

10.1 Graph $ax^2 + c$

A quadratic function is a nonlinear function that can be written in the standard form:

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

Every quadratic function has a U-shaped graph called a parabola.

This section, $b = 0$ so there is no bx term.

KEY CONCEPT For Your Notebook

Parent Quadratic Function

The most basic quadratic function in the family of quadratic functions, called the **parent quadratic function**, is $y = x^2$. The graph of $y = x^2$ is shown below.

The lowest or highest point on a parabola is the **vertex**. The vertex of the graph of $y = x^2$ is $(0, 0)$.

The line that passes through the vertex and divides the parabola into two symmetric parts is called the **axis of symmetry**. The axis of symmetry for the graph of $y = x^2$ is the y-axis, $x = 0$.

KEY CONCEPT For Your Notebook

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

Compared with the graph of $y = x^2$, the graph of $y = ax^2$ is:

- a vertical stretch if $a > 1$
- a vertical shrink if $0 < a < 1$

Compared with the graph of $y = x^2$, the graph of $y = ax^2$ is:

- a vertical stretch with a reflection in the x-axis if $a < -1$,
- a vertical shrink with a reflection in the x-axis if $-1 < a < 0$.

Compared with the graph of $y = x^2$, the graph of $y = x^2 + c$ is:

- an upward vertical translation if $c > 0$,
- a downward vertical translation if $c < 0$.

EXAMPLE 1 Graph $y = ax^2$ where $|a| > 1$

Given: $y = 2x^2$

a. Complete the table of values

x	-2	-1	0	1	2
$2x^2$	$2(-2)^2$	$2(-1)^2$	$2(0)^2$	$2(1)^2$	$2(2)^2$
y	8	2	0	2	8

b. Identify its domain and range
 $D: \mathbb{R}$ $R: y \geq 0$

c. Compare to the parent function
 graph of $y = x^2$ **vertical stretch**

d. Graph the function and the parent function

EXAMPLE 2 Graph $y = ax^2$ where $|a| < 1$

Given: $y = -1/4 x^2$

a. Complete the table of values

x	-4	-2	0	2	4
$-1/4 x^2$	$-1/4(-4)^2$	$-1/4(-2)^2$	$-1/4(0)^2$	$-1/4(2)^2$	$-1/4(4)^2$
y	-4	-1	0	-1	-4

b. Identify its domain and range
 $D: X = \mathbb{R}$ $R: y \leq 0$

c. Graph the function and the parent function

Reflected over x-axis
vertical shrink

EXAMPLE 3 Graph $y = x^2 + c$

Given: $y = x^2 - 2$

a. Complete the table of values

x	-2	-1	0	1	2
$x^2 - 2$	$(-2)^2 - 2$	$(-1)^2 - 2$	$(0)^2 - 2$	$(1)^2 - 2$	$(2)^2 - 2$
y	2	-1	-2	-1	2

b. Identify its domain and range
 $D: X = \mathbb{R}$ $R: y \geq -2$

c. Compare to the parent function graph of $y = x^2$ **shifted down 2**

d. Graph the function and the parent function

EXAMPLE 4 Graph $y = ax^2 + c$

Given: $y = -2x^2 + 4$

a. Complete the table of values

x	-2	-1	0	1	2
y	-2(-2) ² +4	-2(-1) ² +4	-2(0) ² +4	-2(1) ² +4	-2(2) ² +4
	-4	2	4	2	-4

b. Identify its domain and range
 D: $x = \mathbb{R}$ R: $y \leq 4$

c. Graph the function and the parent function

d. Compare to the parent function graph of $y = x^2$

Shifted up 4
 Reflected over x-axis
 Vertical stretch

EXAMPLE 5 Standardized Test Practice

How would the graph of the function $y = x^2 + 6$ be affected if the function were changed to $y = x^2 + 2$?

(A) The graph would shift 2 units up.
 (B) The graph would shift 4 units up.
 (C) The graph would shift 4 units down.
 (D) The graph would shift 4 units to the left.

Example 6- Extended Response

Egg Contest For an engineering contest, you have to create a container for an egg so that the container can be dropped from a height of 30 feet without breaking the egg.

The height y (in feet) of the dropped container is given by the function $y = -16t^2 + 30$ where t is the time (in seconds since the container is dropped).

- Graph the function.
- Identify the range of the function in this situation.
- Find the egg's height at 1 second.
- Use the graph to estimate when the egg is at a height of 10 feet.
- Use the graph to estimate when the egg is on the ground.



Example 6

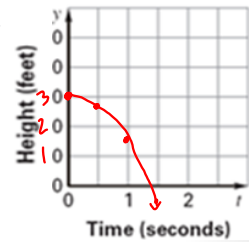
✓ Table/Graph

- R: $0 \leq y \leq 30$
- Height at 1 sec. 14 ft
- Approximate time when height is 10 feet. 1.2
- Approximate time when height is 0 feet (ground). 1.4

$$y = -16t^2 + 30$$

$$y = -16(1.5)^2 + 30$$

x	0	1/2	1	1.5	2
y	30	26	14	-6	



Homework

10.1 Pracce B Worksheet