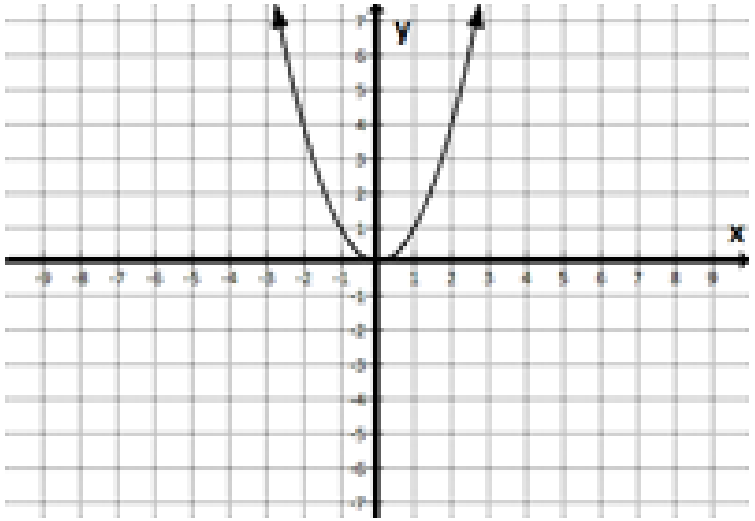


Linear, f(x)=x

Domain		Range
End Behavior		
$as\ x \to -\infty, y \to$		$as\ x \to \infty, y \to$
Critical Points		
Vertex	**X intercepts**	**Y intercepts**

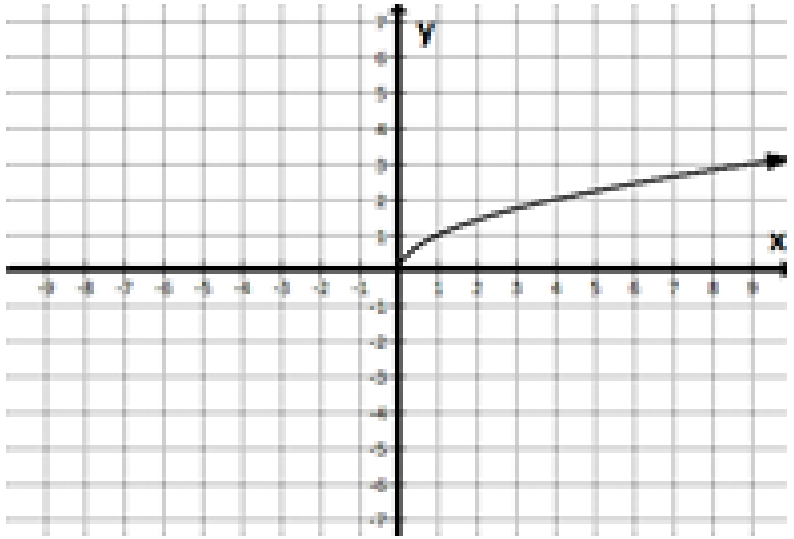
Parent Functions

Quadratic, $f(x)=x^2$



Domain	Range
End Behavior	
$as\ x \to -\infty, y \to$	$as\ x \to \infty, y \to$
Critical Points	
Vertex	**X intercepts** / **Y intercepts**

Parent Functions



Radical (Square Root), f(x)=

Domain		**Range**
	End Behavior	
$as\ x \to -\infty, y \to$		$as\ x \to \infty, y \to$
	Critical Points	
Vertex	**X intercepts**	**Y intercepts**

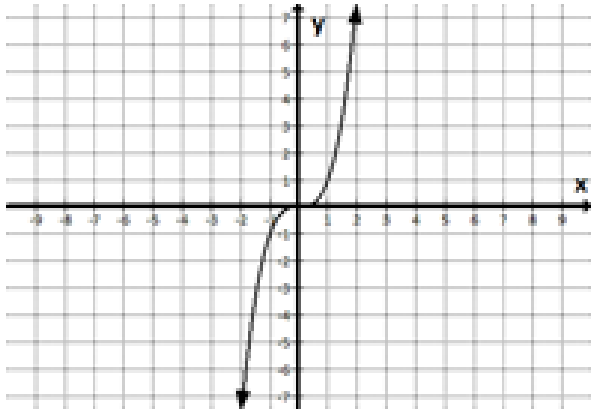
Work with a partner to complete the next five parent functions.

If you're feeling confident complete the last function, Rational.

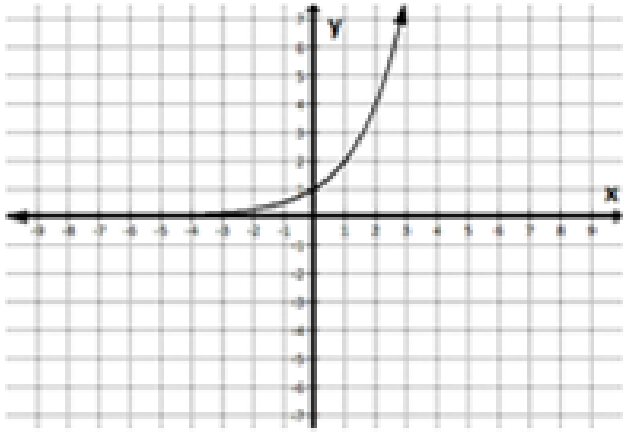
We'll do that one together as a class.

Parent Functions

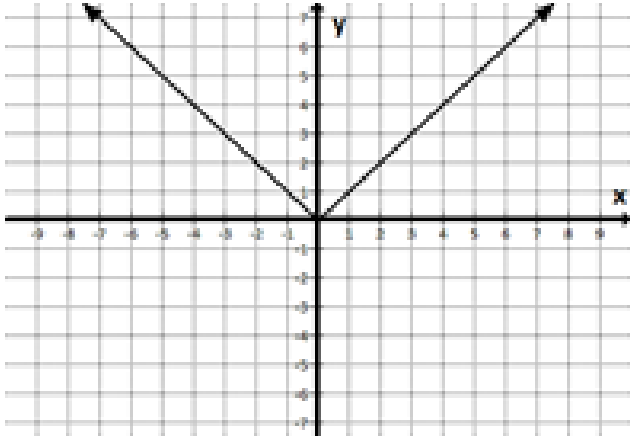
Cubic, $f(x)=x^3$



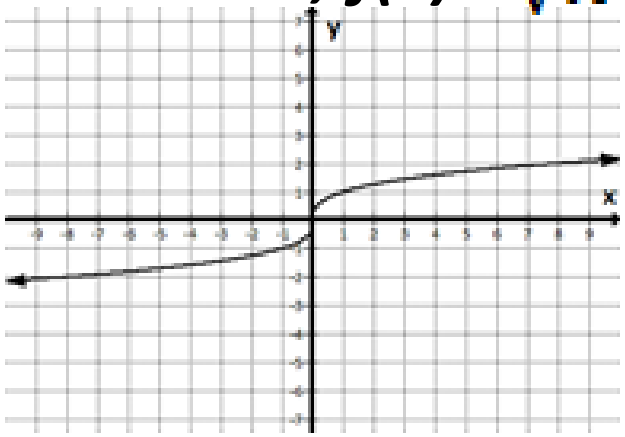
Exponential, $f(x)=b^x$, $b>1$



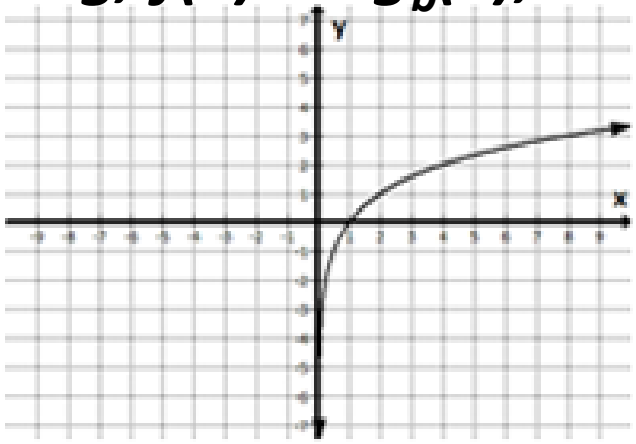
Absolute Value, $f(x)=|x|$



Cube Root, $f(x)=\sqrt[3]{x}$

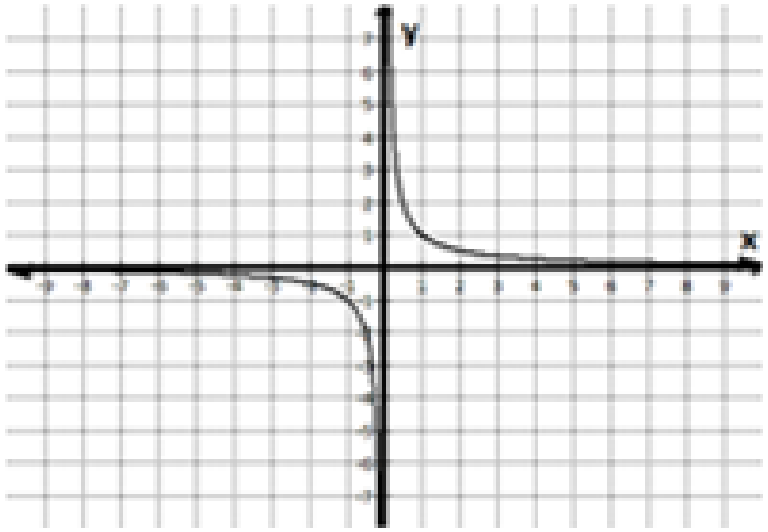


Log, $f(x)= \log_b(x)$, $b>1$



Parent Functions

Rational, Inverse, Reciprocal, f(x)= $\frac{1}{x}$



Domain		Range
	End Behavior	
$as\ x \to -\infty, y \to$		$as\ x \to \infty, y \to$
	Critical Points	
Vertex	**X intercepts**	**Y intercepts**

What's different about this graph?

