

VERTICAL SHIFTING**Exercise #1**

Use the graph of

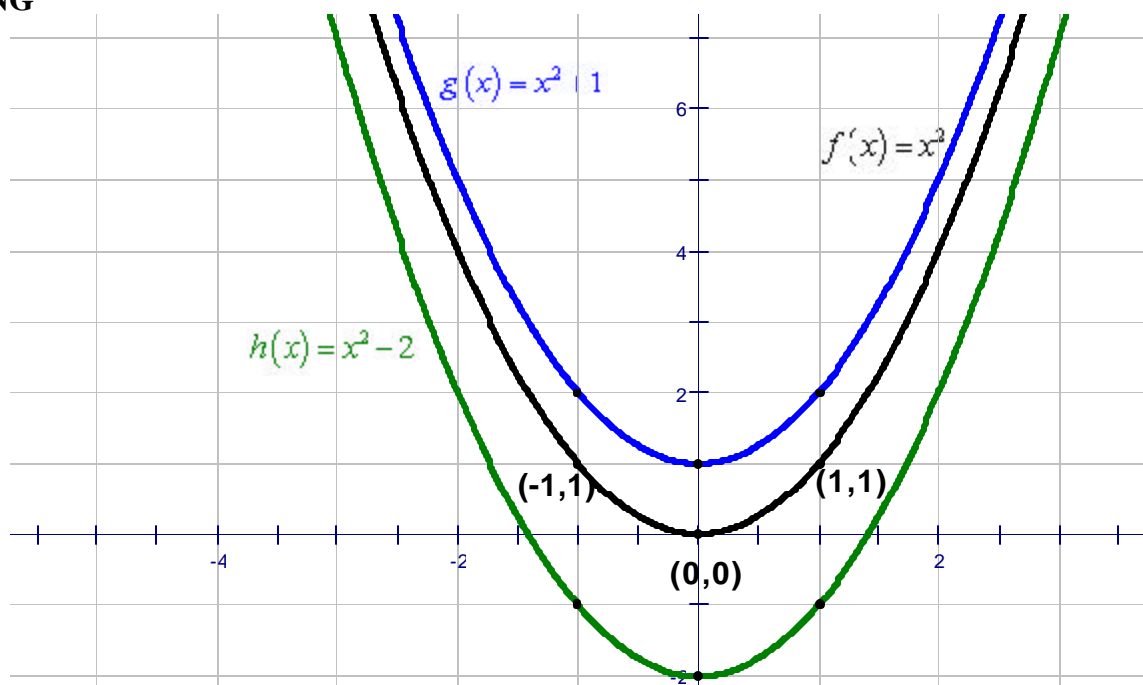
$$f(x) = x^2$$

to obtain the graphs of

$$g(x) = x^2 + 1$$

and

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



Equation	How to obtain the graph	Example
$y = f(x) + k$ $k > 0$	Shift graph of $y = f(x)$ upward k units.	$g(x) = x^2 + 1$
$y = f(x) - k$ $k > 0$	Shift graph of $y = f(x)$ downward k units.	$h(x) = x^2 - 2$

