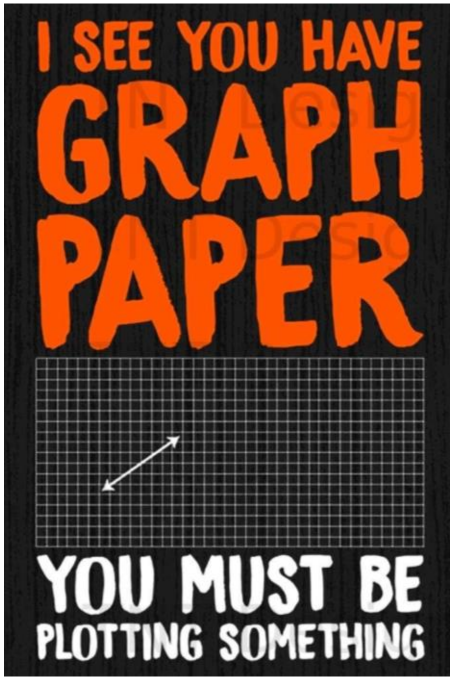
<u>Transformations of the Graphs of Functions:</u>

Vertical Shift

Horizontal Shift

Reflection about the *x*-axis

Reflection about the *y*-axis



Vertical Stretch/Compress

Horizontal Stretch/Compress

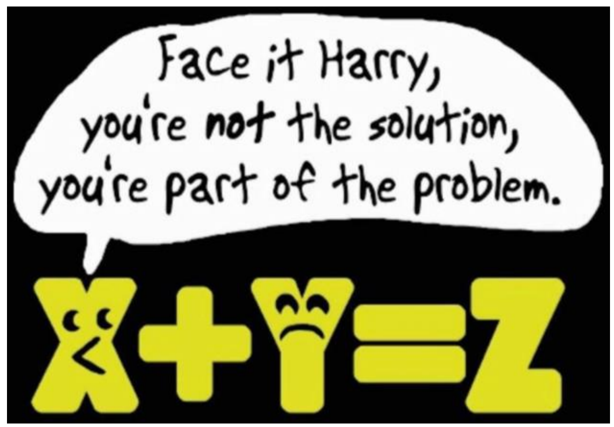
Vertical Shift:

For $c > 0$**,**

The graph of $g(x) = f(x) + c$**, is the graph of** $f(x)$ **shifted *c* units up.**

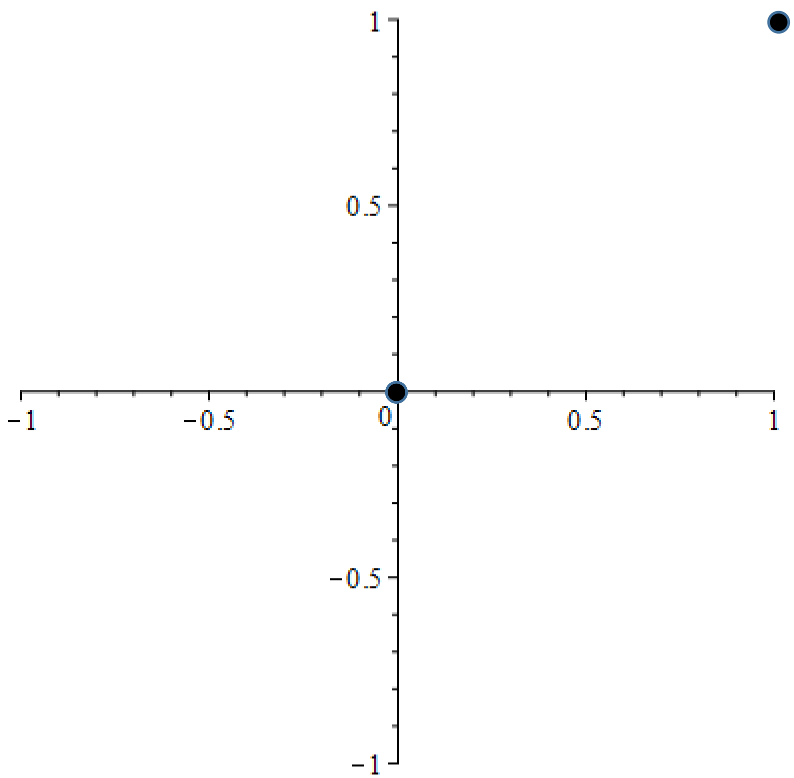
The graph of $g(x) = f(x) - c$**, is the graph of** $f(x)$ **shifted *c* units down.**

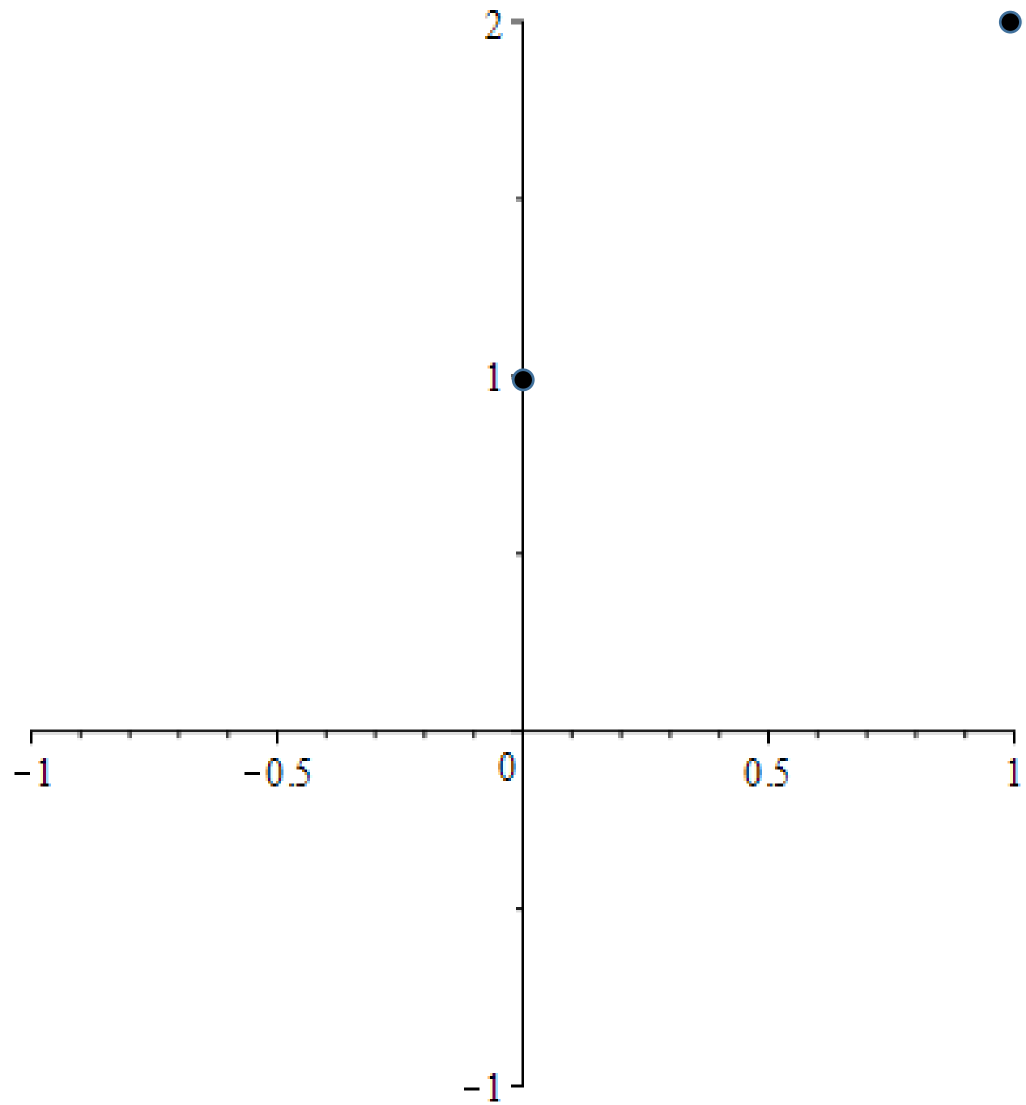
For a vertical shift, the *y*-coordinates change, but the *x*-coordinates remain the same.

