HOW Reminders

- **Preparedness:**
  - Be in the classroom when the bell rings
  - Have something to write with, a calculator, and your notebook

Engagement:

- Have your phone and computer put away

Warm-Up

1) $-8(x-2)-2x=-2-7x$

$x=6$

2) $28-3x=-7-5(-6x-7)$

$x=0$

2.2 Notes - Part 2
Properties of Parabolas

Learning Targets:

- I can find the maximum and minimum values of quadratic functions.
- I can graph quadratic functions using x-intercepts.
- I can solve real-life problems.

Exploration

Go to Desmos. With a partner, graph the following quadratic functions and write down/discuss anything you notice about how the equation is related to the graph.

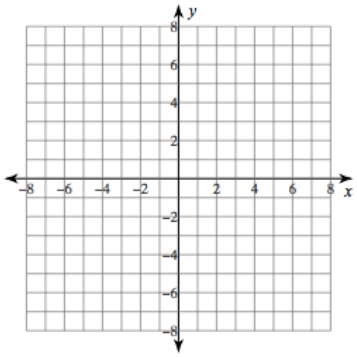
Algebra 2 Name_____

2.2 Exploration

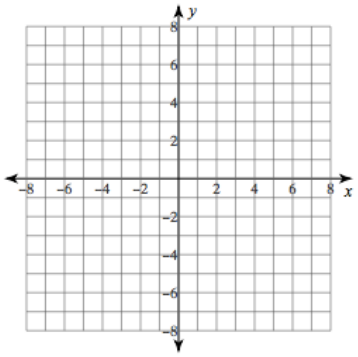
Date_____ Period____

Go to Desmos. With a partner, graph the following quadratic functions and write down/discuss anything you notice about how the equation is related to the graph.

