

## 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  $(x, y) \rightarrow (x, y+3)$    
 $\rightarrow$  only y-values changed in this transformation

A translation is a transformation that moves the graph of a function up, down, left, or right. (the shape and orientation do not change)

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

$y = |x|$  "average joe"

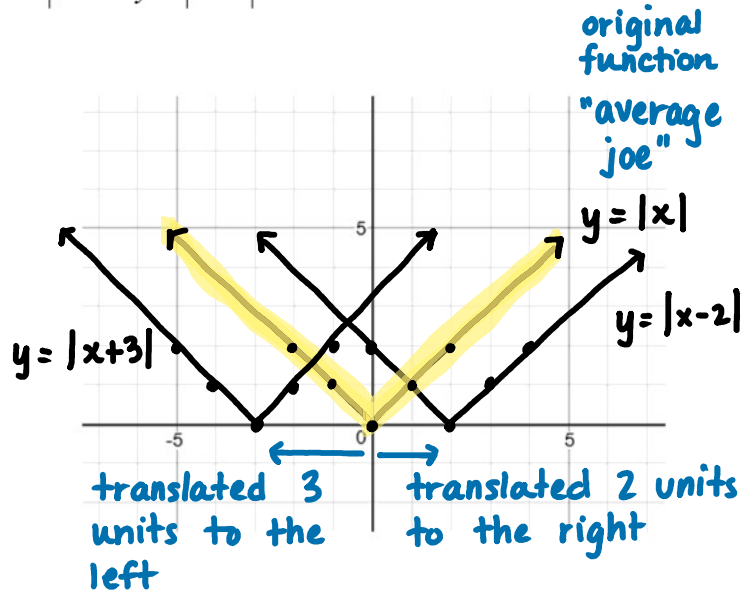
x	y
-2	2
-1	1
0	0
1	1
2	2

$y = |x-2|$

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



\* These functions can also be graphed without a table of values.

**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 ex: if  $h=2$   $y = f(x-2)$
- If  $h < 0$ , the graph of  $y = f(x-h)$  is translated left ex: if  $h=-3$   $y = f(x-(-3))$   
 $y = f(x+3)$

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

$$y = |x|$$

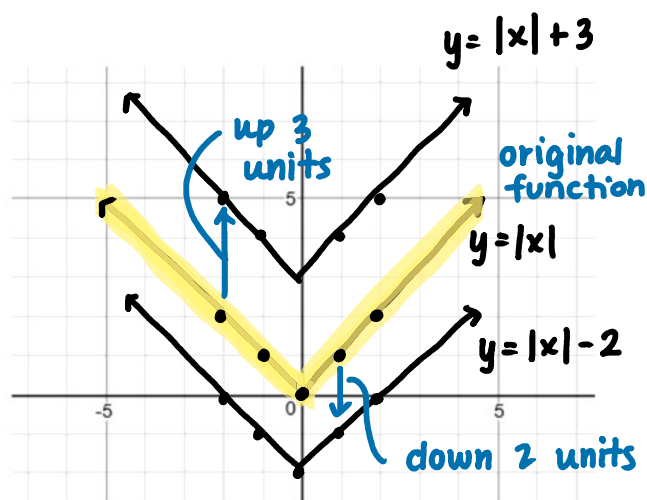
x	y
-2	2
-1	1
0	0
1	1
2	2

$$y = |x| - 2$$

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  $y = f(x)$ . **original function**

- If  $k > 0$  the graph of  $y = f(x) + k$  or  $y - k = f(x)$  is translated up ex:  $k = 5$   $y = f(x) + 5$  or  $y - 5 = f(x)$
- If  $k < 0$  the graph of  $y = f(x) + k$  or  $y - k = f(x)$  is translated down ex:  $k = -1$   $y = f(x) - 1$  or  $y + 1 = f(x)$

put  $h$  &  $k$  together

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

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

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

$$h = 2$$

$$k = 7$$

$$(x, y) \rightarrow (x + 2, y + 7)$$

original transformed

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

$$h = -1$$

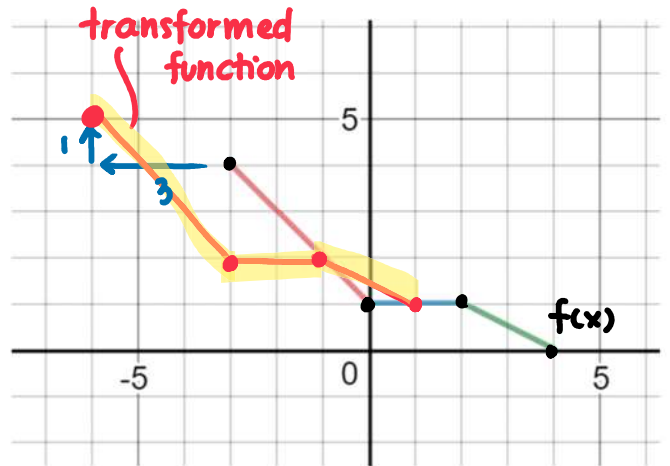
$$k = -3$$

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

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

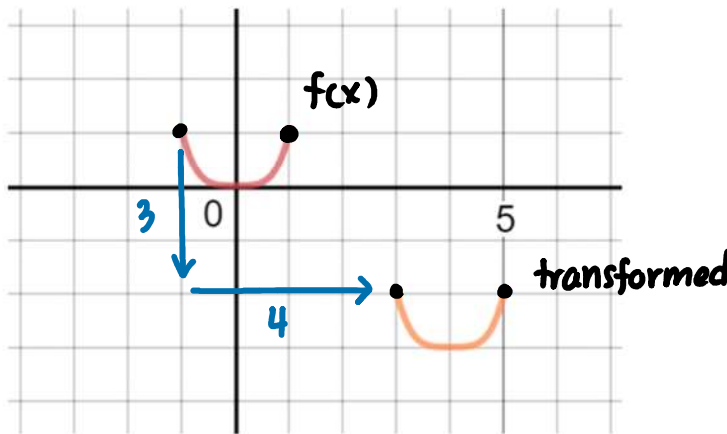
rewrite  
 $y - 1 = f(x + 3)$      $y = f(x + 3) + 1$   
 $h = -3$  ,  $k = 1$

- horizontal translation  
left 3 units
- vertical translation  
up 1 unit



\* use points on original function to locate points on transformed function.

**Example 5:** Given the graph of  $y = f(x)$ , 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  
 $h = 4$
- vertical translation down 3  
 $k = -3$

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

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

**Practice:** p.12 #2 - 4, 5cd, 6 - 8, 11, 17, 18

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