

Algebra 1 · Graphing Quadratic Functions · Lesson

Common Core F-IF.C.7a, F-IF.C.8a, F-IF.B.4, A-SSE.B.3b · mathovore.fr

A quadratic function has the form $f(x) = ax^2 + bx + c$ with $a \neq 0$, and its graph is a U-shaped curve called a parabola. The vertex is the highest or lowest point, the axis of symmetry is the vertical line through it, and the intercepts show where the graph meets the axes. Vertex form and factored form reveal these features directly.

Algebra 1 Common Core: F-IF.C.7a · F-IF.C.8a · F-IF.B.4 · A-SSE.B.3b

Key facts:

- Standards F-IF.C.7a, F-IF.C.8a, F-IF.B.4 and A-SSE.B.3b: graph quadratics, rewrite them, and interpret key features.
- The axis of symmetry is $x = -\frac{b}{2a}$, and the vertex lies on it.
- Vertex form $a(x-h)^2 + k$ shows the vertex; factored form $a(x-p)(x-q)$ shows the zeros.
- If $a > 0$ the vertex is a minimum; if $a < 0$ it is a maximum.
- In a projectile model, the vertex gives the maximum height and the positive zero gives the landing time.

What is a quadratic function?

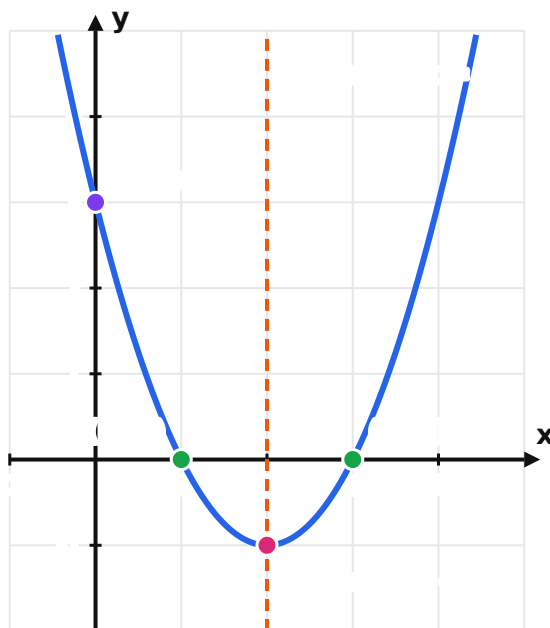
A **quadratic function** can be written $f(x) = ax^2 + bx + c$ with $a \neq 0$. Its graph is a U-shaped curve called a **parabola**. When $a > 0$ the parabola opens up and has a lowest point; when $a < 0$ it opens down and has a highest point.

Vocabulary

Vertex: the turning point of the parabola, which is its maximum or minimum.

Axis of symmetry: the vertical line through the vertex that splits the parabola into mirror images.

x-intercepts (zeros): points where the graph meets the x-axis, so $f(x) = 0$. **y-intercept:** the point $(0, c)$.



The parabola $y = x^2 - 4x + 3$ with its vertex, axis of symmetry and intercepts.

What do the three forms tell you?

Every quadratic can be written in different forms. Each form shows a feature at a glance, so choose the form that answers your question.

Form	Equation	Shows directly
Standard	$y = ax^2 + bx + c$	y-intercept c ; axis $x = -\frac{b}{2a}$
Vertex	$y = a(x - h)^2 + k$	vertex (h, k)
Factored	$y = a(x - p)(x - q)$	zeros p and q

Standard form

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

y-intercept: 3
axis: $x = -b/(2a)$

Vertex form

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

vertex: (2, -1)
max or min: -1

Factored form

$$y = (x - 1)(x - 3)$$

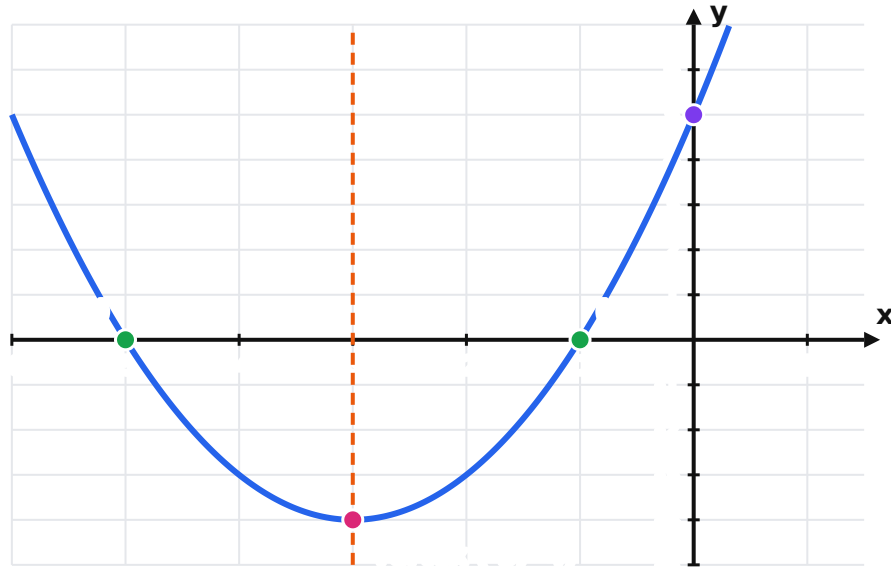
zeros: 1 and 3
axis: $x = 2$

One parabola, three forms: each form makes a different feature easy to read.

