Algebra 1 Unit 6: Quadratic Functions Notes

Day 4 - Graphing Quadratics in Standard Form

Given the following equation, $y = (x + 3)^2 + 1$, how could we go from that form to $y = x^2 + 6x + 10$? — standard

$y = (x+3)^2 + 1$ ← vertex

$y = (x+3)(x+3) + 1$

$y = x^2 + 6x + 9 + 1$

$y = x^2 + 6x + 10$ — same

	x	+3
x	x^2	+3x
+3	+3x	+9

$x^2 + 6x + 9$

What about $y = 3(x + 2)^2 + 3$ to $y = 3x^2 + 12x + 15$?

Expand

$y = 3(x+2)(x+2) + 3$

$y = 3(x^2 + 4x + 4) + 3$

$y = 3x^2 + 12x + 12 + 3$

$y = 3x^2 + 12x + 15$

	x	+2
x	x^2	+2x
+2	+2x	+4

$x^2 + 4x + 4$

This is how we arrive to the standard form of a quadratic function!

Standard Form of a Quadratic Function:

$$y = Ax^2 + Bx + C$$

A determines how the graph opens

(0, C) is the y-intercept.

Finding the Vertex in Standard Form

Graphing in standard form is similar to graphing in vertex form, but the way we find our vertex is different. We use a special formula to find the x-coordinate of our vertex, and substitute that value in our equation to determine the y - coordinate of our vertex.

The formula is: $x = \frac{-b}{2a}$, then substitute x into equation for y.

For example, say we have $y = x^2 + 2x + 7$, how would we find our vertex?

a : 1
b : 2
c : 7

$x = \frac{-2}{2(1)} = -1$

$y = (-1)^2 + 2(-1) + 7$

$y = 1 + -2 + 7 = 6$

(-1, 6)

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Identifying the Vertex Practice

Find the vertex for each of the following quadratics, determine whether the graph opens up or down, and find the y intercept:

$x = \frac{-b}{2a}$ $y =$ plug in x

1. $y = 2x^2 + 8x + 2$ Vertex = (-2, -6)

a : 2
b : 8
c : 2

$x = \frac{-8}{2(2)} = -2$

$y = 2(-2)^2 + 8(-2) + 2$
$8 + -16 + 2$

Graph opens ↑ because a is +.

The y-intercept is (0, 2). (0, c)

2. $y = -x^2 + 2x + 7$ Vertex = (____, ____)

Graph opens _____ because a is ____.

The y-intercept is (0,).

3. $y = -4x^2 + 24x$ Vertex = (3, 36)

a : -4
b : 24
c : 0

$x = \frac{-24}{2(-4)} = 3$

$y = -4(3)^2 + 24(3)$
$= -36 + 72 = 36$

Graph opens ↓ because a is −.

The y-intercept: (0, 0) (0, c)

4. $y = 7x^2 + 9$ Vertex = (0, 9)

a = 7
b = 0
c = 9

$x = \frac{0}{2(7)} = 0$

$y = 7(0)^2 + 9 = 9$

Graph opens ↑ because a is +.

The y-intercept: (0, 9)

y (0, 9)

Steps for Graphing in Standard Form

1) Find the vertex. After using the formula $x = \frac{-b}{2a}$ to find our x- coordinate of our vertex, we substitute that x back into our equation, and our solution is the y-coordinate of our vertex.

2) Use your vertex as the center for your table and determine two x values to the left and right of your x-coordinate and substitute those x values back into the equation to determine the y values.

3) Plot your points and connect them from left to right!

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Graphing in Standard Form Examples

Example 1: Graph $y = x^2 - 2x - 1$.

$a: 1$ $b: -2$ $c: -1$

$x = \frac{+2}{2(1)} = 1$

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

$y = -2$

(0, -1)

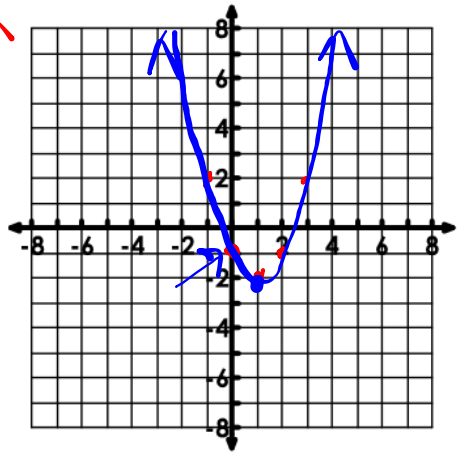
Vertex = (1, -2)