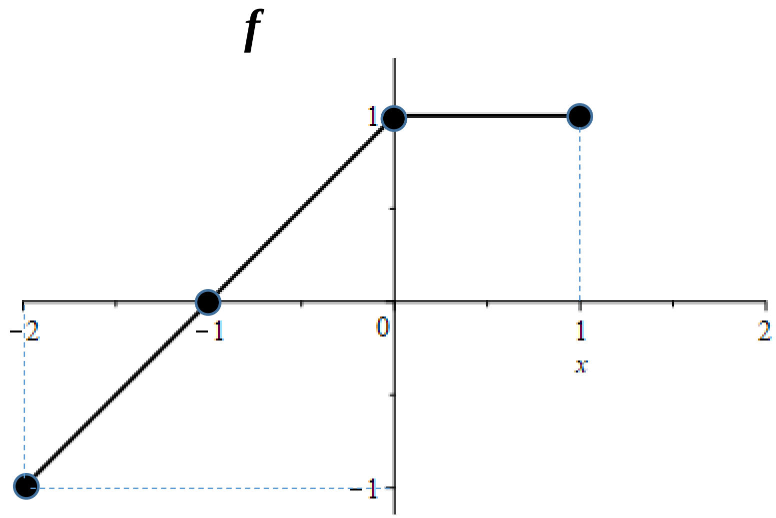


$f = \{(0,0),(1,1)\}$

$g(x) = f(x) + 1,\ g = \{(0,\square),(1,\square)\}$

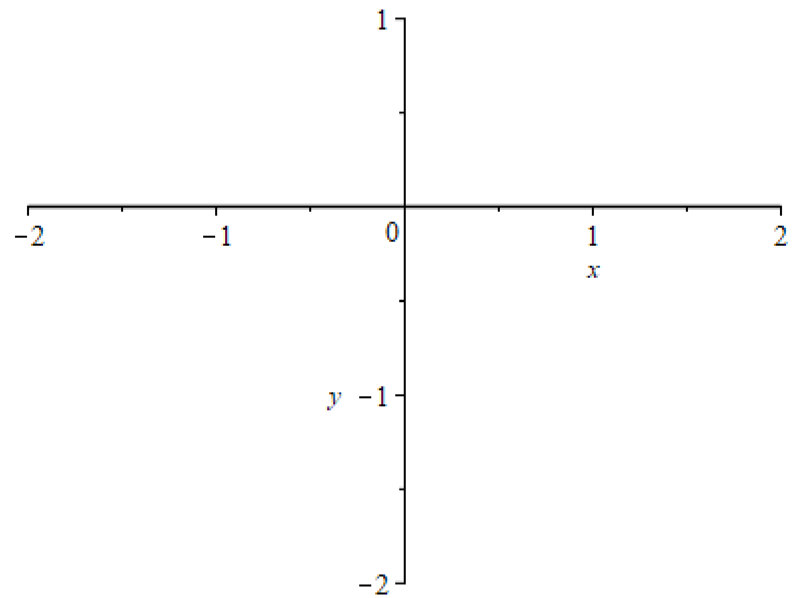






$g(x) = f(x) + 2$

$h(x) = f(x) - 1$



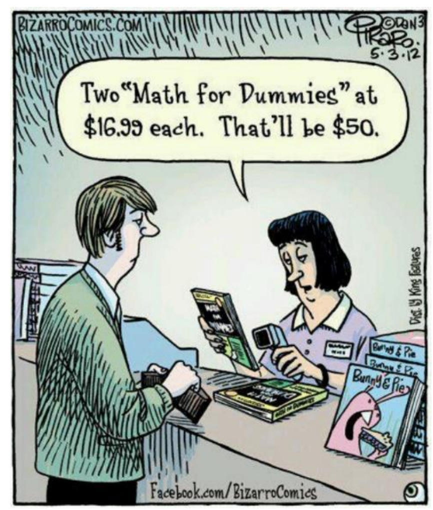
Horizontal Shift:

For $c > 0$**,**

The graph of $g(x) = f(x - c)$**, is the graph of** $f(x)$ **shifted** ***c*** **units to the right.**

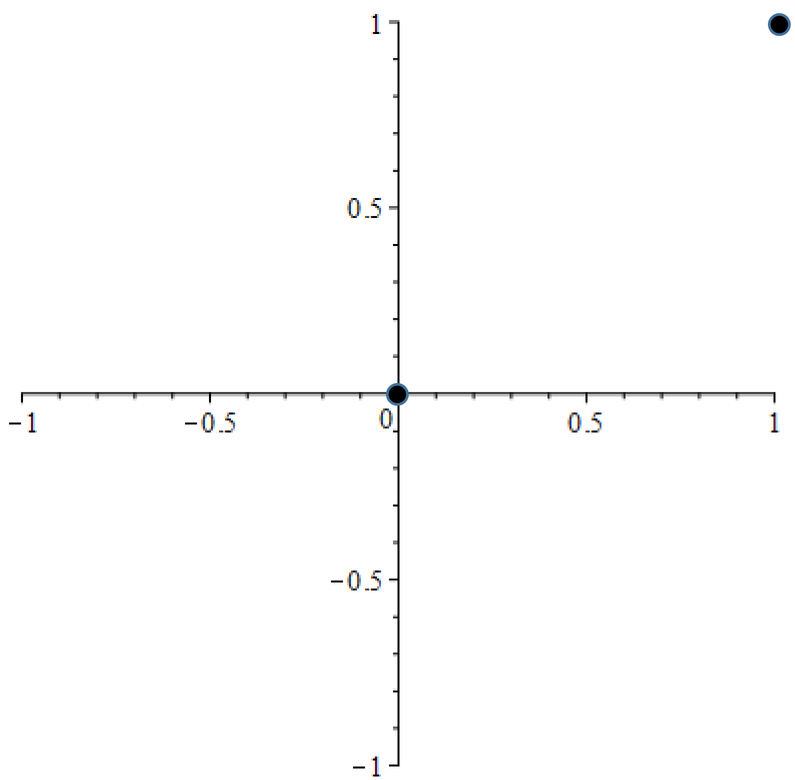
The graph of $g(x) = f(x + c)$**, is the graph of** $f(x)$ **shifted** ***c*** **units to the left.**

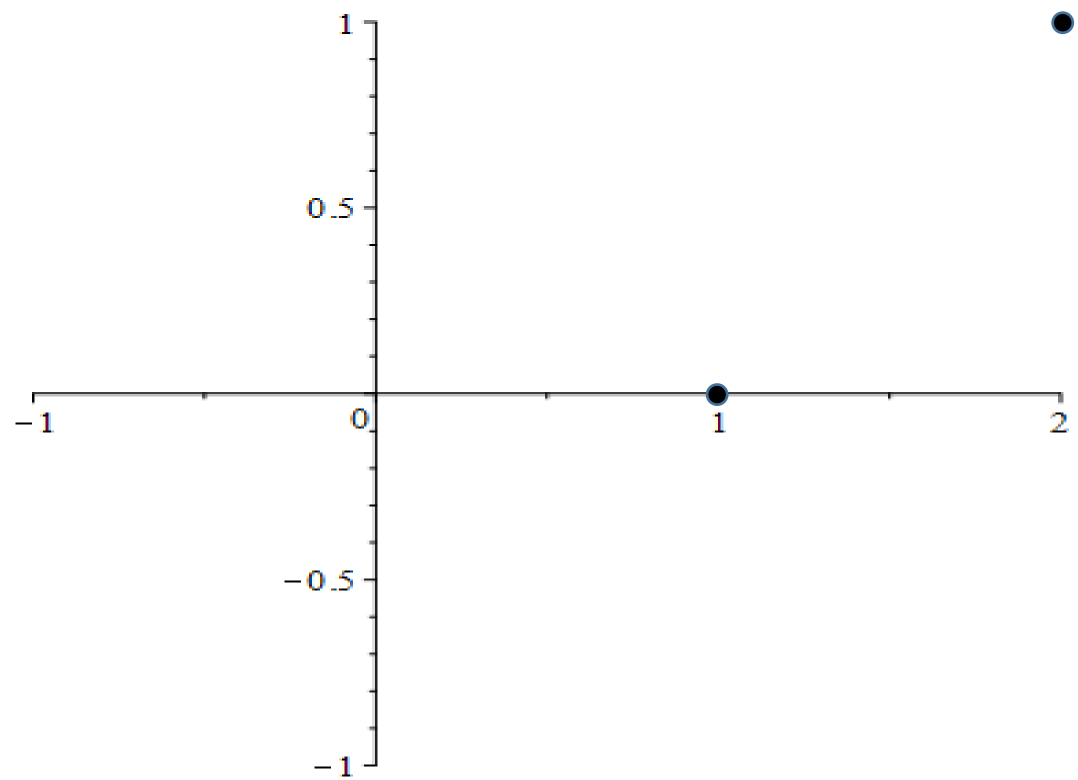
For a horizontal shift, the ***x*****-coordinates change, but the** ***y*****-coordinates remain the same.**

