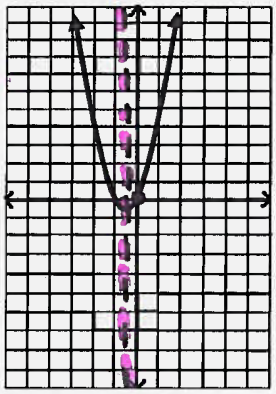
10–2 Graphing Quadratic Functions in the form $y = ax^2 + bx + c$

Now we will consider what the value of **b** in $y = ax^2 + \mathbf{b}x + c$ does to the graph.

Consider the graphs of the following functions.
Where is each graph's line of symmetry and y–intercept?

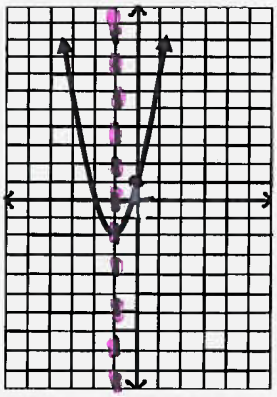
$y = 2x^2 + 2x$



line of symmetry? $x = -\frac{1}{2}$

y-intercept? (0, 0)

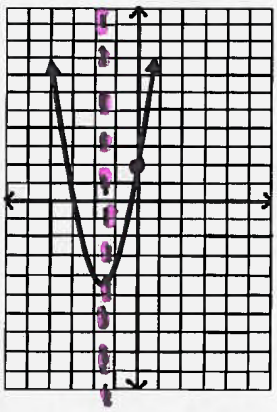
$y = 2x^2 + 4x + 1$



line of symmetry? $x = -1$

y-intercept? (0, 1)

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



line of symmetry? $x = -1\frac{1}{2}$

y-intercept? (0, 2)

Now use the formula $\boxed{x = \frac{-b}{2a}}$ with the equation from each graph above.

$y = 2x^2 + 2x$

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

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

$y = 2x^2 + 4x + 1$

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

$x = -1$

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

$x = \frac{-6}{2(2)} = \frac{-6}{4}$

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

What are you finding by using this formula? the axis of symmetry

* compare ... the bottom answers match the top!

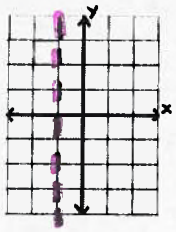
√ Understanding Check:

Use the formula $\boxed{x = \frac{-b}{2a}}$ to predict the axis of symmetry for each of the equations and mark the axis on the graph:

1. $y = 4x^2 + 8x + 5$

$x = \frac{-8}{2(4)} = \frac{-8}{8} = -1$

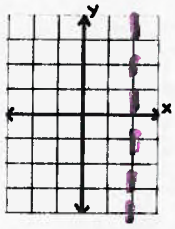
$\boxed{x = -1}$



2. $y = 3x^2 - 12x + 9$

$x = \frac{12}{2(3)} = \frac{12}{6} = 2$

$\boxed{x = 2}$



But finding the axis of symmetry won't help much unless you go back and use the x-value you just found to find the actual vertex. How can you find the vertex using x?

Substitute the x-value back in to find the y.

1. $y = 4x^2 + 8x + 5$

$y = 4(-1)^2 + 8(-1) + 5$

$4(1) - 8 + 5$

$4 - 8 + 5$

$-4 + 5$

$\boxed{y = 1}$

$\boxed{\text{vertex: } (-1, 1)}$

2. $y = 3x^2 - 12x + 9$

$y = 3(2)^2 - 12(2) + 9$

$3(4) - 24 + 9$

$12 - 24 + 9$

$-12 + 9$

$\boxed{y = -3}$

$\boxed{\text{vertex: } (2, -3)}$

Example 1 : Graphing $y = ax^2 + bx + c$ (Putting it all together to graph)

Use all of the shortcuts you have learned to graph the quadratic function:

Double the pattern

$y = 2x^2 + 8x + 5$

Step 1: Find the axis of symmetry.

$x = \frac{-8}{2(2)} = \frac{-8}{4} = -2$ $\boxed{x = -2}$

Step 2: Substitute x=-2 back in to find the vertex.

