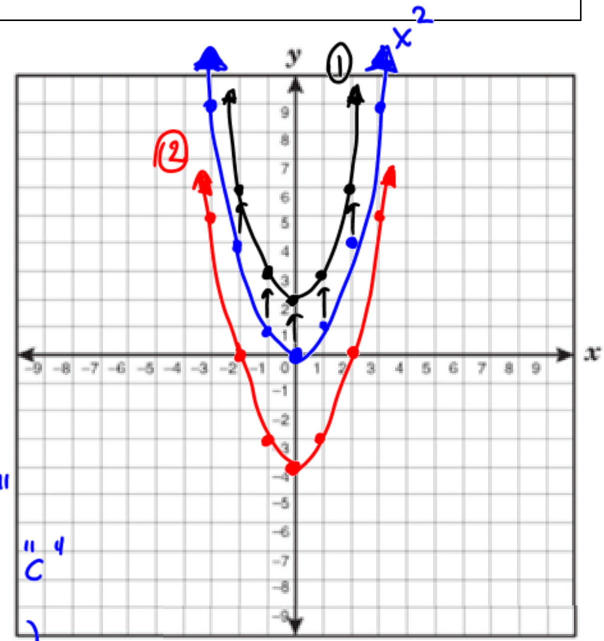
In this activity you will discover the graphical connection between $y = f(x)$ and the functions of the form:

- $y = f(x) + c$, c is a constant
- $y = f(x - d)$, d is a constant
- $y = af(x), a$ is a constant and a > 0
- $y = f(kx), k$ is a constant and k > 0
- $y = -f(x)$
- $y = f(-x)$

Investigation: Type $y = f(x) + c$



1. a. Sketch the graph of $f(x) = x^2$
   b. On the same set of axes sketch the graphs of
   1 • $y = x^2 + 2$
   2 • $y = x^2 - 3$

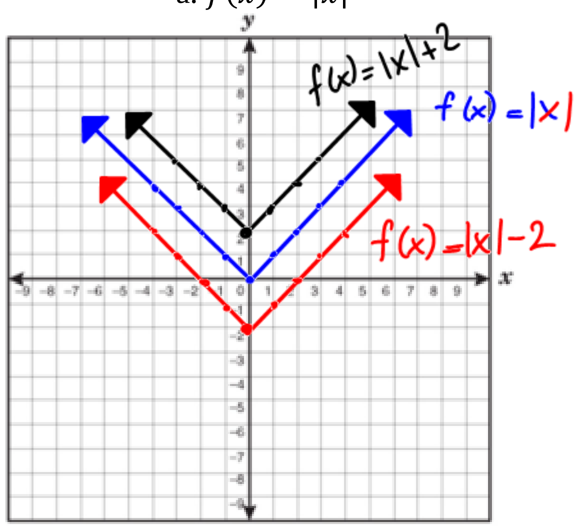
   c. If $y = f(x)$ is transformed to $y = f(x) + c$, where c is a constant, describe the transformation:
   - if c > 0, then graph shifts up as much as "c"
   - if c < 0, then graph shifts down as much as "c"
   - Any point (x, y) under this transformation becomes (x, y+c)

Notice than only "y" changes, b/c it's a vertical shift

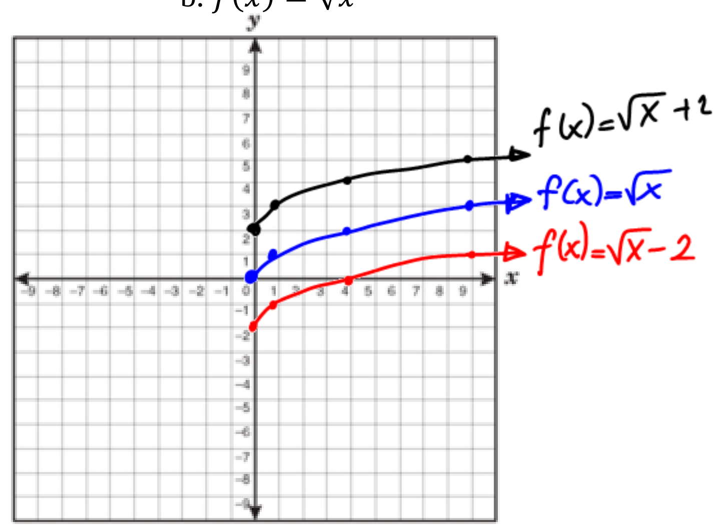
2. Using the pattern you discovered in 1c, sketch $y = f(x), y = f(x) + 2, and\ y = f(x) - 2$on the same set of axes for each of the following functions:

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

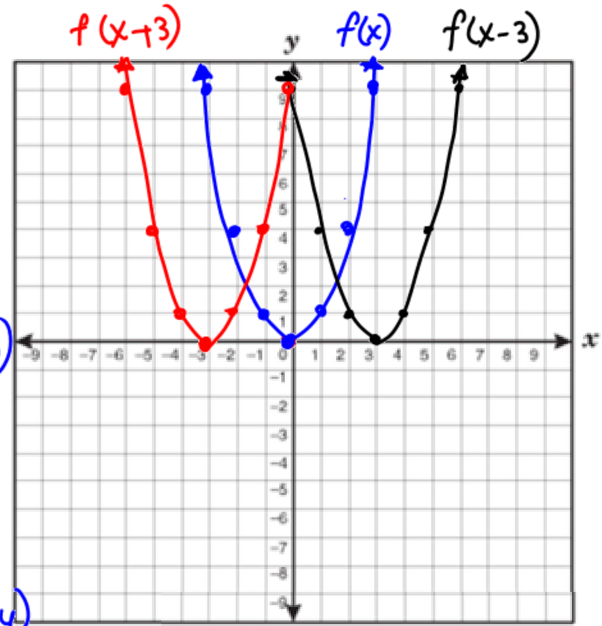
a. $f(x) = |x|$



b. $f(x) = \sqrt{x}$



Investigation: Type $y = f(x - d)$



1. a. Sketch the graph of $f(x) = x^2$
   b. On the same set of axes sketch the graphs of
   - $y = (x - 3)^2$ → vertex $(3,0)$ → $d = {}^{+}3$
   - $y = (x + 3)^2$ → vertex $(-3,0)$ $d = {}^{-}3$

Recall $y = a(x-h)^2 + k$ Vertex is (h, k)
when "+3" subbed $(x-3)$, "-3" subbed $(x+3)$

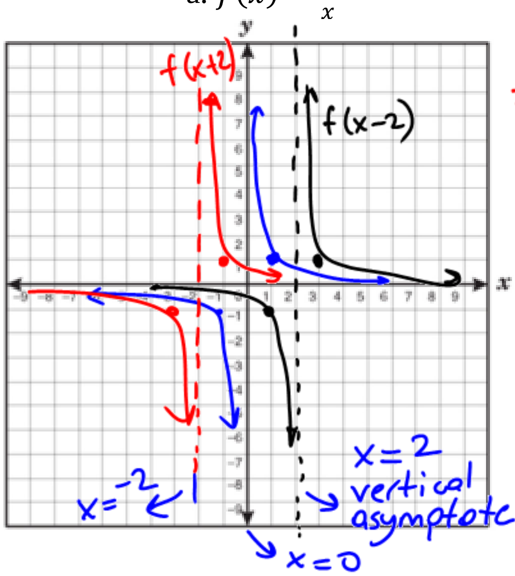
   c. If $y = f(x)$ is transformed to $y = f(x - d)$, where d is a constant, describe the transformation:
   - if d > 0, then graph shifts right "d" units
   - if d < 0, then graph shifts left "d" units
   - Any point (x, y) under this transformation becomes $(x+d, y)$

This is a horizontal shift; therefore only "x" coordinate changes.

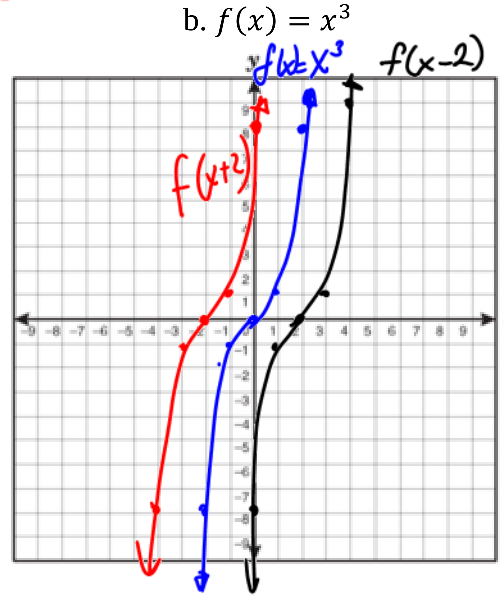
2. Using the pattern you discovered in 1c, sketch $y = f(x), y = f(x - 2), and\ y = f(x + 2)$ on the same set of axes for each of the following functions:

a. $f(x) = \frac{1}{x}$ $f(x-2) = \frac{1}{x-2}$ → $x \neq 2$

$f(x+2) = \frac{1}{x+2}$ → $x \neq {}^{-}2$



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

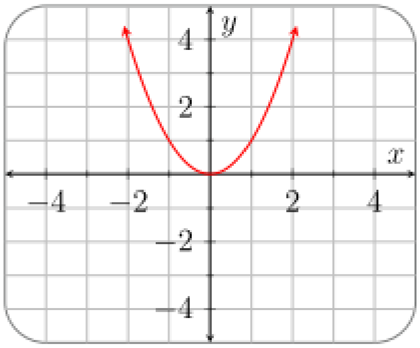


COMMUNICATION
When a function is translated, we use key words such as translate (shift), units, up or down.
For example, $y = (x - 2)^2 + 1$ the parent function has been shifted 2 units right and 1 unit up.

