

Summarizing the Roles of a, h & k

Role of a:

Direction of Opening:

- When $a > 0$, the parabola opens UP.
 - e.g. $y = 3x^2$; $a = 3$
- When $a < 0$, the parabola has been **reflected** and opens DOWN.
 - e.g. $y = -3x^2$; $a = -3$

Shape:

- If $|a| > 1$, i.e. $a > 1$ or $a < -1$, then the graph of $y = a(x - h)^2 + k$ has been **STRETCHED** by a factor of a .
 - e.g. $y = 2x^2$; $a = 2$
- If $|a| < 1$, i.e. a is between -1 and 1 , then the graph of $y = a(x - h)^2 + k$ has been **COMPRESSED** by a factor of a .
 - e.g. $y = \frac{1}{2}x^2$; $a = \frac{1}{2}$ or 0.5

Steps:

$a \cdot (1, 3, 5, 7)$

- The step pattern is: _____

Role of h:

Properties:

- If $h > 0$, then the graph of $y = a(x - h)^2 + k$ is **translated horizontally** h units to the RIGHT.
 - e.g. $y = (x - 3)^2$; $h = +3$
- If $h < 0$, then the graph of $y = a(x - h)^2 + k$ is **translated horizontally** h units to the LEFT.
 - e.g. $y = (x + 3)^2$; $h = -3$

Relation to the Vertex:

- The value of h is the x - coordinate of the vertex.
 - e.g. the vertex of $y = (x + 3)^2$ is $(-3, 0)$.

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

Role of k:

Properties:

- If $k > 0$, then the graph of $y = a(x - h)^2 + k$ is **translated vertically** k units UP.
 - e.g. $y = x^2 + 3$; $k = +3$
- If $k < 0$, then the graph of $y = a(x - h)^2 + k$ is **translated vertically** k units DOWN.
 - e.g. $y = x^2 - 3$; $k = -3$

Relation to the Vertex:

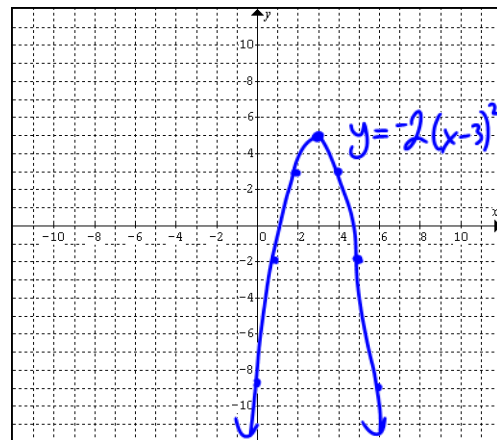
- The value of k is the y - coordinate of the vertex.
 - e.g. the vertex of $y = x^2 + 3$ is $(0, 3)$.

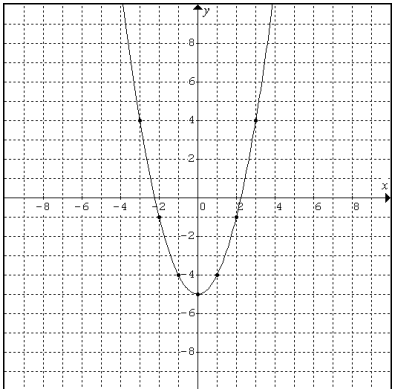
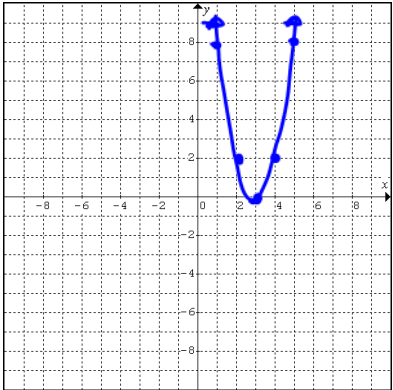
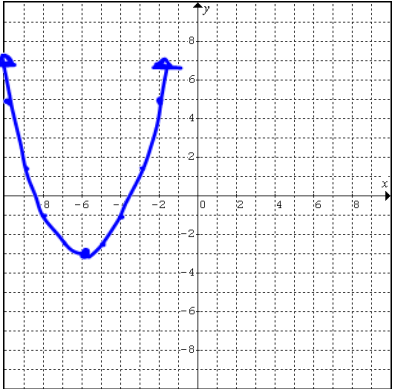
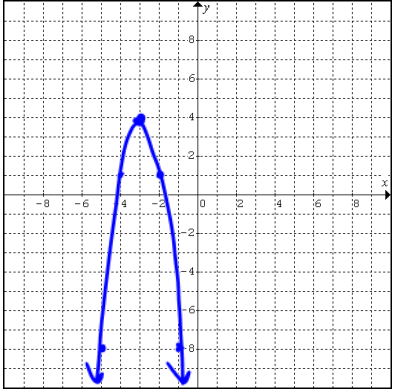
x-Intercepts:

