

## Unit 7A Day 3 and 4: Shifting Functions

Focus Question: How do I shift a function vertically or horizontally?

### A. Background:

On day 1 and 2, we said that both absolute value and quadratic functions could have 1, 2, or 0 x intercepts. But how do we get that to happen? translating

All functions in a family are really just a transformation (change) made to the parent function. There are 4 transformations that can be applied to a function.

Today and tomorrow we will look at two of these transformations:  $f(x) + k$  and  $f(x + k)$  where  $f(x)$  is the function and  $k$  is some constant value (almost always an integer).

1. How are the expressions  $f(x) + k$  and  $f(x + k)$  different? whether or not the k is in ( ) or out

the k is affecting the y

the k is affecting the x

$f(3) = 2(3) + 4$

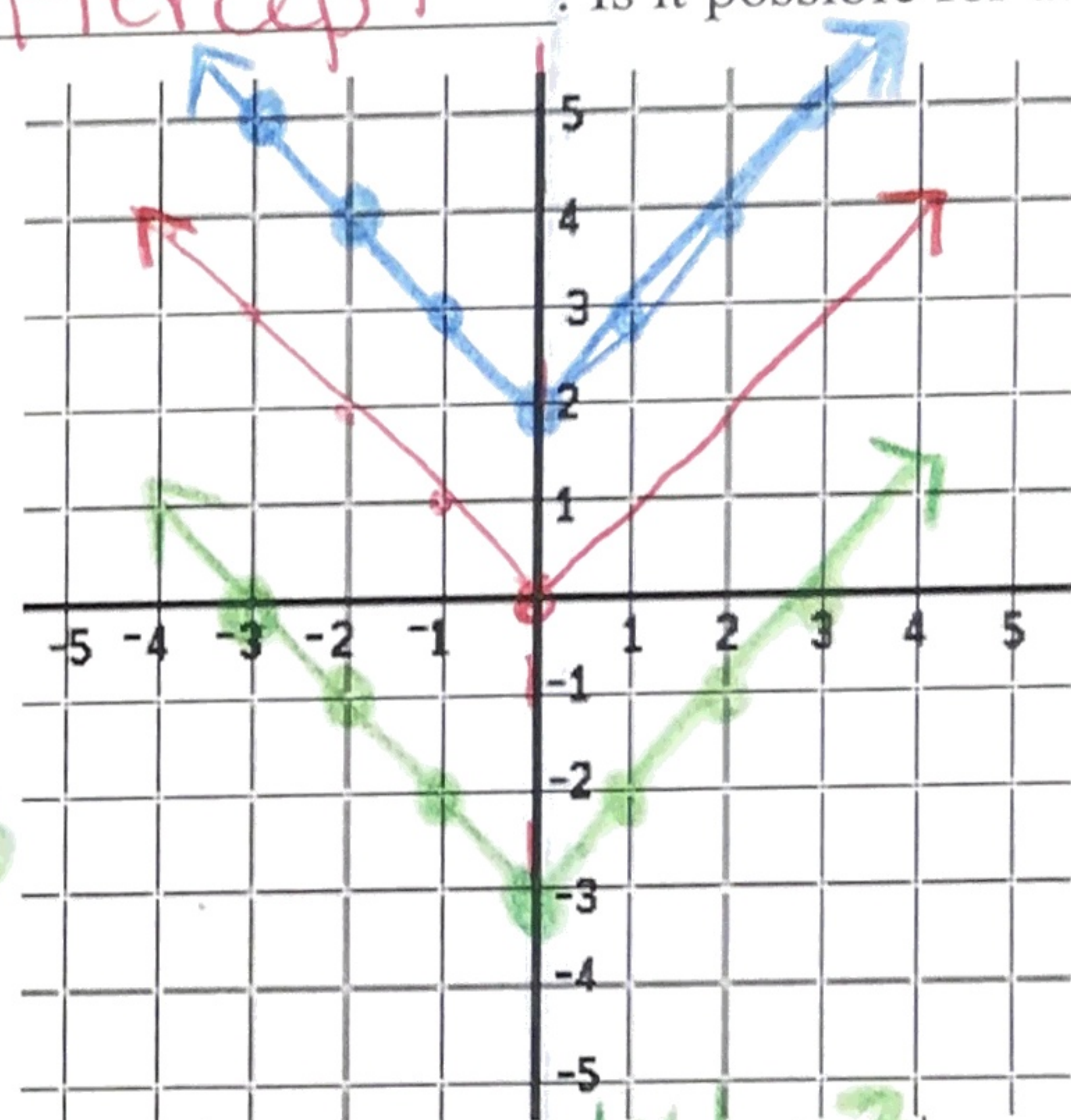
2. Think back... find  $f(3)$  when  $f(x) = 2x + 4$  meant substitute 3 for x.