Transformations

When a function is **shifted** in any way from its **parent function**, it is said to be **transformed.** We call this a **transformation of a function**. Functions are typically transformed either **vertically** or **horizontally.**

Transformations

Two categories of Function Transformations

1. Rigid Transformations

The basic shape of the graph is unchanged.

Vertical Shifts
Horizontal Shifts
Reflections

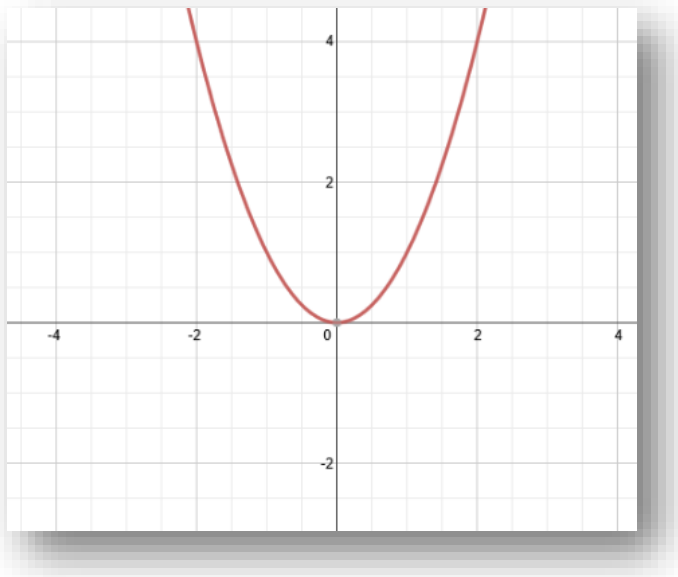
2. NonRigid Transformations

Cause a distortion, a change in the graph.

Stretches
Shrinks (Compressions)

Transformations

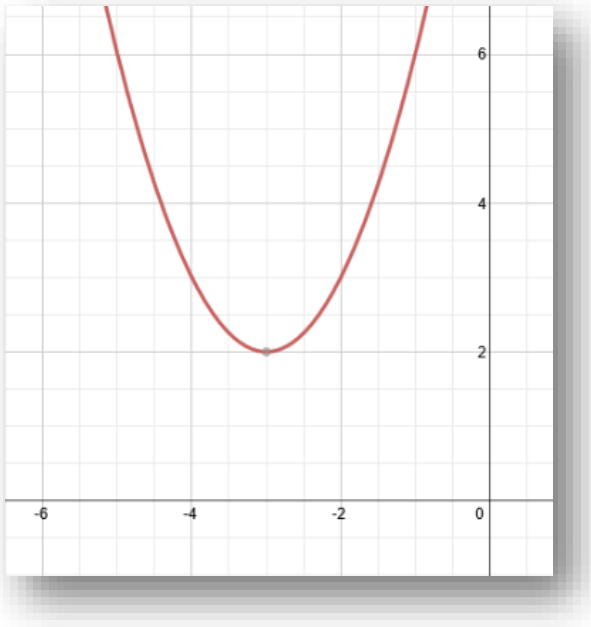
Some simple transformations…



Parent Function

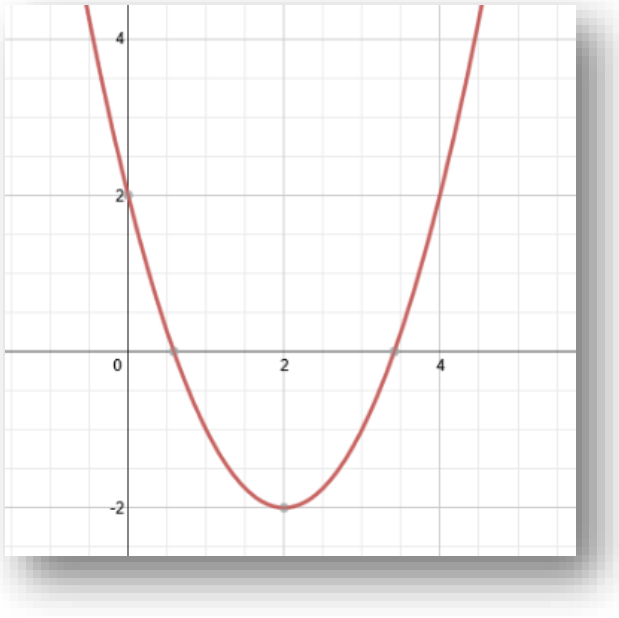
Quadratic

$f(x)=x^2$



Transformed Function

Shifted
Left 3 units
Up 2 units

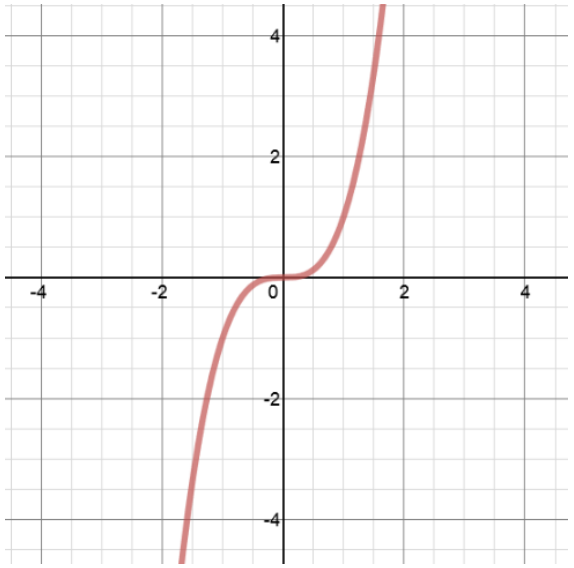


Transformed Function

Shifted
Right 2 units
Down 2 units

Transformations

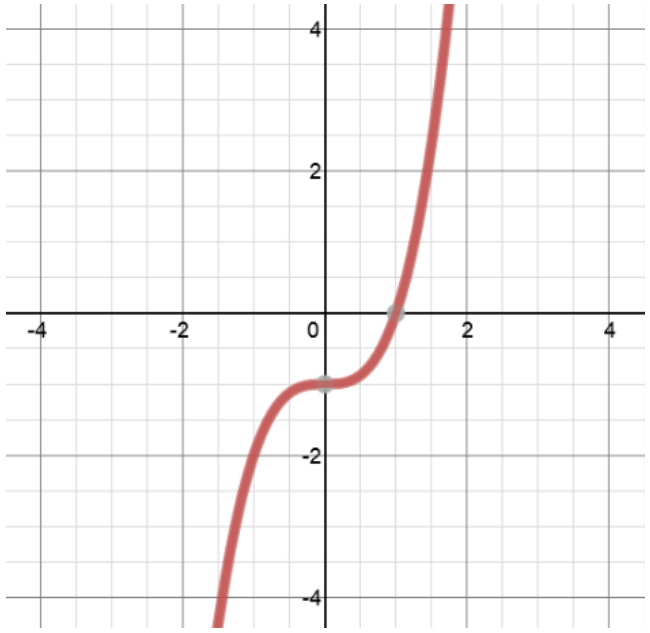
Identify the parent function and the transformations represented in the graphs.



Parent Function

Cubic

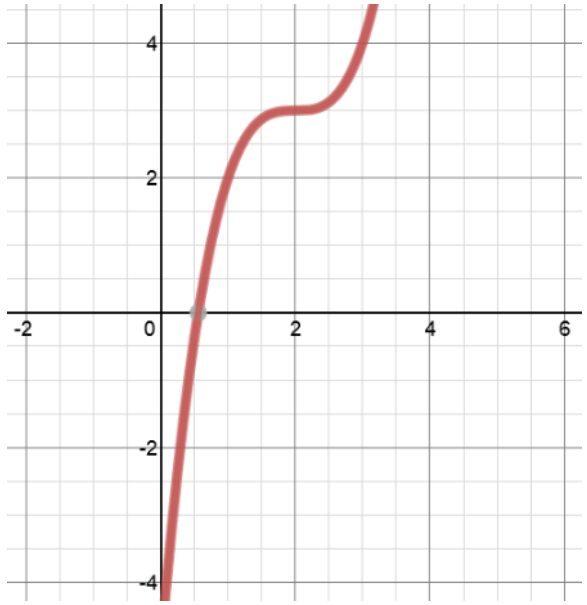
$f(x)=x^3$



Transformed Function

Shifted

Down 1 unit



Transformed Function

Shifted

Right 2 units

Up 3 units

So how do we represent these transformations algebraically?

