

# 1.1 Horizontal and Vertical Translations

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### 1.1 Horizontal and Vertical Translations

A transformation of a function changes the equation, which will change any combination of the location, shape, and orientation of the graph.

The relationship between the set of points of the original graph to the set of points on the transformed graph is called a mapping.

e.g. Mapping Notation  $(x, y) \rightarrow (x, y+3)$

$$(x, y) \rightarrow (x+2, y)$$

A translation is a transformation that moves the graph of a function up, down, left, or right.

**Ex. #1:** Sketch the graphs of  $y = |x|$ ,  $y = |x-2|$ , and  $y = |x+3|$  on the axes below.

$$y = |x|$$

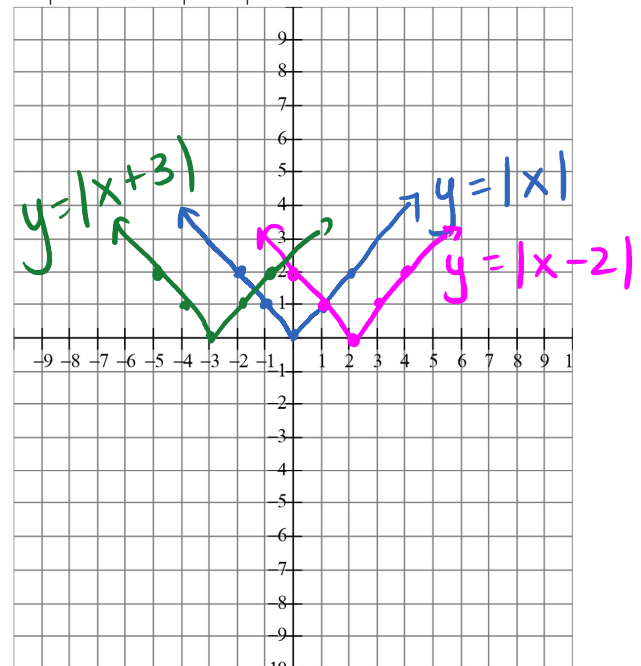
x	y
-2	2
-1	1
0	0
1	1
2	2

$$y = |x-2|$$

x	y
0	2
1	1
2	0
3	1
4	2

$$y = |x+3|$$

x	y
-5	2
-4	1
-3	0
-2	1
-1	2



**Horizontal Translation:**

In general the graph of  $y = f(x - h)$  is Horizontal translation to  $y = f(x)$ .

- If  $h > 0$  the graph of  $y = f(x - h)$  is translated Right  $y = f(x - 2)$
- If  $h < 0$  the graph of  $y = f(x - h)$  is translated left  $y = f(x - (-5))$   
 $y = f(x + 5)$

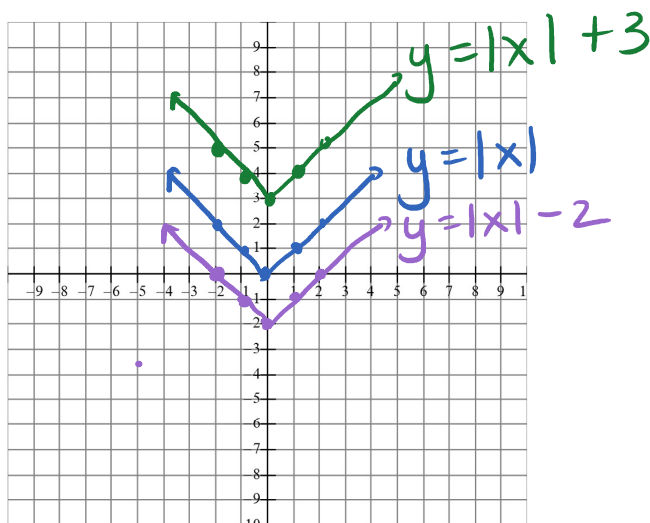
**Ex. #2:** Sketch the graph of  $y = |x|$ ,  $y = |x| - 2$ , and  $y = |x| + 3$  on the axes below.