Exercise #2

Use the graph of

$$f(x) = |x|$$

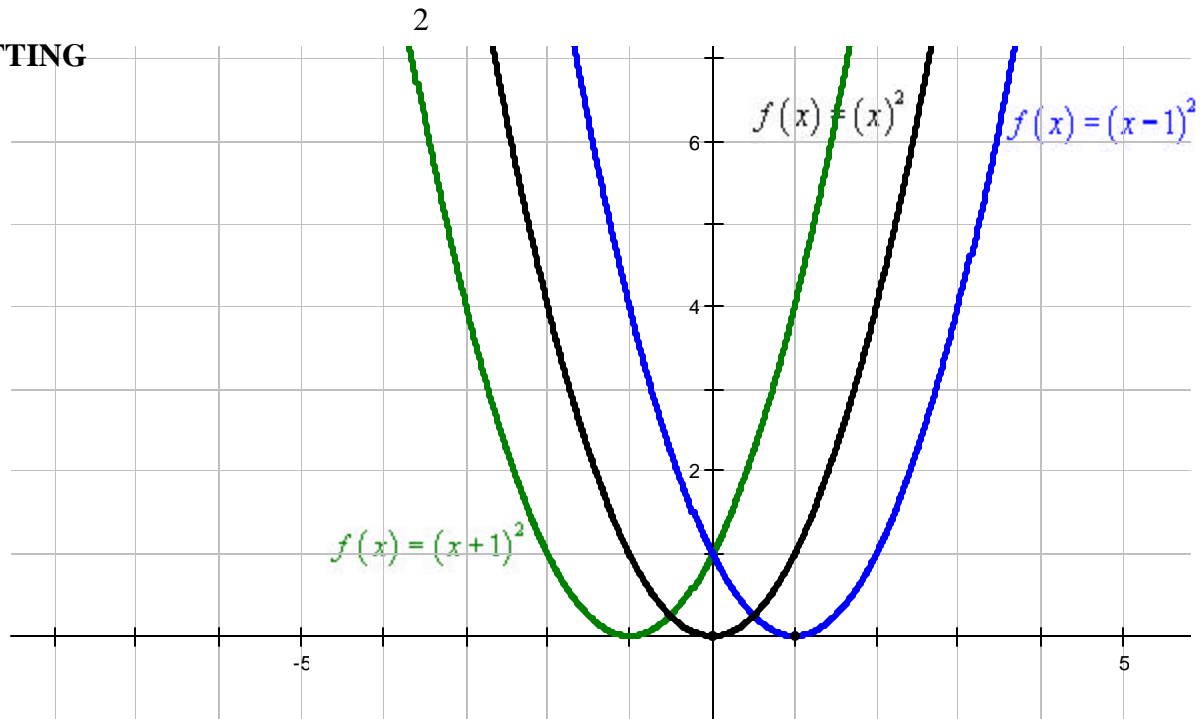
to obtain the graph of

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

HORIZONTAL SHIFTING

Exercise #3

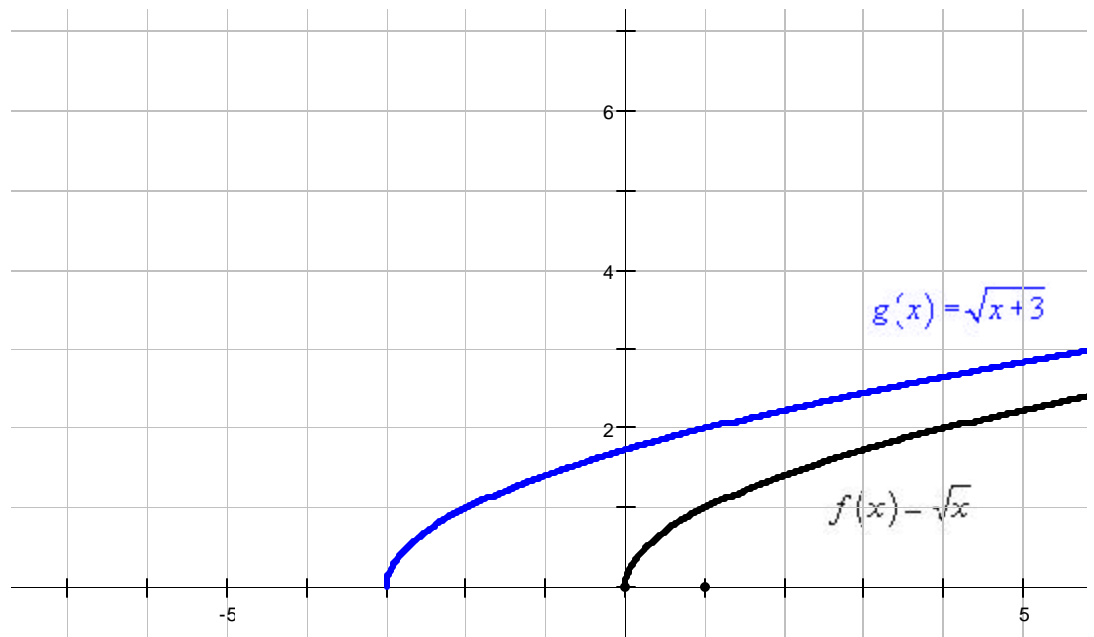
Use the graph of
 $f(x) = x^2$
 to obtain the graphs of
 $g(x) = (x-1)^2$
 and
 $h(x) = (x+1)^2$.



Equation	How to obtain the graph	Example
$y = f(x-h)$ $h > 0$	Shift graph of $y = f(x)$ to the right h units.	$g(x) = (x-1)^2$
$y = f(x+h)$ $h > 0$	Shift graph of $y = f(x)$ to the left h units.	$h(x) = (x+1)^2$

Exercise #4

Use the graph of
 $f(x) = \sqrt{x}$
 to obtain the graph of
 $g(x) = \sqrt{x-3}$.