Today we will focus on Rigid Transformations

Transformations

Vertical Transformations

When functions are transformed on the **outside** of the f(x) part, you move the function up and down.

Function Notation	Description of Transformation
$g(x) = f(x) \pm c$	Vertical shift **up** C units if C is **positive**
	Vertical shift **down** C units if C is **negative**

Transformations

Vertical Transformations

Function Notation	Description of Transformation
$g(x) = f(x) \pm c$	Vertical shift **up** C units if C is **positive**
	Vertical shift **down** C units if C is **negative**

How do we interpret this function notation?

Let $f(x) = x^2$ and $c = 3$ then $g(x) = x^2 + 3$

Let $f(x) = \sqrt{x}$ and $c = -4$ then $g(x) = \sqrt{x} - 4$

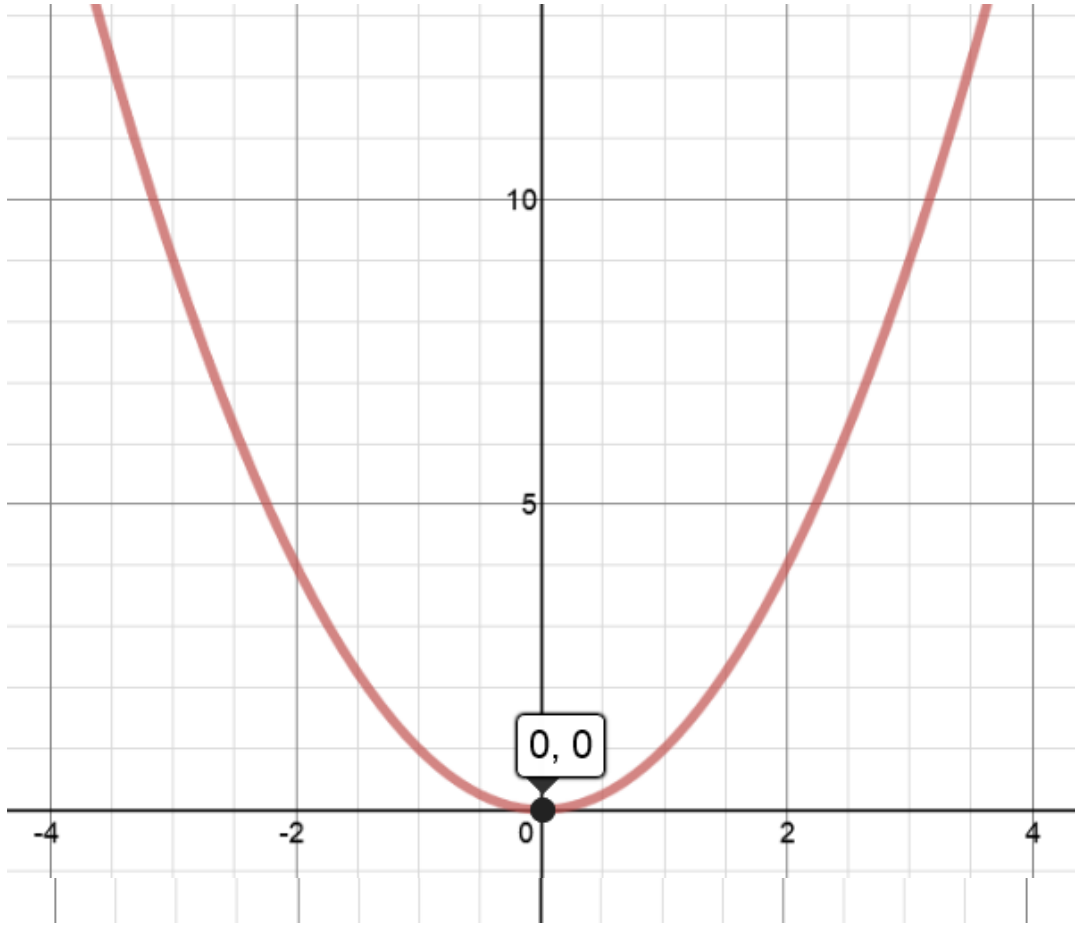
Let $f(x) = 2^x$ and $c = 7$ then $g(x) = 2^x + 7$

Transformations

Let's play **"What's going to happen to the parent function?"**

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

X	f(x) X^2	g(x) X^2+3
3	9	12
2	4	7
1	1	4
0	0	3
-1	1	4
-2	4	7
-3	9	12

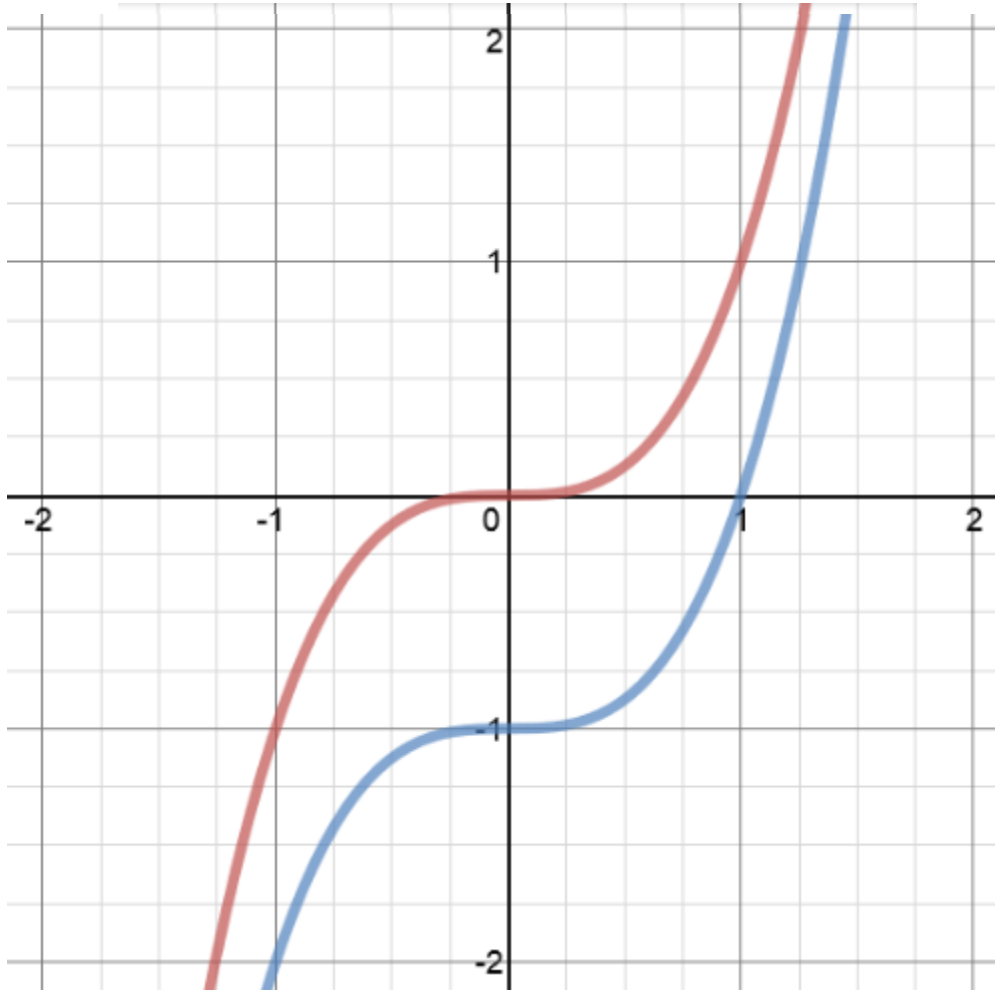


Transformations

Let's play **"What's going to happen to the parent function?"**

$$g(x) = x^3 - 1$$

X	f(x) X^3	g(x) X^3-1
3	27	26
2	8	7
1	1	0
0	0	-1
-1	-1	-2
-2	-8	-9
-3	-27	-28



Transformations

Write the equation for the transformed function represented in this graph.

