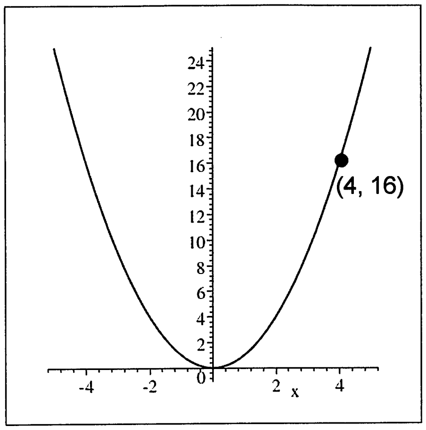
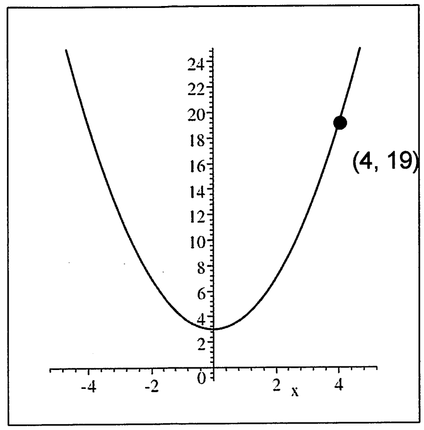
Shifting

$$f(x) = x^2 \qquad f_1(x) = x^2 + 3$$

x	*f*(*x*)
0	0
1 or -1	1
2 or -2	4
3 or -3	9
4 or -4	16

x	*f*(*x*) + 3
0	3
1 or -1	4
2 or -2	7
3 or -3	12
4 or -4	19





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

$$f_1(x) = x^2 + 3$$

Vertical Shifting

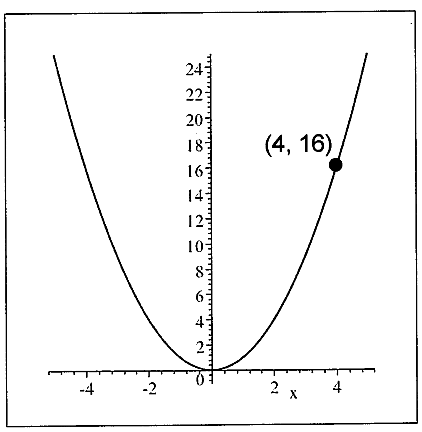
- If *c* is positive, then a graph of *y* = *f(x)* + *c* will be shifted *c* units vertically upward.
- If *c* is positive, then a graph of *y* = *f(x)* – *c* will be shifted *c* units vertically downward.

