

## Vertical Reflection

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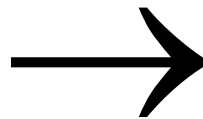
$$-y = x^2$$

- So far, we have looked at how a horizontal translation (HT), vertical translation (VT) and a vertical stretch (VS) effect the graph of  $y = x^2$ . Now, we will look at the situation when the image graph is a **reflection in the x-axis**. The mapping rule for a reflection in the x-axis is given by:  $(x, y) \rightarrow (x, -y)$ . This rule is telling us to keep the x-values the same in the image table of values, but to multiply all y-values by  $-1$  in the image table of values.
- Example:  
We will use a mapping rule to generate a table of values for the  $-y = x^2$  function and then graph it and the  $y = x^2$  function on the same axes.

Table of  
Values for  
 $y = x^2$

x	y
-3	9
-2	4
-1	1
0	0
1	1
2	4
3	9

$$(x, y) \rightarrow (x, -y)$$

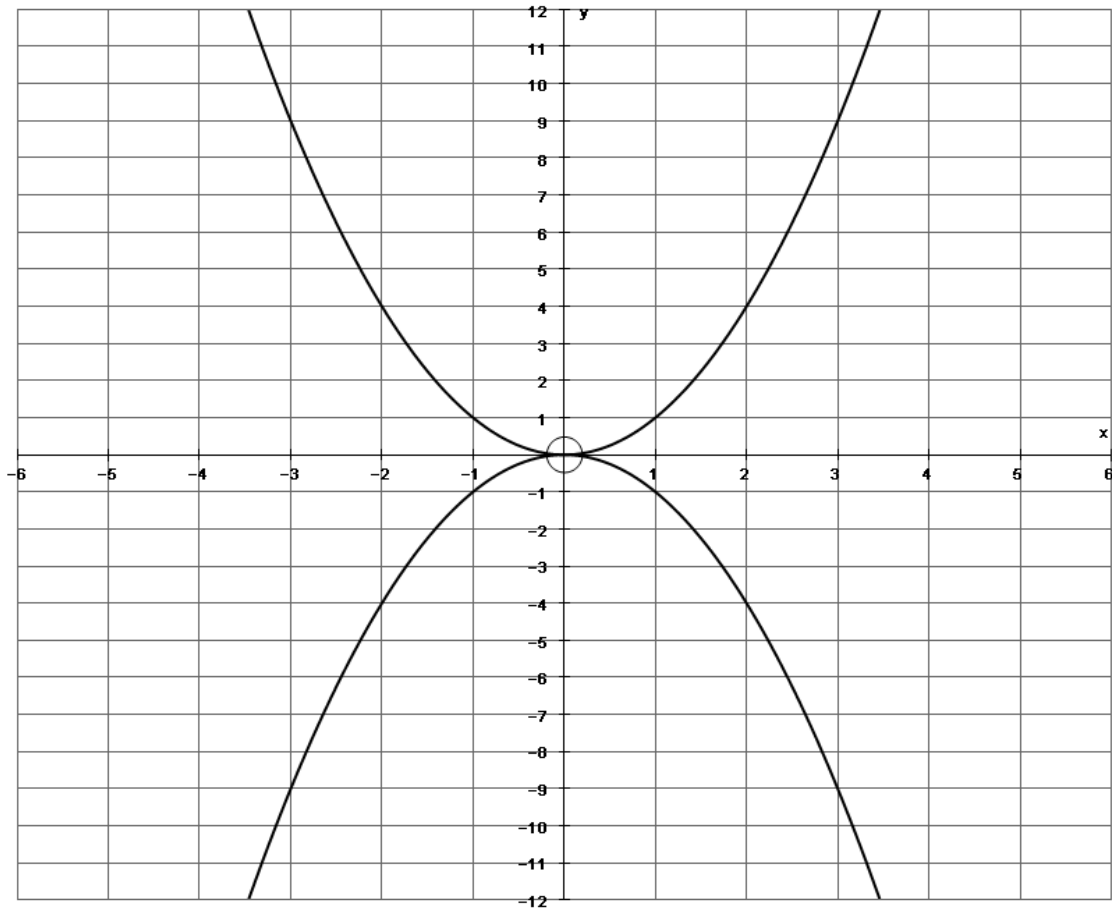


New Table of  
Values for  
 $-y = x^2$

x	y
-3	-9
-2	-4
-1	-1
0	0
1	-1
2	-4
3	-9

same x – value

y – value multiplied by  $-1$



## Summary

Equation:

$$-y = x^2$$

Mapping Rule:

$$(x, y) \rightarrow (x, -y)$$

- When there is a  $-y$  in the function, the result will be a **REFLECTION** in the x-axis.

- The Vertical Stretch factor is always positive and, therefore, does **NOT** tell us if there is a reflection in the x-axis.

$$\boxed{VS = |a|}$$

- Example 1:

(a.) In the function  $-\frac{1}{7}y = x^2$ , the mapping rule will be

$(x, y) \rightarrow (x, -7y)$ , where the  $VS = 7$ .

