Aim: Students will be able to explore the quadratic functions and understand the role of a in $y = ax^2 + bx + c$.

DoNow: Graph the functions on graphing paper and compare their graphs:

1. $y = x^2$

x						
y						

2. $y = 2x^2$

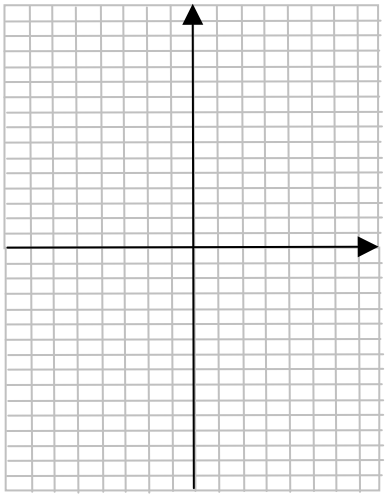
x						
y						

3. $y = -x^2$

x						
y						

4. $y = -2x^2$

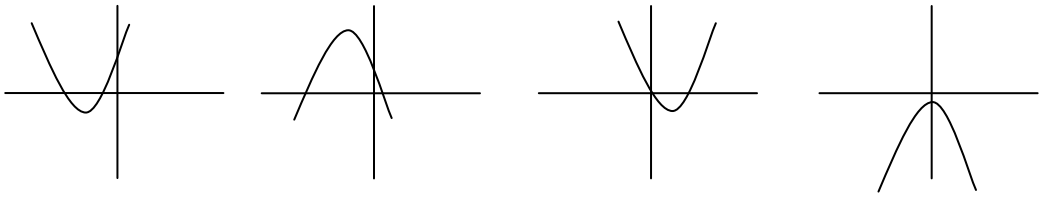
x						
y						



1. Parabolas & Axis of Symmetry

a. The path of a projectile is called a ***parabola***, and the line in the middle of the parabola is the ***axis of symmetry***.

b. ***Exercise***: Draw the ***axis of symmetry*** of the following parabolas.



c. Each parabola that you have seen is the graph of a ***quadratic function***.

2. Quadratic Function & Standard Form

a. For $a \neq 0$, the function $y = ax^2 + bx + c$ is a ***quadratic function***. When a quadratic function is written in the form $y = ax^2 + bx + c$, it is in ***standard form***.

b. ***Exercise***: Name the value of a, b, and c for each quadratic function.

i. $y = x^2 + 3x + 5$ $a =$ ____, $b =$ ____, $c =$ ____

ii. $y = -2x^2 - 5$ $a =$ ____, $b =$ ____, $c =$ ____

iii. $y = 2x^2 + x + 7$ $a =$ ____, $b =$ ____, $c =$ ____

iv. $y = 5x^2 - 12$ $a =$ ____, $b =$ ____, $c =$ ____

v. $y = -3x^2$ $a =$ ____, $b =$ ____, $c =$ ____

vi. $y = 4x^2 + 2x$ $a =$ ____, $b =$ ____, $c =$ ____

c. ***Exercise***: Write each quadratic function in standard form.

i. $y = 3 - 4x^2 + 2x$ standard form _____

ii. $y = 7x + 3 + 5x^2$ standard form _____

3. The role of "*a*" – Vertex (the highest or lowest point of a parabola)

a. When a parabola opens ***upward***, the y-coordinate of the vertex is the ***minimum*** value of the function.

b. When a parabola opens ***downward***, the y-coordinate of the vertex is the ***maximum*** value of the function.

c. How a affect the parabola?

a > 0,	***opens upward***
a < 0,	***opens downward***

a is positive, smiley face

a is negative, sad face

d. ***Exercise***: Tell whether each parabola opens ***upward or downward*** and whether the y-coordinate of the vertex is a ***maximum or minimum***.