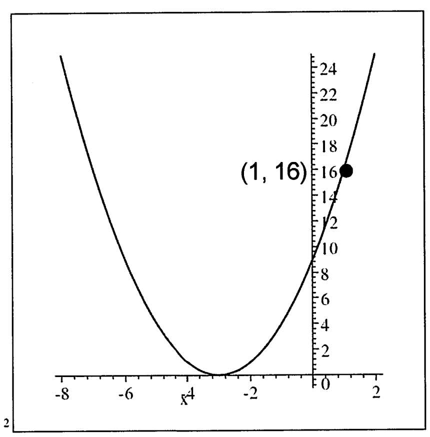
$f(x) = x^2$

x	f(x)
0	0
1 or -1	1
2 or -2	4
3 or -3	9
4 or -4	16

$f_2(x) = (x+3)^2$

x	f(x)
-3	0
-4 or -2	1
-5 or -1	4
-6 or 0	9
- 7 or 1	16





$f(x) = x^2$

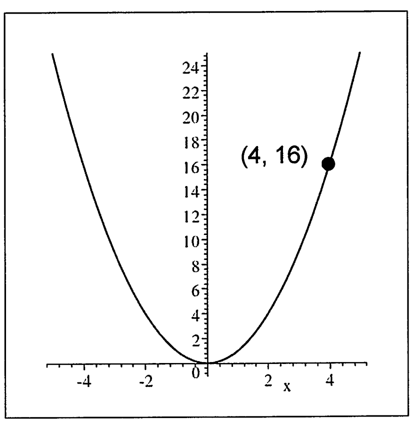
$f_2(x) = (x+3)^2$

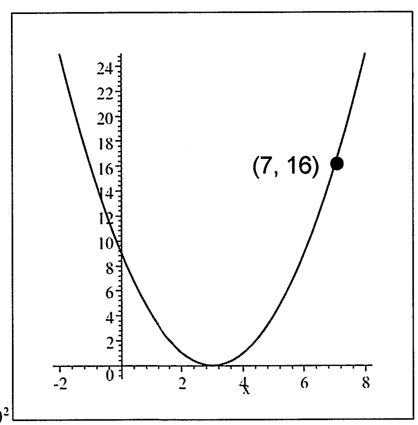
$f(x) = x^2$

x	f(x)
0	0
1 or -1	1
2 or -2	4
3 or -3	9
4 or -4	16

$f_3(x) = (x-3)^2$

x	f(x)
3	0
2 or 4	1
1 or 5	4
0 or 6	9
-1 or 7	16





$f(x) = x^2$

$f_3(x) = (x-3)^2$

Horizontal Shifting

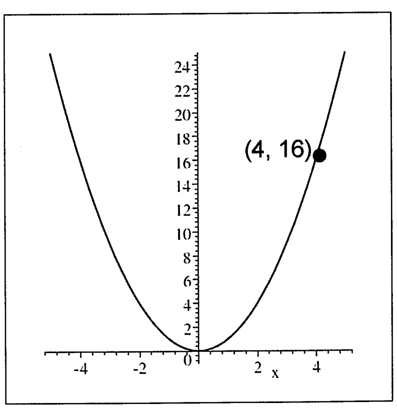
- If c > 0, the graph of $y = f(x - c)$ will be shifted horizontally c units **right** from the graph of $y = f(x)$.
- If $c > 0$, the graph of $y = f(x + c)$ will be shifted horizontally c units **left** from the graph of $y = f(x)$.

REFLECTIONS

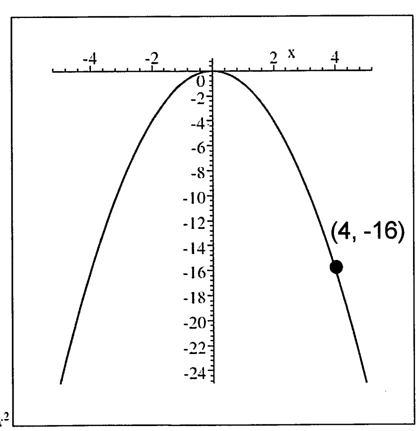
$f(x) = x^2$ $f_4(x) = -x^2$

x	f(x)
0	0
1 or -1	1
2 or -2	4
3 or -3	9
4 or -4	16

x	f(x)
0	0
1 or -1	-1
2 or -2	-4
3 or -3	-9
4 or -4	-16



$$f_4(x) = -x^2$$



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

Vertical Reflection

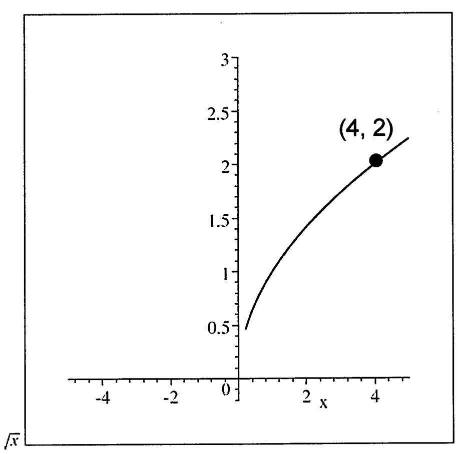
- The graph of *y* = *-f(x)* will be reflected vertically over the *x*-axis from *y* = *f(x)*.