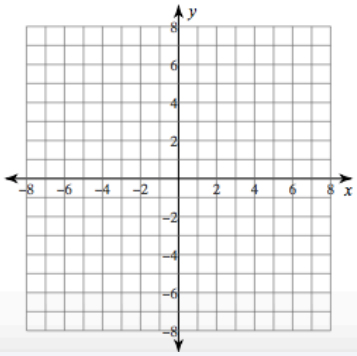
1) $y = x^2 - 2x + 1$



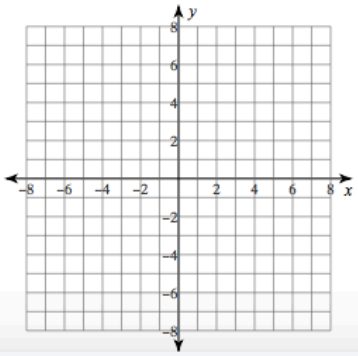
2) $y = -2x^2 + 4x - 5$



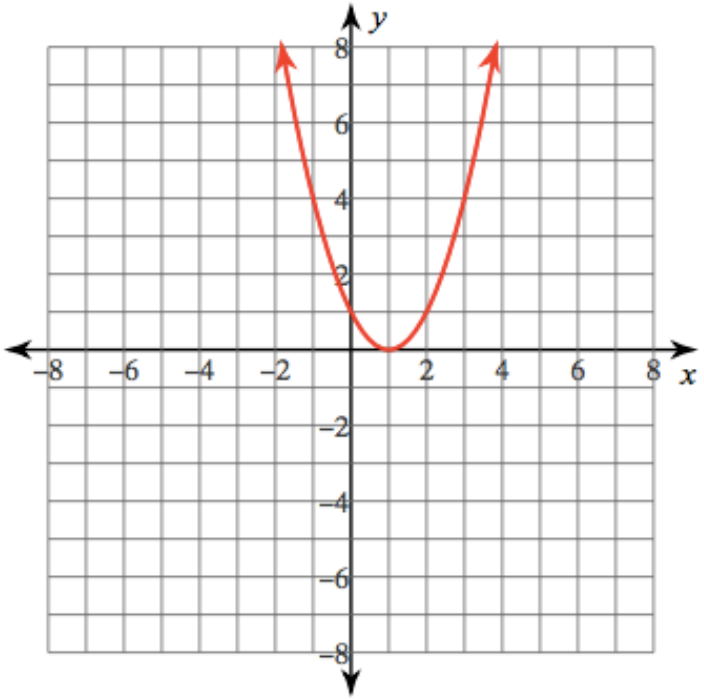
3) $y = -x^2 - 4x - 7$



4) $y = 3x^2 + 12x + 7$



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



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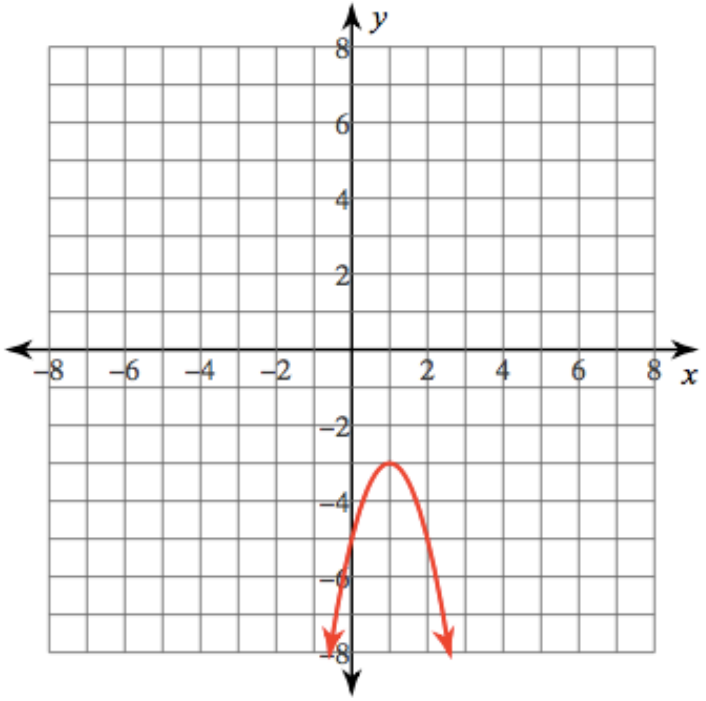

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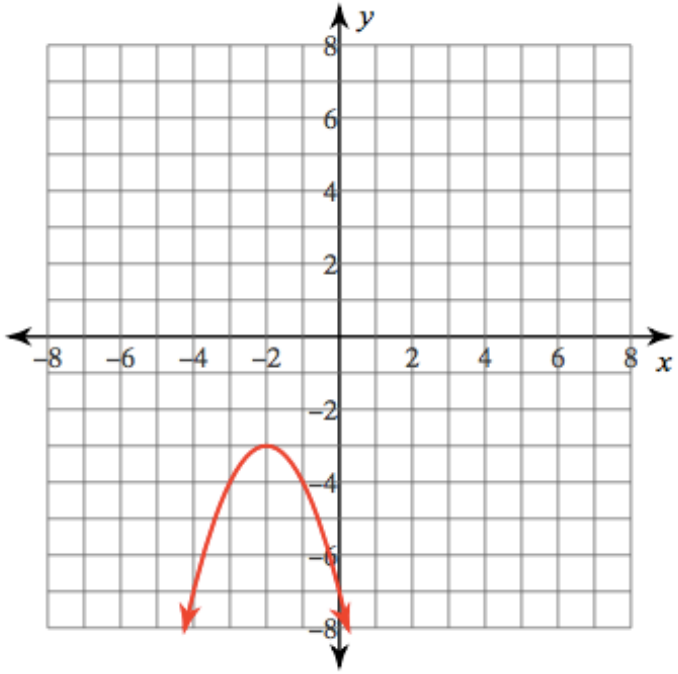