i. $y = 0.2x^2$ opens _____ y-coordinate of the vertex is a _____

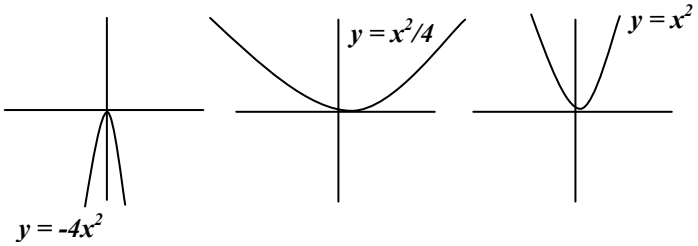
ii. $y = -0.5x^2$ opens _____ y-coordinate of the vertex is a _____

4. The role of "*a*" -- Width of a parabola

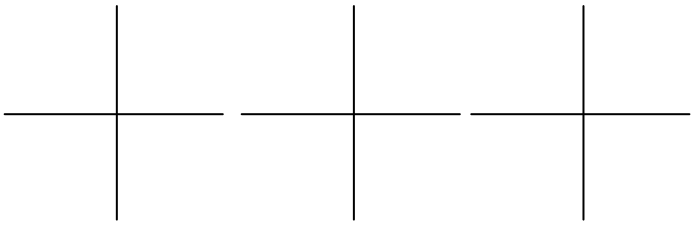
a. The value of ***a*** also affects the ***width of a parabola***.

The ***larger the |a|,***	the ***narrower*** the graph
The ***smaller the |a|,***	the ***wider*** the graph

b. Example: The quadratic functions: $y = -4x^2$, $y = x^2/4$, and $y = x^2$, where $y = -4x^2$ is the narrowest.



c. ***Exercise***: Roughly draw and order a group of quadratic functions $y = 2x^2$, $y = x^2/2$, $y = x^2$.



d. Order each group of quadratic functions from widest to narrowest graph.

1) *(A)* $y = 4x^2$, *(B)* $y = -2x^2$, *(C)* $y = \frac{1}{3}x^2$

2) *(A)* $y = -2x^2$, *(B)* $y = -x^2$, *(C)* $y = \frac{1}{5}x^2$

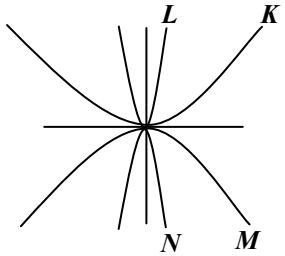
e. Match each of the following function with corresponding graph.

1) $y = 3x^2$

2) $y = -3x^2$

3) $y = \frac{1}{3}x^2$

4) $y = -\frac{1}{3}x^2$



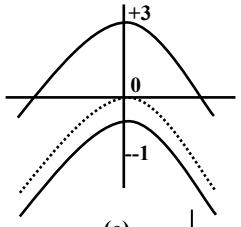
Aim: Students will be able to explore the quadratic functions and understand the role of ***c*** and ***b*** in $y = ax^2 + bx + c$.

DoNow: Graph the functions on graphing paper and compare their graphs:

1. **Changing *c***: Changing the value of ***c*** in the function $y = ax^2 + c$ changes the ***vertical position*** of the parabola. ***c*** is the ***y-intercept*** for the graph.

If c > 0,	***the graph shifts up.***
If c < 0,	***the graph shifts down.***

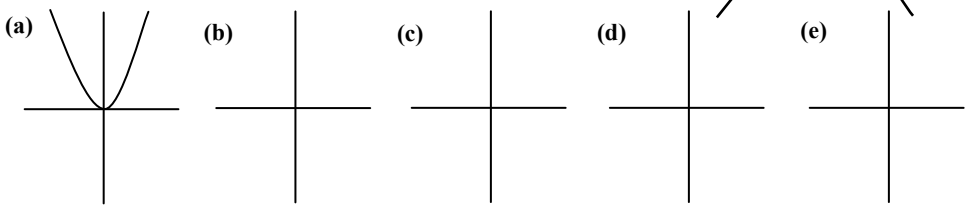
2. **Example**: Graphing and comparing the quadratic functions $y = -x^2$, $y = -x^2 + 3$, $y = -x^2 - 1$, and find the maximum value for each equation.



   a. $y = -x^2 + 3$, shifts the parabola $y = -x^2$ up 3 units.
   b. $y = -x^2 - 1$, shifts the parabola $y = -x^2$ down 1 unit.