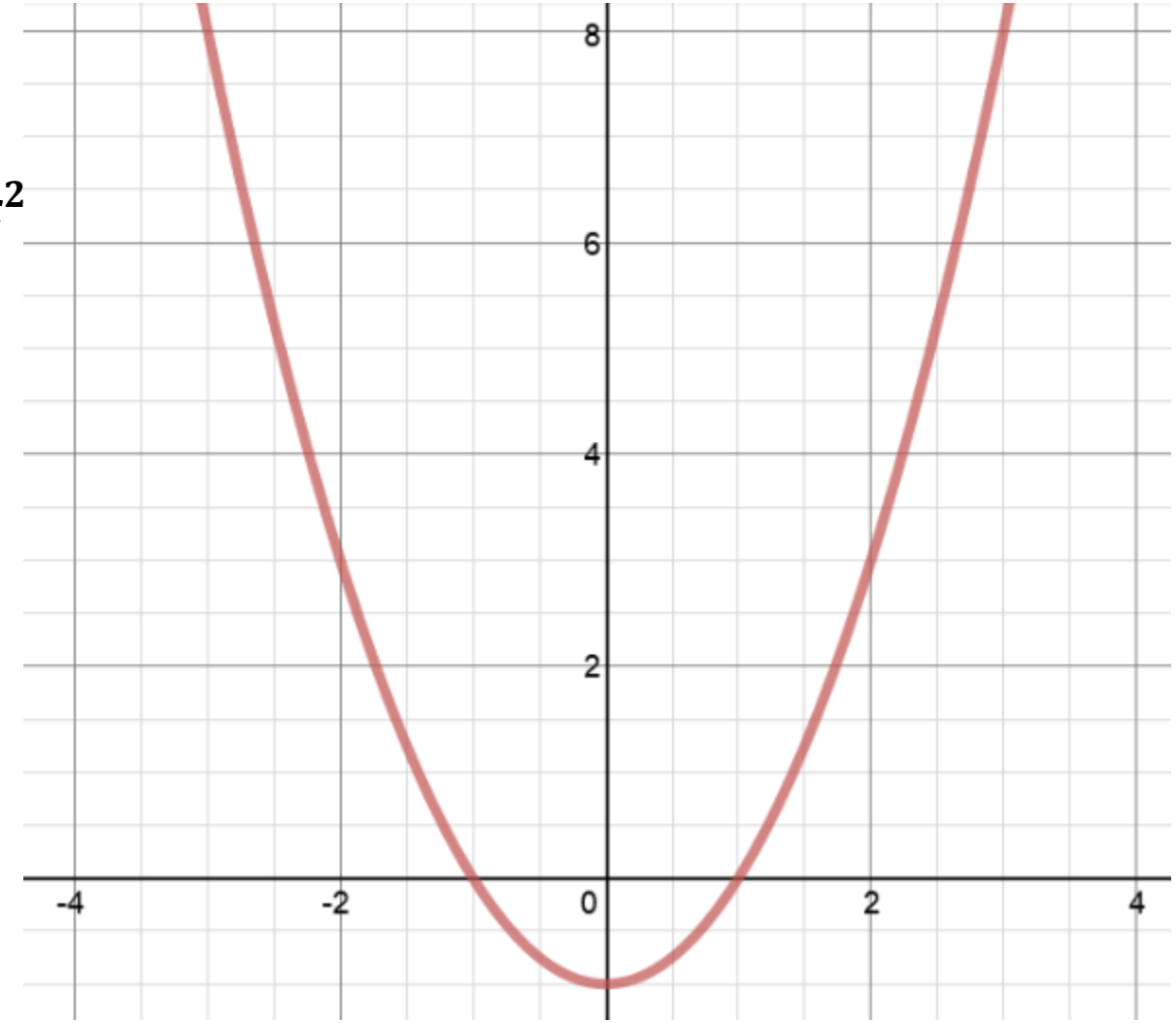
$g(x) = x^2 - 1$

Parent Function? **Quadratic, $f(x) = x^2$**

Critical point that can help us? **Vertex**

Which way did it go? **Down**

By how much? **1 unit**



Transformations

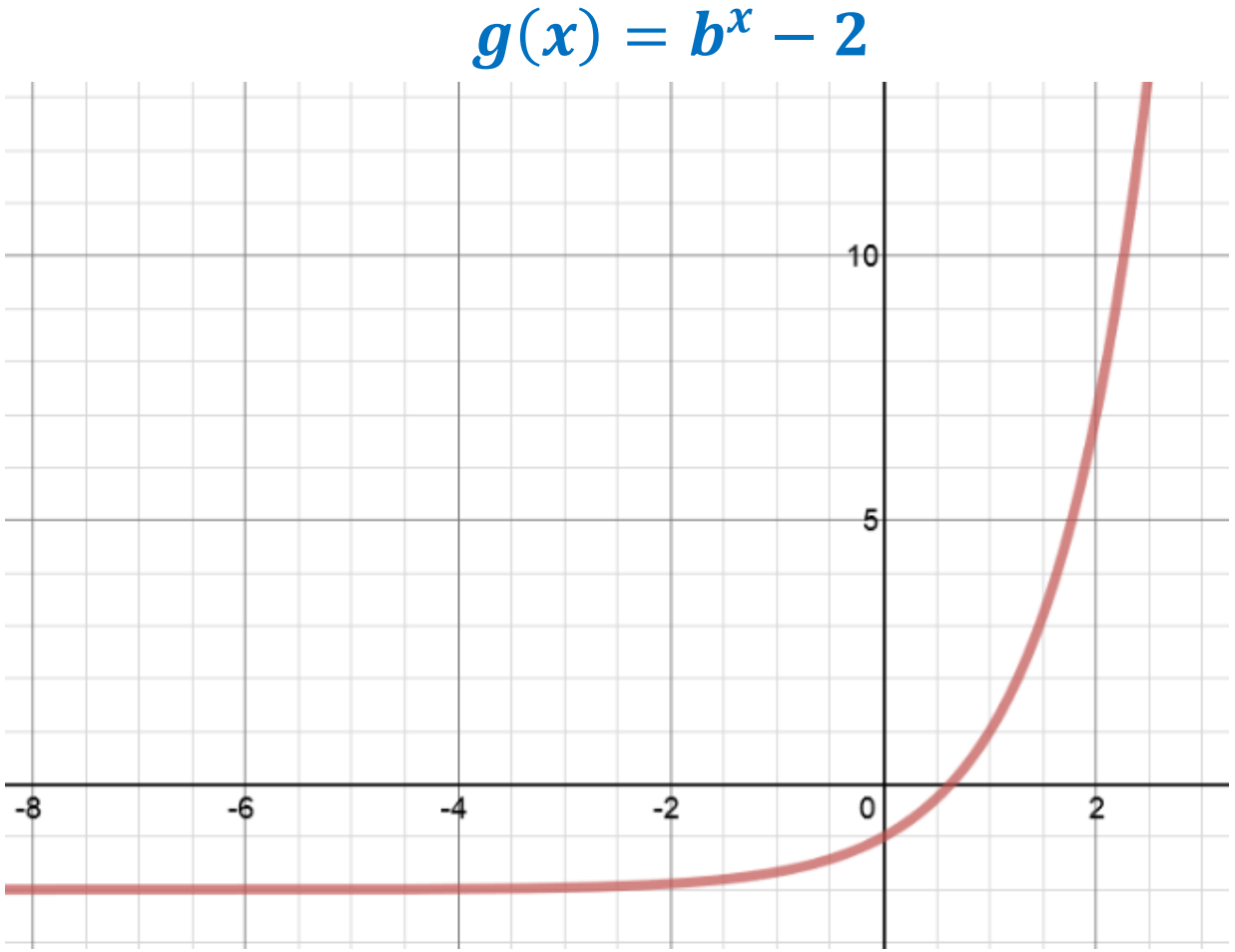
Write the equation for the transformed function represented in this graph.

Parent Function? **Log, $f(x) = b^x$**

Critical point that can help us? **Intercepts**

Which way did it go? **Down**

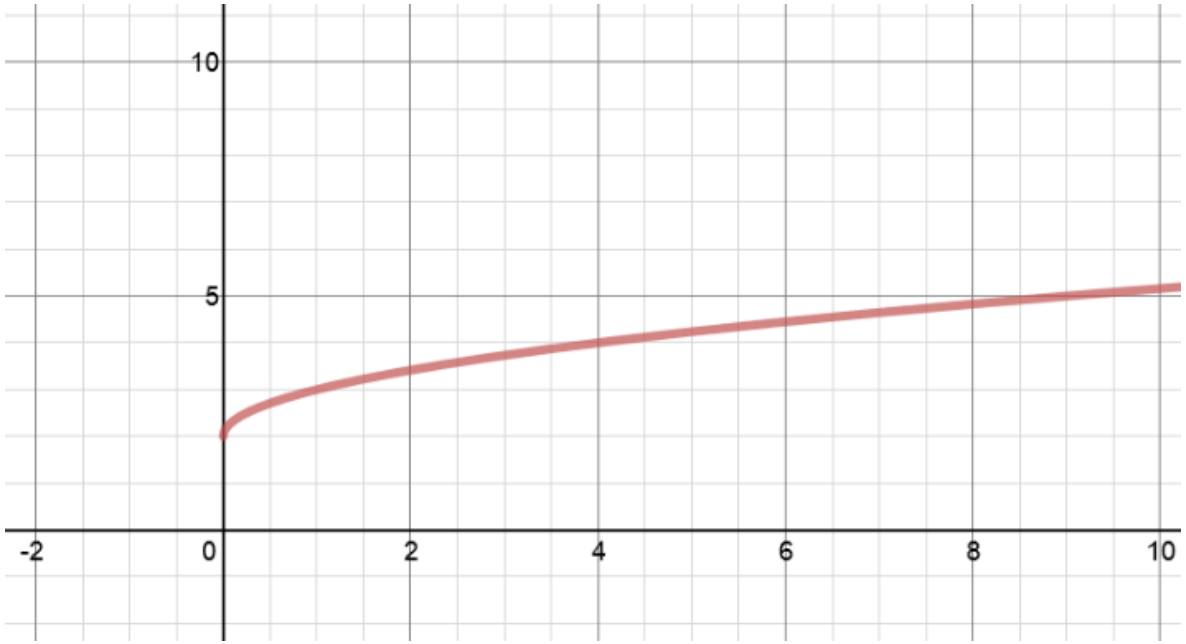
By how much? **2 units**



Transformations

Write the equation for the transformed function represented in this graph.

$$g(x) = \sqrt{x} + 2$$



Parent Function? **Radical, $f(x) = \sqrt{x}$**

Critical point that can help us? **Intercepts**

Which way did it go? **Up**

By how much? **2 units**

Horizontal Translations

When functions are transformed on the **inside** of the "f(x) part", you move the function left and right. Notice the direction is the opposite of the sign inside the "f(x) part".