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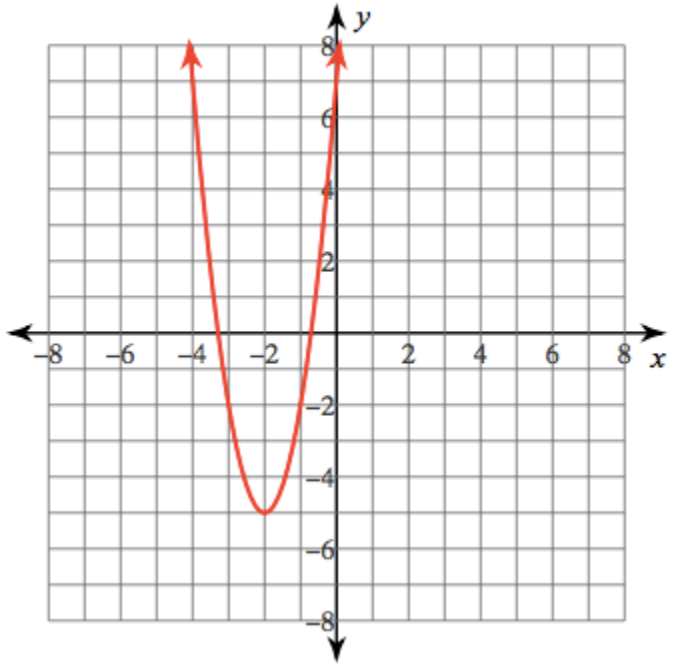
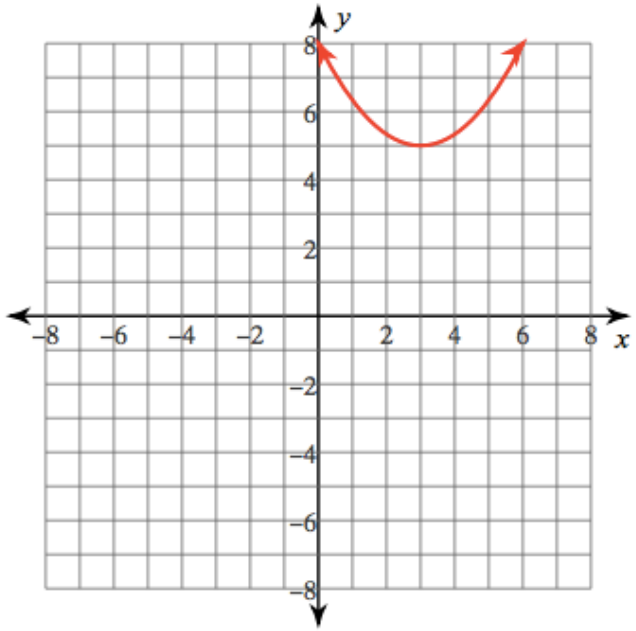
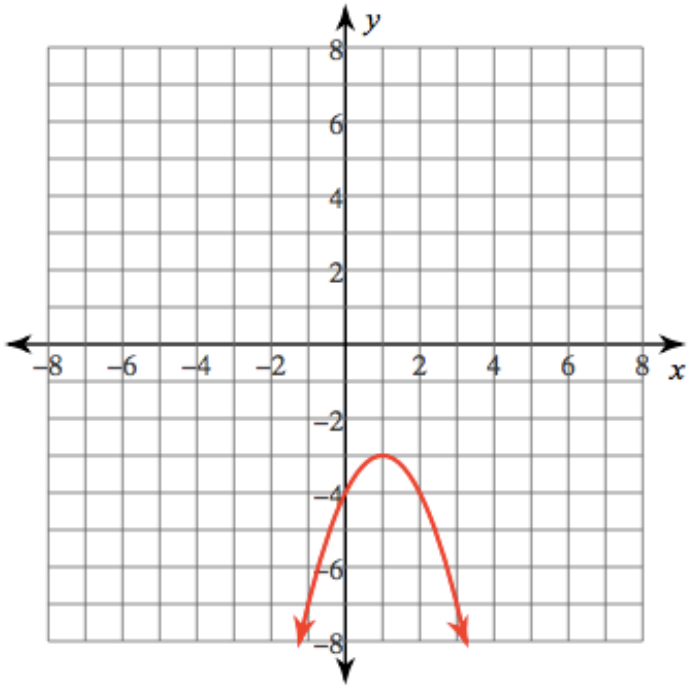


