

## 2.4A: Transformations of Functions

- I can describe transformations from a rule, graph, or function equation
- I can graph parent functions and transform them on a graph
- I can write a function equation for a transformation rule or graph

### VOCABULARY

**Parent Function:** The simplest version of a function

- Only 1 operation happens to  $\pi$  in the equation.
- The graph is centered/starts on the origin.

**Transformation:** A change to a parent function. The basic shape remains.

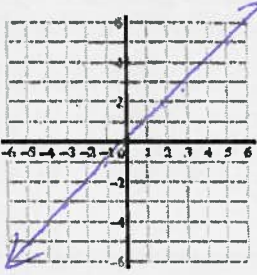
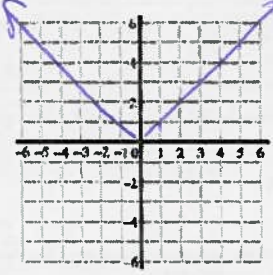
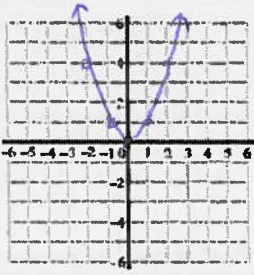
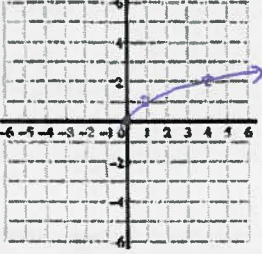
- Can also transform a *PRE-IMAGE*, any function (not necessarily the parent), into a new *IMAGE*.

**Scale Change:** A reflection, stretch, and/or shrink.

- This is done with multiplication (negatives) or division

**Translation:** A shift – up or down, left or right

### Parent Functions:

Name	Linear	Absolute Value	Quadratic	Square Root
Equation	$y = x$	$y =  x $	$y = x^2$	$y = \sqrt{x}$
Shape	Line	V	Parabola	$\frac{1}{2}$ Sideways Parabola
Graph				

### Transformation Rules:

- Given ordered pairs, the rule states how they change or TRANSFORM

### Scale Changes: Distort the function

- **Reflections:** Multiplying by a negative
  - $-x$  reflects over the y-axis
  - $-y$  reflects over the x-axis
- **Stretches:** Multiplying x or y by values  $> 1$
- **Shrinks:** Multiplying x or y by values  $0 < a < 1$

Stretch/Shrink or Shift to x:

horizontal

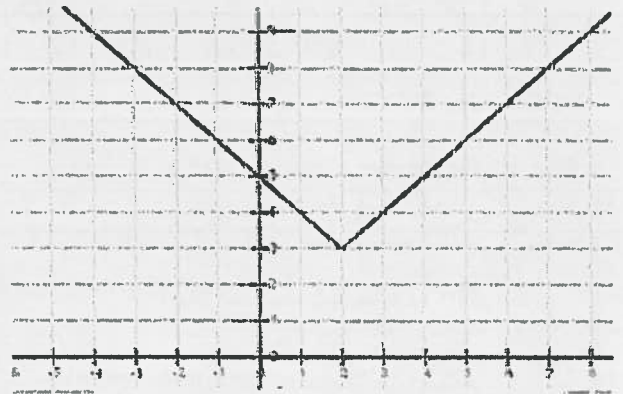
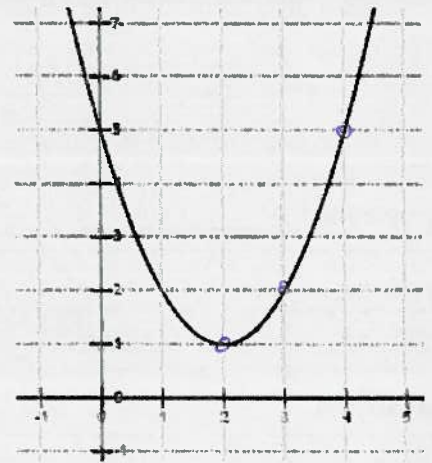
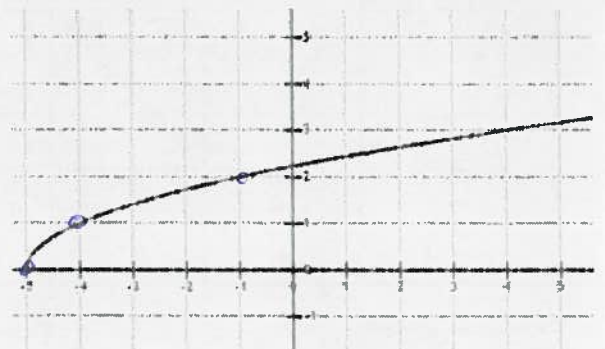
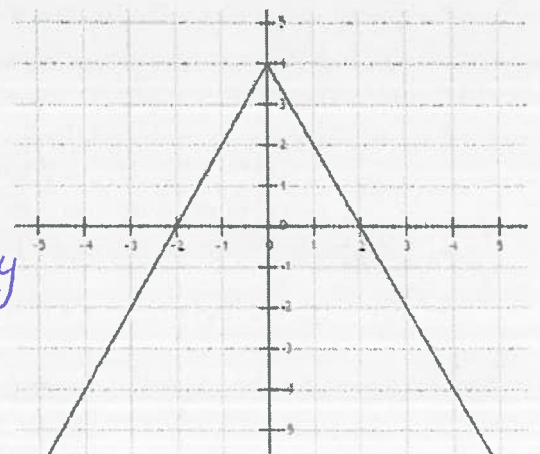
Stretch/Shrink or Shift to y:

vertical

**Translations:** Shape stays the same, just moves location

**Graphs and Transformation Rules:**

A graph is shown, state the parent function and describe how it was transformed. Then write the rule.

**Ex1:**Parent Function:  $y = |x|$ Reflection: noneScale: none (slope is still 1)Translation: right 2, up 3Rule:  $(x, y) \rightarrow (x+2, y+3)$ **Ex2:**Parent Function:  $y = x^2$ Reflection: noneScale: none (still  $1^2=1, 2^2=4$  from vertex)Translation: right 2, up 1Rule:  $(x, y) \rightarrow (x+2, y+1)$ **Ex3:**Parent Function:  $y = \sqrt{x}$ Reflection: noneScale: none (still  $\sqrt{1}=1, \sqrt{4}=2$ )Translation: left 5Rule:  $(x, y) \rightarrow (x-5, y)$ **Ex4:**Parent Function:  $y = |x|$ Reflection: over x-axis  $\rightarrow -y$ Scale: slope = -2 \* slope always on yTranslation: up 4Rule:  $(x, y) \rightarrow (x, -2y+4)$ 

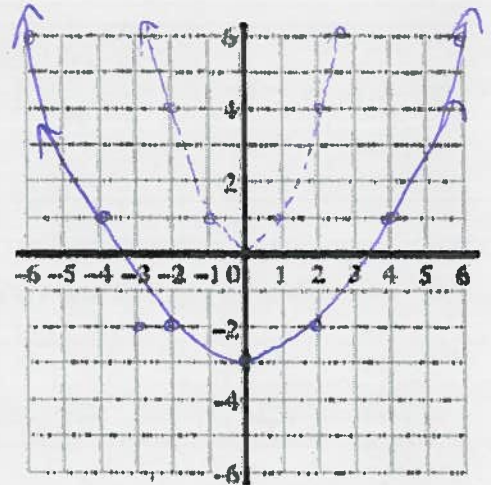
A rule and parent function are given. Graph the parent. Describe the transformation and graph it.