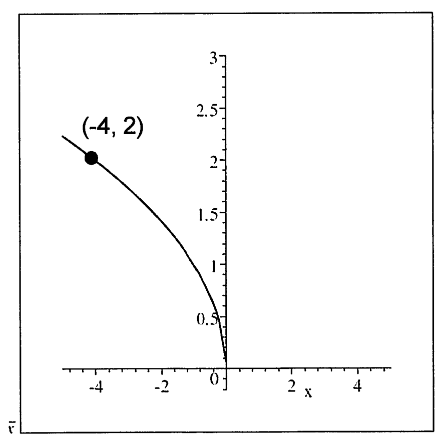
$$g(x) = \sqrt{x}$$

x	f(x)
0	0
1	1
4	2
9	3
16	4

$$g_1(x) = \sqrt{-x}$$

x	f(x)
0	0
-1	1
-4	2
-9	3
-16	4





$$g(x) = \sqrt{x} \qquad g_1(x) = \sqrt{-x}$$

Horizontal Reflection

- The graph of $y = f(-x)$ would be reflected horizontally about the y-axis from $y = f(x)$.

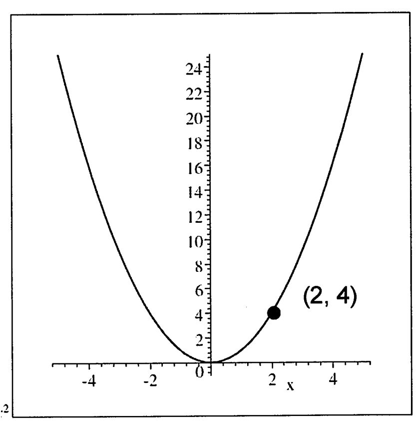
STRETCHING/COMPRESSING

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

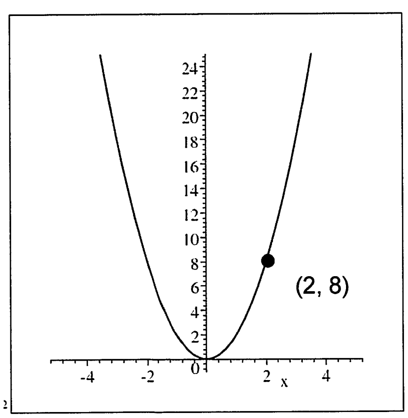
x	f(x)
0	0
1 or -1	1
2 or -2	4
3 or -3	9
4 or -4	16