5) $y = \frac{1}{3}x^2 - 2x + 8$



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



Standard Form:

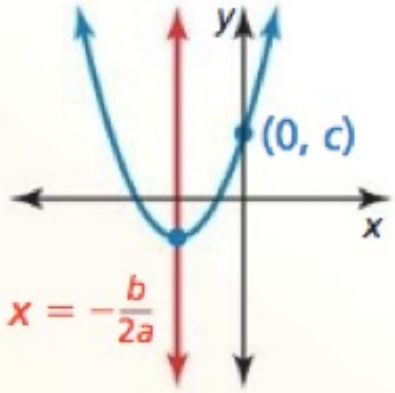
- Quadratic functions can also be written in **standard form**: $f(x) = ax^2 + bx + c$.

- c is the y-intercept.

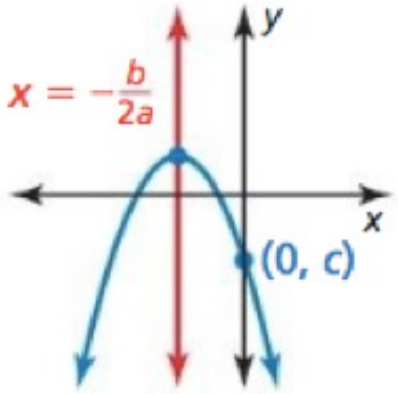
- When your function is in standard form, you have to solve to find the vertex:
  - x-coordinate = $\frac{-b}{2a}$
  - When you get your x, plug it into your original function to get the y.

Properties of the Graph of $f(x) = ax^2 + bx + c$

$y = ax^2 + bx + c, a > 0$



$y = ax^2 + bx + c, a < 0$



- The parabola opens up when $a > 0$ and opens down when $a < 0$.
- The graph is narrower than the graph of $f(x) = x^2$ when $|a| > 1$ and wider when $|a| < 1$.
- The axis of symmetry is $x = -\frac{b}{2a}$ and the vertex is $\left(-\frac{b}{2a}, f\left(-\frac{b}{2a}\right)\right)$.
- The y-intercept is c. So, the point $(0, c)$ is on the parabola.

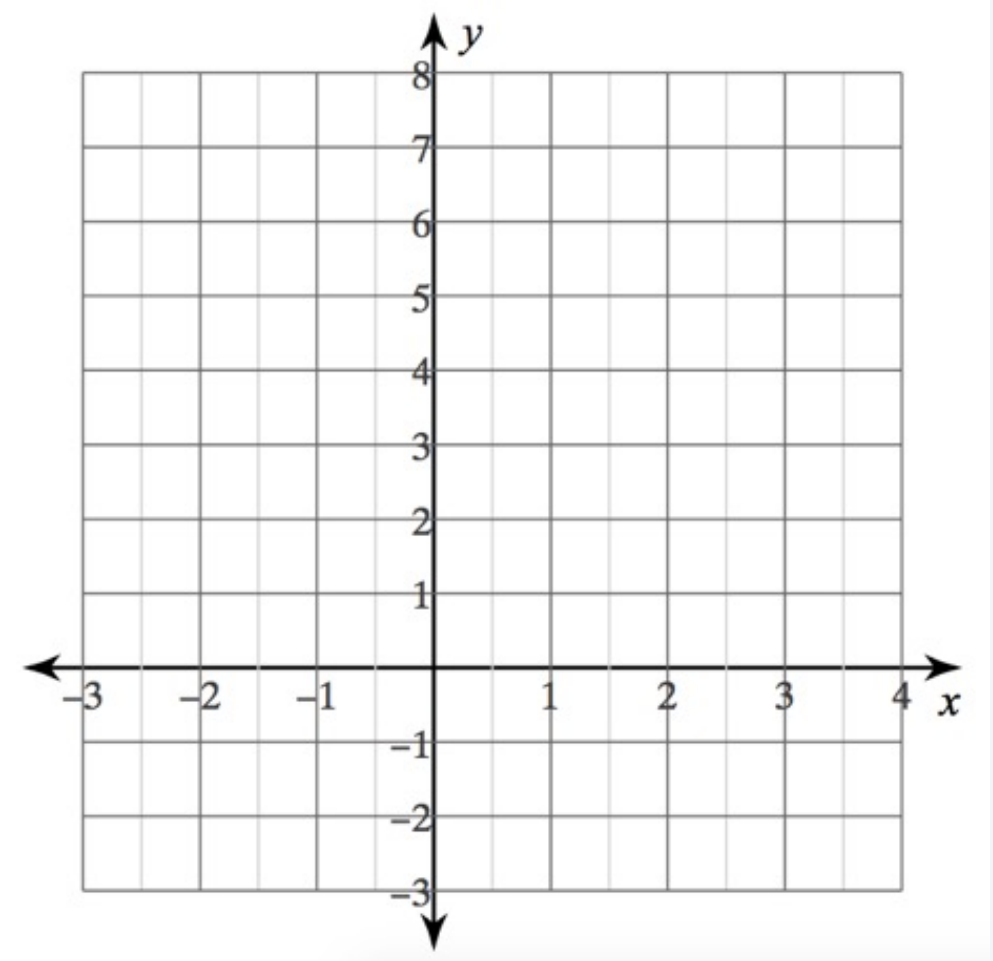
Example 2:

Graph $f(x) = 3x^2 - 6x + 1$.
Label the vertex and axis of symmetry.

Use $x = \frac{-b}{2a}$ to find the x -coordinate of the vertex.

$$a = 3, b = -6, c = 1$$

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



Example 2:

Graph $f(x) = 3x^2 - 6x + 1$.
Label the vertex and axis of symmetry.

Now plug in your $x = 1$ to find the y.

$$f(1) = 3x^2 - 6x + 1$$

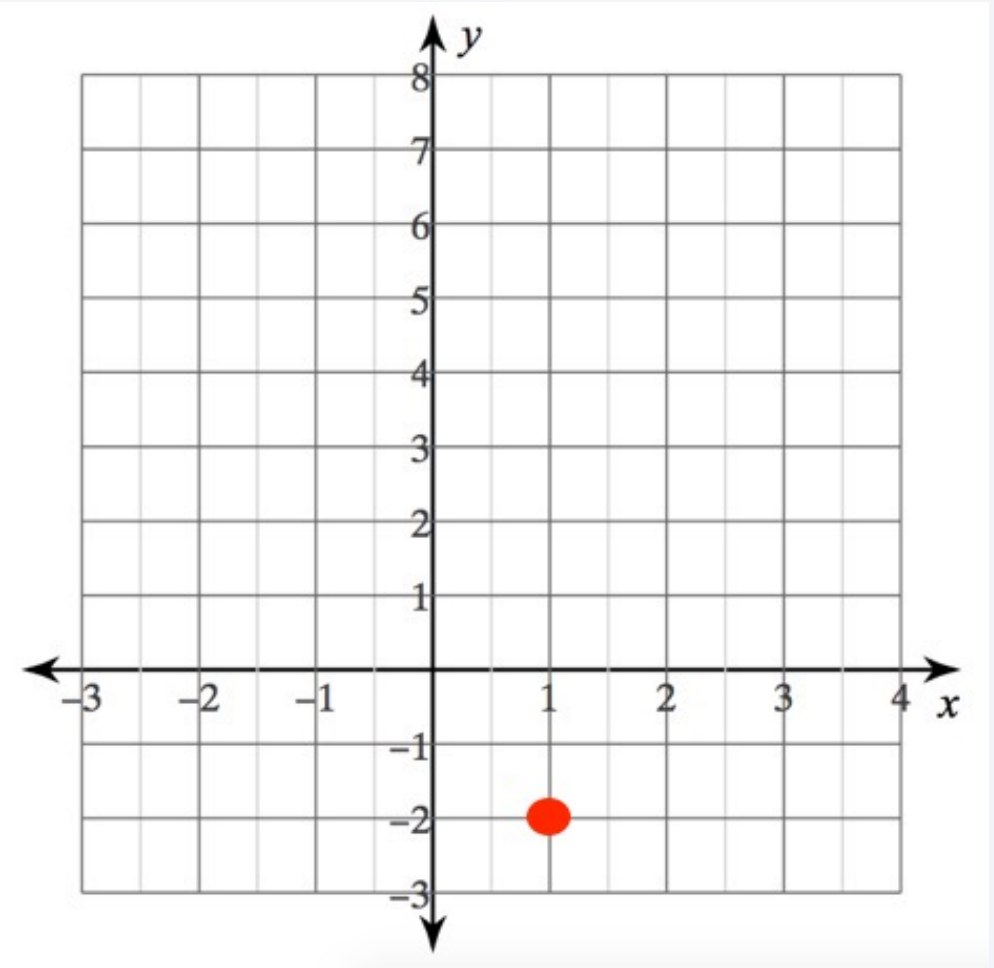
$$= 3(1)^2 - 6(1) + 1$$

$$= 3(1) - 6 + 1$$

$$= 3 - 6 + 1$$

$$= -3 + 1$$

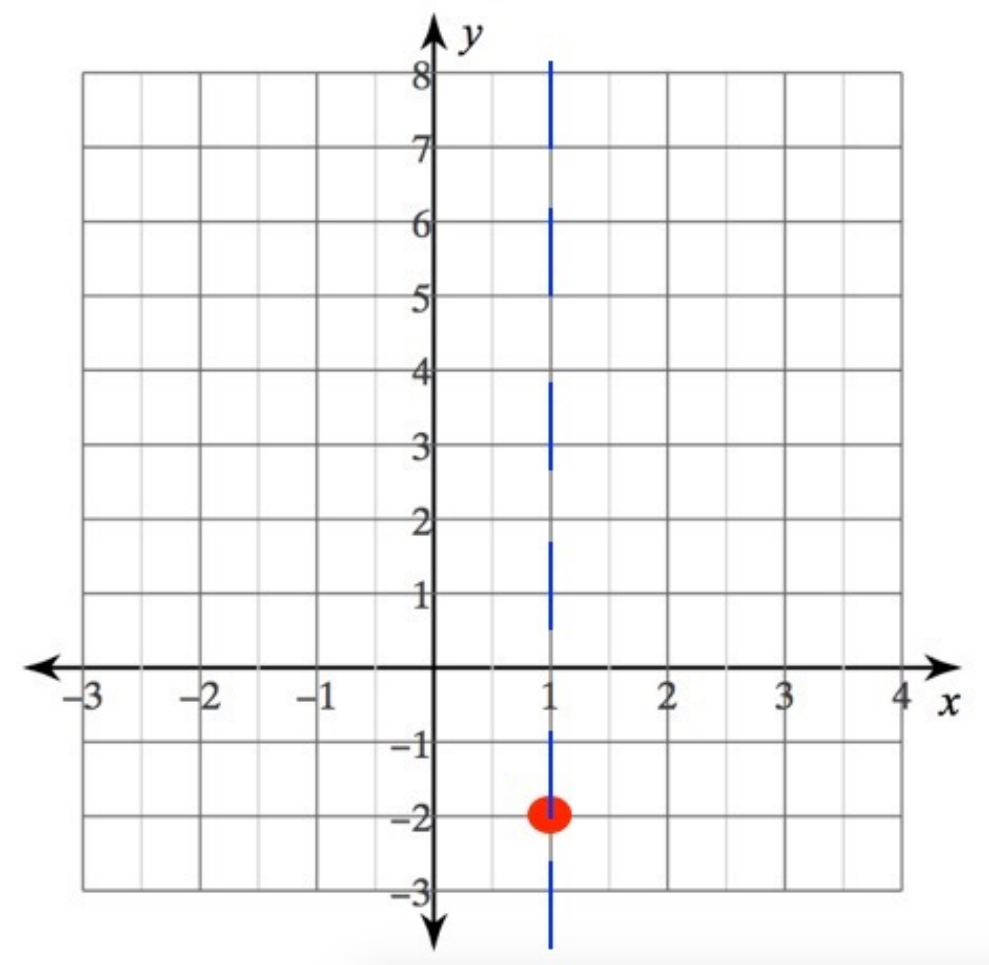
$$= -2 \quad \Rightarrow \quad (1, -2)$$



