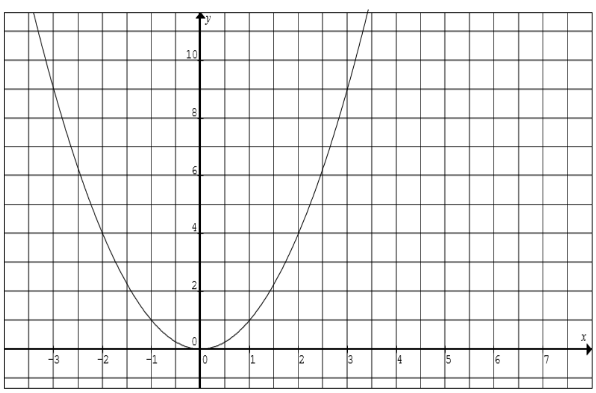
Precalculus 11 — Sec 3.1 – Quadratic Functions in Standard Form (Part 2)

As we continue, the 'p' value in $y=(x-p)^2$ has one function only:

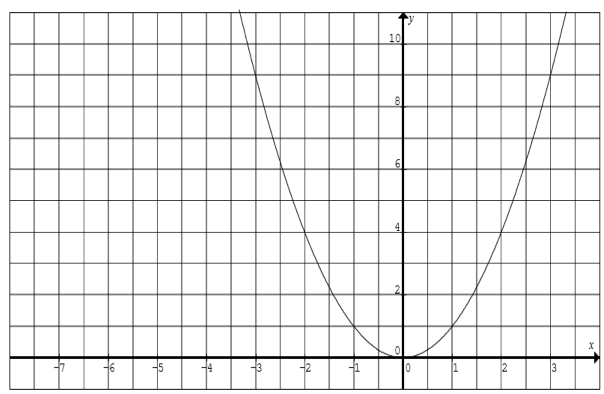
- It determines how the graph will shift horizontally, ie, shift left or right
    - If $p=(+)ve$, ie, $y=(x-(+p))^2=(x-p)^2$, the graph shifts right 'p' units
    - If $p=(-)ve$, ie, $y=(x-(-p))^2=(x+p)^2$, the graph shifts left 'p' units
- The key thing to remember is that only the x-coordinates are affected through addition or subtraction.
    - The shape of the new graph will not change, ie, it will BE CONGRUENT