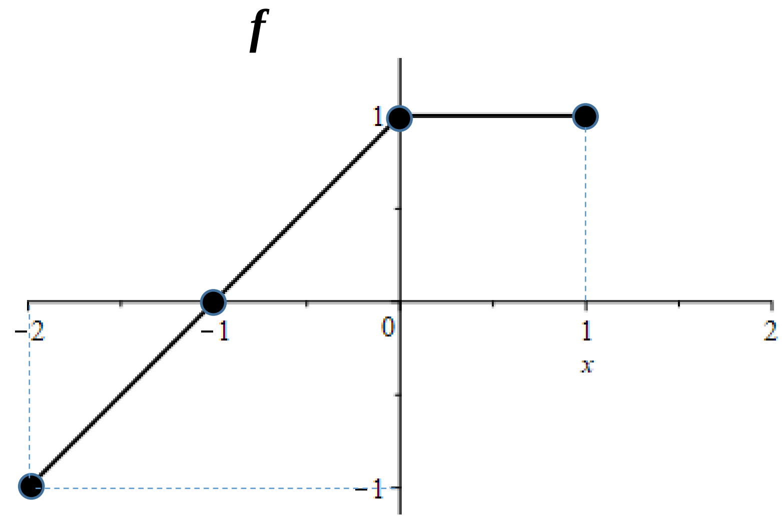


$f = \{(0,0),(1,1)\}$

$g(x) = f(x-1),\ g = \{(\square,0),(\square,1)\}$

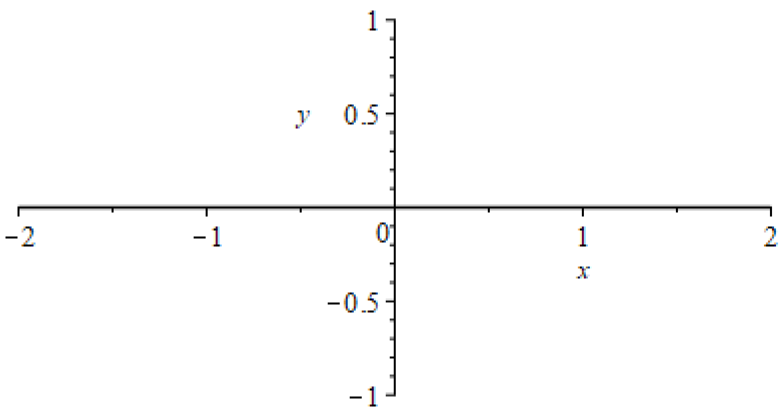


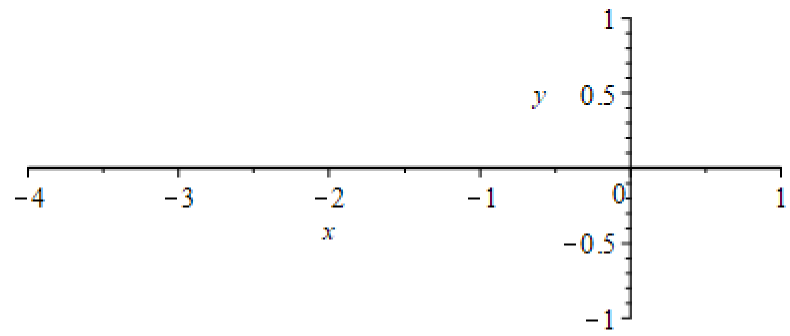




$g(x) = f(x-1)$

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

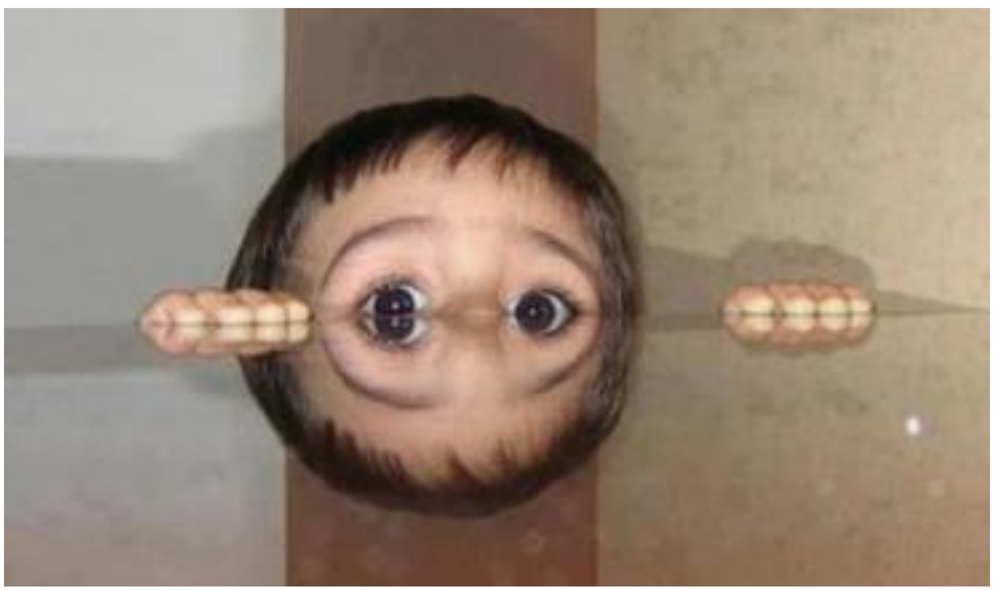


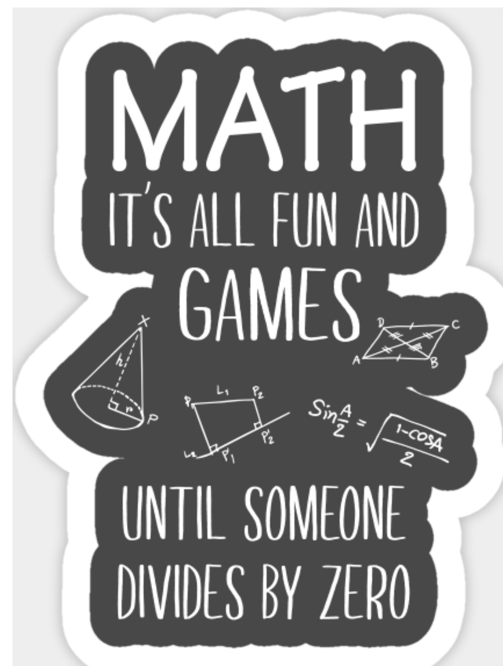


Reflection about the x-axis:

The graph of $g\left(x\right)=-f\left(x\right)$ **is the graph of** $f\left(x\right)$ **reflected about the *x*-axis.**

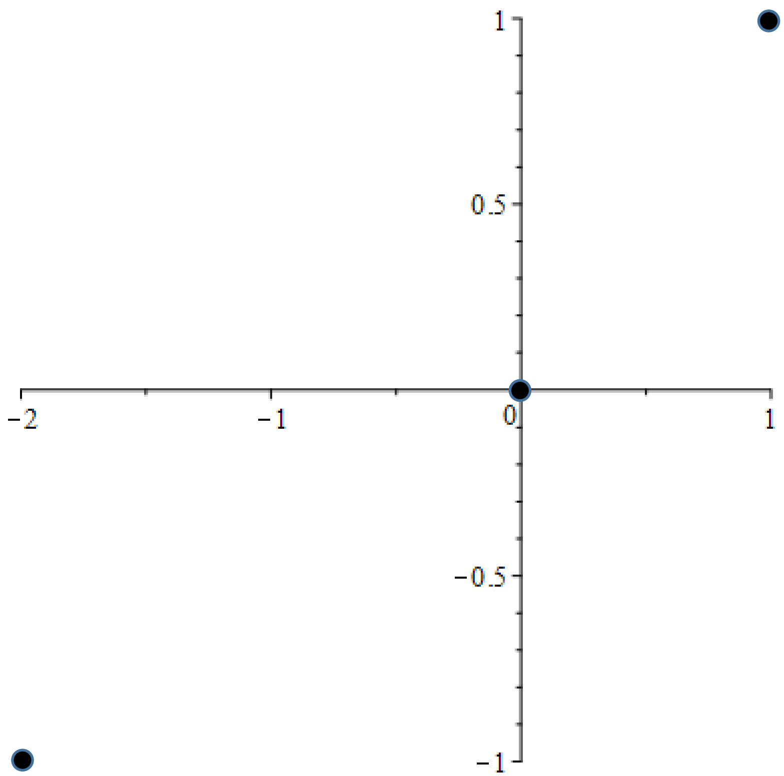
For reflection about the *x*-axis, the non-zero *y*-coordinates change, but the *x*-coordinates remain the same.