Example 2:

Graph $f(x) = 3x^2 - 6x + 1$.
Label the vertex and axis of symmetry.

Since its vertex is $(1, -2)$, the axis of symmetry is $x = 1$.

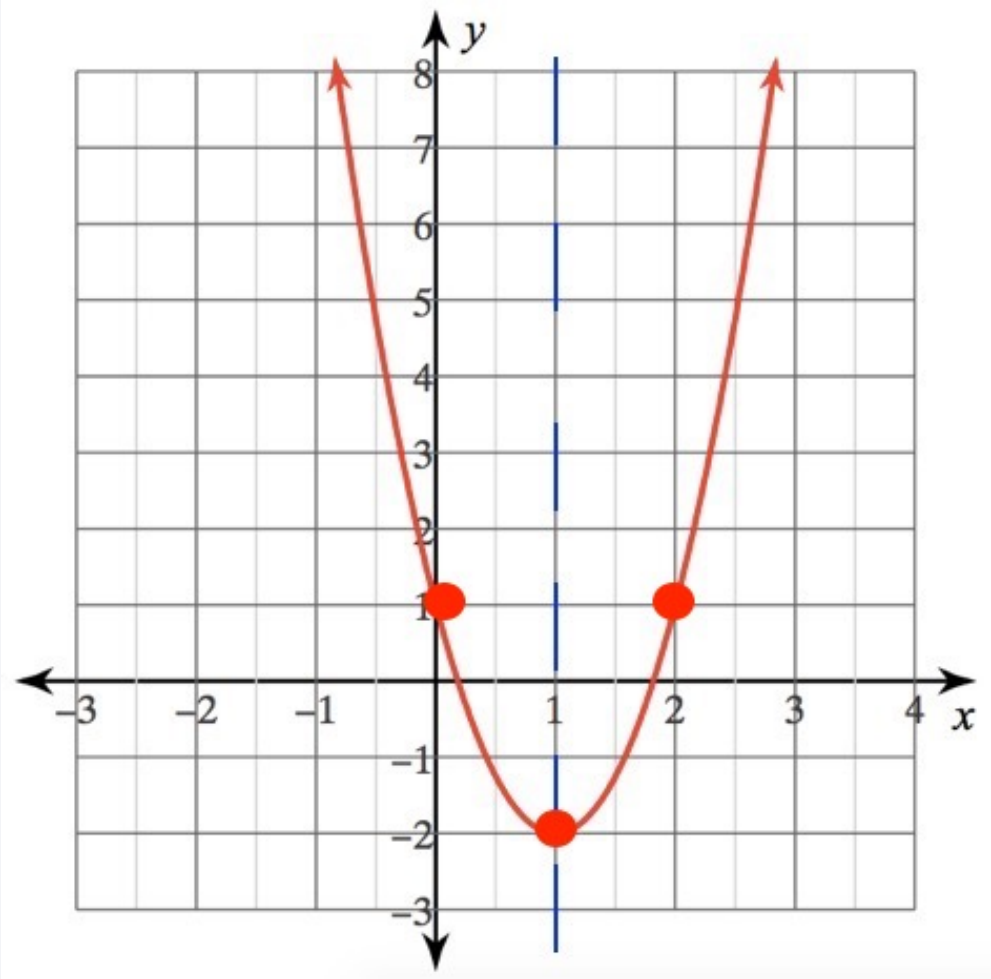


Example 2:

Graph $f(x) = 3x^2 - 6x + 1$.
Label the vertex and axis of symmetry.