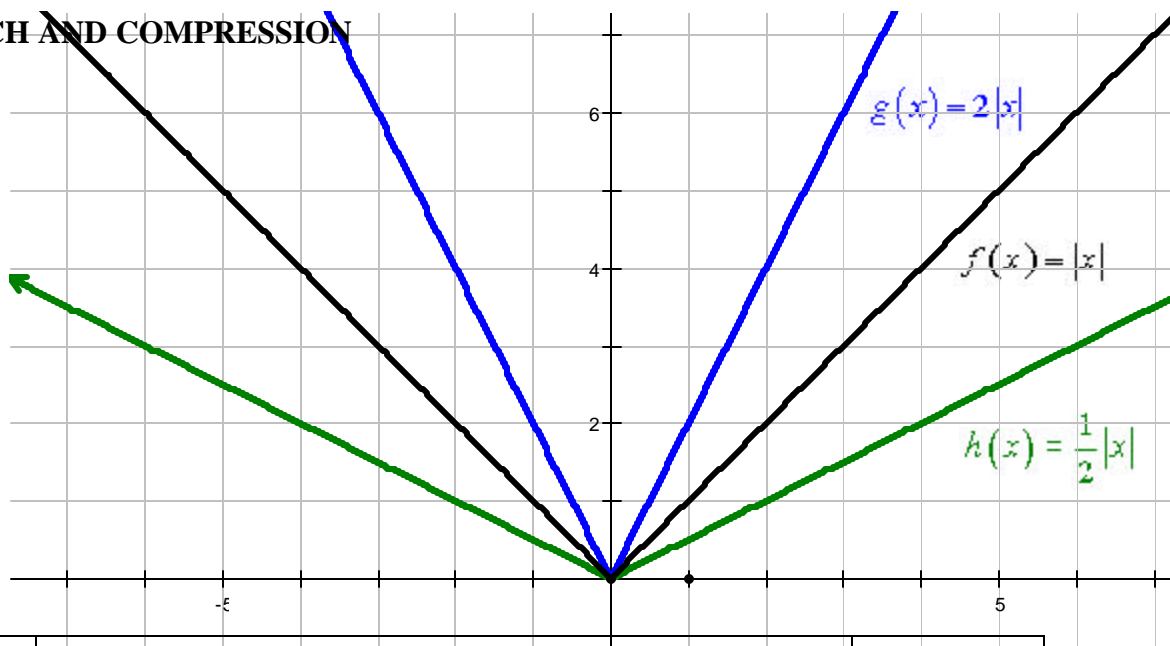


VERTICAL STRETCH AND COMPRESSION

Exercise #5

Use the graph of
 $f(x) = |x|$
 to obtain the graphs of
 $g(x) = 2|x|$
 and

$$h(x) = \frac{1}{2}|x|$$



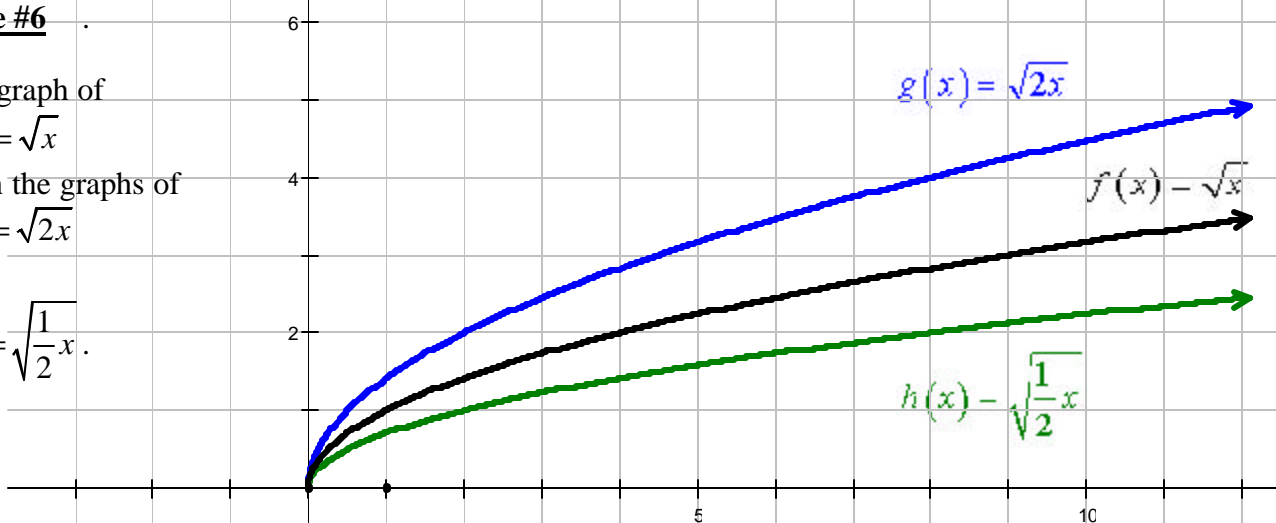
Equation	How to obtain the graph	Example
$y = af(x)$ $a > 1$	Stretch the graph of $y = f(x)$ vertically by a factor of a .	$g(x) = 2 x $
$y = af(x)$ $0 < a < 1$	Compress the graph of $y = f(x)$ vertically by a factor of a .	$h(x) = \frac{1}{2} x $