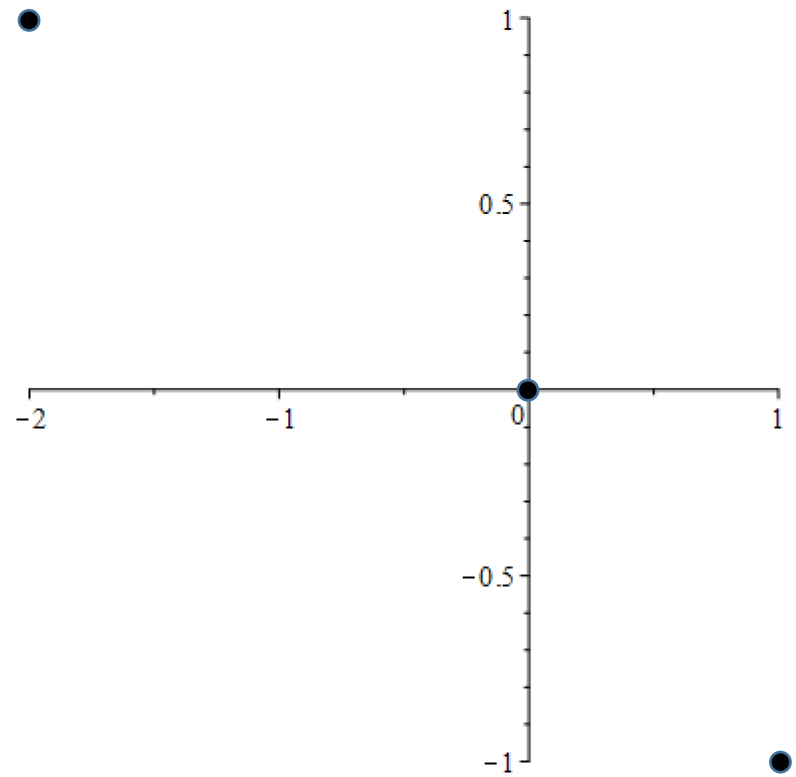




$$f=\{(0,0),(1,1),(-2,-1)\}$$

$$g(x)=-f(x),\ g=\{(0,\square),(1,\square),(-2,\square)\}$$





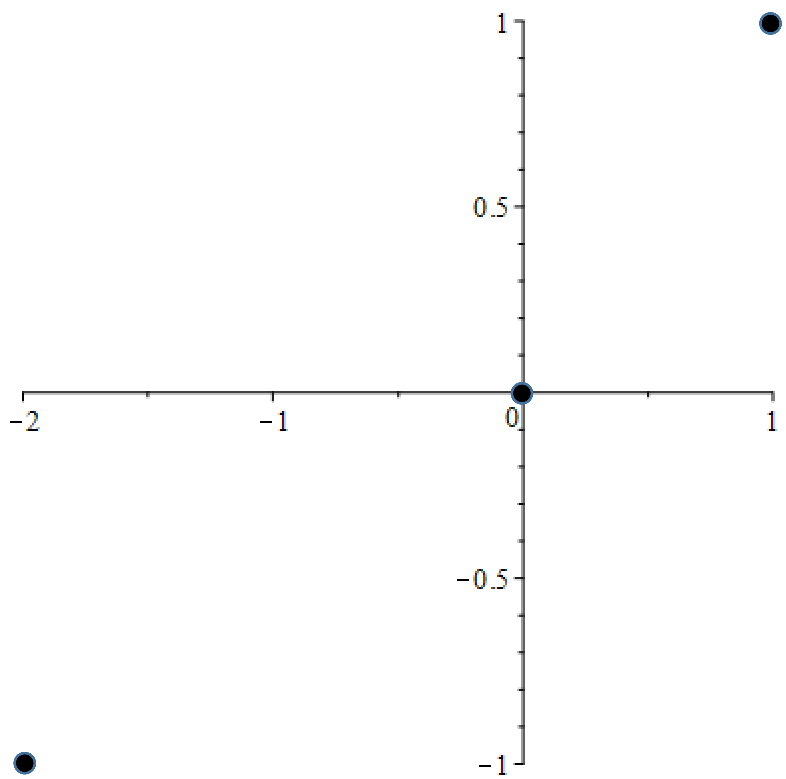
Reflection about the y-axis:

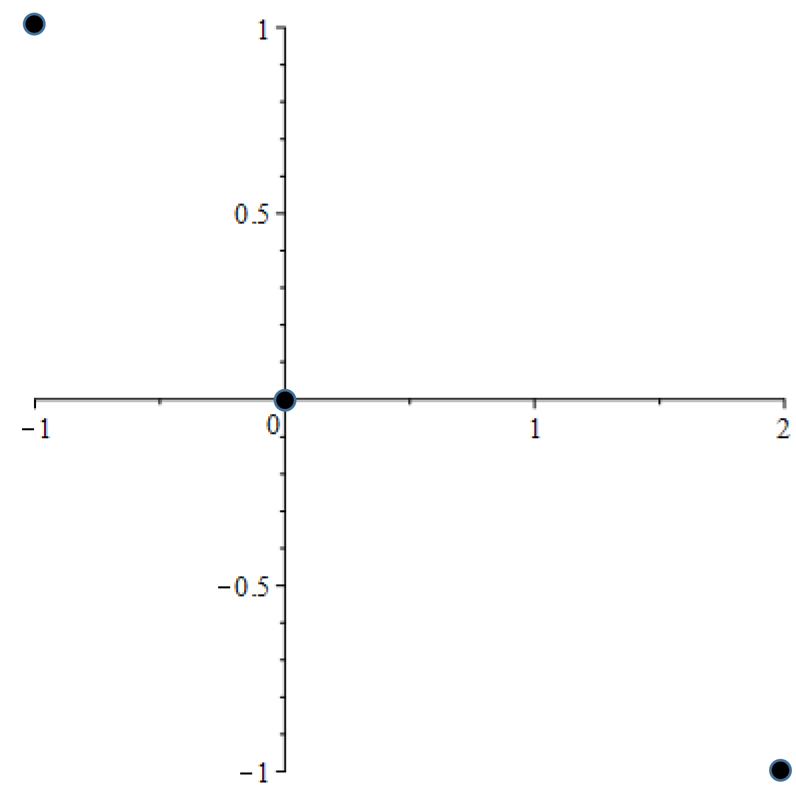
The graph of $g(x) = f(-x)$ is the graph of $f(x)$ reflected about the *y*-axis.

For reflection about the *y*-axis, the non-zero *x*-coordinates change, but the *y*-coordinates remain the same.

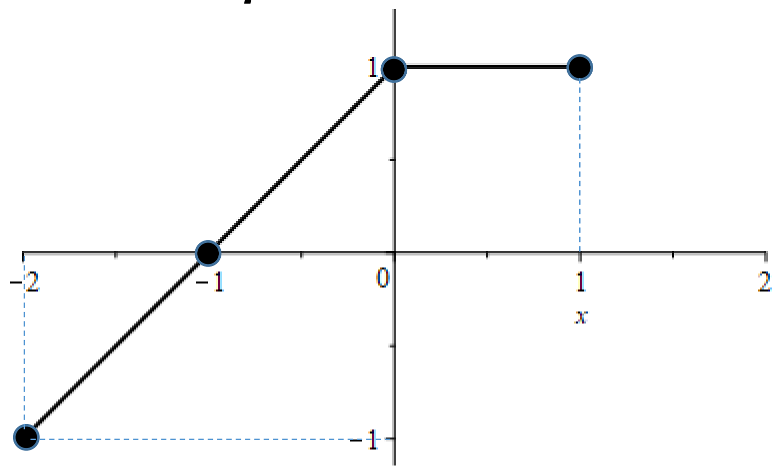
$f = \{(0,0),(1,1),(-2,-1)\}$

$g(x) = f(-x),\ g = \{(\boxed{},0),(\boxed{},1),(\boxed{},-1)\}$



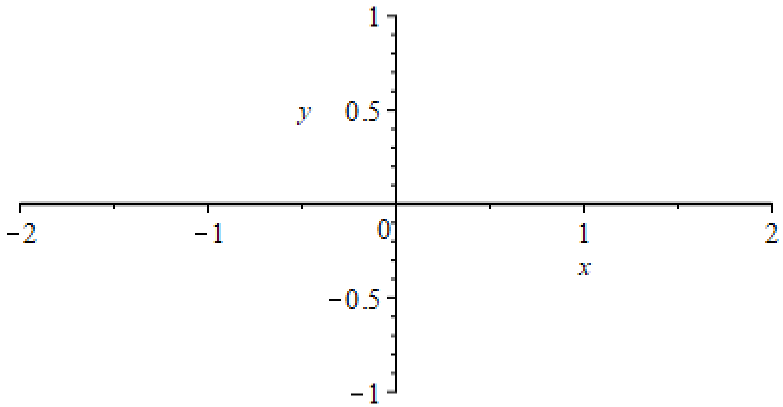


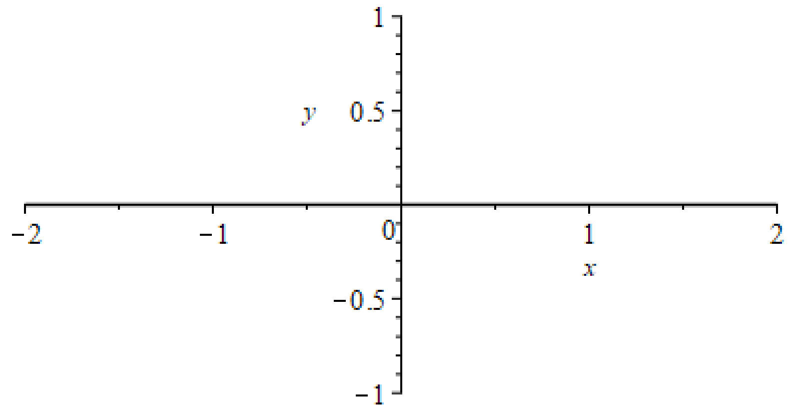
f



$g(x) = -f(x)$

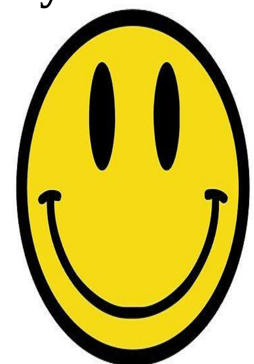
$h(x) = f(-x)$



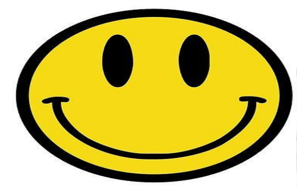


<u>Vertical Stretch/Compress:</u>

For $c > 1$**, the graph of** $g(x) = cf(x)$ **is the graph of** $f(x)$ ***<u>stretched</u>*** **away from the *x*-axis by a factor of *c*.**