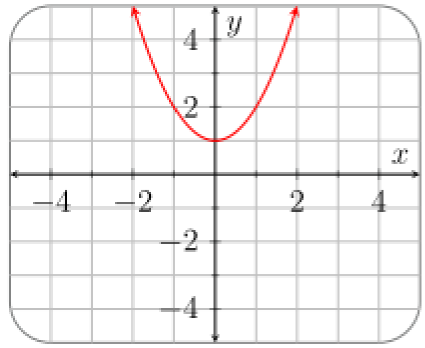
Try. State the transformations for: $y = (x + 3)^2 - 2$
The parent function has been shifted 3 units left and 2 units down

Horizontal & Vertical Translation Practice

1. Each of the following graphs show a shift of the function f that has formula $f(x) = x^2$. Describe the shifts involved to obtain the function g.



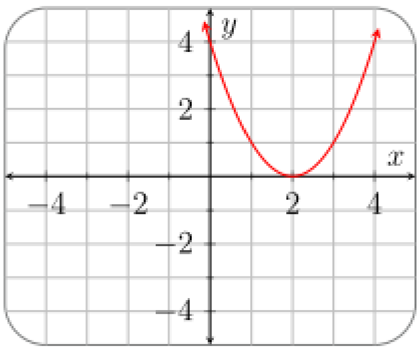
(a) $f(x) = x^2$



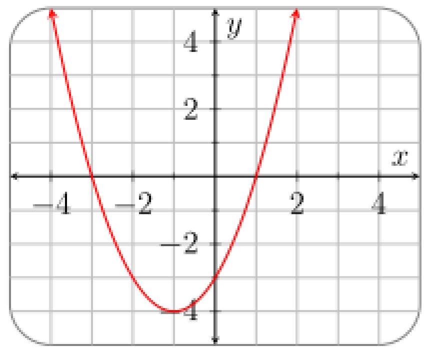
(b) $g(x) = x^2 + 1$

shifted 1 unit up

shifted 2 units right

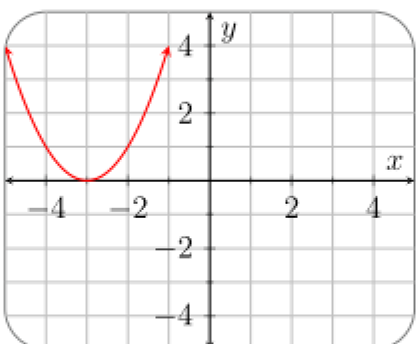


(c) $g(x) = (x - 2)^2$

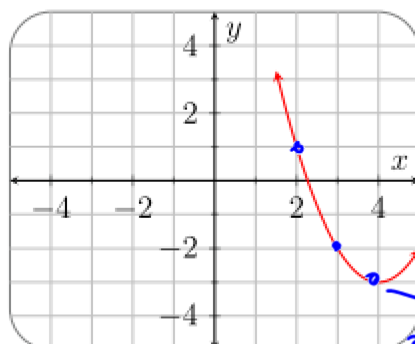


(d) $g(x) = (x + 1)^2 - 4$

shifted 1 unit left and 4 units down.

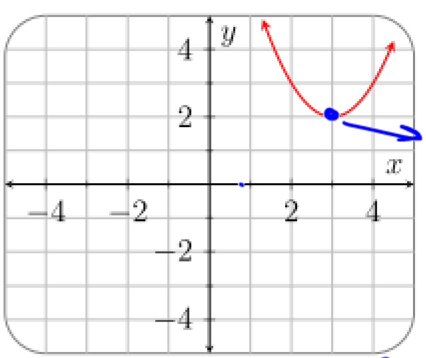


(e) $g(x) = (x+3)^2$



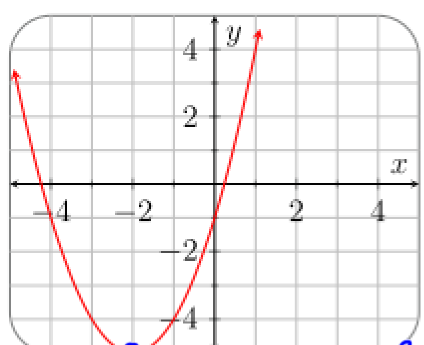
vertex (4,-3)

(f) $g(x) = (x-4)^2-3)$



(3,2)

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



(-2,-4)

(h) $g(x) = (x+2)^2-4$

Figure 1: Shifts of $f(x) = x^2$.