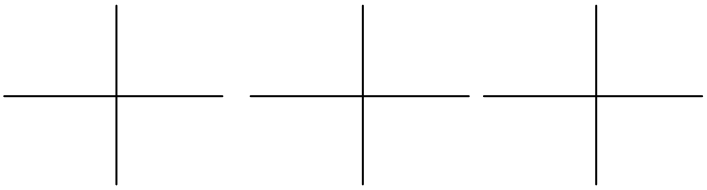
3. ***Exercise*:** If graph (a) is $y = 0.5x^2$, can you graph

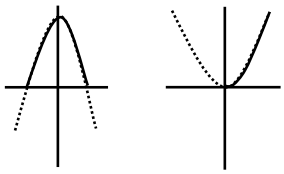
   a. $y = 0.5x^2$
   b. $y = 0.5x^2 + 2$
   c. $y = 0.5x^2 - 2$
   d. $y = -0.5x^2 + 2$
   e. $y = -0.5x^2 - 2$



4. **Graphing Calculator:** Using graphing calculator to graph quadratic functions.

   a. $y = x^2 - 2x$
   b. $y = x^2 - 3x + 2$
   c. $y = x^2 - 9$





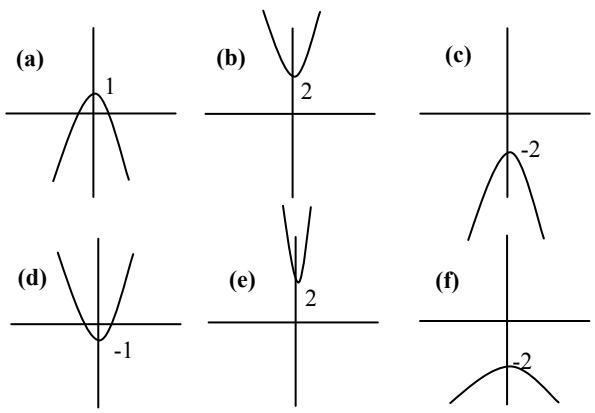
5. **Real-life data range:** No negative part for x or y values or for both values.

6. Describe whether each quadratic function has a maximum or minimum.

1) $y = 2x^2 + 7$	☐ maximum	☐ minimum	value = _____
2) $y = x^2 - 3$	☐ maximum	☐ minimum	value = _____
3) $y = -x^2 - 4$	☐ maximum	☐ minimum	value = _____
4) $y = -5x^2 + 12$	☐ maximum	☐ minimum	value = _____

7. Match each of the following function with corresponding graph.

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



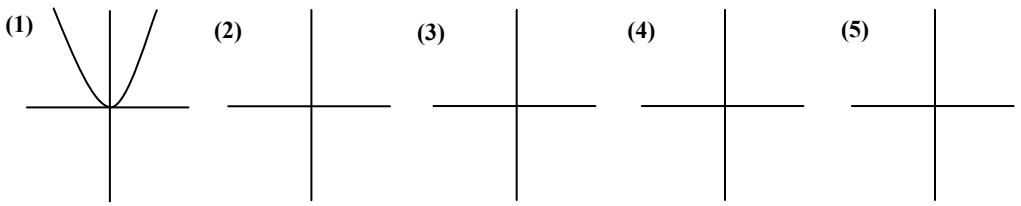
8. If graph (1) is $y = x^2$, can you graph

2) $y = x^2 - 3$

3) $y = x^2 + 3$

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

5) $y = -2x^2 - 3$



9. **Changing *b*:** So far, we only deal with $b = 0$. When $b \neq 0$, the parabola shifts right or left. The ***axis of symmetry*** is no longer the y-axis.