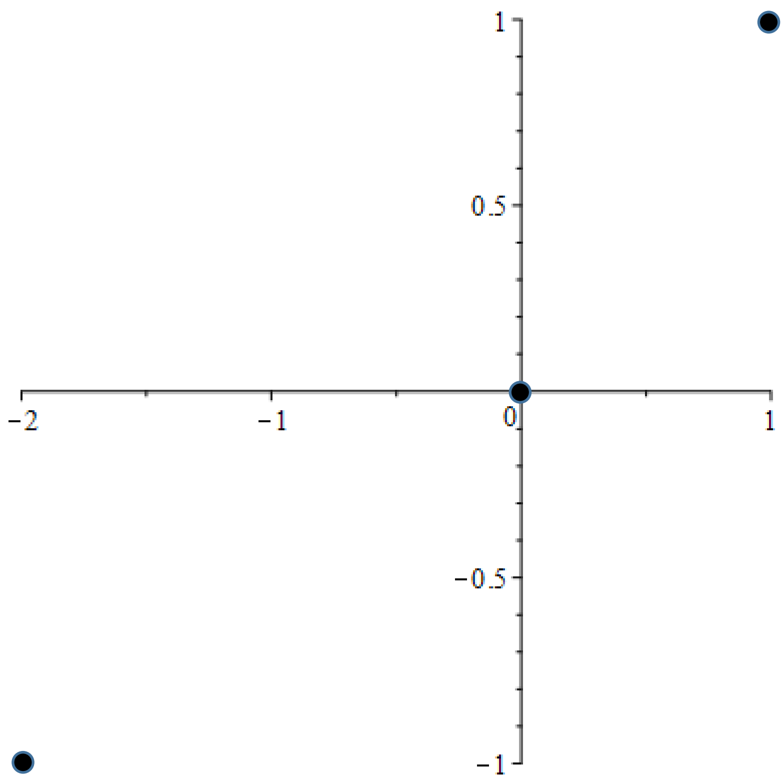


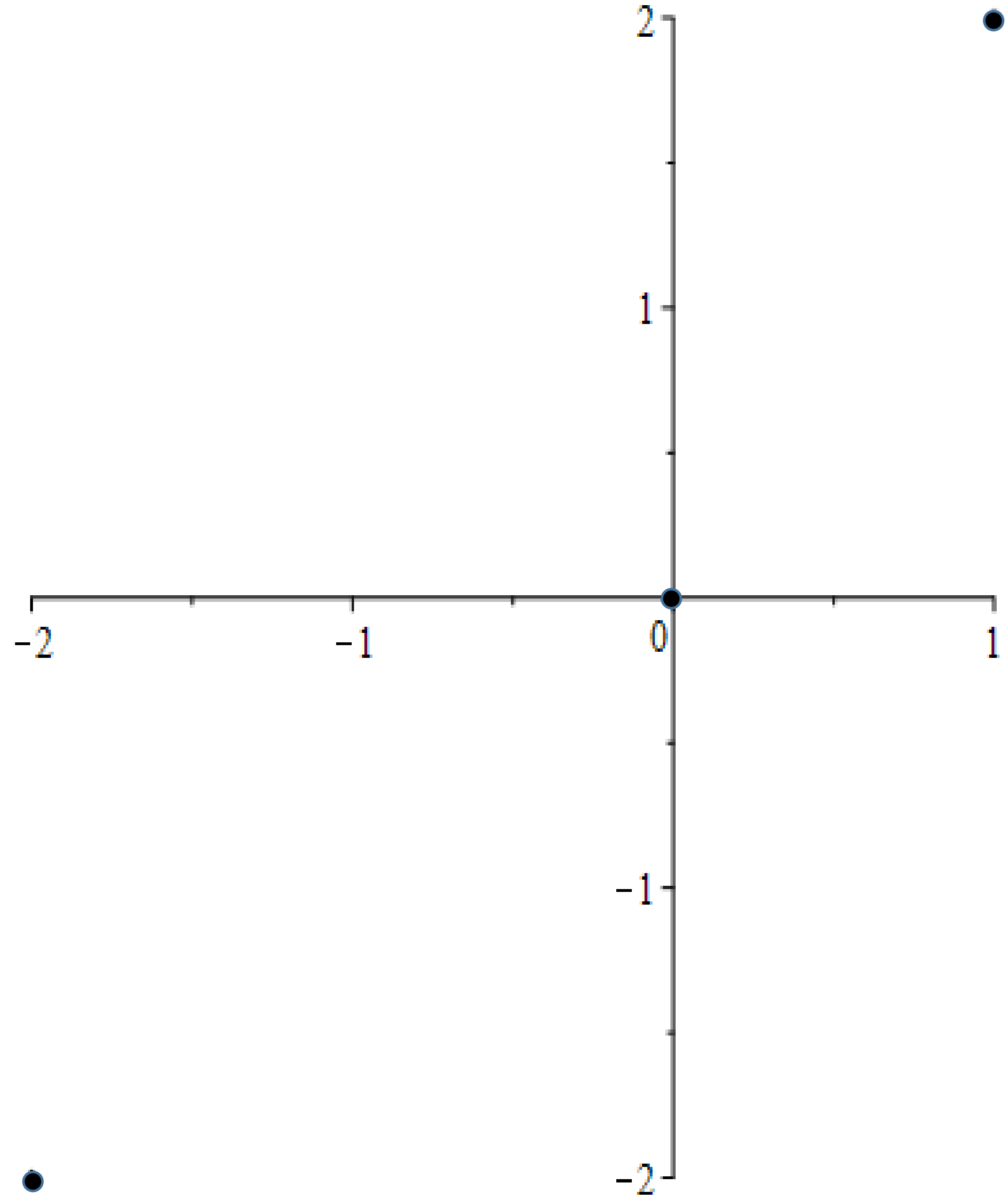
For $0 < c < 1$**, the graph of** $g(x) = cf(x)$ **is the graph of** $f(x)$ ***<u>compressed</u>*** **toward the *x*-axis by a factor of *c*.**



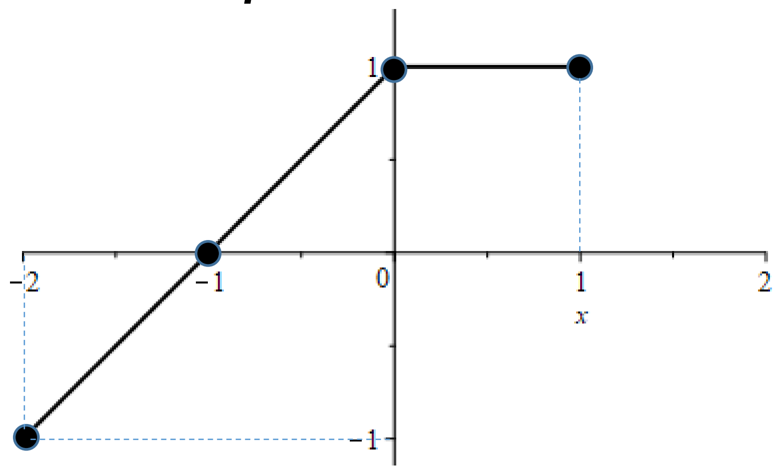
For a vertical stretch/compress, the non-zero *y*-coordinates change, but the *x*-coordinates remain the same.

$f=\{(0,0),(1,1),(-2,-1)\}$ $\qquad$ $g(x)=2f(x),\ g=\{(0,\square),(1,\square),(-2,\square)\}$