2. Consider the graph of f given in **Figures 2 to 7.** For the shifts given underneath the figures, **state** if they represent a horizontal or a vertical shift, and then sketch this shift on the axis provided.

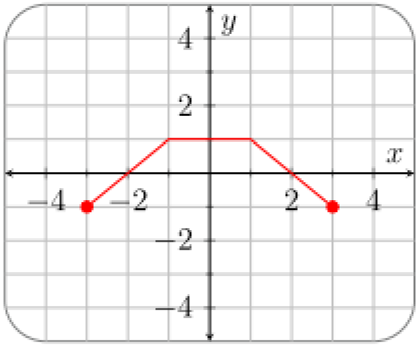


Figure 2: $f(x)$

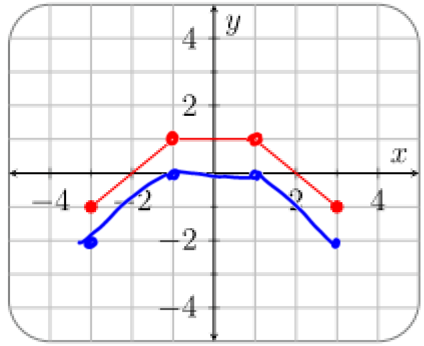


Figure 3: $f(x)-1$

vertical shift 1 dwn

horizontal 2 right

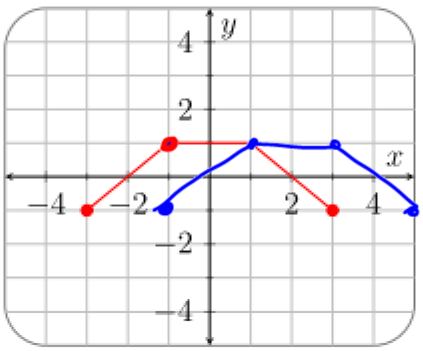


Figure 4: $f(x-2)$

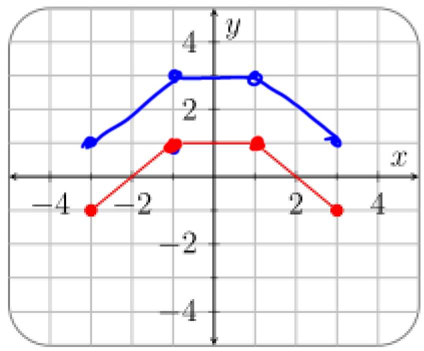


Figure 5: $f(x)+2$

vertical 2 up

horizontal 3 left

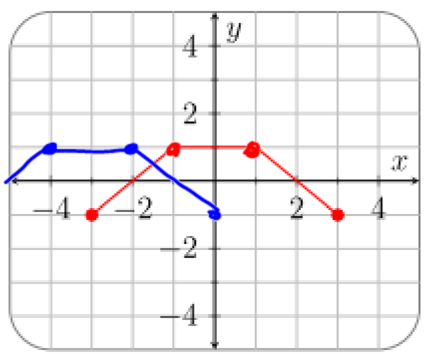


Figure 6: $f(x+3)$

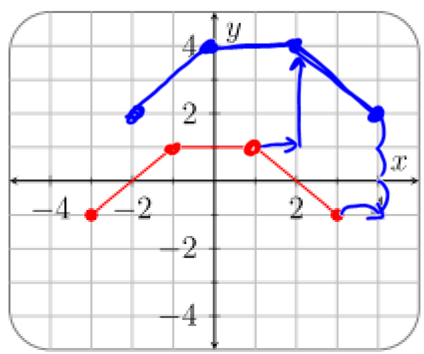


Figure 7: $f(x-1)+3$

1 right 3 up

SUMMARY

In general, if f is a function and c is constant, then the graph of

$y=f(x)+c$ is the graph of $y=f(x)$ shifted - **vertically** upwards if c > 0 - **vertically** downwards if c < 0. *This is called an OUTSIDE CHANGE*	$y=f(x-h)$is the graph of $y=f(x)$ shifted - **horizontally** to the left if h > 0 - **horizontally** to the right if h < 0 *This is called an INSIDE CHANGE*