HORIZONTAL COMPRESSION AND STRETCH

Exercise #6

Use the graph of
 $f(x) = \sqrt{x}$
 to obtain the graphs of
 $g(x) = \sqrt{2x}$
 and

$$h(x) = \sqrt{\frac{1}{2}x}$$



Equation	How to obtain the graph	Example
$y = f(ax)$ $a > 1$	Compress the graph of $y = f(x)$ horizontally by a factor of $\frac{1}{a}$.	$g(x) = \sqrt{2x}$
$y = f(ax)$ $0 < a < 1$	Stretch the graph of $y = f(x)$ horizontally by a factor of $\frac{1}{a}$.	$h(x) = \sqrt{\frac{1}{2}x}$

Exercise #7

Find the function that is finally graphed after the following transformations are applied to the graph of

a) $f(x) = \sqrt{x}$;

b) $g(x) = x^3$.

1) Shift left 3 units

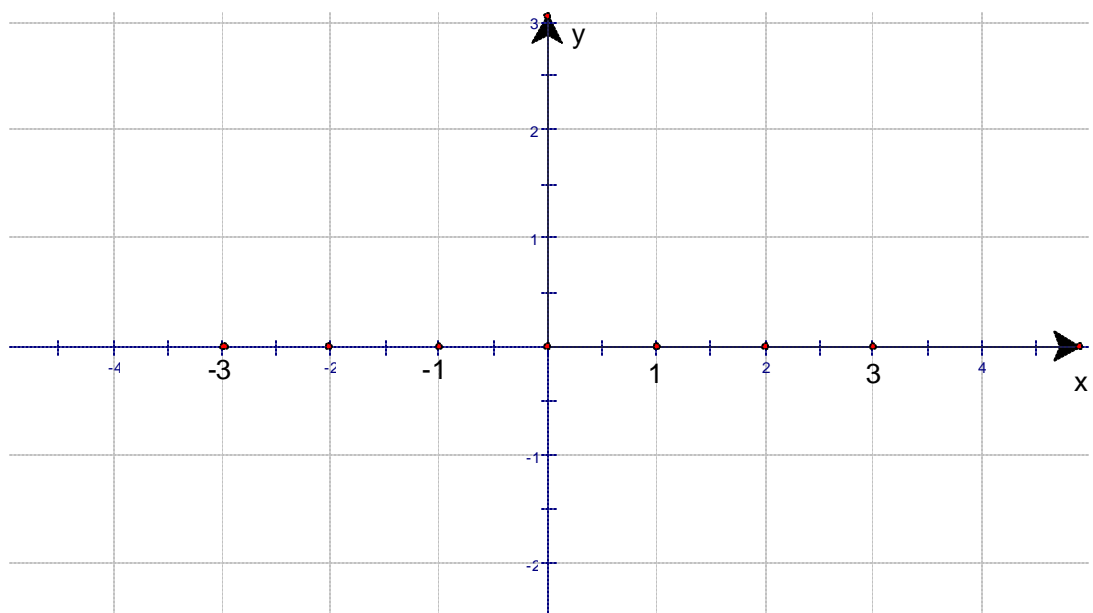
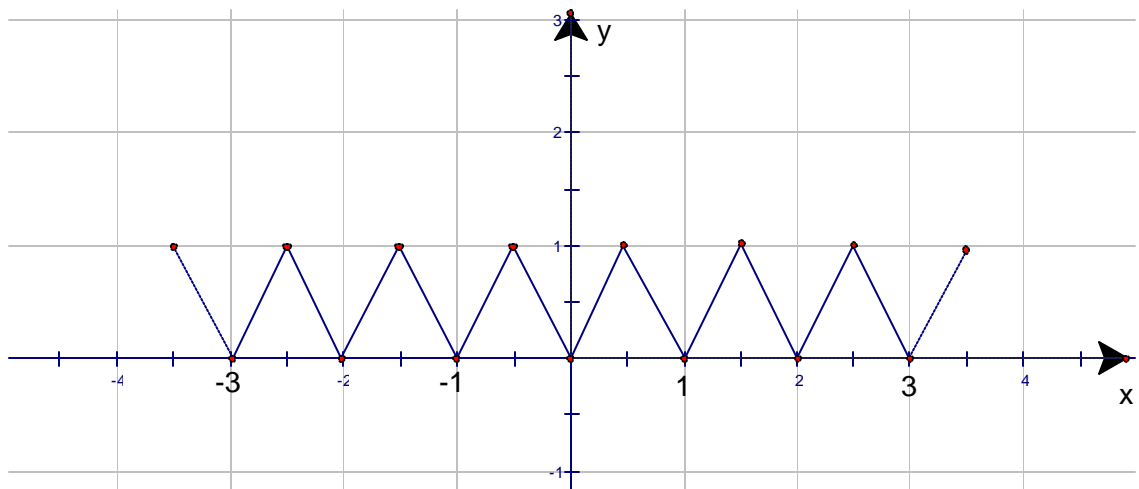
2) Shift up 1 unit.