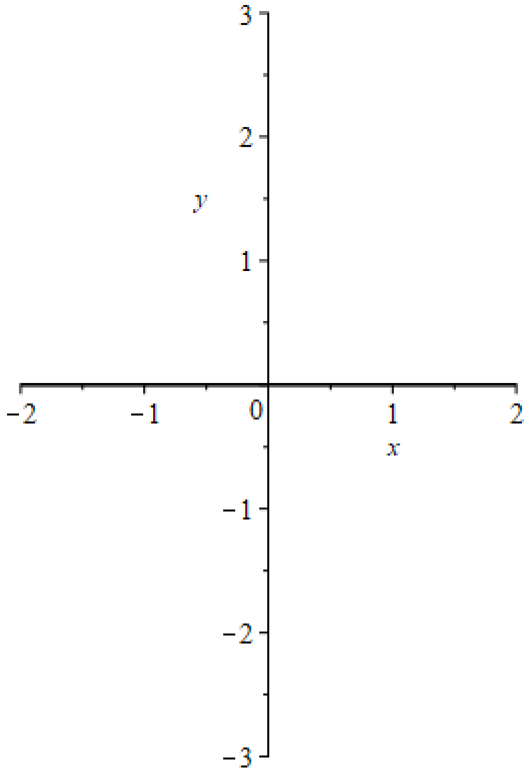




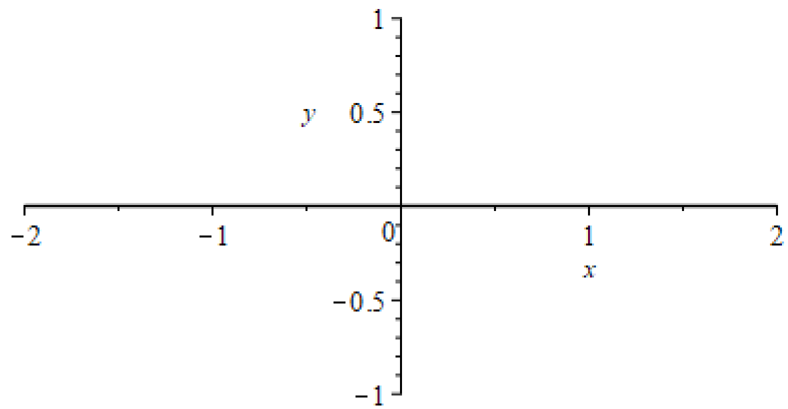
f



$g(x) = 3f(x)$

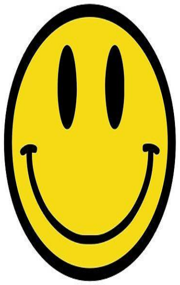


$h(x) = \frac{1}{2} f(x)$

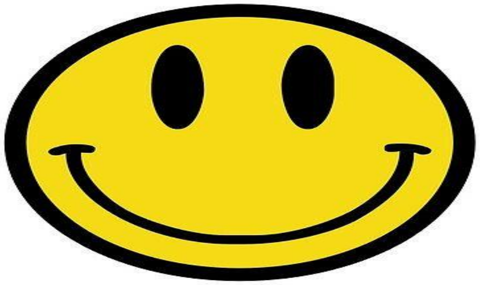


Horizontal Stretch/Compress:

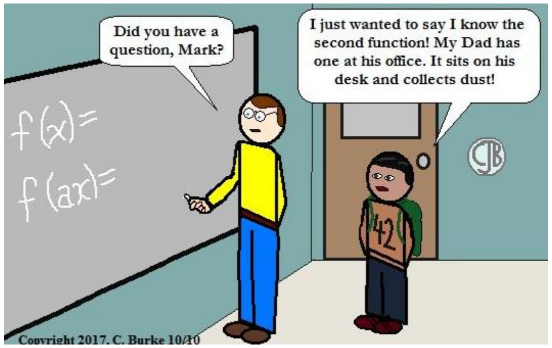
For $c > 1$, the graph of $g(x) = f(cx)$ is the graph of $f(x)$ *compressed* toward the *y*-axis by a factor of $\frac{1}{c}$.



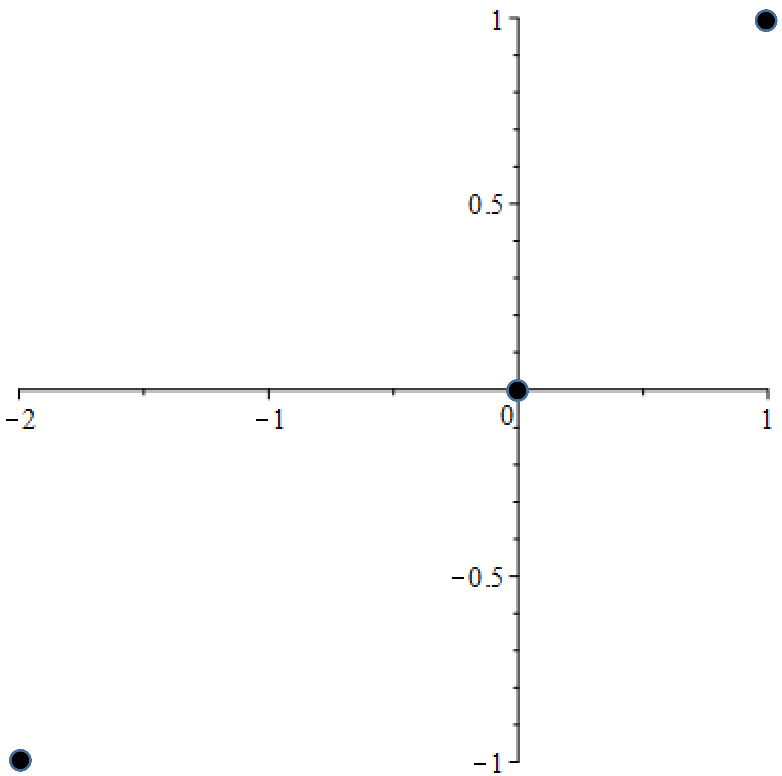
For $0 < c < 1$, the graph of $g(x) = f(cx)$ is the graph of $f(x)$ *stretched* away from the *y*-axis by a factor of $\frac{1}{c}$.

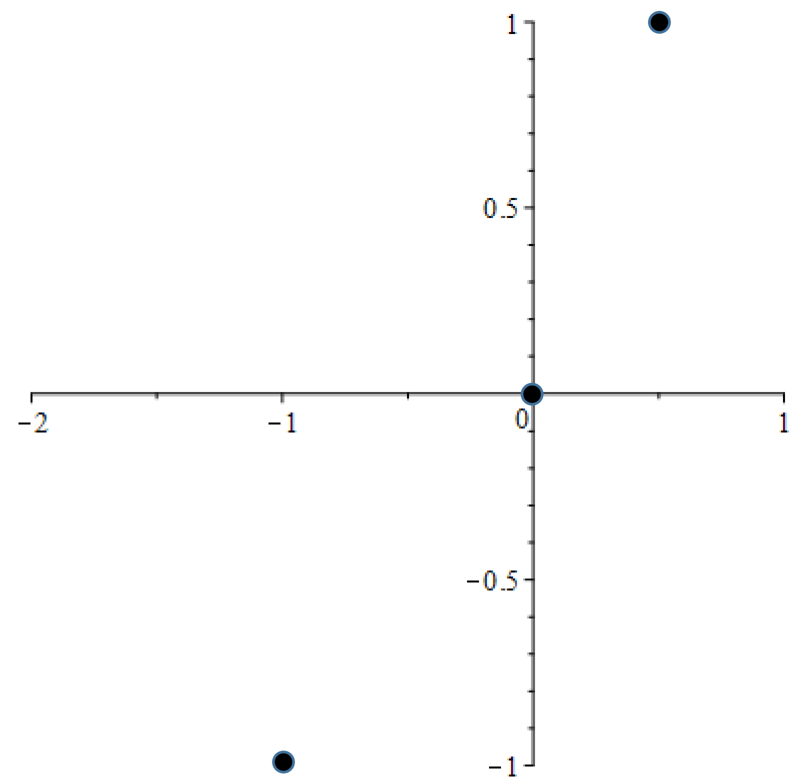


For a horizontal stretch/compress, the non-zero *x*-coordinates change, but the *y*-coordinates remain the same.

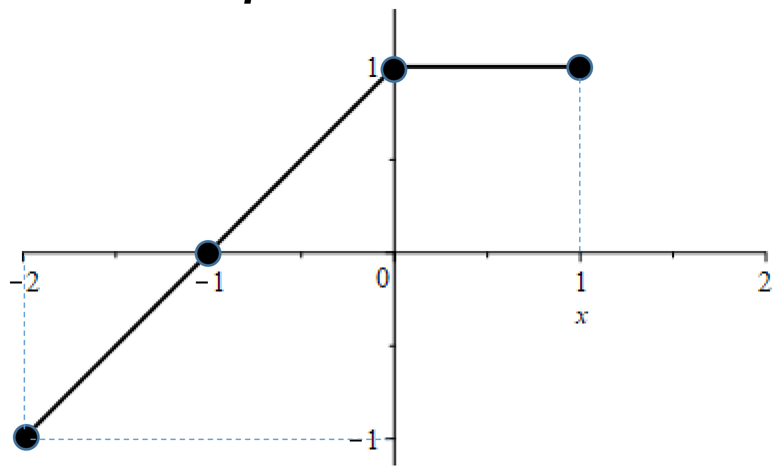


$f = \{(0,0),(1,1),(-2,-1)\}$ $g(x) = f(2x),\ g = \{(\square,0),(\square,1),(\square,-1)\}$

