# CHAPTER 6

# Quadratic Functions

Math 1201: Linear Functions $y = mx + b$

$y = 3x - 4$

$3x$ is the linear term

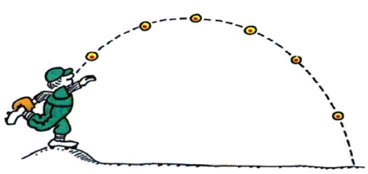
3 is the leading coefficient

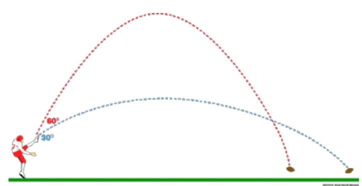
-4 is the constant term

Math 2201: Quadratic Functions

Math 3201: Cubic, Quartic, Quintic Functions

**Section 6.1:** Exploring Quadratic Relations





The path a ball travels
gives a special "U" shape
called a "***parabola***."

***Quadratic Functions:***

→ the shape is a parabola

→ the simplest quadratic function is $y = x^2$

(The word *quadratic* comes from the word *quadratum*, a Latin word meaning *square*.)

How to create a quadratic function?

↳ the result of multiplying two linear functions:

Example:

$(i) \quad y=(x+1)(x-4)$

$(ii) \quad y=(3x-2)^2$

What do you notice about the degree (highest exponent of the variable) of the function?

Which of the following functions are quadratic?

i) $y = 5(x+3)$

ii) $y = 5x(x+3)$

iii) $y = 5(x^2+3)$

iv) $y = (5x+1)(x+3)$

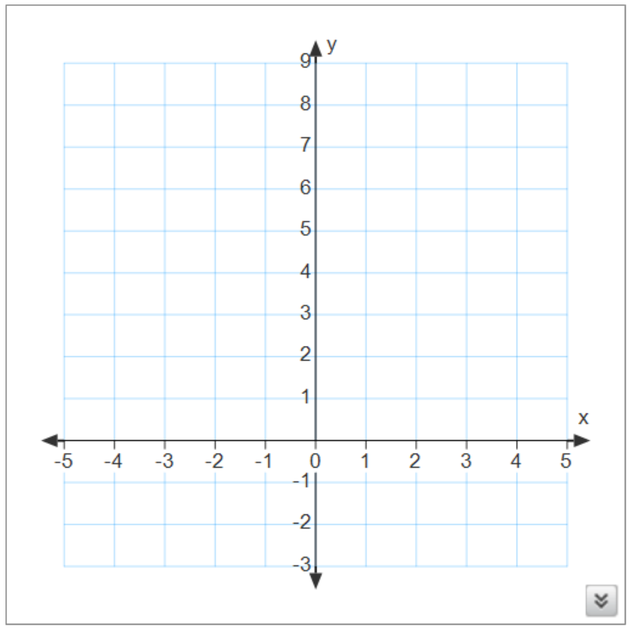
v) $y = 5^2(x+3)$

vi) $y = 5(x+3)^2 + 2$

Characteristics of the basic quadratic function $y = x^2$.

Create table of values

| x | y |
|---|---|
| -2 | |
| -1 | |
| 0 | |
| 1 | |
| 2 | |




What is the vertex?__________

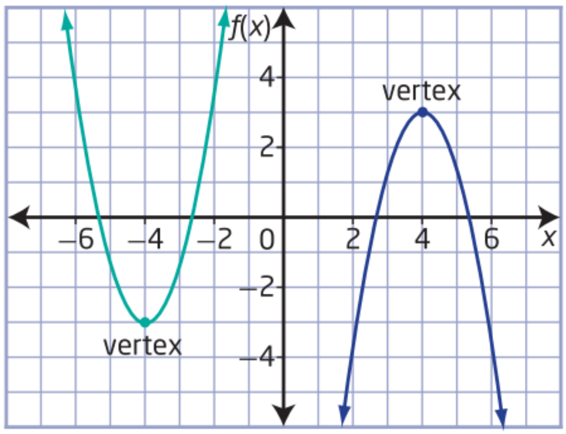
What is the x-intercept?__________

What is the y-intercept?__________

What is the domain and range? Domain:__________

Range:__________

***Direction of Opening:  a parabola can open up or down.***

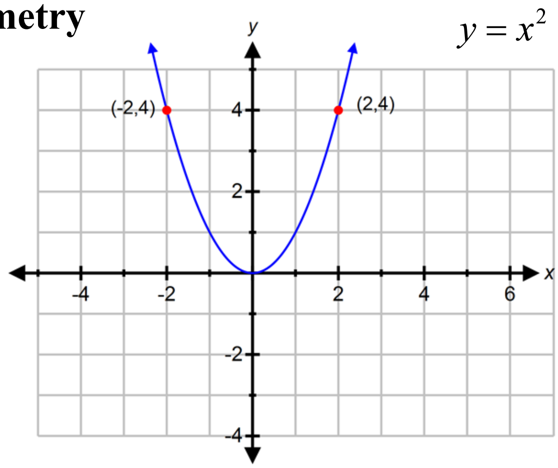



When the graph opens **up** the vertex is the lowest point on the graph and the y-coordinate of the vertex is the minimum value of the function.

When the graph opens **down** the vertex is the highest point on the graph and the y-coordinate of the vertex is the maximum value of the function.

## *Axis of Symmetry*

- The parabola is symmetric about a vertical line called the **axis of symmetry**




- This lines divides the graph into two equal parts.
- It is the mirror image
- It intersects the parabola at the vertex

The equation of the axis of symmetry corresponds to the <u>*x*-coordinate</u> of the vertex

- What is the equation of the axis of symmetry for the above graph?

