2-1 Using Transformations to Graph Quadratic Functions

It's time for……… A new parent function!

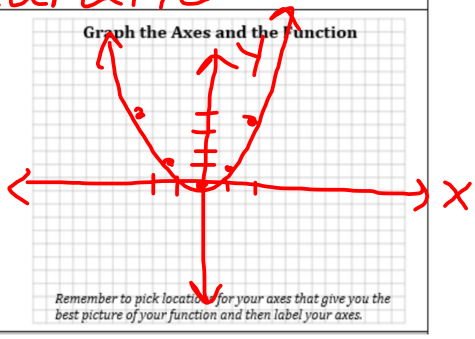
Function: $f(x) = x^2$

Family: Quadratic

Key Points

x	$f(x)$
-2	4
-1	1
0	0
1	1
2	4

Graph the Axes and the Function



Remember to pick locations for your axes that give you the best picture of your function and then label your axes.

2-1 Using Transformations to Graph Quadratic Functions

Domain	
Written Description	Interval Notation
All real #s	$(-\infty, \infty)$ $\mathbb{R}$
Range	
Written Description	Interval Notation
no negatives	$[0, \infty)$
Intercepts: (0,0)	
Symmetry: y-axis	
Why is this a function? passes the vertical line test	
Write at least one thing that describes this function that will help you remember it. *ex. a description of the shape, where it crosses the x-axis, how it's different from another similar function*	

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$(-2)^2$

Make a table of values and use it to graph the following functions on the same coordinate plane. Use the same x-values for each function.

$f(x) = x^2$

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

$h(x) = 2x^2$

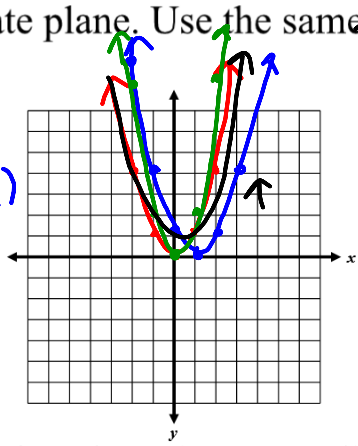
$p(x) = x^2 + 1$

x	$f(x)$
-2	4
-1	1
0	0
1	1
2	4

x	$g(x)$
-2	9
-1	4
0	1
1	0
2	1

x	$h(x)$
-2	8
-1	2
0	0
1	2
2	8

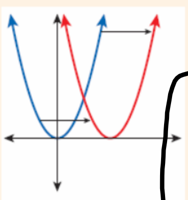
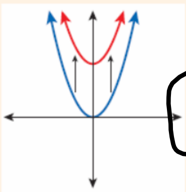
x	$p(x)$
-2	5
-1	2
0	1
1	2
2	5



Describe how the graphs of the last three functions differ from the graph of $f(x) = x^2$.

2-1 Using Transformations to Graph Quadratic Functions

While you can graph quadratic functions by making a table of values, you can also graph quadratic functions by applying transformations to the parent function $f(x) = x^2$.

Translations of Quadratic Functions	
Horizontal Translations	**Vertical Translations**
Horizontal Shift of $\lvert h \rvert$ Units	Vertical Shift of $\lvert k \rvert$ Units
 $f(x) = x^2$ $f(x-h) = (x-h)^2$ Moves left for $h < 0$ Moves right for $h > 0$	 $f(x) = x^2$ $f(x) + k = x^2 + k$ Moves down for $k < 0$ Moves up for $k > 0$

2-1 Using Transformations to Graph Quadratic Functions

Example 1: Translating Quadratic Functions

Use the graph of $f(x) = x^2$ as a guide, describe the transformations of each function.

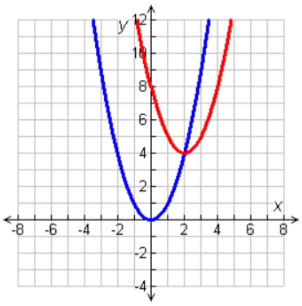
$g(x) = (x - 2)^2 + 4$

$h = 2$

$K = 4$

shifts right 2

shifts up 4



2-1 Using Transformations to Graph Quadratic Functions

Example 2: Translating Quadratic Functions

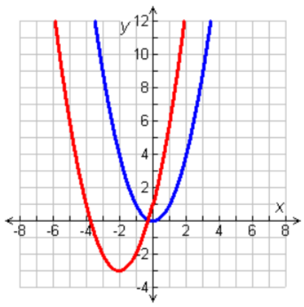
Use the graph of $f(x) = x^2$ as a guide, describe the transformations of each function.

$(x-(-2))^2$ $h = -2$ $K = -3$

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

left 2

down 3



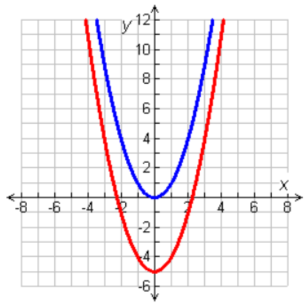
2-1 Using Transformations to Graph Quadratic Functions

Check It Out! Example 3

Using the graph of $f(x) = x^2$ as a guide, describe the transformations of each function.