Ex5:

Parent Function:  $y = x^2$       Rule:  $(x, y) \rightarrow (2x, y - 3)$

$$\begin{aligned} (0, 0) &\rightarrow (0, -3) \\ (1, 1) &\rightarrow (2, -2) \\ (2, 4) &\rightarrow (4, 1) \\ (3, 9) &\rightarrow (6, 6) \end{aligned}$$

Transformation: horizontal stretch,  
shift down 3

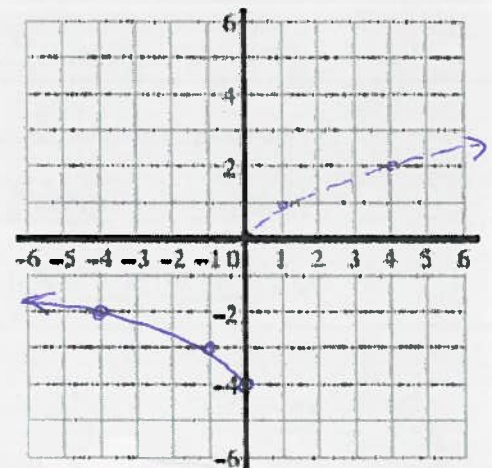


Ex6:

Parent Function:  $y = \sqrt{x}$       Rule:  $(x, y) \rightarrow (-x, y - 4)$

$$\begin{aligned} (0, 0) &\rightarrow (0, -4) \\ (1, 1) &\rightarrow (-1, -3) \\ (4, 2) &\rightarrow (-4, -2) \end{aligned}$$

Transformation: reflection over y-axis,  
shift down 4

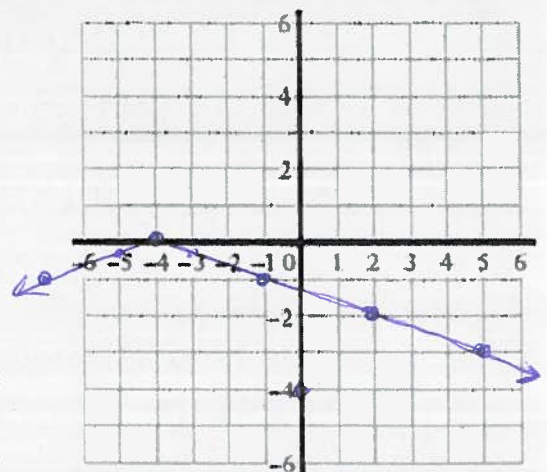


Quick Check:

A: Parent Function:  $y = |x|$       Rule:  $(x, y) \rightarrow (x - 4, -\frac{1}{3}y)$

$$\begin{aligned} (0, 0) &\rightarrow (-4, 0) \\ (1, 1) &\rightarrow (-3, -\frac{1}{3}) \\ (3, 3) &\rightarrow (-1, -1) \\ (6, 6) &\rightarrow (2, -2) \end{aligned}$$

Transformation: reflection over x-axis,  
vertical shrink, shift left 4



## Rules and Equations

- General form of an equation:  $y = a \cdot \text{function}(x - h) + k$ 
  - reflection over  $x$ -axis
  - vertical stretch
  - abs. val.  $( )^2$
  - horizontal shift
  - vertical shift

- Note  $(x - h)$ : This means the equation shows the OPPOSITE of  $h$

Given the equation, describe the transformation and write the rule:

Ex7:  $y = -4|x - 3| + 6$

Parent Function:  $y = |x|$

Reflection: over  $x$ -axis

Scale: vertical stretch

Translation: right 3, up 6

Rule:  $(x, y) \rightarrow (x, -4y + 6)$

Ex8:  $y = \frac{1}{2}(x + 6)^2 - 3$

Parent Function:  $y = x^2$

Reflection: none

Scale: vertical shrink

Translation: left 6, down 3

Rule:  $(x, y) \rightarrow (x - 6, y - 3)$

## Do &amp; Discuss:

B:  $y = -2\sqrt{x + 3}$

Parent Function:  $y = \sqrt{x}$

Reflection: over  $x$ -axis

Scale: vertical stretch

Translation: left 3

Rule:  $(x, y) \rightarrow (x - 3, -2y)$

C:  $y = -|x| - 5$

Parent Function:  $y = |x|$

Reflection: over  $x$ -axis

Scale: none

Translation: down 5

Rule:  $(x, y) \rightarrow (x, -y - 5)$

## Additional Resources:

**Textbook:** This topic is not presented in the textbook to this extent

**Online Video:** <https://www.khanacademy.org/math/algebra2/radical-equations-and-functions/shifting-reflecting-functions/v/graphs-of-square-root-functions>

- There are differences in how things are explained, including the notation used.