So  $f(x + k)$  means that you substitute  $(x + k)$  everywhere that there is an x.

3.  $f(x) + k$  would mean that you copy the function, put the k on the end and simplify.

4. For linear functions we say that  $f(x) = mx + b$ . b stands for y-intercept. Is it possible for the y-intercept to be negative? yes

5. So when we say  $f(x + k)$  or  $f(x) + k$ , can k be negative? yes



### B. Transforming $f(x) + k$

affecting the y

Parent function  $f(x) = |x|$

1. Find  $g(x)$  if  $g(x) = f(x) + 2$

$g(x) = |x| + 2$

2. Find  $h(x)$  if  $h(x) = f(x) - 3$

$h(x) = |x| - 3$

3. Use three different colors to graph each function

$f(x) =  x $	
x	f(x)
-3	3
-2	2
-1	1
0	0
1	1
2	2
3	3

$g(x) =  x  + 2$	
x	g(x)
-3	5
-2	4
-1	3
0	2
1	3
2	4
3	5

$h(x) =  x  - 3$	
x	h(x)
-3	0
-2	-1
-1	-2
0	-3
1	-2
2	-1
3	0

Has 1 x-intercepts

It moved up

It moved down

The a.o.s. is x=0

Is that what you thought it would do? yes  
It now has 0 x-intercepts.

Is that what you thought it would do? yes  
It now has 2 x-intercepts

Vertex is (0,0)

a.o.s. x=0 vertex (0,2)

a.o.s. x=0 vertex (0,-3)

✓  $f(x) + k$  moves functions up or down so it is a vertical shift!  
+k      -k



*affecting the x bits in the ( ) with the x*

C. Transforming  $f(x + k)$

Parent function  $f(x) = x^2$

1. Find  $g(x)$  if  $g(x) = f(x + 3)$

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

I think it will....