$y = |x|$

x	y
-2	2
-1	1
0	0
1	1
2	2

$y = |x| - 2$

x	y
-2	0
-1	-1
0	-2
1	-1
2	0



$y = |x| + 3$

x	y
-2	5
-1	4
0	3
1	4
2	5

**Vertical Translations:**

In general the graph of  $y = f(x) + k$  or  $y - k = f(x)$  is Vertical translation to  $y = f(x)$ .

- If  $k > 0$  the graph of  $y = f(x) + k$  or  $y - k = f(x)$  is translated up.  
 $y = f(x) + 5$  or  $y - 5 = f(x)$
- If  $k < 0$  the graph of  $y = f(x) + k$  or  $y - k = f(x)$  is translated down.  
 $y = f(x) - 3$  or  $y + 3 = f(x)$

$$y = f(x - h) + k$$

**Ex. #3:** Identify the values of  $h$  and  $k$  for the following **and** describe the function using mapping notation.

(a)  $y = f(x - 2) + 7$

$h = 2$   
 $k = 7$   
 $(x, y) \rightarrow (x + 2, y + 7)$

(b)  $y + 3 = f(x + 1)$

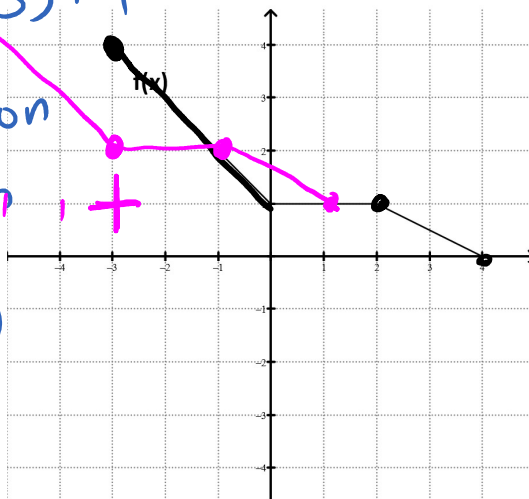
$y = f(x + 1) - 3$   
 $h = -1$   
 $k = -3$   
 $(x, y) \rightarrow (x - 1, y - 3)$

**Ex. #4:** Given the graph of  $y = f(x)$ , list the transformations of the graph  $y - h = f(x - h)$ , sketch the graph of the transformed function and write the transformation using mapping notation.

$y - 1 = f(x + 3)$

$y = f(x + 3) + 1$

- horizontal translation left 3
- vertical translation up 1

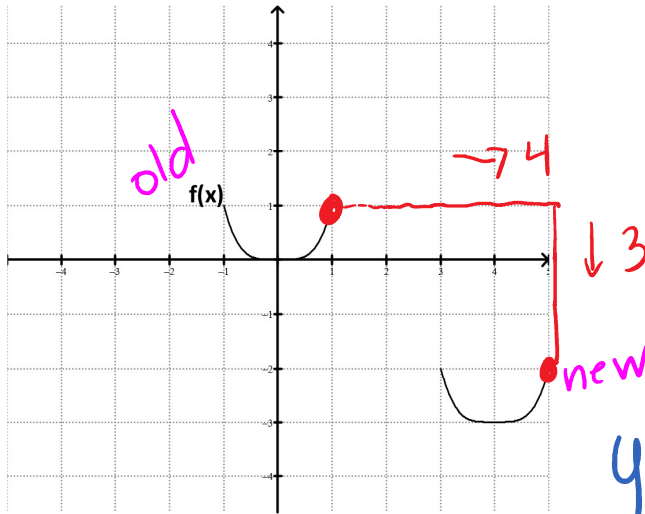


$(x, y) \rightarrow (x - 3, y + 1)$

old	
-3	4
0	1
2	1
4	0

Fake axis  
 $\leftarrow 3$   
 $\uparrow$

**Ex. #5:** Given the graph of  $f(x)$ , list the transformations to get the new graph and determine the equation of the transformed graph. Write the equation in the form  $y = f(x - h) + k$ .



- Horizontal translation  
right 4
- Vertical translation  
down 3

$$y = f(x - 4) - 3$$