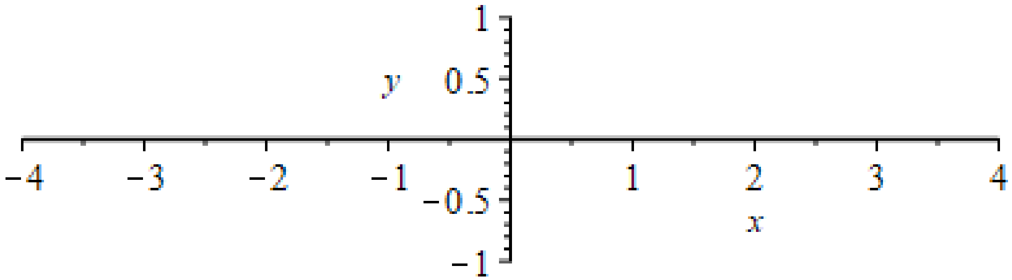




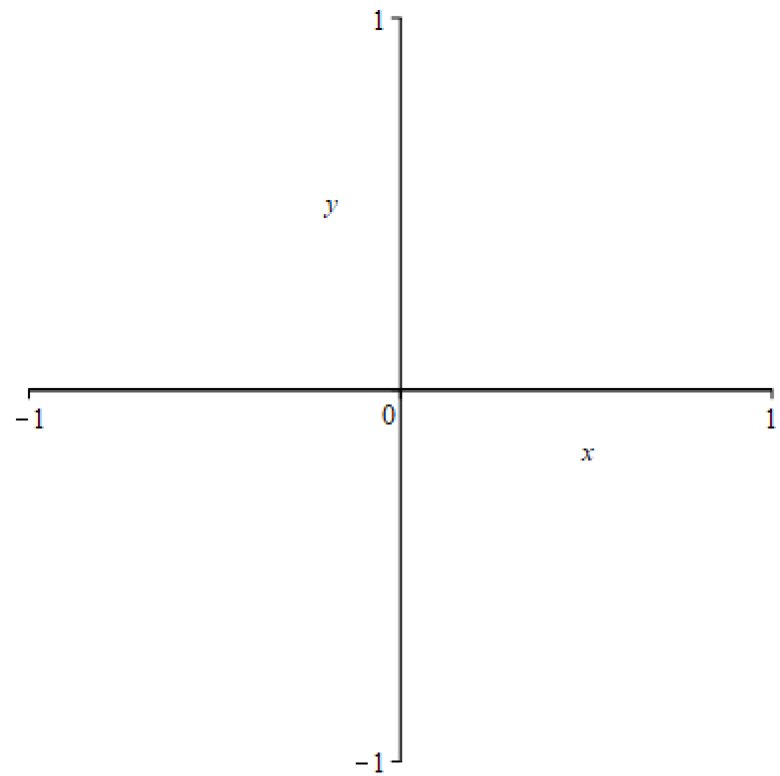
f



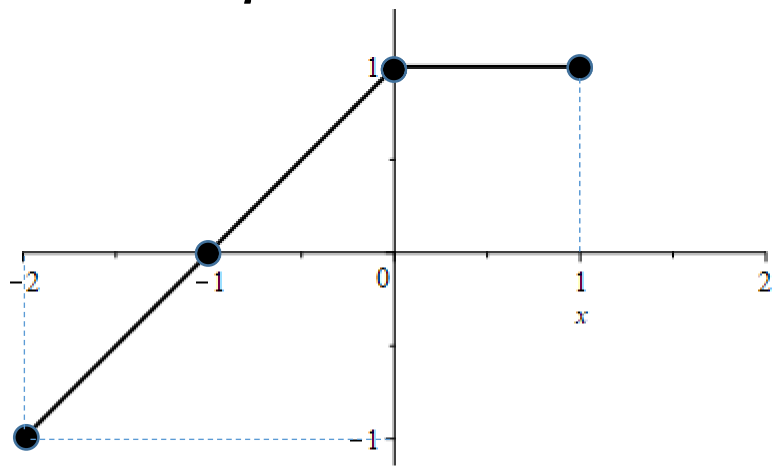
$g(x) = f\left(\frac{1}{2}x\right)$



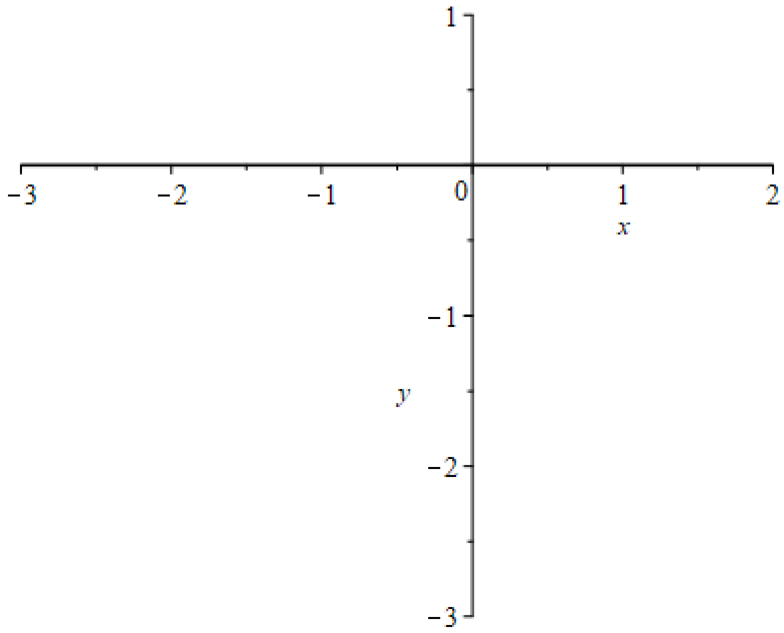
$h(x) = f(3x)$



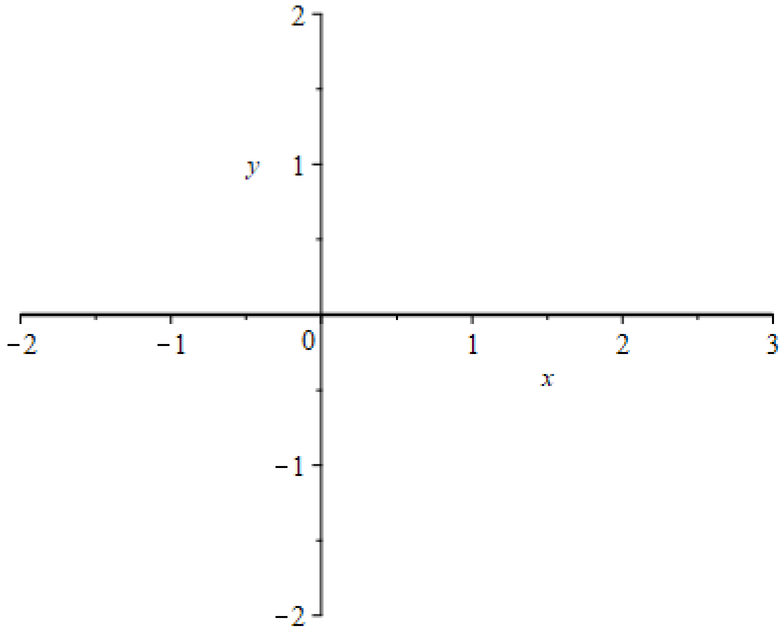
f



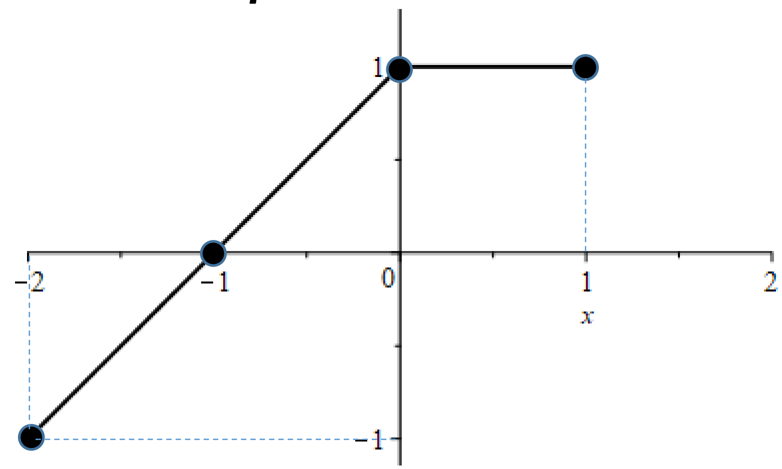
$g(x) = f(x+1) - 2$



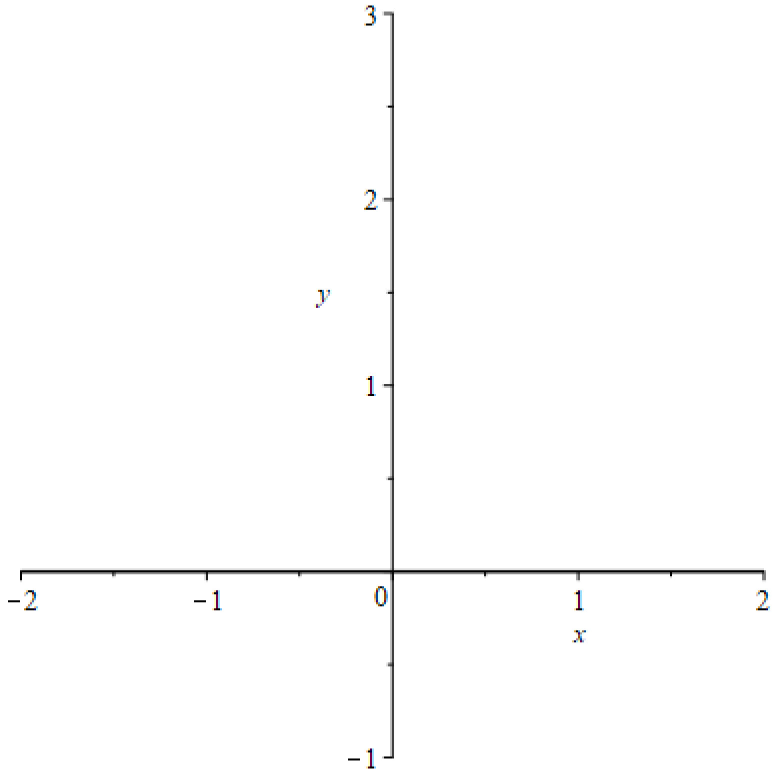
$h(x) = 2f(x-1)$



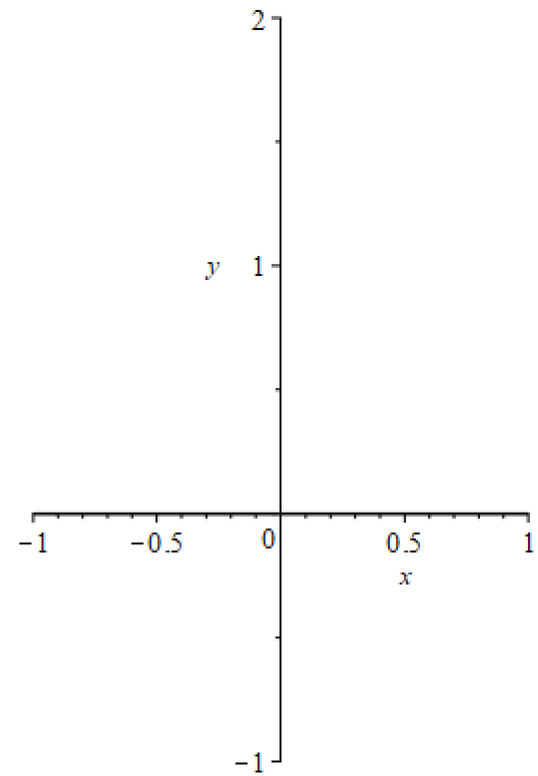
f

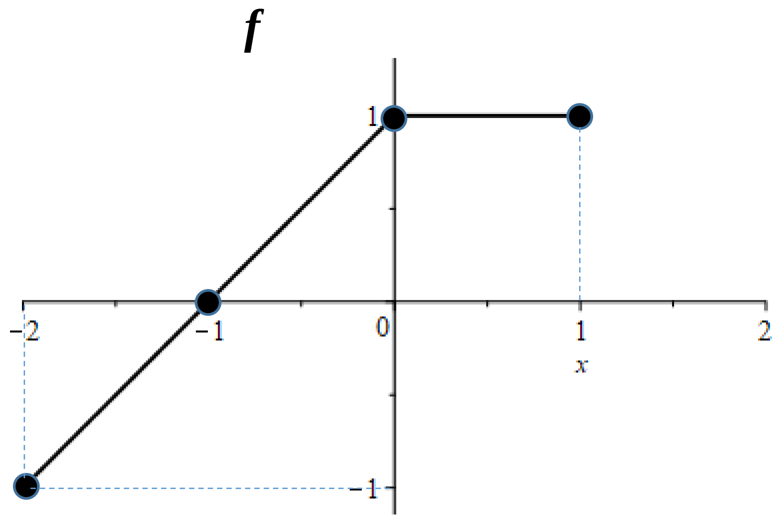


