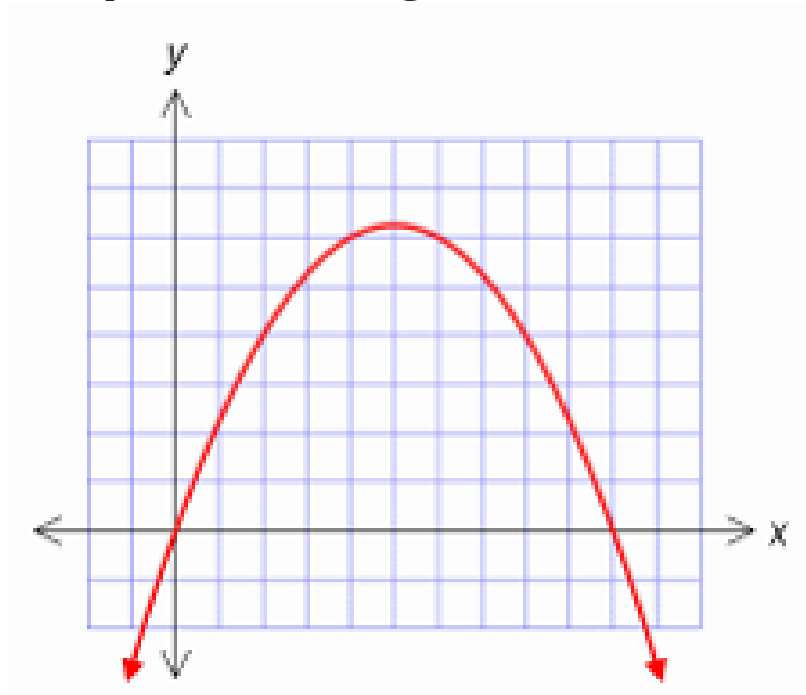


## Properties of Quadratic Functions



Functions in mathematics have different characteristics that help describe them. Quadratic Functions are no different.

Quadratic functions' shape, direction and location are some of the properties that will be explored in-depth in this learning experience.

## Targeted Learning Outcomes

It is expected that you will be able to:

Demonstrate an understanding of the characteristics of quadratic functions, including

1. vertex
2. intercepts
3. domain and range
4. axis of symmetry

By the end of this learning experience, you can demonstrate that you are able to:

1. Determine, with technology, the intercepts of the graph of a quadratic function or the roots of the corresponding quadratic equation.
2. Explain the relationships among the roots of an equation, the zeros of the corresponding function, and the  $x$ -intercepts of the graph of the function.
3. Explain, using examples, why the graph of a quadratic function may have zero, one, or two  $x$  intercepts.
4. Determine, with technology, the coordinates of the vertex of the graph of a quadratic function.
5. Determine the equation of the axis of symmetry of the graph of a quadratic function, given the  $x$ -intercepts of the graph.
6. Determine the domain and range of a quadratic function.
7. Sketch the graph of a quadratic function.

## Mental Math 1

Answer the following questions without a calculator.

Make a note of the solutions you come up with.

Evaluate:  $4^2$

Solve for y:  $2x + y = 8$

Evaluate:  $2 \times 3^2$

The distance between a cabin and a lake is 68 ft. A tree is halfway between the cabin and the lake. How far is the tree from the cabin?

Cole wants to buy a pair of shoes. The shoes are \$85.00 at regular price.

Today, there is a 10% off sale. If Cole buys them today, how much does he save?

$$\underline{85 \times 0.1 = \$8.50}$$

$$\begin{array}{l} \cancel{2x} + y = 8 - 2x \\ \underline{y = 8 - 2x} \end{array}$$

## Quadratic Functions

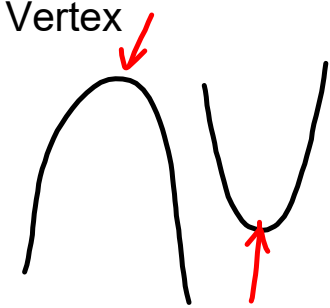
**Recall that a function is a special type of relation where each element in the domain is associated with exactly one element in the range.**