$$f_5(x) = 2x^2$$

x	f(x)
0	0
1 or -1	2
2 or -2	8
3 or -3	18
4 or -4	32



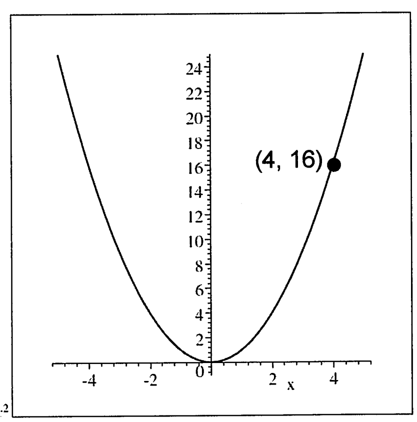
$$f(x) = x^2$$

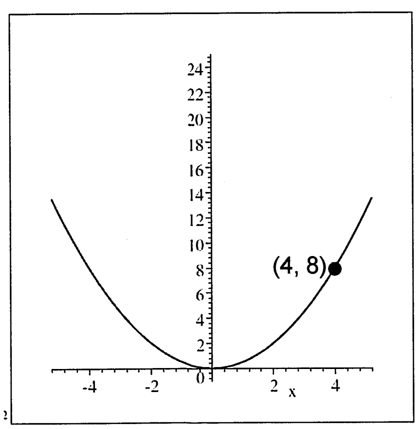


$$f_5(x) = 2x^2$$

$$f_6(x) = \frac{1}{2}x^2$$

x	f(x)
0	0
1 or -1	½
2 or -2	2
3 or -3	9/2
4 or -4	8





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

$$f_6(x) = \frac{1}{2}x^2$$

Vertical Stretch or Compression

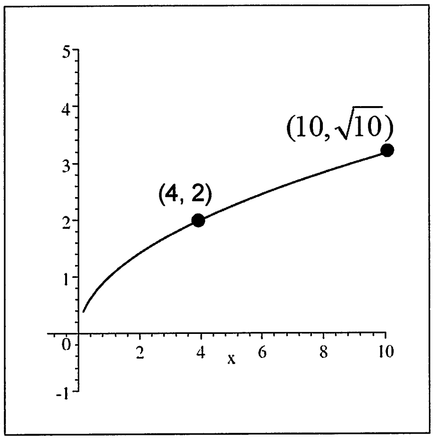
- If c > 1, the graph of *y = c f(x)* will be stretched vertically by a factor of *c* from the graph of *y = f(x).*
- If *0 < c < 1,* the graph of *y = c f(x)* will be compressed vertically by a factor of *c* from the graph of *y = f(x).*

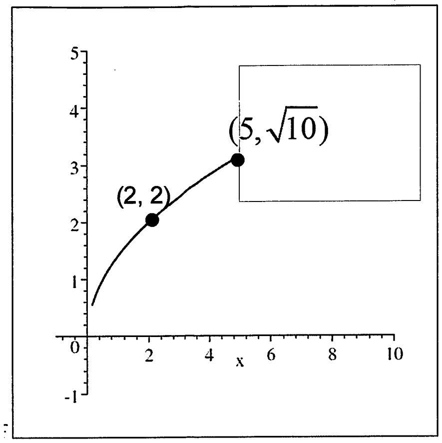
x	f(x)
0	0
1	1
4	2
9	3
16	4

x	f(x)
0	0
½	1
2	2
9/2	3
8	4

$$g(x) = \sqrt{x}$$

$$g_2(x) = \sqrt{2x}$$





$g(x) = \sqrt{x}$

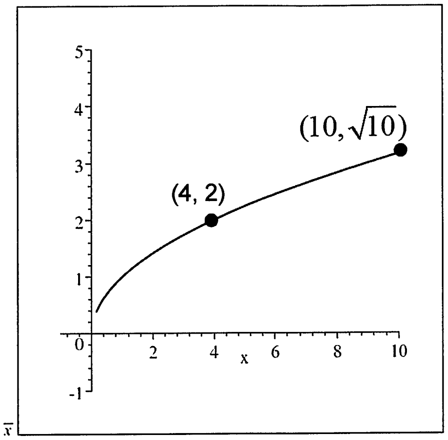
$g_2(x) = \sqrt{2x}$

x	f(x)
0	0
1	1
4	2
9	3
16	4

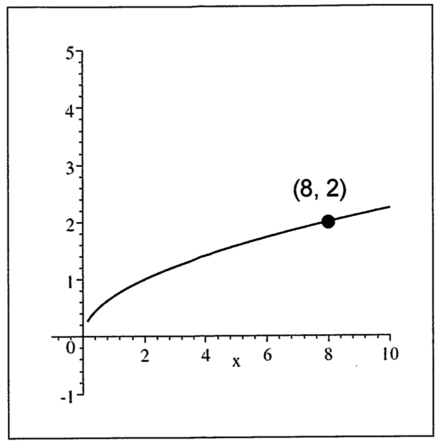
x	f(x)
0	0
2	1
8	2
18	3
32	4

$g(x) = \sqrt{x}$

$g_3(x) = \sqrt{\frac{1}{2}x}$



$$g(x) = \sqrt{x}$$



$$g_3(x) = \sqrt{\frac{1}{2}x}$$

Horizontal Stretch or Compression

- If $c > 1$, the graph of $y = f(cx)$ will be horizontally **compressed** by a factor of $1/c$ from the graph of $f(x)$.
- If $0 < 1/c < 1$, the graph of $y = f((1/c)x)$ will be horizontally **stretched** by a factor of c from the graph of $f(x)$.