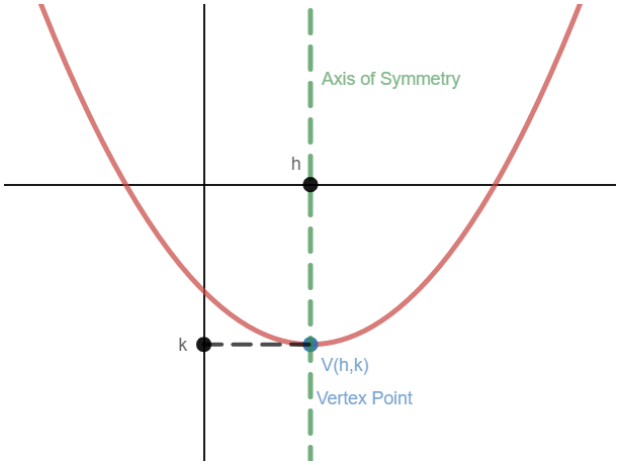
4.4 Graph $y = a(x - h)^2 + k$

A Vertex Form

The *vertex form* of a quadratic relation is:

$$y = a(x - h)^2 + k$$



- ✓ The *vertex* of the parabola is $V(h, k)$
- ✓ The graph is *translated horizontally* h units and *vertically* k units
- ✓ The *equation* of the *axis of symmetry* is $x = h$
- ✓ The graph is *vertically expanded* (stretched) (if $|a| > 1$) or *compressed* (if $|a| < 1$)
- ✓ If $a < 0$, then the graph is *reflected* with respect to (in) the x-axis
- ✓ The parabola *opens up(ward)* if $a > 0$ and *down(ward)* if $a < 0$
- ✓ The *y-intercept* value is given by $y_{int} = a(0 - h)^2 + k$ (substitute $x = 0$)
- ✓ The *x-intercepts* are the x numbers when $y = 0$ and can be found by isolating x from the equation $0 = a(x - h)^2 + k$

Example 1. Describe the transformations on the graph of $y = x^2$ to get the graph of $y = -2(x + 3)^2 + 4$.

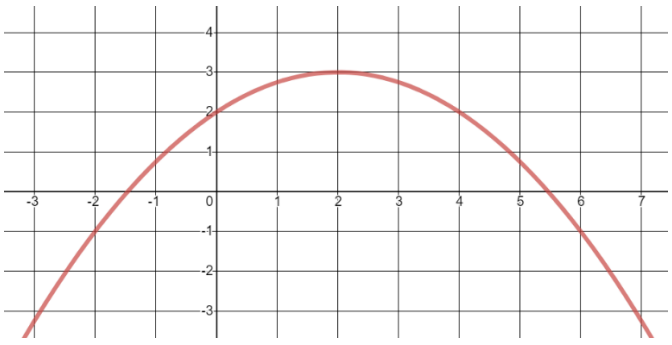
Example 2. The following transformations are performed on the graph of $y = x^2$. Write an equation for the graph after all transformation are done.

a) Reflection with respect to the x-axis
b) Vertical compression by a factor of ¼
c) Horizontal translation (shift) to the right by 5 units
d) Vertical translation (shift) by 3 units down

Example 3. Describe and graph each of the following quadratic relations.

$y = a(x-h)^2 + k$	a) $y = (x-2)^2 + 1$	b) $y = -2(x+1)^2 + 8$	c) $y = 0.5(x-3)^2 - 8$
Vertex $V(h,k)$			
Equation of the axis of symmetry: $x = h$			
If $a > 0$ (parabola opens upward) If $a < 0$ (parabola opens downward)			
y-intercept value: $y_{int} = a(0-h)^2 + k$			
Graph Sketch			
Range of y numbers			
x-intercepts values: Solve for x: $0 = a(x-h)^2 + k$			

Example 4. Determine the equation of the parabola shown.



Example 5. (Application) A ball is thrown vertically upward, and its height is modelled by the following quadratic relation $h = -5(t-2)^2 + 75$, where h is the height of the ball after t seconds. Find:

a) the initial height of the ball

b) the maximum height

c) the moment of time when the ball is at the maximum height

d) the time when the ball will hit the ground

e) the graph of the given relation

Notes: Textbook Pages 180-185
Homework: Textbook Pages 185-188 #7, 9, 10, 12, 13, 19 (optional)