**A quadratic function is a polynomial function in the form  $y = ax^2 + bx + c$  (standard form), where  $a$  cannot be zero, i.e. there will be a term with an  $x^2$ . The degree of all quadratic functions is 2.**

**A word that may be used to describe the shape of quadratic functions is parabola.**

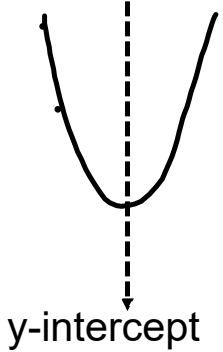
## Definitions

Vertex



The highest or lowest point of the parabola.

Line of symmetry



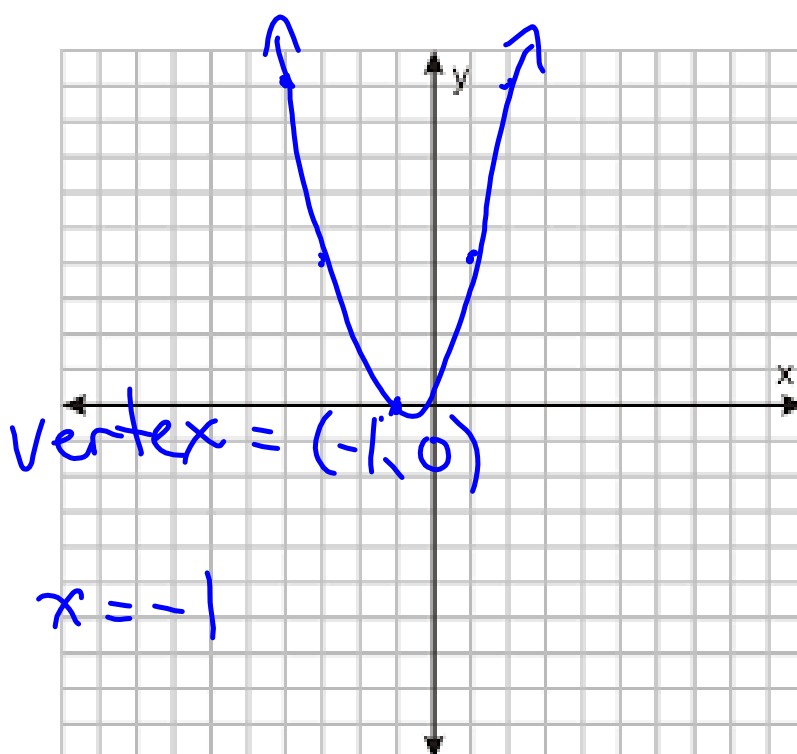
Axis of Symmetry is the vertical line that can be drawn through the middle of the parabola.  
 $x = h$   $h$  is the  $x$ -coordinate of the vertex

The point at which the graph crosses the  $y$ -axis.

$$y = ax^2 + bx + c \quad \leftarrow y\text{-intercept}$$

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

<del>-4x</del>	9
-3	4
-2	1
-1	0
0	1
1	4
2	9
3	



$$y = ax^2 + bx + c$$

The effect of a

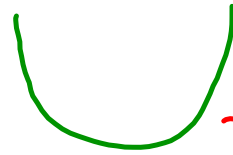
$$y = -x^2 + 2x + 1$$



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

a is bigger  
parabola gets skinny

$$y = \frac{1}{4}x^2 + 2x + 1$$



when a is  
smaller the  
parabola gets  
wider

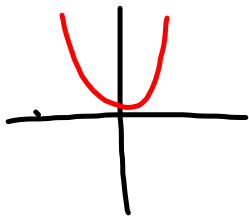
$$y = -x^2 + 2x + 1$$



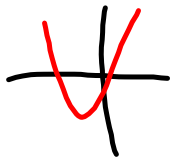
When a is negative  
the parabola points down

The effect of b

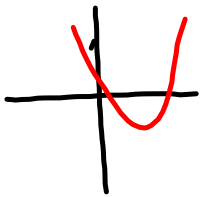
$$y = x^2$$



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



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



$$y = ax^2 + bx + c$$

when  $b = 0$

When b gets bigger  
the graph moves to  
the left.