$y = 2(-2)^2 + 8(-2) + 5$

$2(4) - 16 + 5$

$8 - 16 + 5$

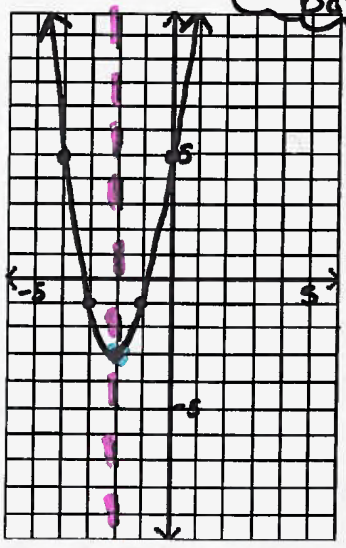
$-8 + 5$

$\boxed{y = -3}$

$\boxed{\text{vertex } (-2, -3)}$

Step 3: Plot the $2x^2$ pattern from (-2,-3)

2, 6, 10 boxes



Step 4: Check the y-intercept to check for accuracy & draw the parabola.

x^2 = 1, 3, 5, 7 boxes
$2x^2$ = 2, 6, 10, 14 boxes
$3x^2$ = 3, 9, 15, 21 boxes

√ Understanding Check:
Use the y-intercept, the axis of symmetry, and the vertex to graph each of the following quadratics.

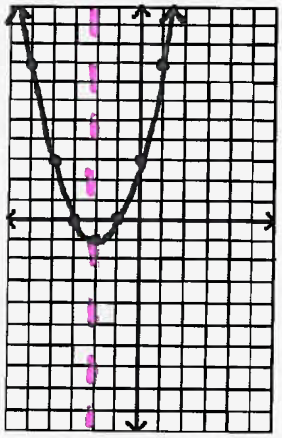
* In my classroom we graph by counting boxes.

a. $y = x^2 + 4x + 3$

$x = \frac{-4}{2(1)} = \frac{-4}{2} = -2$

$y = (-2)^2 + 4(-2) + 3$
$4 - 8 + 3$
$-4 + 3 = -1$

vertex: $(-2, -1)$

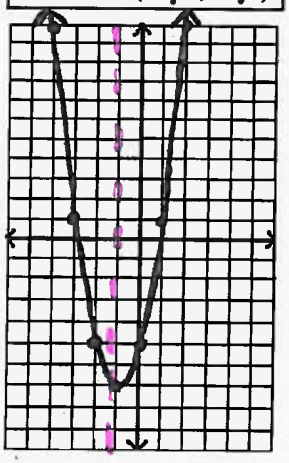


b. $y = 2x^2 + 4x - 5$

$x = \frac{-4}{2(2)} = \frac{-4}{4} = -1$

$y = 2(-1)^2 + 4(-1) - 5$
$2(1) - 4 - 5$
$2 - 4 - 5$
$-2 - 5 = -7$

vertex: $(-1, -7)$

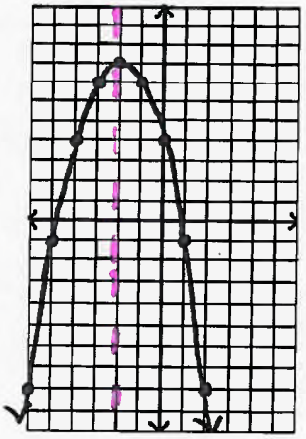


c. $y = -x^2 - 4x + 4$

$x = \frac{4}{2(-1)} = \frac{4}{-2} = -2$

$y = -(-2)^2 - 4(-2) + 4$
$-(4) + 8 + 4$
$4 + 4$
$= 8$

vertex: $(-2, 4)$

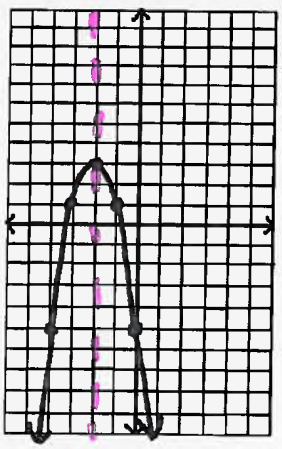


d. $y = -2x^2 - 8x - 5$

$x = \frac{8}{2(-2)} = \frac{8}{-4} = -2$

$y = -2(-2)^2 - 8(-2) - 5$
$-2(4) + 16 - 5$
$-8 + 16 - 5$
$= 3$

vertex: $(-2, 3)$

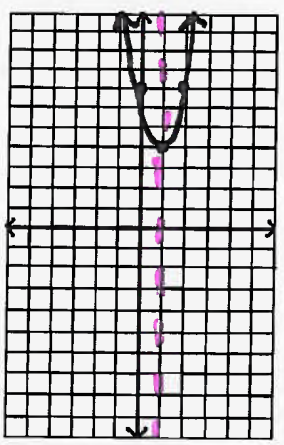


e. $y = 3x^2 - 6x + 7$

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

$y = 3(1)^2 - 6(1) + 7$
$3(1) - 6 + 7$
$3 - 6 + 7$
$= 4$

vertex: $(1, 4)$



f. $y = 4x^2 - 16x + 10$

$x = \frac{16}{2(4)} = \frac{16}{8} = 2$

$y = 4(2)^2 - 16(2) + 10$
$4(4) - 32 + 10$
$16 - 32 + 10$
$-16 + 10$
$= -6$

vertex: $(2, -6)$