$g(x) = x^2 - 5$

shifts down 5



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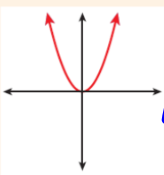
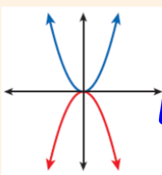
inside outside

Reflections	
Reflection Across *y*-axis	Reflection Across *x*-axis
 Input values change. $f(x) = x^2$ $\boxed{f(-x)} = (-x)^2 = x^2$ The function $f(x) = x^2$ is its own reflection across the *y*-axis.	 Output values change. $f(x) = x^2$ $\boxed{-f(x)} = -(x^2) = -x^2$ The function is flipped across the *x*-axis.

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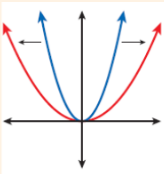
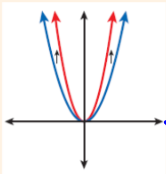
inside outside

Stretches and Compressions	
Horizontal Stretch/Compression by a Factor of $\lvert b \rvert$	Vertical Stretch/Compression by a Factor of $\lvert a \rvert$
 Input values change. $f(x) = x^2$ $f\left(\frac{1}{b}x\right) = \left(\frac{1}{b}x\right)^2$	 Output values change. $f(x) = x^2$ $a \cdot f(x) = ax^2$
$\lvert b \rvert > 1$ stretches away from the y-axis.	$\lvert a \rvert > 1$ stretches away from the x-axis.
$0 < \lvert b \rvert < 1$ compresses toward the y-axis.	$0 < \lvert a \rvert < 1$ compresses toward the x-axis.

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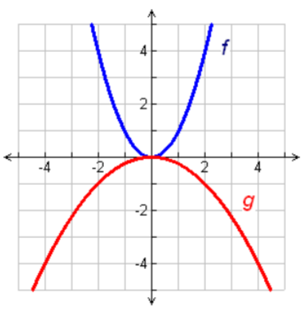
Example 4: Reflecting, Stretching, and Compressing Quadratic Functions

Using the graph of $f(x) = x^2$ as a guide, describe the transformations and then graph each function.

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

reflection in x-axis
vertical compression by 1/4



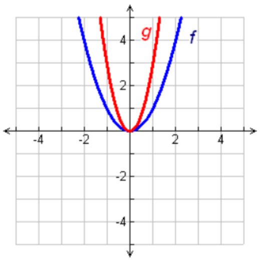
2-1 Using Transformations to Graph Quadratic Functions

Example 5: Reflecting, Stretching, and Compressing Quadratic Functions

Using the graph of $f(x) = x^2$ as a guide, describe the transformations and then graph each function.

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

horizontal compression by 1/3



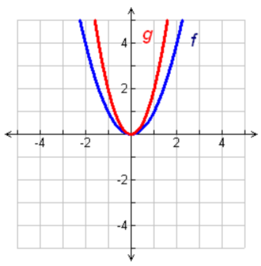
2-1 Using Transformations to Graph Quadratic Functions

Check It Out! Example 6

Using the graph of $f(x) = x^2$ as a guide, describe the transformations and then graph each function.

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

horizontal compression by 1/2



2-1 Using Transformations to Graph Quadratic Functions

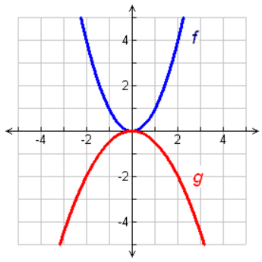
Check It Out! Example 7

Using the graph of $f(x) = x^2$ as a guide, describe the transformations and then graph each function.

$g(x) = -\frac{1}{2}x^2$

reflection in x-axis

vertical comp. by ½



2-1 Using Transformations to Graph Quadratic Functions

If a parabola opens upward, it has a lowest point. If a parabola opens downward, it has a highest point. This lowest or highest point is the **vertex of the parabola**.

The parent function $f(x) = x^2$ has its vertex at the origin. You can identify the vertex of other quadratic functions by analyzing the function in *vertex form*. The **vertex form** of a quadratic function is $f(x) = a(x - h)^2 + k$, where a, h, and k are constants.

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2-1 Using Transformations to Graph Quadratic Functions

Vertex Form of a Quadratic Function

$$f(x) = a(x-h)^2 + k$$

a indicates a reflection across the *x*-axis and/or a vertical stretch or compression.

h indicates a horizontal translation.

k indicates a vertical translation.

Because the vertex is translated *h* horizontal units and *k* vertical from the origin, the vertex of the parabola is at (h, k).

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Example 8: Writing Transformed Quadratic Functions

Use the description to write the quadratic function in vertex form.

The parent function $f(x) = x^2$ is vertically stretched by a factor of $\frac{4}{3}$ and then translated 2 units left and 5 units down to create *g.*

2-1 Using Transformations to Graph Quadratic Functions

Check It Out! Example 9

Use the description to write the quadratic function in vertex form.

The parent function $f(x) = x^2$ is vertically compressed by a factor of $\frac{2}{3}$ and then translated 2 units right and 4 units down to create *g*.

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2-1 Using Transformations to Graph Quadratic Functions

Check It Out! Example 10

Use the description to write the quadratic function in vertex form.

The parent function $f(x) = x^2$ is reflected across the *x*-axis and translated 5 units left and 1 unit up to create *g*.

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