*up? , down, right*

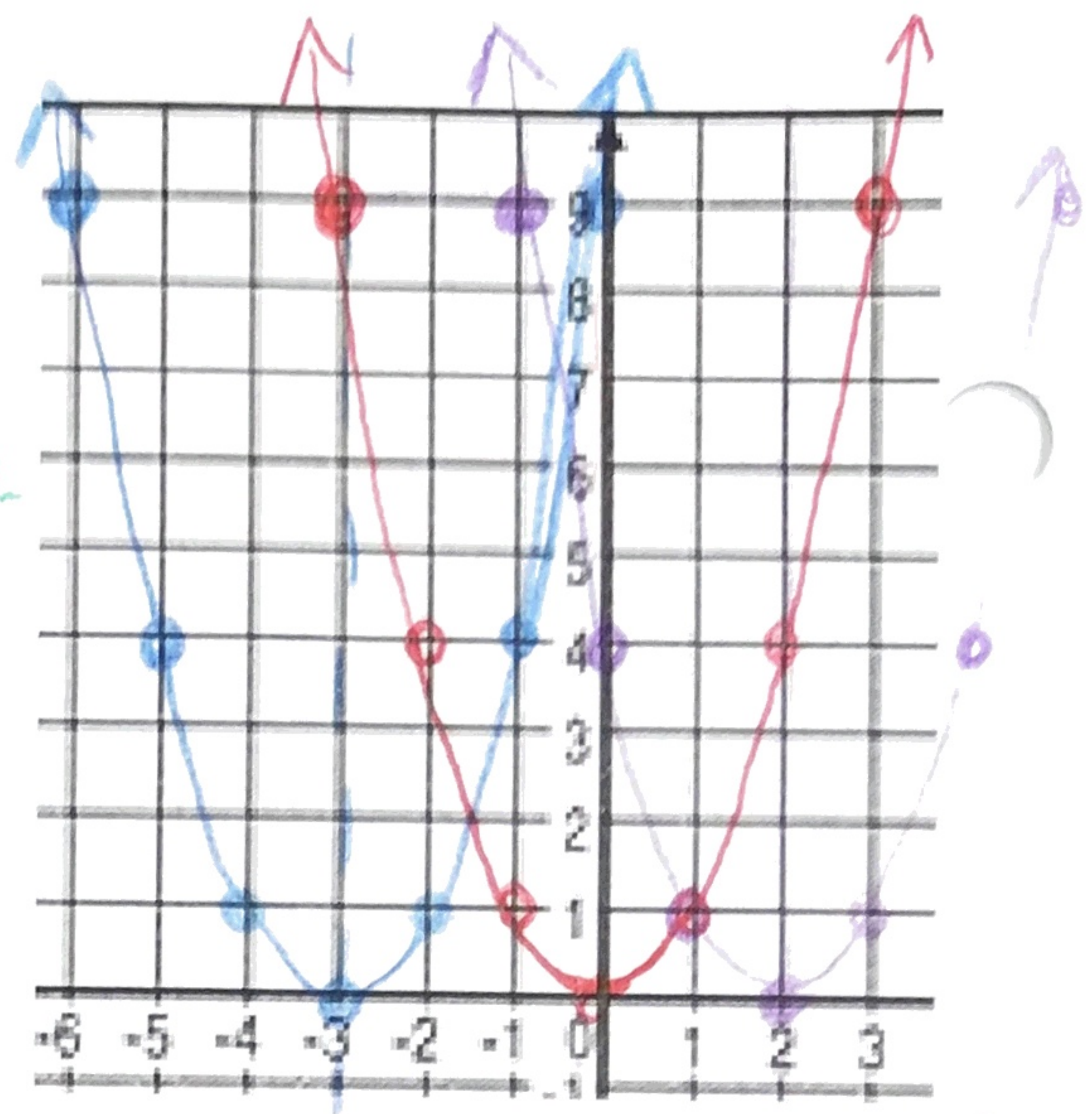
2. Find  $h(x)$  if  $h(x) = f(x - 2)$

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

I think it will....

*left*

3. Use three different colors to graph each function



$f(x) = x^2$	
x	f(x)
-6	36
-5	25
-4	16
-3	9
-2	4
-1	1
0	0
1	1
2	4
3	9

$g(x) = (x + 3)^2$	
x	g(x)
-6	9
-5	4
-4	1
-3	0
-2	1
-1	4
0	9
1	16
2	25
3	36

$h(x) = (x - 2)^2$	
x	h(x)
-6	64
-5	49
-4	36
-3	25
-2	16
-1	9
0	4
1	1
2	0
3	1

Function	Parent $f(x) = x^2$	$g(x) = f(x + 3)$	$h(x) = f(x - 2)$
Vertex	(0, 0)	(-3, 0)	(2, 0)
a.o.s.	$x = 0$	$x = -3$	$x = 2$
Moved		Left!	Right!
Everything...			

$f(x + k)$  moves functions left or right so it is a horizontal shift!  
*(x+k) (x-k)*