Function Notation	Description of Transformation
$g(x) = f(x \pm c)$	Horizontal shift **left** C units if C is **positive**.
	Horizontal shift **right** C units if C is negative

Transformations

Horizontal Translations

Function Notation	Description of Transformation
$g(x) = f(x \pm c)$	Horizontal shift **left** C units if C is **positive**.
	Horizontal shift **right** C units if C is negative

How do we interpret this function notation?

Let $f(x) = x^2$ and $c = 3$ then $g(x) = (x + 3)^2$

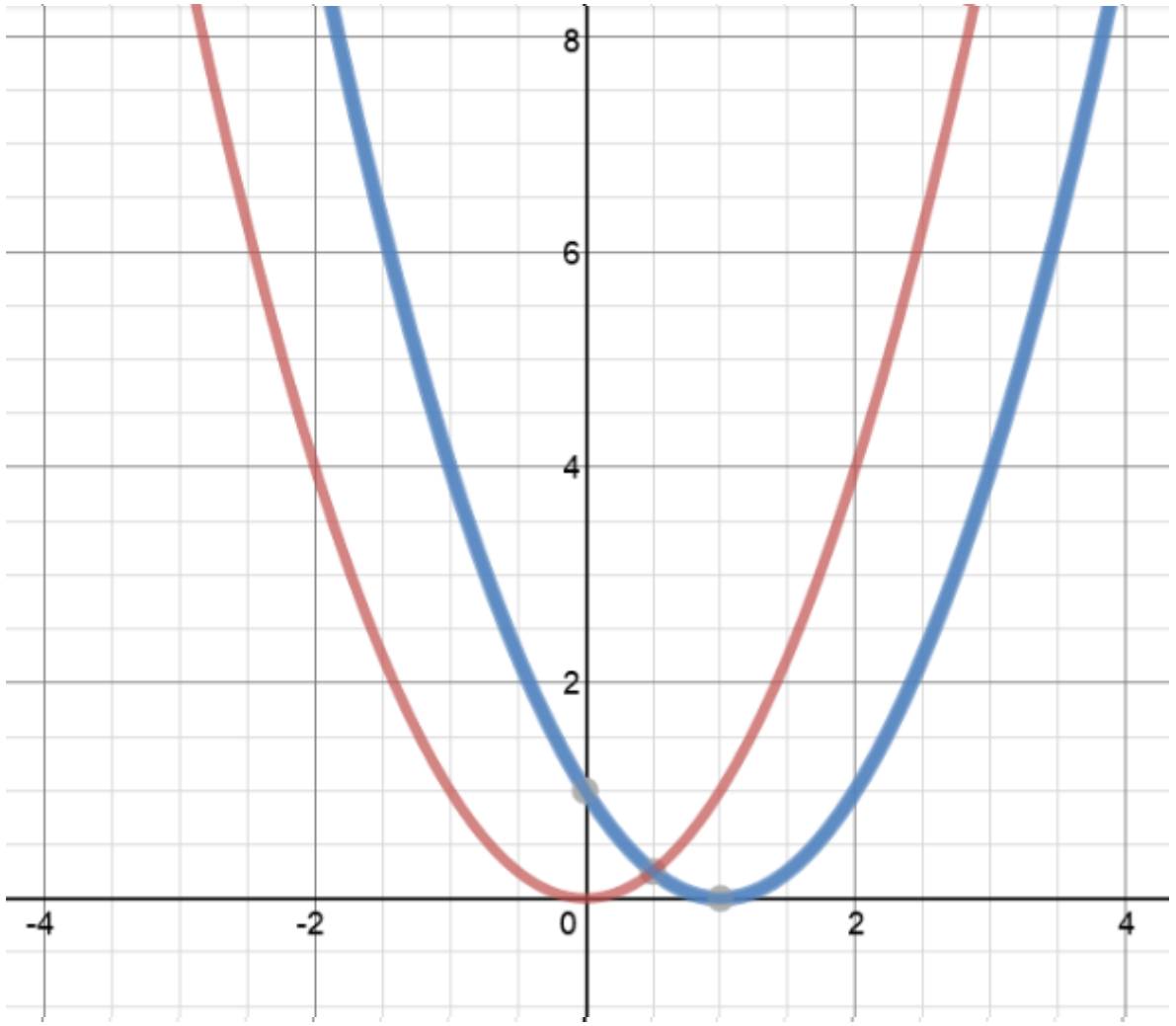
Let $f(x) = \sqrt{x}$ and $c = -4$ then $g(x) = \sqrt{x - 4}$

Let $f(x) = 2^x$ and $c = 7$ then $g(x) = 2^{x+7}$

Transformations

Let's play **"What's going to happen to the parent function?"**

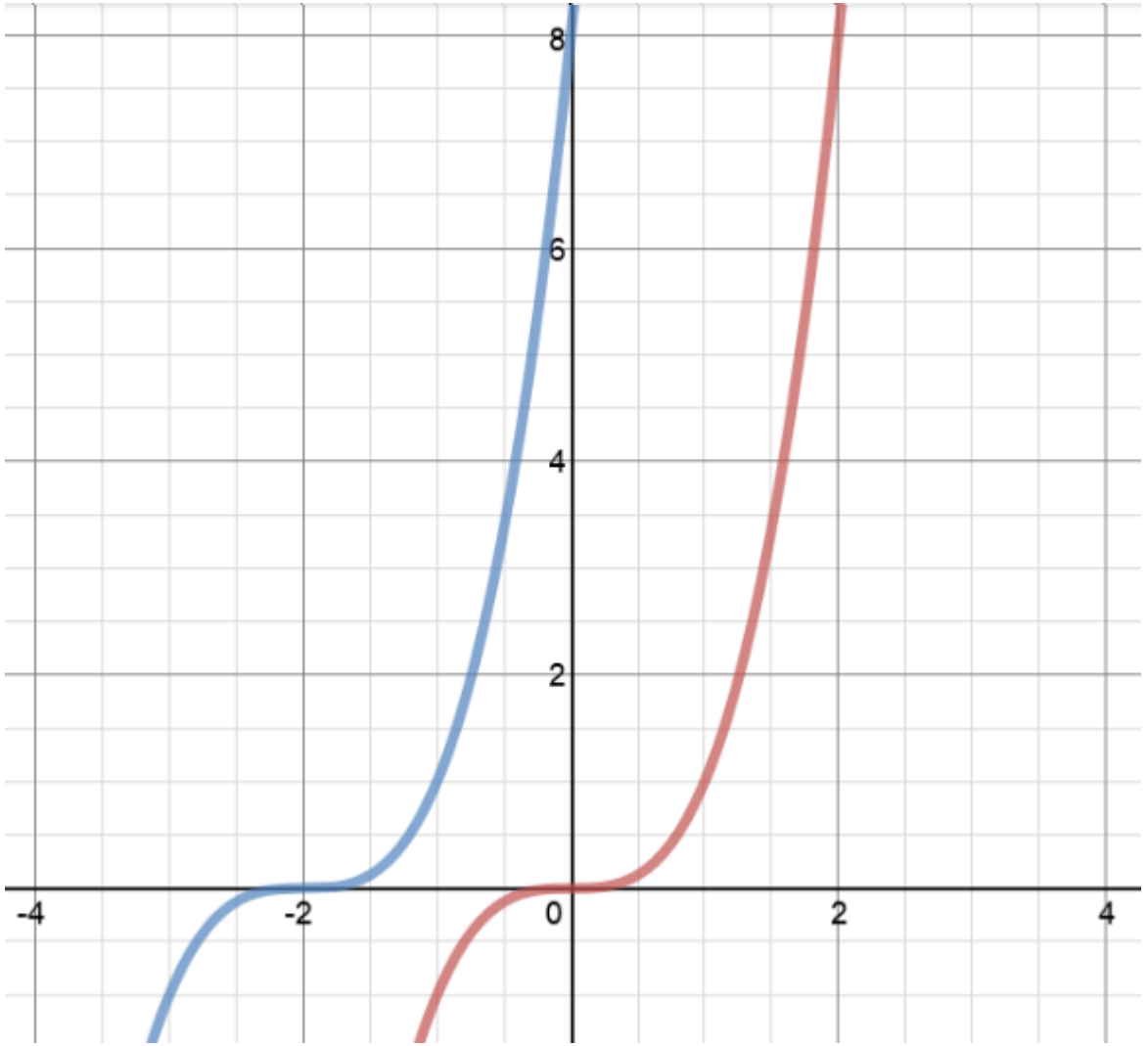
$$g(x) = (x-1)^2$$



Transformations

Let's play **"What's going to happen to the parent function?"**

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



Transformations

Write the equation for the transformed function represented in this graph.