1) The graph of $y = ax^2 + bx + c$, where $a \neq 0$, has the line

$$x = \frac{-b}{2a} \text{ as its } \textit{axis of symmetry}$$

2) The ***x-coordinate of the vertex*** is $\frac{-b}{2a}$ and the

y-intercept* of the graph is *c

10. ***Example***: Graph the quadratic functions $y = 5 - 4x - x^2$.

1) Rewrite the function in ***standard form***: $y = -x^2 - 4x + 5$

2) Find the ***y-intercept c***: 5.

3) Find the equation of the ***axis of symmetry***: $x = -b/(2a) = -(-4)/(2 * (-1)) = -2$, i.e., $x = -2$

4) Find the ***coordinates of the vertex***: ***x***-coordinate of the vertex is –2. Substitute –2 for ***x***, and we get $y = -(-2)^2 - 4(-2) + 5 = 9$. So, the vertex is at (–2, 9).

5) Make the table of value and graph the function.

11. ***Exercise*:** Find the equation of the ***axis of symmetry*** for the following quadratic functions.

1) $y = x^2 - 4x + 4$ axis of symmetry: _____

2) $y = x^2 + 6x + 5$ axis of symmetry: _____

12. ***Exercise*:** Find the coordinates of the ***vertex*** and the ***y-intercepts*** for the following quadratic functions.

1) $y = x^2 - 2x + 1$ vertex: _____ y-intercept: _____

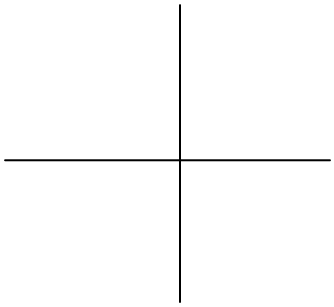
2) $y = x^2 + 4x + 4$ vertex: _____ y-intercept: _____

13. ***Exercise*:** Graph $y = x^2 - 6x + 9$. Find the equation of the axis of symmetry, the coordinates of the vertex, and the *y*-intercept.

axis of symmetry: _____

vertex: _____

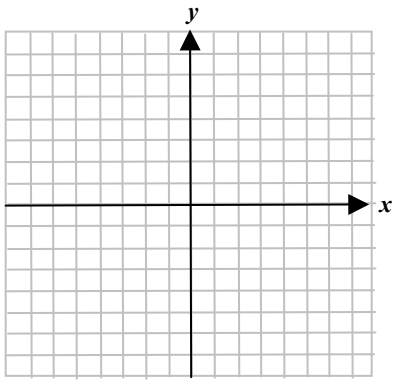
y-intercept: _____



Find the equation of the *axis of symmetry*, coordinates of the *vertex,* and y-intercept and graph the following quadratic functions.

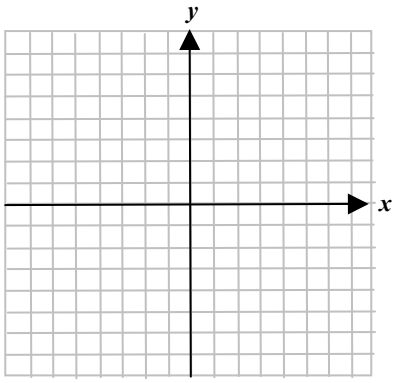
a. $y = x^2 - 4$ axis of symmetry: _____ vertex: _____ y-intercept: _____

x					
y					



b. $y = x^2 - 5x + 6$ axis of symmetry: _____ vertex: _____ y-intercept: _____

x					
y					



c. $y = -x^2 + 3x - 2$ axis of symmetry: _____ vertex: _____ y-intercept: _____

x					
y