D. Why couldn't we learn this when we learned linear?

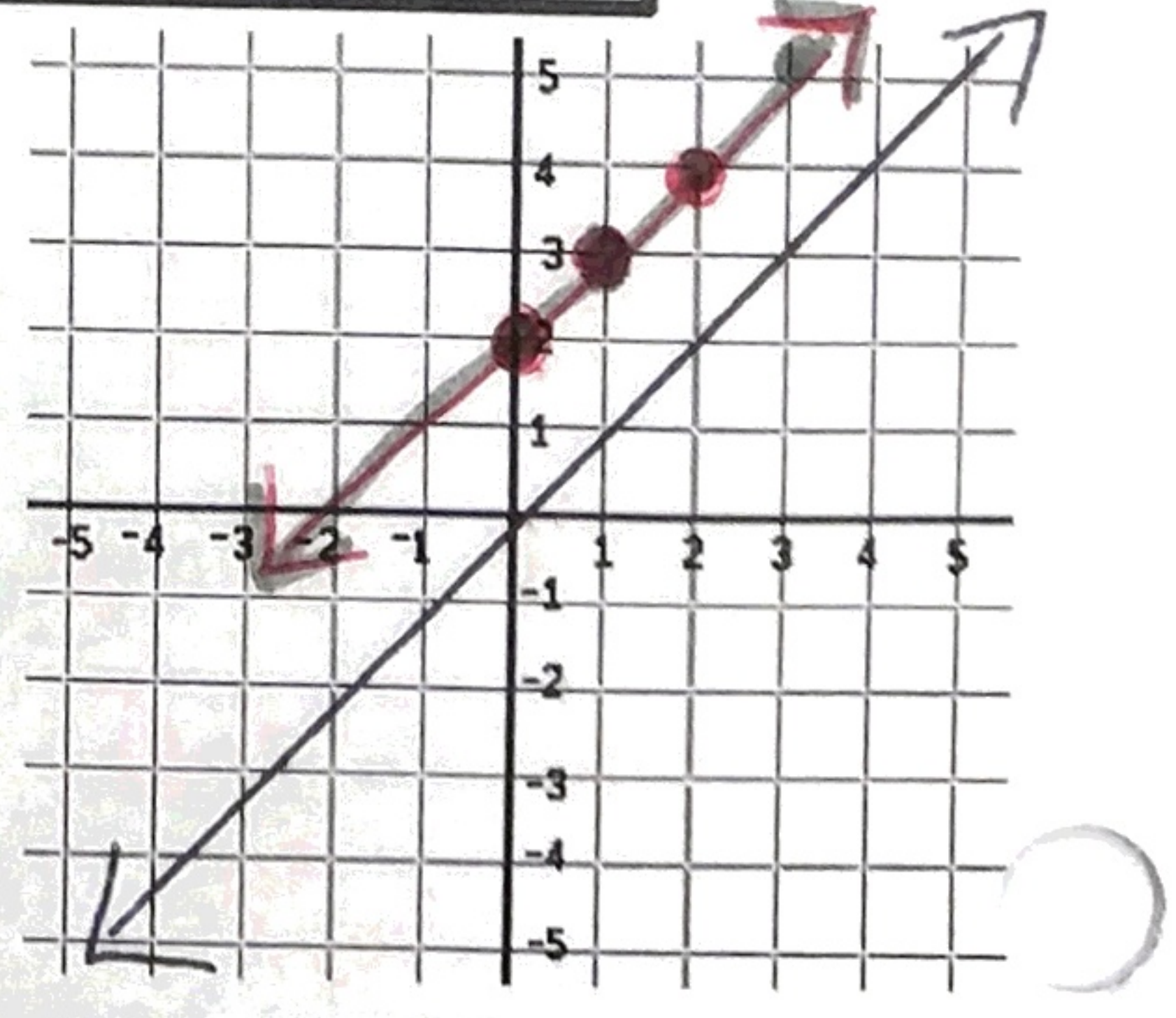
Linear parent function:  $f(x) = x$

Graph  $f(x) = x + 2$  ✓

Graph  $f(x) = (x + 2)$

In linear, a shift up is identical to a shift left.

(Unless a stretch or compression is involved and we haven't learned that yet!)





E. Summary

1. What kind of transformation is  $f(x) + k$ ?

It is a vertical shift because you are doing something to  $f(x)$  which represents  $y$ . The  $y$  axis goes vertically.

a. If  $k$  is positive it moves up

b. If  $k$  is negative it moves down

2. What kind of transformation is  $f(x + k)$ ?

It is a horizontal shift because you are doing something to  $x$ .

The  $x$  axis goes horizontal.

\* } a. If  $k$  is positive it moves left

b. If  $k$  is negative it moves right

3. Give the vertex of the following functions without graphing

Function	Vertex	a.o.s.	Explanation
$f(x) = (x + 3)^2 + 4$	$(-3, 4)$	$x = -3$	the parent went left 3 & up 4
$g(x) =  x - 7  - 3$	$(7, -3)$	$x = 7$	the parent went right 7 & down 3
$h(x) =  x  + 1$	$(0, 1)$	$x = 0$	the parent went up 1
$j(x) = (x - 1)^2 + 5$	$(1, 5)$	$x = 1$	the parent went right 1 & up 5
$k(x) = (x + 4)^2$	$(-4, 0)$	$x = -4$	the parent went left 4

$m(x) = (x - 3)^2 + 6$   $(3, 6)$   $x = 3$

4. Tell what has happened to each function and write the new function

a.  $f(x) = 2x$  and  $g(x) = f(x - 3) + 4$

↑ right 3 & up 4

$$g(x) = 2(x - 3) + 4$$

$$= 2x - 6 + 4$$

$$= 2x - 2$$

b.  $g(x) = 5^x$  and  $h(x) = g(x - 2) - 6$

↑ right 2 & down 6

$$h(x) = 5^{x-2} - 6$$

c.  $j(x) = x^2$  and  $k(x) = j(x + 7) + 2$

↑ left 7 & up 2

$$k(x) = (x + 7)^2 + 2$$