$g(x) = f(-x) + 2$

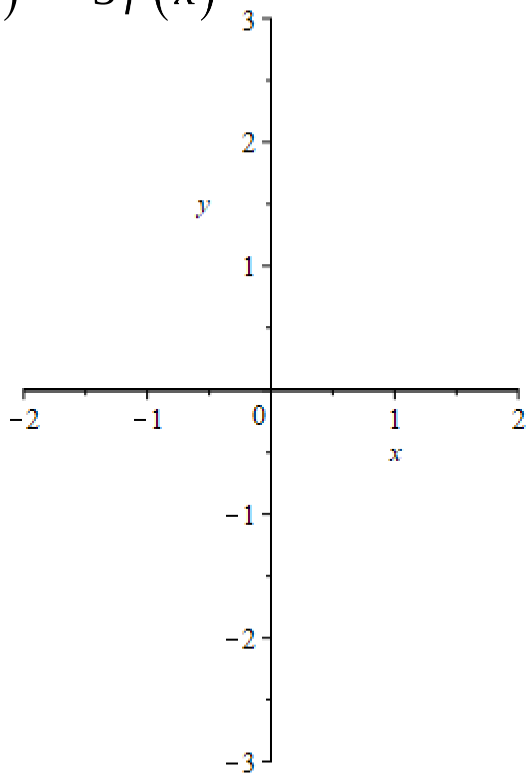


$h(x) = f(2x) + 1$

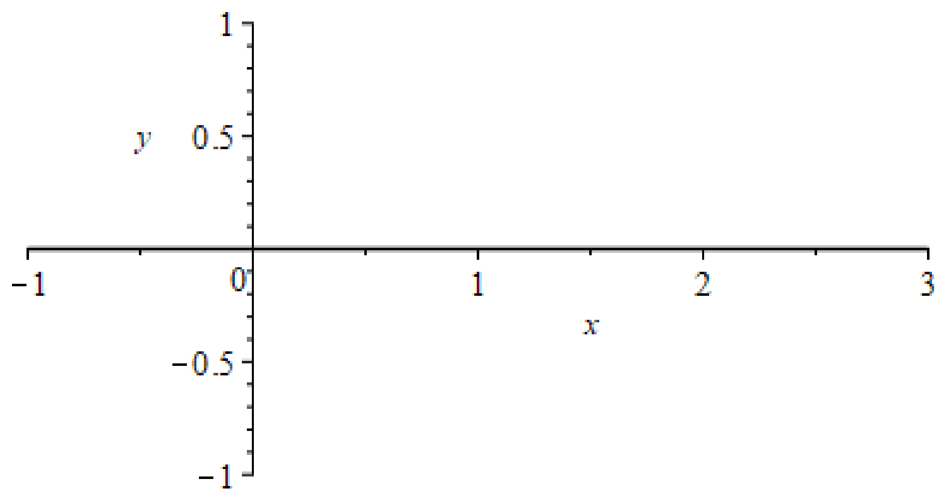


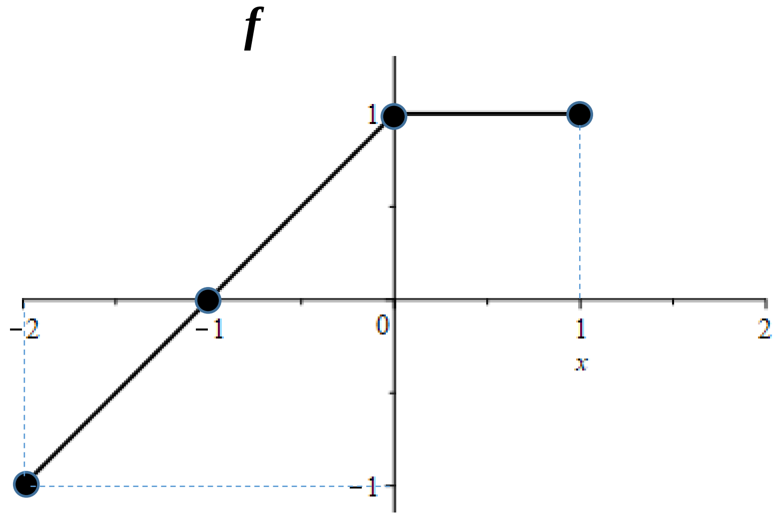


$g(x) = -3f(x)$

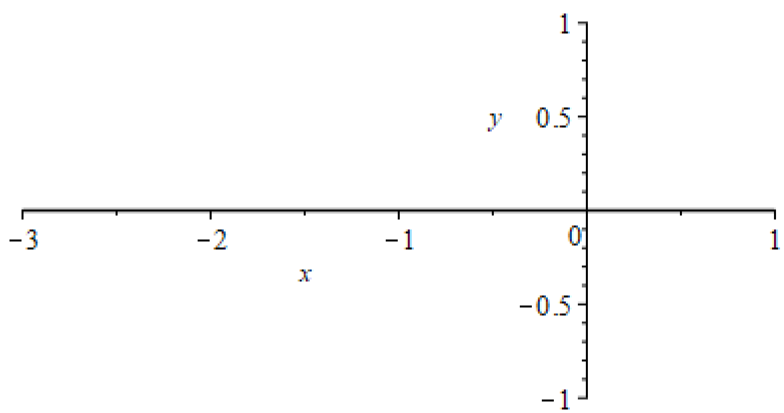


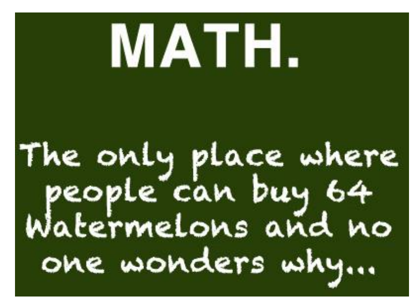
$h(x) = f(1-x)$




f
1
−2
−1
0
1
2
x
−1

$$g(x) = f(2x+4)$$


1
y
0.5
−3
−2
−1
0
1
x
−0.5
−1


MATH.
The only place where people can buy 64 Watermelons and no one wonders why...