Example 1: Given $y=x^2$, graph the following functions

a) $y=(x-3)^2$

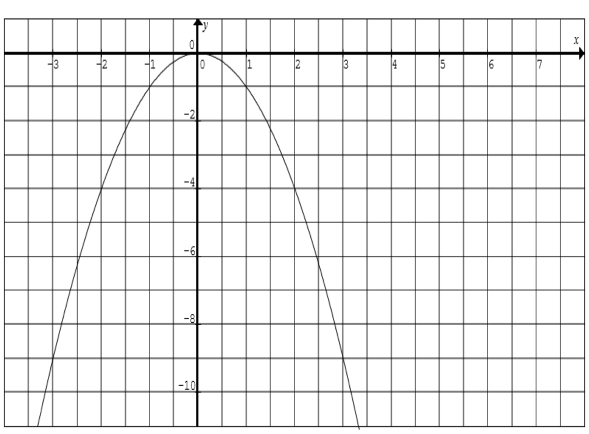


b) $y=(x+2)^2$

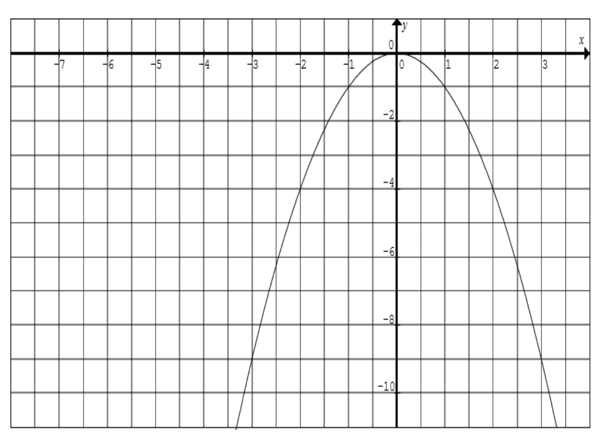


Example 2: Given $y=-x^2$, graph the following functions

a) $y=-(x-2)^2$



b) $y=-(x+1)^2$

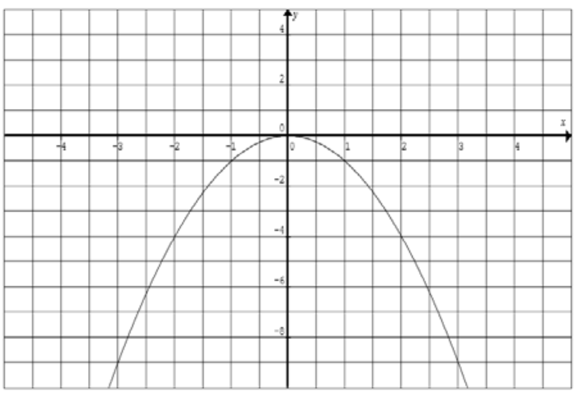


The 'q' value in $y = x^2 + q$ has only one function:

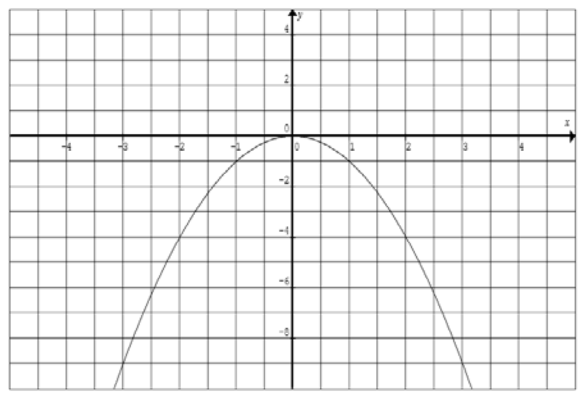
- It determines how the graph will <u>shift vertically</u>, ie, shift up or down
  - If $q = (+)ve$, ie, $y = x^2 + (+q) = x^2 + q$, the graph shifts up 'q' units
  - If $q = (-)ve$, ie, $y = x^2 + (-q) = x^2 - q$, the graph shifts down 'q' units
- The main thing is that <u>only the y-coordinates will be affected through addition or subtraction</u>
  - The shape of the new graph will not change, ie, it will BE CONGRUENT