Now look at your equation to find the y-intercept.

c is the y-intercept, so the y-intercept $= 1$.



Work with a partner:

Identify the vertex and axis of symmetry of each.

1) $y = 2x^2 + 16x + 27$

$(-4, -5)$ axis: $x = -4$

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

$(0, -4)$ axis: $x = 0$

3) $y = 4x^2 - 72x + 324$

$(9, 0)$ axis: $x = 9$

4) $y = 3x^2 + 16x + 27$

(-2.67, 5.67)

5) $y = -x^2 - 10x - 17$

$(-5, 8)$ axis: $x = -5$

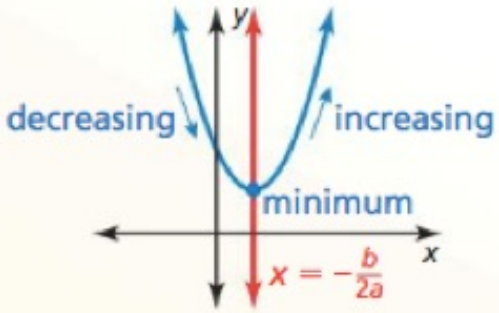
6) $y = 2x^2 + 24x + 75$

$(-6, 3)$ axis: $x = -6$

Minimum and Maximum Values

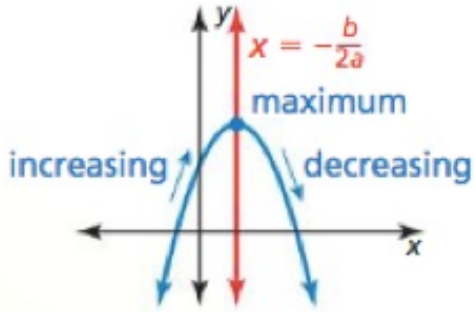
For the quadratic function $f(x) = ax^2 + bx + c$, the y-coordinate of the vertex is the **minimum value** of the function when $a > 0$ and the **maximum value** when $a < 0$.

$a > 0$



- Minimum value: $f\left(-\frac{b}{2a}\right)$
- Domain: All real numbers
- Range: $y \geq f\left(-\frac{b}{2a}\right)$
- Decreasing to the left of $x = -\frac{b}{2a}$
- Increasing to the right of $x = -\frac{b}{2a}$

$a < 0$



- Maximum value: $f\left(-\frac{b}{2a}\right)$
- Domain: All real numbers
- Range: $y \leq f\left(-\frac{b}{2a}\right)$
- Increasing to the left of $x = -\frac{b}{2a}$
- Decreasing to the right of $x = -\frac{b}{2a}$

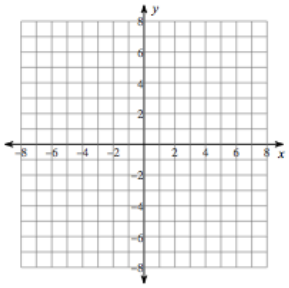
Your Turn!

Algebra 2 Name_____

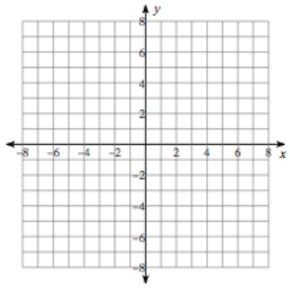
Standard Form Date_____ Period____

Identify the vertex, axis of symmetry, min/max value, *y*-intercept, and decreasing/increasing values of each. Then sketch the graph.

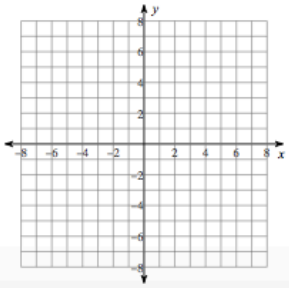
1) $f(x) = 2x^2 + 8x + 6$



2) $f(x) = x^2 + 6x + 3$



3) $f(x) = 2x^2 + 8x + 2$



4) $f(x) = -x^2 + 2x + 3$