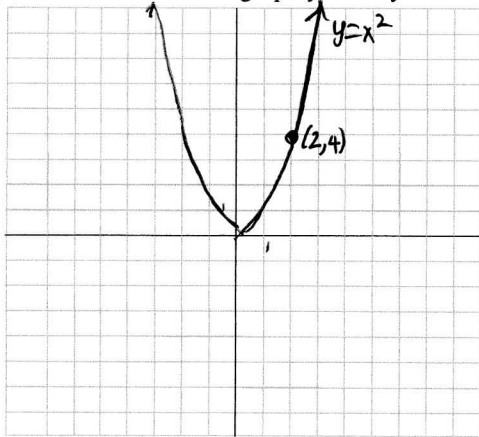


Using transformations to graph.

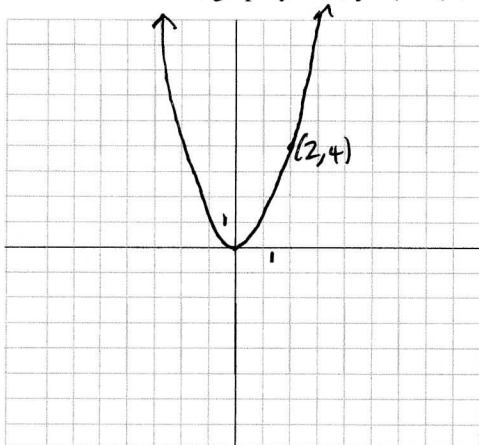
(1) On the axes below, graph  $y = x^2$ ,  $y = x^2 - 4$ , and  $y = x^2 + 2$



X	$y = x^2$	$y = x^2 - 4$	$y = x^2 + 2$
0	0		
2	4		

GENERALIZATION: VERTICAL SHIFT - For  $c > 0$ , to graph  
 $f(x) + c$ , shift the graph of  $f(x)$  UP  $c$  units,  
 $f(x) - c$ , shift the graph of  $f(x)$  DOWN  $c$  units.

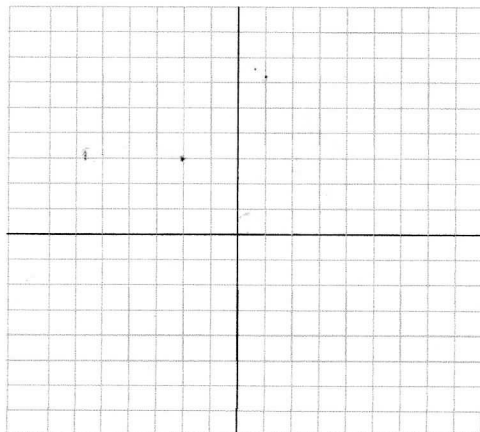
(2) On the axes below, graph  $y = x^2$ ,  $y = (x-2)^2$ , and  $y = (x+3)^2$ .



X	$y = x^2$	$y = (x-2)^2$	$y = (x+3)^2$
0	0		
2	4		

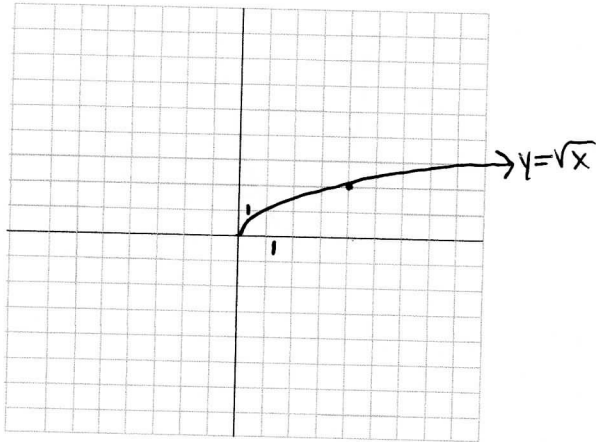
GENERALIZATION: HORIZONTAL SHIFT - For  $c > 0$ , to graph  
 $f(x+c)$ , shift the graph of  $f(x)$  LEFT  $c$  units,  
 $f(x-c)$ , shift the graph of  $f(x)$  RIGHT  $c$  units.

Example: Combining horizontal and vertical shifts.



$$y = |x+1| - 3$$

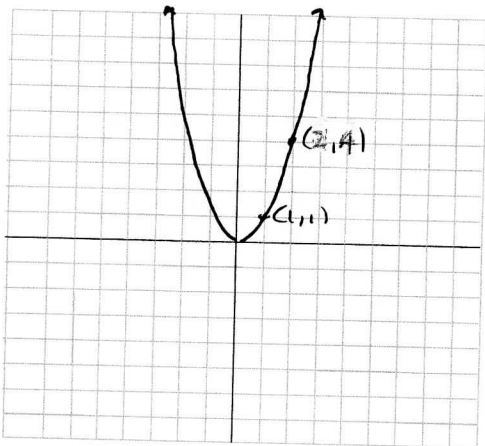
(3) Graph  $y = \sqrt{x}$ ,  $y = -\sqrt{x}$ ,  $y = \sqrt{-x}$



x	$y = \sqrt{x}$	$y = -\sqrt{x}$	$y = \sqrt{-x}$
1	1		
4	2		

GENERALIZATION: REFLECTION - To graph  
 $-f(x)$ , reflect the graph of  $f(x)$  in the x axis,  
 $f(-x)$ , reflect the graph of  $f(x)$  in the y axis.

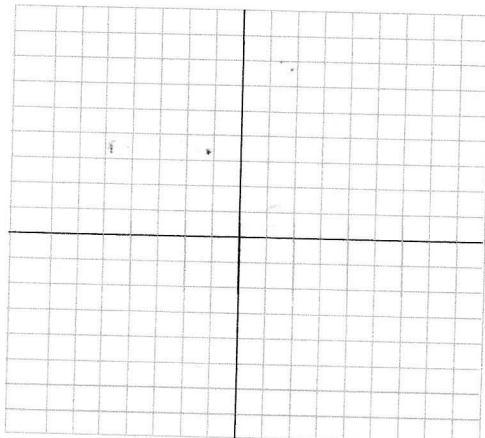
(4) Graph  $y = x^2$ ,  $y = 3x^2$ , and  $y = \frac{1}{2}x^2$ .



x	$y = x^2$	$y = 3x^2$	$y = \frac{1}{2}x^2$
1	1		
2	4		

GENERALIZATION: VERTICAL STRETCH/SHRINK -  
 $cf(x)$  where  $c > 1$ , vertically stretch the graph of  $f(x)$ ,  
 $cf(x)$  where  $0 < c < 1$ , vertically shrink or compress the graph of  $f(x)$ .

Example:



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