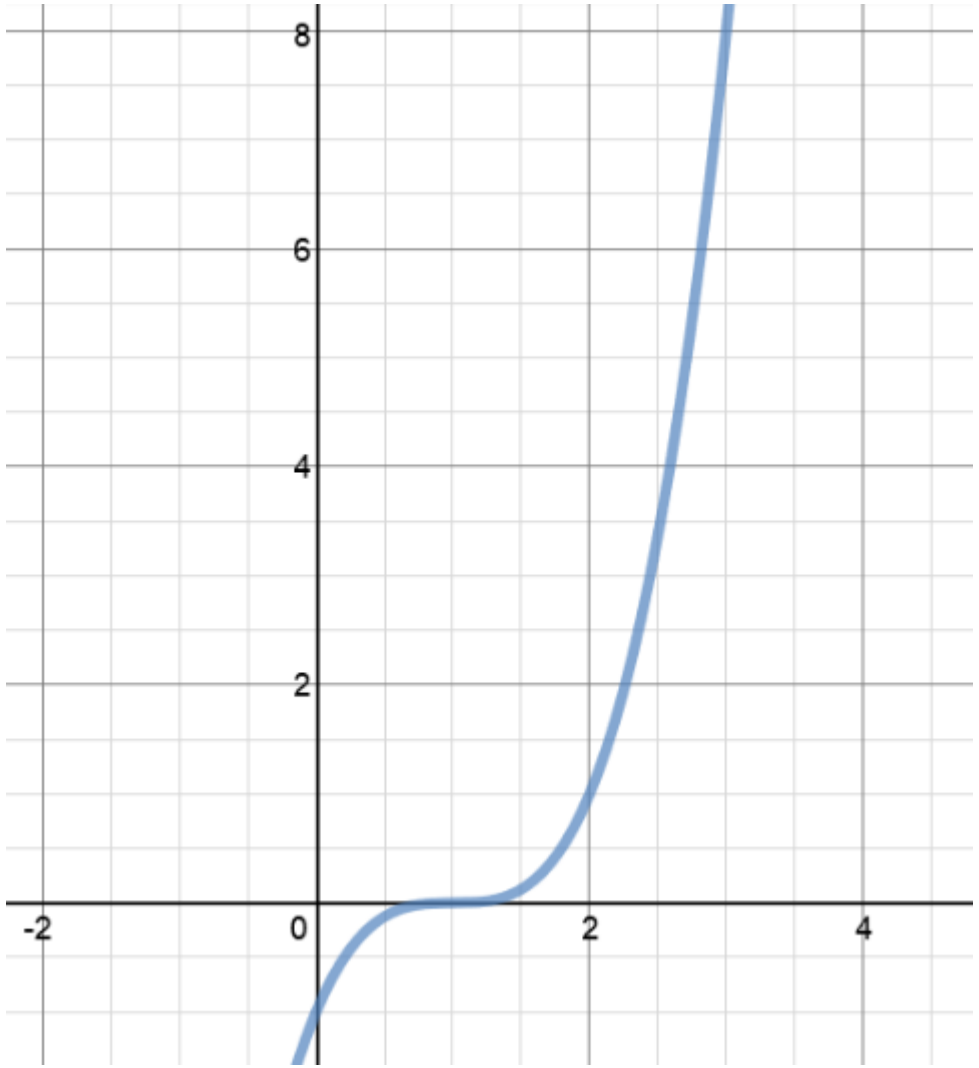
Parent Function? **Cubic, $f(x) = x^3$**

Critical point that can help us? **Intercepts**

Which way did it go? **Left**

By how much? **1 unit**

$$g(x) = (x-1)^3$$



Transformations

Write the equation for the transformed function represented in this graph.

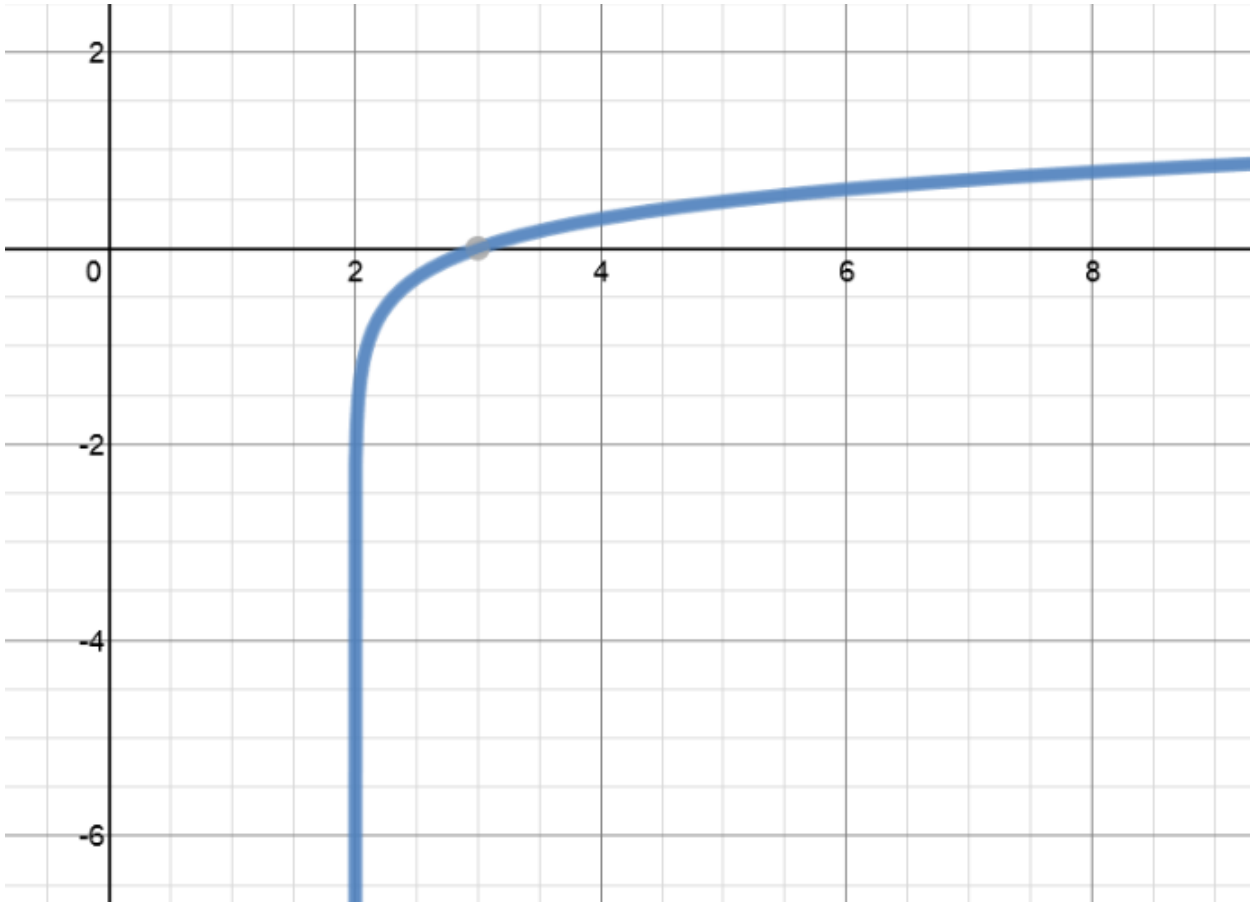
Parent Function? **Log, $f(x) = Log\ x$**

Critical point that can help us? **Intercepts**

Which way did it go? **Right**

By how much? **2 units**

$$f(x) = log(x - 2)$$



Transformations

Write the equation for the transformed function represented in this graph.