How do you graph a parabola?

1. Find the axis of symmetry with $x = -\frac{b}{2a}$.
2. Substitute that x -value to get the vertex.
3. Find the intercepts: $y = c$ at $x = 0$, and solve $y = 0$ for the zeros.
4. Plot the points, reflect them across the axis, and draw a smooth curve.

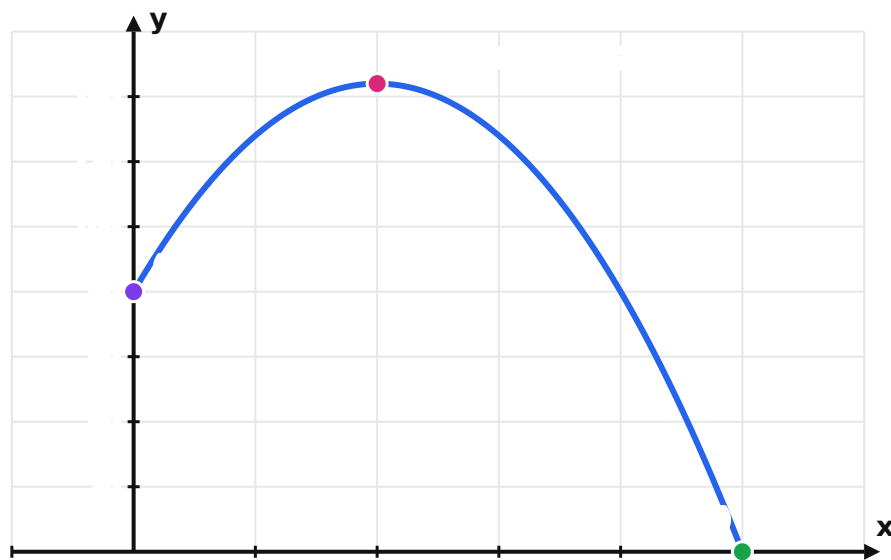
Worked example. Graph $y = x^2 + 6x + 5$. The axis is $x = -\frac{6}{2} = -3$ and $y = 9 - 18 + 5 = -4$, so the vertex is $(-3, -4)$. Completing the square confirms it: $x^2 + 6x + 9 - 9 + 5 = (x + 3)^2 - 4$. Factoring gives $(x + 1)(x + 5)$, so the zeros are -1 and -5 , and the y-intercept is 5.



The graph of $y = x^2 + 6x + 5 = (x + 3)^2 - 4$, with its axis of symmetry dashed.

How are parabolas used to model real situations?

A launched object follows a parabola. If a ball leaves a platform so that $h(t) = -16t^2 + 64t + 80$, the axis is $t = 2$ and the highest point is $h(2) = 144$ feet. Factoring $-16(t - 5)(t + 1)$ shows the ball lands at $t = 5$ seconds; the zero $t = -1$ is not part of the story. Areas work the same way: a rectangle with a fixed amount of fence has its largest area at the vertex of the area function.



Height h (feet) of a launched ball after t seconds.

Graphing Quadratic Functions: frequently asked questions

How do you find the vertex of a parabola?

Use $x = -\frac{b}{2a}$ to find the x-coordinate, then substitute it into the function to find the y-coordinate. In vertex form $y = a(x-h)^2 + k$, the vertex is simply (h, k) .

What does the sign of a tell you?

If $a > 0$ the parabola opens up and the vertex is a minimum. If $a < 0$ it opens down and the vertex is a maximum. A larger $|a|$ makes the parabola narrower.

How many x-intercepts can a parabola have?

A parabola can cross the x-axis at two points, touch it at exactly one point (the vertex), or miss it completely. A parabola that opens up with its vertex above the axis has none.

Why complete the square?

Completing the square rewrites $ax^2 + bx + c$ in vertex form $a(x-h)^2 + k$, which shows the vertex and the maximum or minimum value without graphing.

How do you find the maximum height of a thrown object?

Write its height as a quadratic function of time with a negative leading coefficient. The maximum height is the y-value of the vertex, found at $t = -\frac{b}{2a}$.