Exercise #8

The graph of $y = f(x)$ is shown. Sketch the graph of each function:

a) $y = f(2x)$

b) $y = f\left(\frac{1}{2}x\right)$.

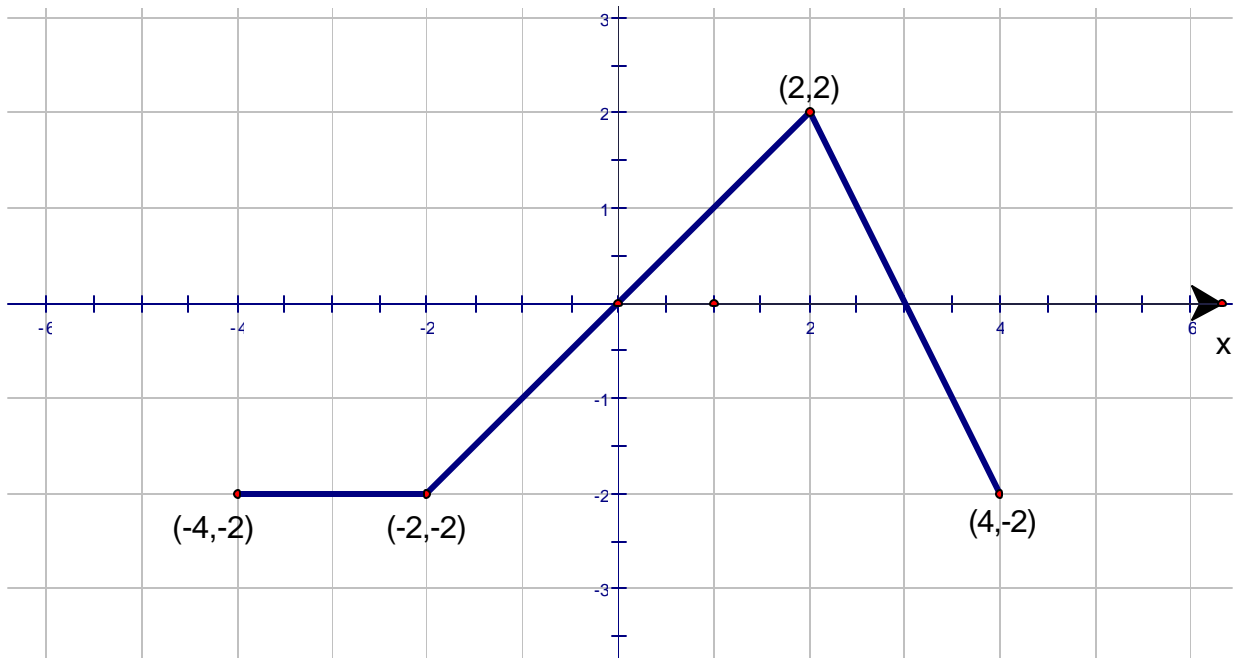


Exercise #9

The graph of $y = f(x)$ is shown. Sketch the graph of each function:

a) $H(x) = f(x+1) - 2$

b) $Q(x) = \frac{1}{2}f(x)$.