When b gets smaller  
the graph shifts to  
the right.



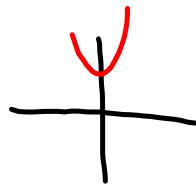
The Effect of C

$$y = x^2$$



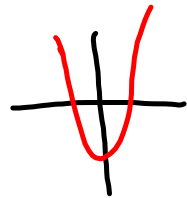
c = y-intercept

$$y = x^2 + 3$$



When c is increased  
the graph shifts  
UP

$$y = x^2 - 3$$



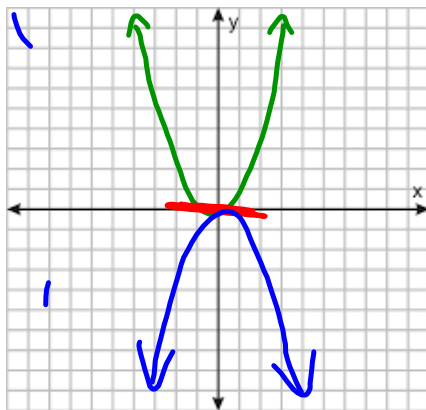
When C is decreased  
the graph shifts  
down.

## Min Value vs Max Value

$$y = \underline{a}x^2 + bx + c$$

+ or -  
 $y = x^2$   
 min value  
 $(0, 0)$

$y = -x^2$   
 max value  
 $(0, 0)$



min/max  
 Value occur  
 at the vertex  
 when a is positive  
 $\rightarrow$  min value.

When a is  
 negative  
 $\rightarrow$  max value.

## Domain and Range

Domain  $\rightarrow$  The  $x$  values of a quadratic function

$$\underline{\{x \mid x \in \mathbb{R}\}}$$

The set of all real numbers.

Range  $\rightarrow$  The  $y$  values of a quadratic function.

(min/max value is important to know)

Ex.  $y = x^2$   
min  $\rightarrow y = 0$

$$\{y \mid y \geq 0, y \in \mathbb{R}\}$$

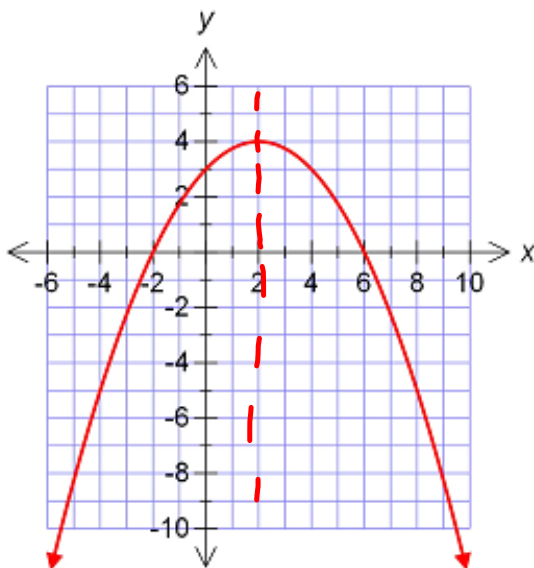
$$y \geq$$

$y = -x^2$   
max  
 $y \leq$

The set of all values greater than or equal to 0.

### Reading Information From a Graph

**Example:** The graph of a quadratic function is given below.



1. What are the coordinates of the vertex?
2. In what direction does the parabola point?
3. What is the sign on the  $a$  value?
4. What is the equation of the axis of symmetry?
5. What is the  $y$ -intercept?
6. What are the  $x$ -intercepts?
7. What is the domain and range of the quadratic function?

1.  $(2, 4)$     2. Down    3. negative  
 4.  $x = 2$     5.  $(0, 3)$     6.  $(-2, 0), (6, 0)$   
 7.  $\{x \mid x \in \mathbb{R}\}$      $\{y \mid y \leq 4, y \in \mathbb{R}\}$