Example 3: Given $y = -x^2$, graph the following functions

a) $y = -x^2 - 2$

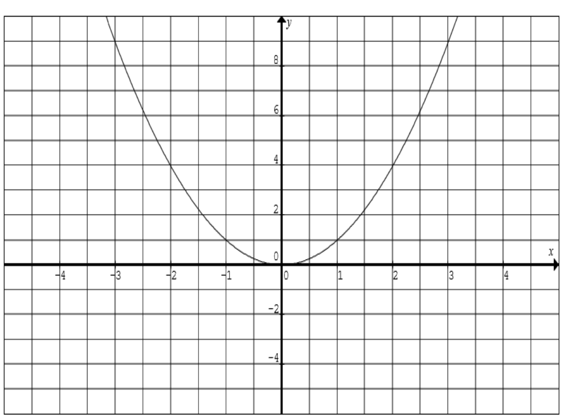


b) $y = -x^2 + 4$

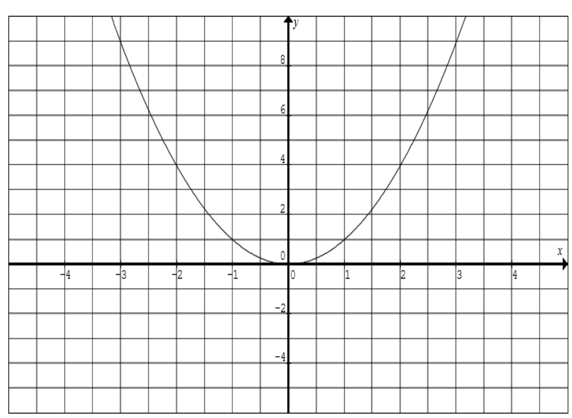


Example 4: Given $y = x^2$, graph the following functions

1) $y = x^2 - 5$



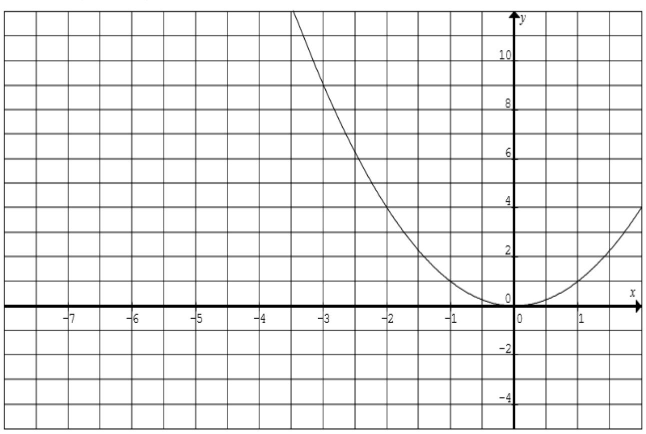
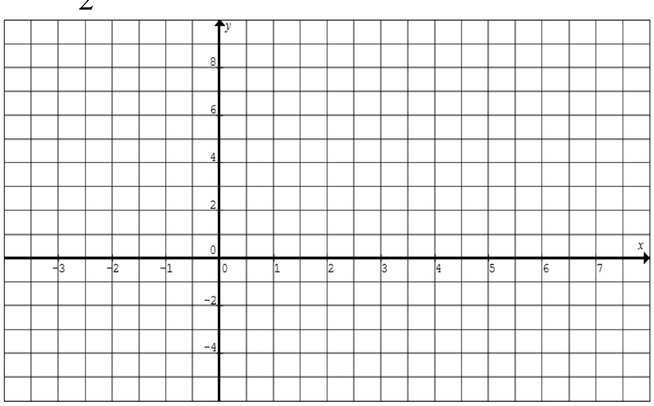
2) $y = x^2 + 3$

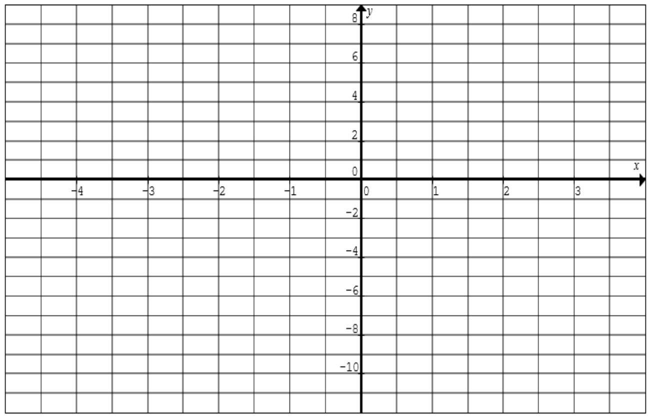


If we put all these transformations altogether, we can graph any quadratic functions in standard form: $y = a(x-p)^2 + q$ To graph quadratic functions properly, the following steps must be done in order:

1) All vertical expansions or compressions
   - VE if $a > 1$, ie, $y = 3x^2$ and VC if $0 < a < 1$, ie, $y = \frac{2}{5}x^2$
2) All vertical reflections
   - Reflect about the horizontal axis if $a = (-)ve$, ie, $y = -ax^2$
3) All horizontal translations
   - Left if $p = (-)ve$, ie, $(x+p)^2$ and right if $p = (+)ve$, ie, $(x-p)^2$
4) All vertical translations
   - Down if $q = (-)ve$, ie, $x^2 - q$ and up if $p = (+)ve$, ie, $x^2 + q$

Example 5: Graph the following functions and list all transformations in order.

<table>
<tr><td>1) $y = (x+3)^2 - 4$

</td><td>$y = x^2$ is drawn to help you out</td></tr>
<tr><td>2) $y = \frac{1}{2}(x-2)^2 - 5$

</td><td></td></tr>
</table>

3) $y=-2(x+1)^2+8$ 	

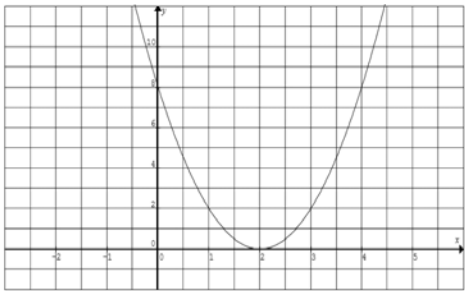
Example 6: Determine the equation of the graph in standard form given the vertex is at (-2, 3) and the y-intercept is 6.