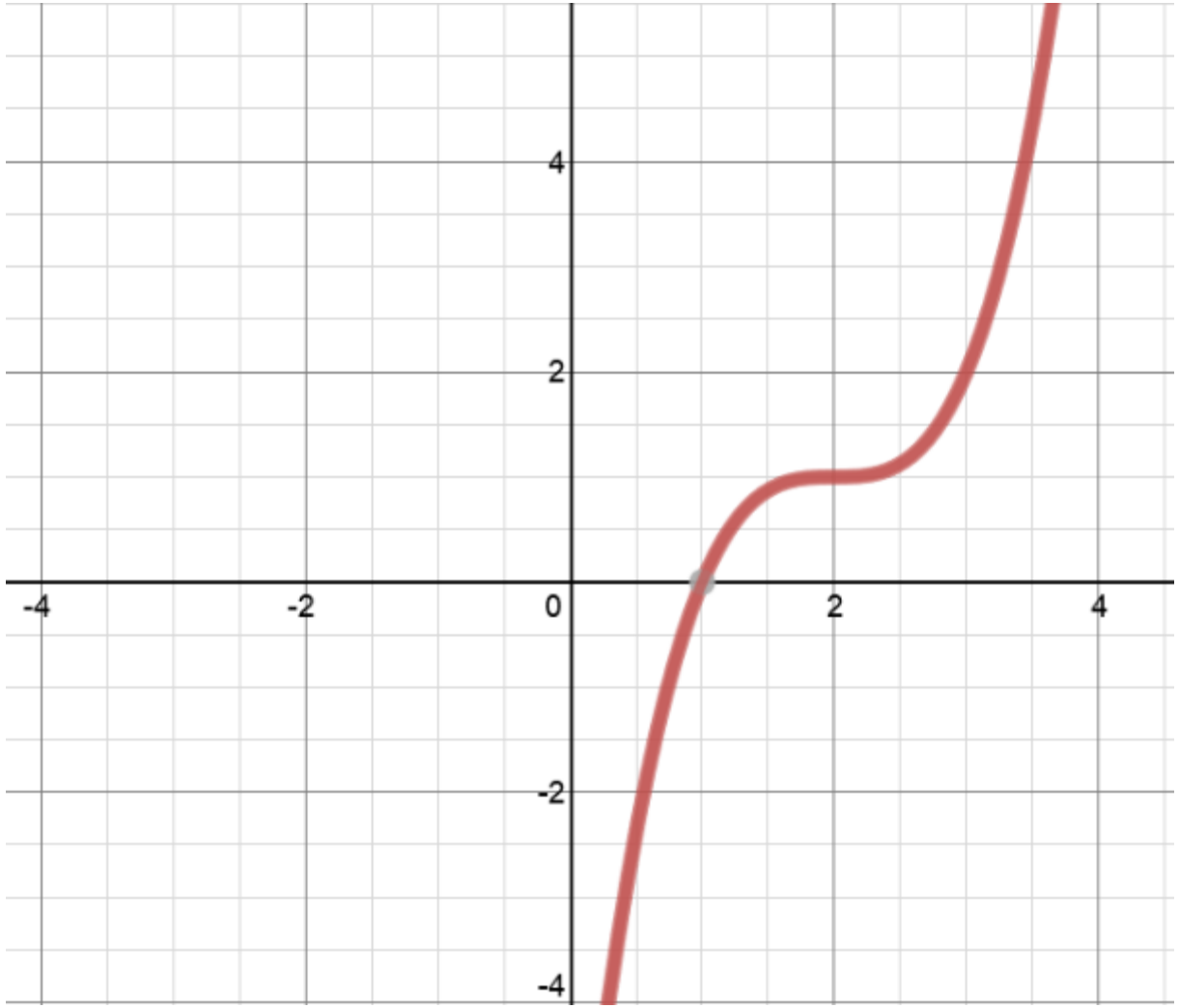
$f(x) = (x-2)^3+1$

Parent Function? **Cubic, $f(x) = x^3$**

Critical point that can help us? **Intercepts**

Which way did it go? **Left and up**

By how much? **Left 2 and up 1**



Transformations

Reflections

When a negative sign is found on the **outside** of the "f(x) part" the function is **flipped** **over the x-axis**.

When a negative sign is found on the **inside** of the "f(x) part" the function is **flipped** **over the y-axis**.

Function Notation	Description of Transformation
$g(x) = -f(x)$	Reflected over the x-axis
$g(x) = f(-x)$	Reflected over the y-axis

Transformations

Reflections

Function Notation	Description of Transformation
$g(x) = -f(x)$	Reflected over the x-axis
$g(x) = f(-x)$	Reflected over the y-axis

How do we interpret this function notation?

Let $f(x) = x^2$, then $-f(x) = -x^2$ and $f(-x) = (-x)^2$

Let $f(x) = \sqrt{x}$, then $-f(x) = -\sqrt{x}$ and $f(-x) = \sqrt{-x}$

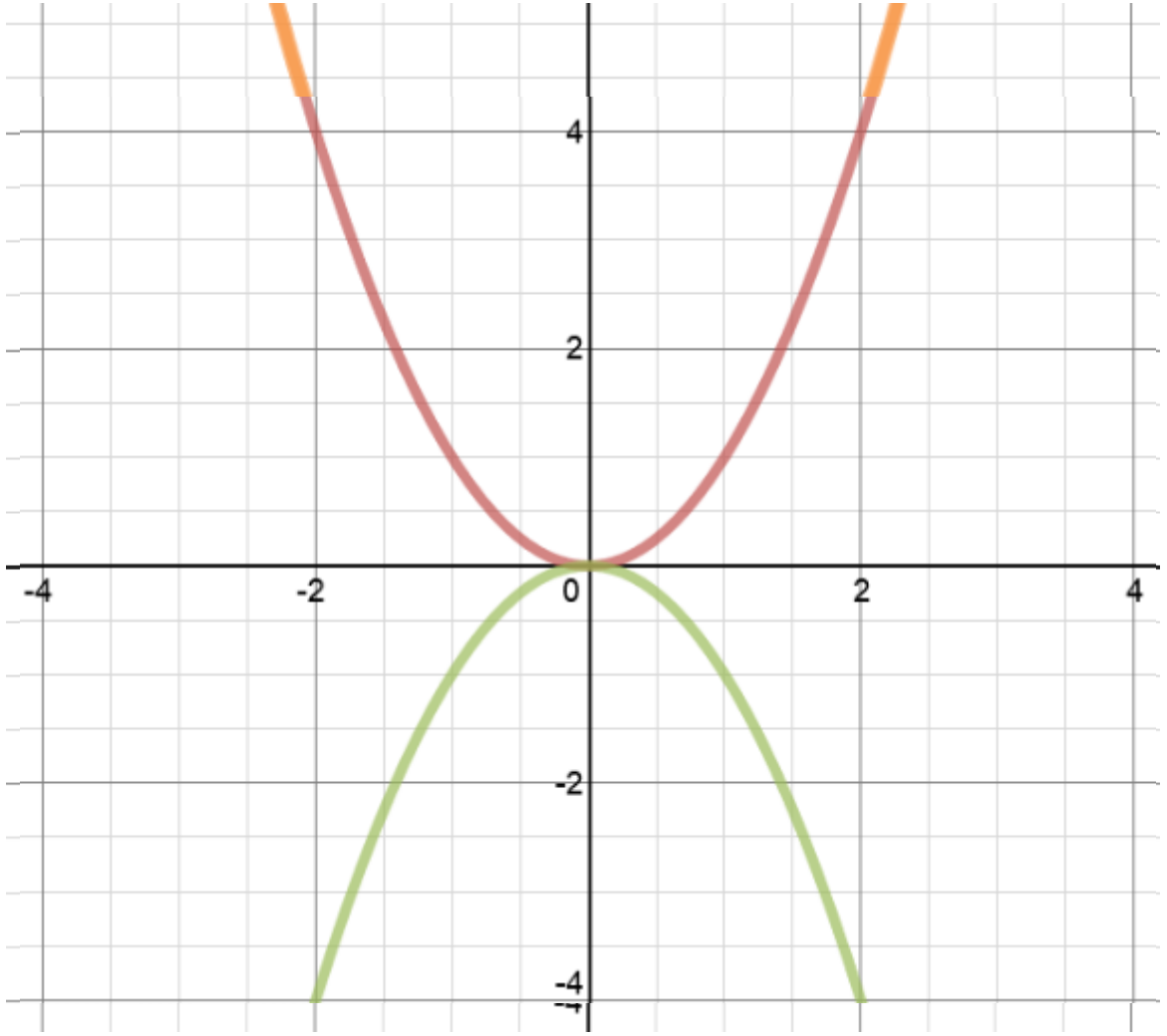
Let $f(x) = 2^x$, then $-f(x) = -2^x$ and $f(-x) = 2^{-x}$