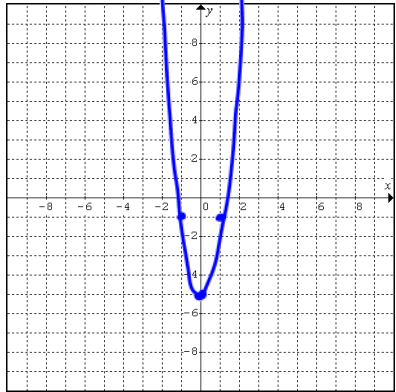
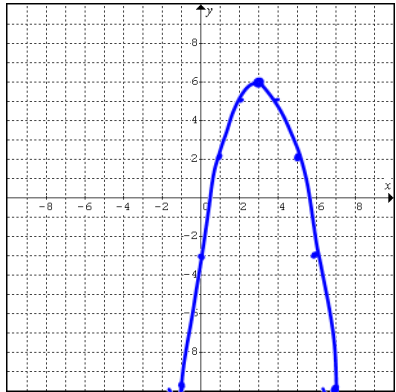
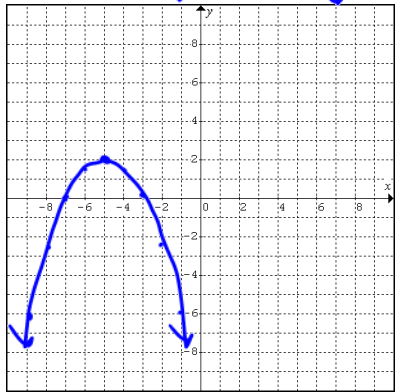
- If $k = 0$, then the graph has 1 zero (x-intercept).
- If a and k have the same sign, then the graph has _____ zeros (x-intercepts).
- If a and k have the opposite sign, then the graph has _____ zeros (x-intercepts).

Example: $y = -2(x - 3)^2 + 5$

- vertex: $(3, 5)$
- steps: $-2 \cdot (1, 3, 5, 7) = -2, -6, -10, -14$
- Transformations:
 - Reflection : Reflection about the "x" axis
 - Stretch/Comp : Stretched vertically by a factor of 2
 - Translation : Translated horizontally 3 units RIGHT and vertically 5 units UP
- Number of x-intercepts:



Quadratic Function	Transformation(s)	Vertex	Step Pattern	Graph
$y = x^2 - 5$	shift 5 units down	(0, -5)	1, 3, 5, 7, ...	 A coordinate plane showing a parabola opening upwards. The vertex is at (0, -5). The x-axis ranges from -8 to 8, and the y-axis ranges from -8 to 8. The parabola passes through points (-2, -9), (0, -5), and (2, -9).
$y = 2(x - 3)^2$	Stretched vertically b.a.f.o 2 Shift 3 units RIGHT	(3, 0)	2 · (1, 3, 5, 7) 2, 6, 10, 14	 A coordinate plane showing a parabola opening upwards. The vertex is at (3, 0). The x-axis ranges from -8 to 8, and the y-axis ranges from -8 to 8. The parabola passes through points (1, 2), (3, 0), and (5, 2). Blue arrows indicate the direction of the parabola.
$y = \frac{1}{2}(x + 6)^2 - 3$	Compressed vertically b.a.f.o 0.5 Shifted 6 units left 3 units down	(-6, -3)	0.5, 1.5, 2.5, 3.5	 A coordinate plane showing a parabola opening upwards. The vertex is at (-6, -3). The x-axis ranges from -8 to 8, and the y-axis ranges from -8 to 8. The parabola passes through points (-8, -1), (-6, -3), and (-4, -1). Blue arrows indicate the direction of the parabola.
$y = -3(x + 3)^2 + 4$	Reflected about the "x" axis Stretched vertically b.a.f.o 3 Shifted 3 units LEFT, 4 units UP	(-3, 4)	-3 · (1, 3, 5, 7) -3, -9, -15, -21	 A coordinate plane showing a parabola opening downwards. The vertex is at (-3, 4). The x-axis ranges from -8 to 8, and the y-axis ranges from -8 to 8. The parabola passes through points (-5, 1), (-3, 4), and (-1, 1). Blue arrows indicate the direction of the parabola.

Quadratic Function	Transformation(s)	Vertex	Step Pattern	Graph
$y = 4x^2 - 5$	Stretched vertically base 4. Shifted 5 units Down	$(0, -5)$	$4, 12, 20$	
$y = -(x-3)^2 + 6$	Reflected about the "x" axis Shifted 3 units RIGHT and 6 units UP	$(3, 6)$	$-1, -3, -5, -7$	
$y = -\frac{1}{2}(x+5)^2 + 2$	Reflected about the "x" axis Compressed vertically base 0.5 Shifted 5 units left 2 units up	$(-5, 2)$	$-0.5, -1.5, -2.5, -3.5$	
$y = -3(x-1)^2 + 2$	Reflected about the "x" axis Stretched vertically base 3 Shifted 1 unit RIGHT, 2 units UP	$(1, 2)$	$-3, -9, -15$	