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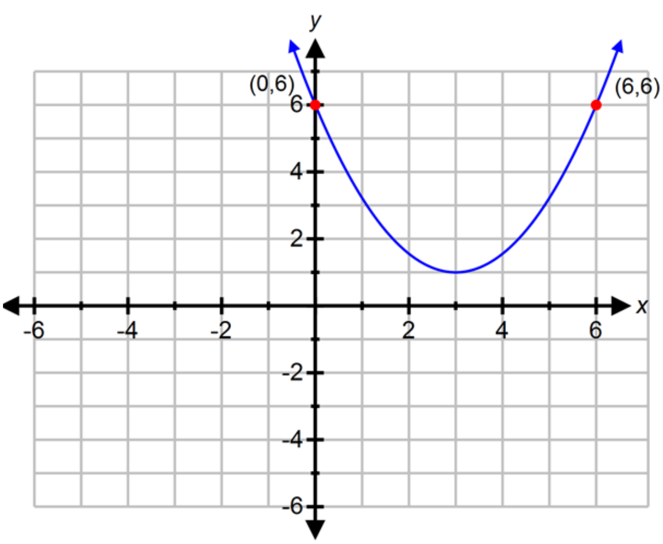
Another Example:




What is the equation of the axis of symmetry?

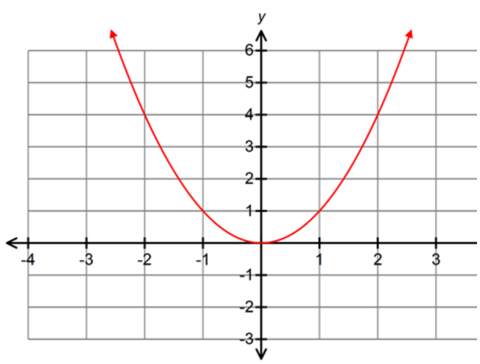
***Relation vs Function***

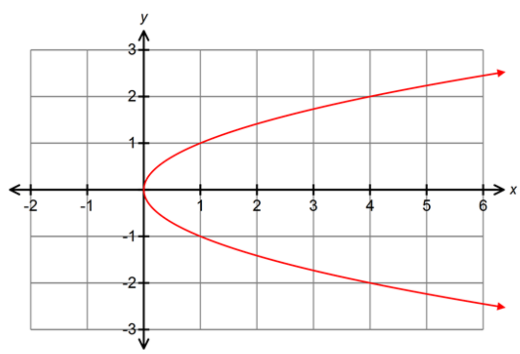
Why are quadratic *relations* also quadratic *functions*?

> For every value of $x$ there is only one value for $y$.

> It passes the vertical line test!

Think about:



## *Standard Form of A Quadratic Function:*

$$y = ax^2 + bx + c \quad \text{where} \quad a \neq 0$$

Terminology:

- $ax^2$ = the ***quadratic term***
- $a$ = the ***coefficient*** of the quadratic term

Example: $y = 3x^2 - 4x + 1$

$3x^2 \longrightarrow$ ________ term and 3 is the ________________

$-4x \longrightarrow$ ________ term and -4 is the ________________

$1 \longrightarrow$ ________

# ***Standard Form of A Quadratic Function:***

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

↳ Investigate the parameters $a$ , $b$ and $c$

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Part A: The Effect of ***a*** in $y = ax^2$ on the graph of $y = x^2$

1) What happens to the direction of the opening of the quadratic if $a < 0$ or $a > 0$ ?

2) If the quadratic opens upward, is the vertex a maximum or minimum point?

3) If the quadratic opens downward, is the vertex a maximum or minimum point?

4) Is the shape of the parabola effected by the parameter $a$ ?
Are some graphs wider or narrower compared to the original $y = x^2$ ?

5) What happens on the graph when $a = 0$ ?

## Part B. The Effect of $b$ on the graph of $y = x^2$

What is the effect of parameter $b$ in $y = x^2 + bx$ on the graph of $y = x^2$ ?

- ***b*** changes the location of the:__________and the ___________

## Part C. The Effect of $c$ on the graph of $y = x^2$

What is the effect of parameter $c$ in $y = x^2 + c$ on the graph of $y = x^2$?

- the $c$-value changes the ___________________

## In Summary

### Key Ideas

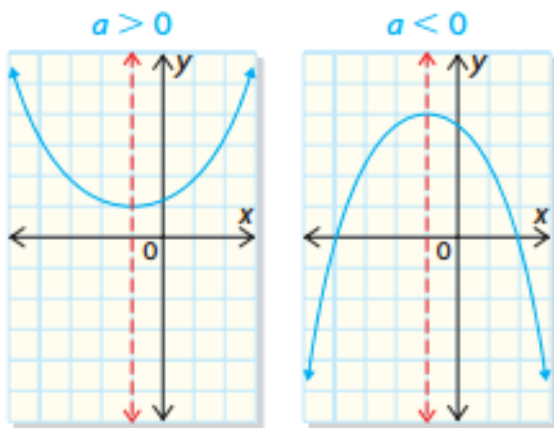
- The degree of all quadratic functions is 2.
- The standard form of a quadratic function is

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

  where $a \neq 0$.
- The graph of any quadratic function is a parabola with a single vertical line of symmetry.

### Need to Know

- A quadratic function that is written in standard form, $y = ax^2 + bx + c$, has the following characteristics:
  - The highest or lowest point on the graph of the quadratic function lies on its vertical line of symmetry.
  - If $a$ is positive, the parabola opens up. If $a$ is negative, the parabola opens down.




  - Changing the value of $b$ changes the location of the parabola's line of symmetry.
  - The constant term, $c$, is the value of the parabola's $y$-intercept.

***Work Sample*** **6.1: pg. 324 #s 1a-f, 2a-e, 5a-d**