Transformations

Reflection across the x axis

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

X	X^2	$-X^2$
3	9	-9
2	4	-4
1	1	-1
0	0	0
-1	1	-1
-2	4	-4
-3	9	-9

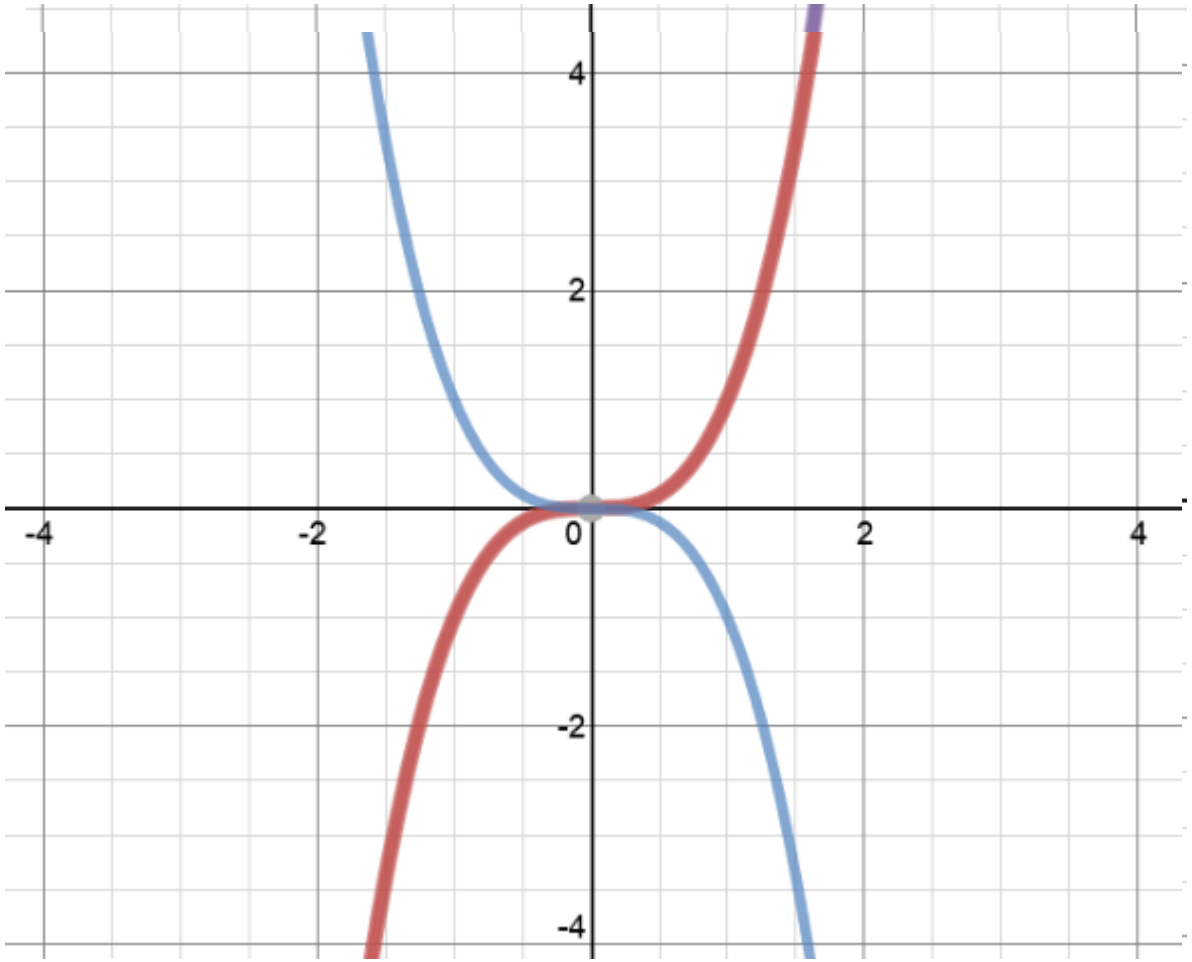


Transformations

Reflection across the y axis

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

X	-X	$(-X)^3$
3	-3	-27
2	-2	-8
1	-1	-1
0	0	0
-1	1	1
-2	2	8
-3	3	27



Transformations

Write the equation for the transformed function represented in this graph.

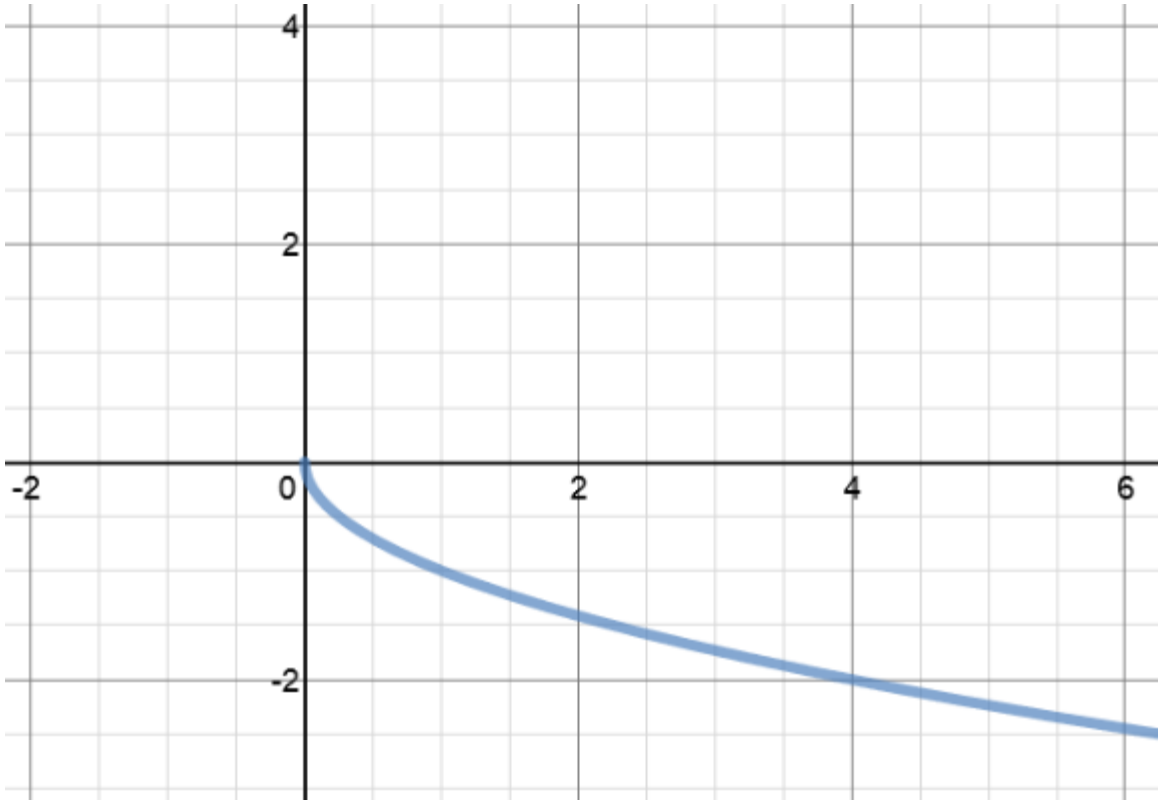
Parent Function? **Radical, $f(x) = \sqrt{x}$**

Critical point that can help us? **Intercepts**

Which way did it go? **No Change**

Which axis has it flipped over? **X-axis**

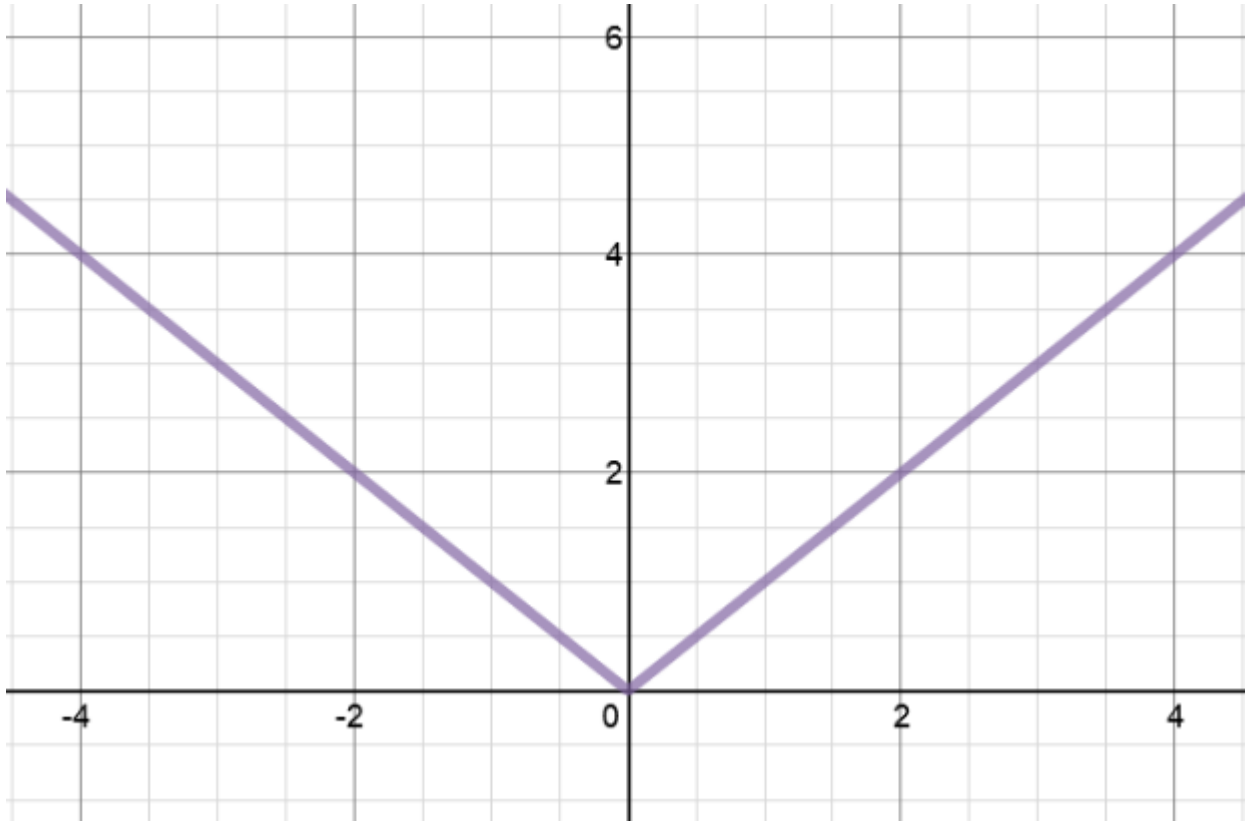
$f(x) = -\sqrt{x}$



Transformations

Write two equations that could represent the function presented in this graph.

$$g(x) = |x|$$
$$g(x) = |-x|$$



Summary of the Rigid Transformations

Function Notation	Description of Transformation
$f(x) = f(x) + C$	Vertical shift up C units
$f(x) = f(x) - C$	Vertical shift down C units
$f(x) = f(x + C)$	Horizontal shift left C units
$f(x) = f(x - C)$	Horizontal shift right C units
$f(x) = -f(x)$	Flip over the x-axis
$f(x) = f(-x)$	Flip over the y-axis

ORDER OF OPERATIONS		
P	Please	Parentheses
E	Excuse	Exponents
M	My	Multiplication
D	Dear	Division
A	Aunt	Addition
S	Sally	Subtraction

Did we meet our objectives?