**Exercise #10**

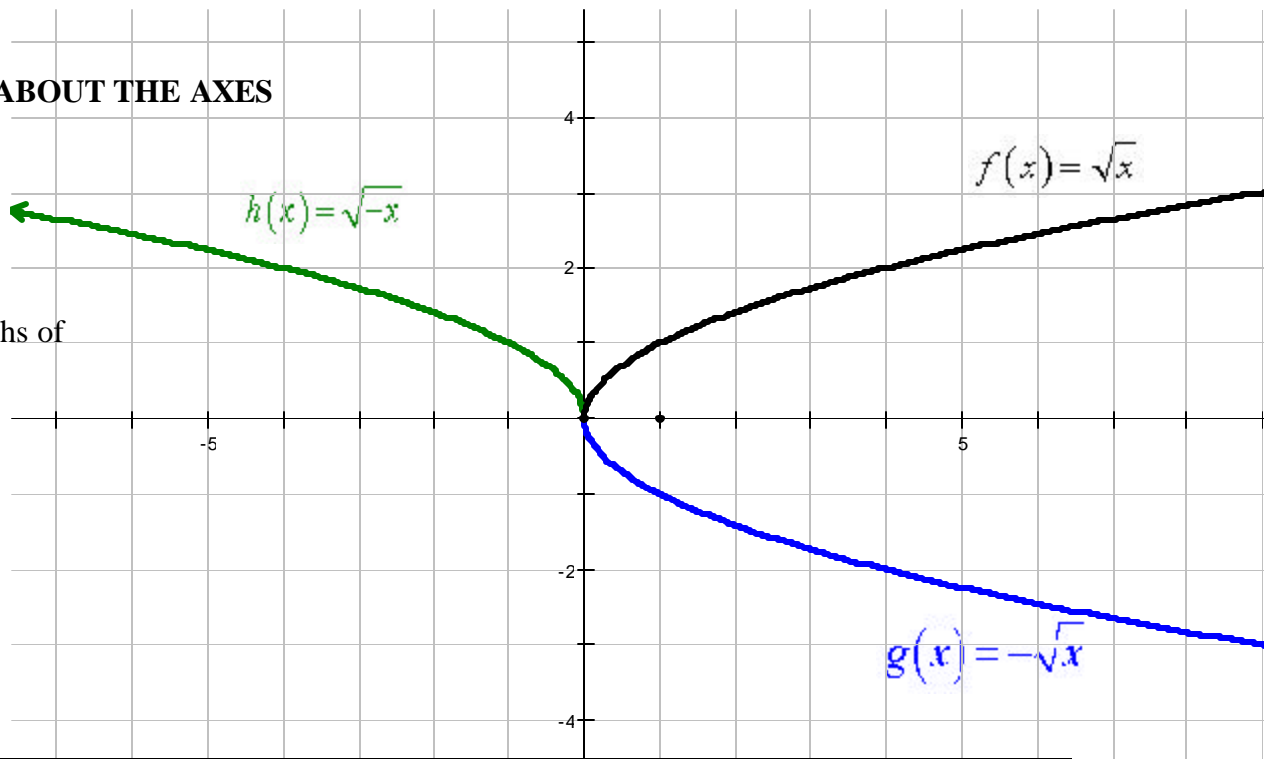
If $(0, 3)$ is a point on the graph of $y = f(x)$, which of the following points must be on the graph of $y = 2f(x)$?

- a) $(0, 3)$
- b) $(0, 2)$
- c) $(0, 6)$
- d) $(6, 0)$.

REFLECTION ABOUT THE AXES

Exercise #11

Use the graph of
 $f(x) = \sqrt{x}$
 to obtain the graphs of
 $g(x) = -\sqrt{x}$
 and
 $h(x) = \sqrt{-x}$



Equation	How to obtain the graph	Example
$y = -f(x)$	Reflect the graph of $y = f(x)$ about the x -axis.	$g(x) = -\sqrt{x}$
$y = f(-x)$	Reflect the graph of $y = f(x)$ about the y -axis.	$h(x) = \sqrt{-x}$

Exercise #12 Graph each function using the techniques of shifting, compressing, stretching, and/or reflecting. Start with the graph of the basic function and show all stages.

a) $f(x) = \frac{1}{-x} + 2$

b) $g(x) = -(x+1)^3 - 1$