(b.) In the function  $-5y = x^2$ , the mapping rule will be

$(x, y) \rightarrow (x, -\frac{1}{5}y)$ , where the  $VS = \frac{1}{5}$ .

- Example 2:

Let's look at the following functions. We will use a mapping rule to generate a table of values for the image function and then graph all three functions on the same axes.

(a.)  $y = x^2$

(b.)  $-\frac{1}{4}y = x^2$

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

$(x, y) \rightarrow (x, -4y)$

$(x, y) \rightarrow (x, -\frac{1}{4}y)$

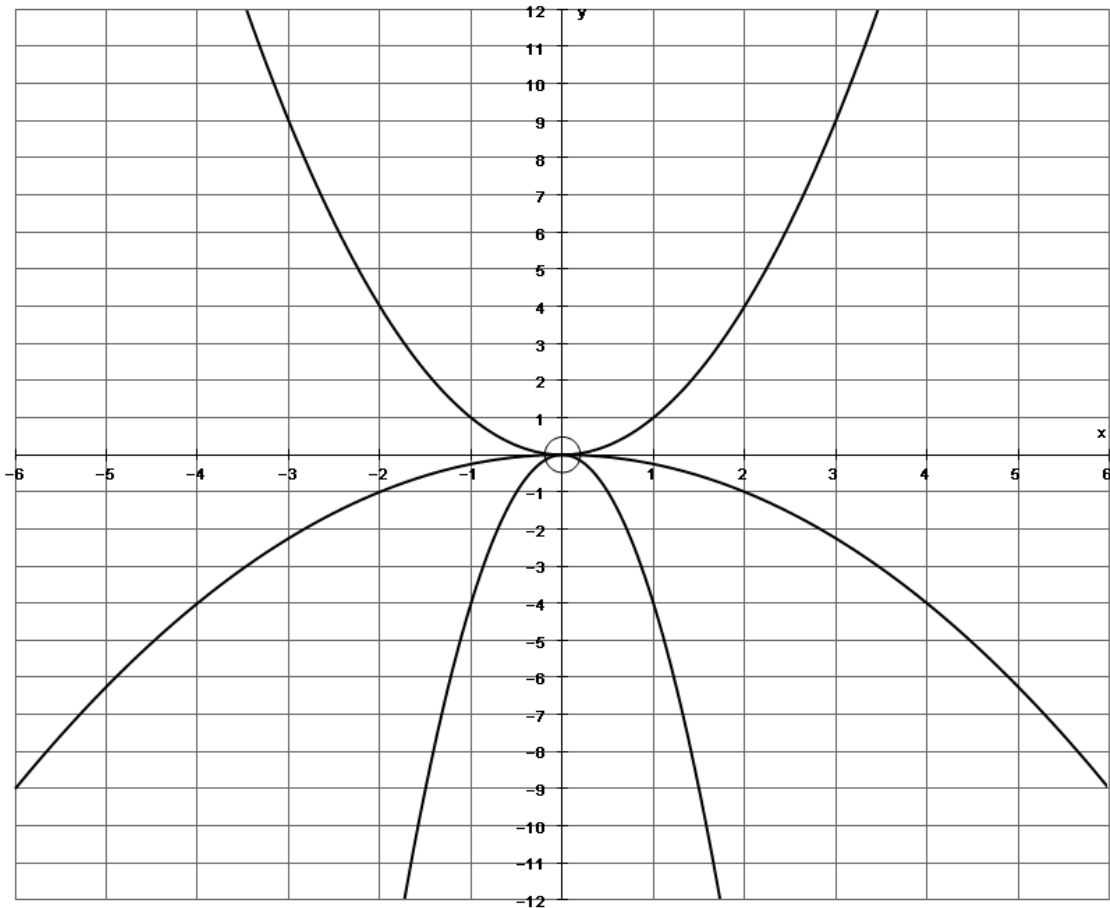
$VS = 4$

$VS = \frac{1}{4}$

x	y
-3	9
-2	4
-1	1
0	0
1	1
2	4
3	9

x	y
-3	-36
-2	-16
-1	-4
0	0
1	-4
2	-16
3	-36

x	y
-3	$-\frac{9}{4}$
-2	-1
-1	$-\frac{1}{4}$
0	0
1	$-\frac{1}{4}$
2	-1
3	$-\frac{9}{4}$



## Summary

Equation:

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

$$VS = |a|$$

Mapping Rule:

$$(x, y) \rightarrow (x, ay)$$

- The VS is the **RECIPROCAL** of the numerical coefficient of  $y$  in the function.
- The VS is the **SAME** as the numerical coefficient of  $y$  in the mapping rule.
- The Vertical Stretch factor is always positive.
- When  $VS > 1$ , the graph is “thinner” than  $y = x^2$ .
- When  $0 < VS < 1$ , the graph is “wider” than  $y = x^2$ .
- When there is a  $-y$  in the equation, the result will be a **REFLECTION** in the  $x$ -axis.