x	-1	0	1	2	3
y	2	-1	-2	-1	2

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

$1 + 2 - 1 = 2$

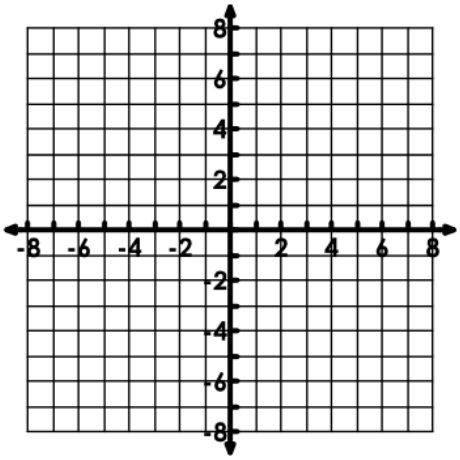
$y = 0^2 - 2(0) - 1 = -1$



Example 2: Graph: $y = 3x^2 - 6x$.

Vertex = (____, ____)

x					
y		0			9



Example 3: Graph $y = 2x^2 + 3$.

$a: 2$ $b: 0$ $c: 3$

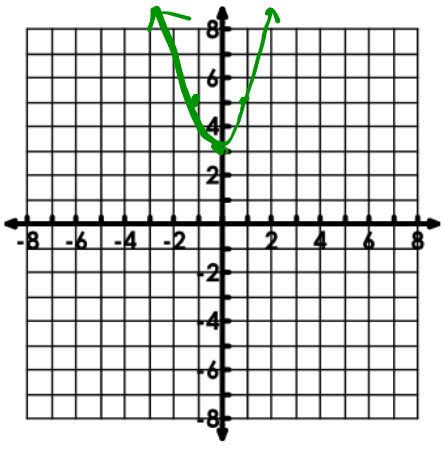
$x = \frac{-b}{2a} = \frac{0}{2(2)} = 0$

$y = 2(0)^2 + 3 = 3$

Vertex = (0, 3)

x	-2	-1	0	1	2
y	11	5	3	5	11

(0, 3)



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Example 4: Graph: $y = -x^2 + 6x - 9$.

$x = \frac{-6}{2(-1)} = 3$

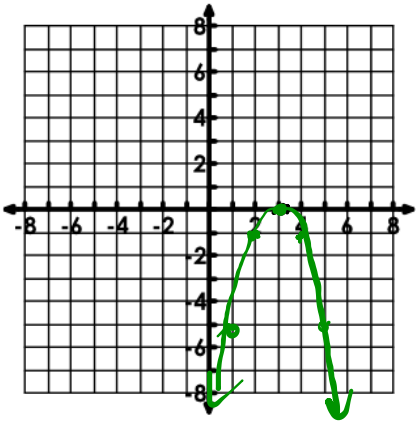
$y = -(3)^2 + 6(3) - 9$

$y = -9 + 18 - 9$

$y = 0$

Vertex = (3, 0)

x	1	2	3	4	5
y	-4	-1	0	-1	-4

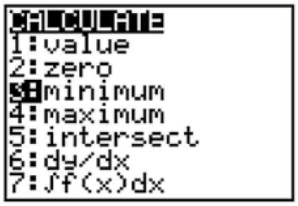


Using a Graphing Calculator to find the Vertex of Quadratics in Standard Form

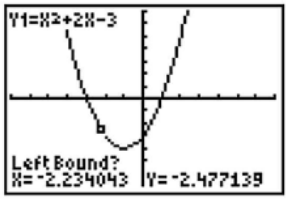
We already know how to graph quadratics, so let's try and find the vertex of these equations using our graphing calculators! Graph $y = x^2 + 2x - 3$

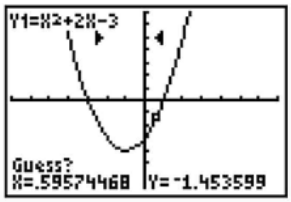
1. Hit **Y =** and enter the equation into y_1.

2. Hit **2nd** followed by **Trace** (you really want the calc function). If your parabola OPENS UP select 3: minimum, if your parabola OPENS DOWN select 4: maximum.

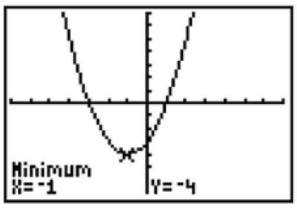


3. (You may have to move the spider left and right using your arrow buttons).
The calculator will ask you "left bound?" hit **Enter**. The calculator will then ask you "right bound?" hit **Enter**. The calculator will then ask you "guess?" hit **Enter**.





4. Your maximum or minimum coordinates will be displayed on the screen and that is your vertex!



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