1) Use the coordinates of the vertex and substitute into the equation
   $y=a(x-p)^2+q \quad \Longrightarrow$
2) Since the y-intercept = 6, substitute the coordinates, which happens to be (,   ), into the equation and solve for 'a'
   $y=a(x-p)^2+q \quad \Longrightarrow$

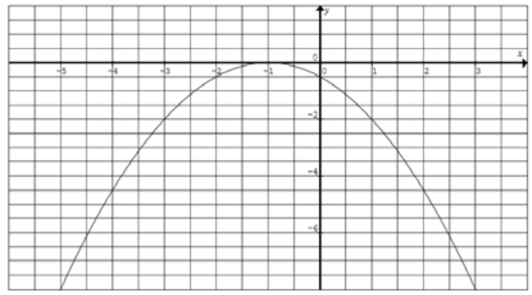
Example 7: What is the equation of the graph, in standard form, with a vertex at (-2, 3) and passes through (3, 4)

1) Quadratic functions will have <u>one x-intercept</u> only if $q = 0$

a) $y = 2(x-2)^2$



b) $y = -0.5(x+1)^2$

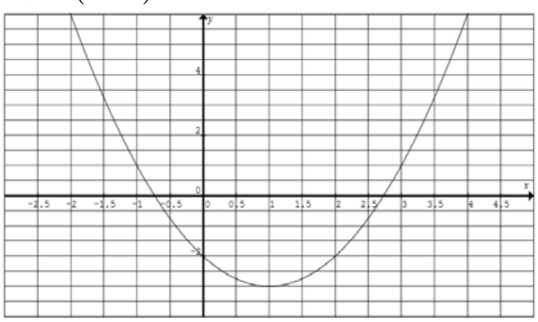


2) Quadratic functions will have <u>two x-intercepts</u> only if

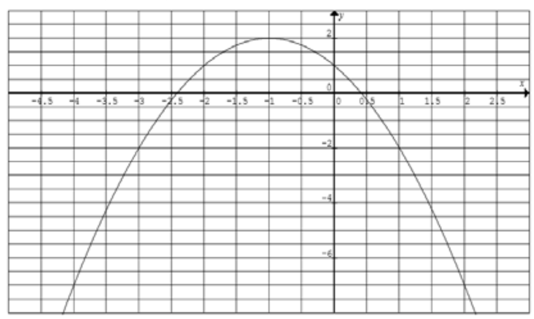
a. The graph opens up ($a = (+)ve$) and $q < 0$

b. The graph opens down ($a = (-)ve$) and $q > 0$

a) $y = (x-1)^2 - 3$



b) $y = -(x+1)^2 + 2$

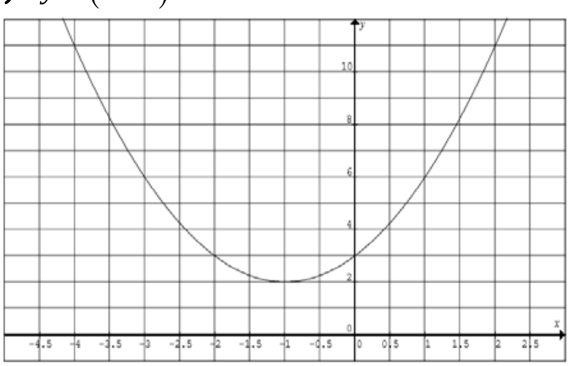


3) Quadratic functions will have <u>no x-intercept</u> if

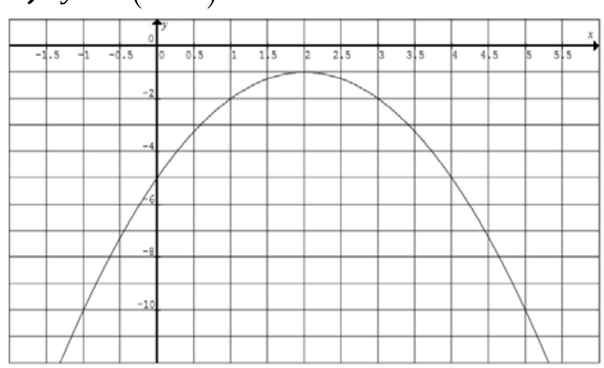
a) The graph opens up ($a = (+)ve$) and $q > 0$

b) The graph opens down ($a = (-)ve$) and $q < 0$

a) $y = (x+1)^2 + 2$



b) $y = -(x-2)^2 - 1$



Example 8: Given each equation, determine the number of x-intercepts

a) $y=-\frac{3}{2}(x+4)^2-6$	b) $y=-\frac{2}{5}(x-3)^2+4$	c) $y=3(x-6)^2$

Example 9: A small toy rocket is launched into the air. It reaches a maximum height of 120 m and falls 10 m from the launch pad. Assuming the flight of the rocket is parabolic, write an equation, in standard form, describing the height (h) of the rocket as a function of its horizontal distance (d) from the launch pad

Homework: