

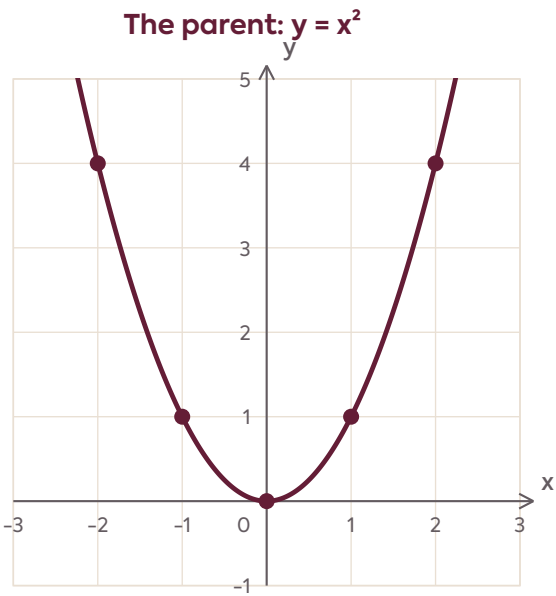
LESSON 30 | MEET THE IDEA

Quadratic graphs and their key features

Thursday, February 11, 2027 . 6:00–7:00 PM Central

By the end, I can...
Read a quadratic graph, identify its key features, and state a sensible domain and range in mathematics and in context.

A **quadratic function** can be written $y = ax^2 + bx + c$, with $a \neq 0$. Its graph is a curved shape called a **parabola**. Begin with $y = x^2$.



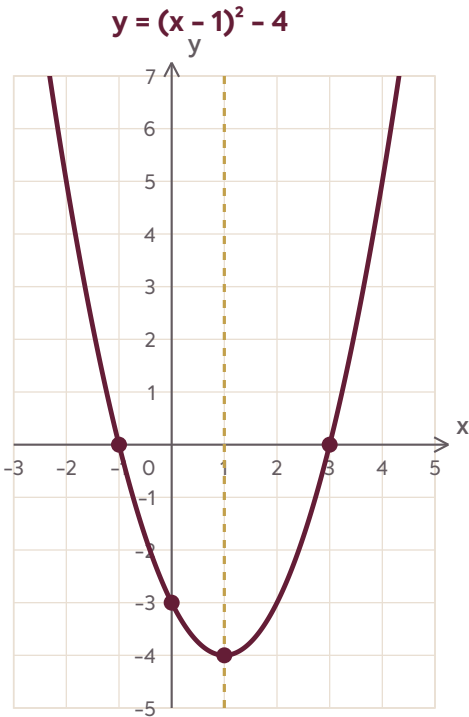
- Vertex: (0, 0)**
The lowest point.
- Axis of symmetry: $x = 0$**
The left and right halves mirror each other.
- Opening: upward**
Both arms continue beyond the window.

x	-2	-1	0	1	2
$y = x^2$	4	1	0	1	4

Plot the table points, then draw a smooth curve through them. Equal distances left and right of the axis give equal y-values. Do not join the points with sharp corners.

LESSON 30 | VERTEX, INTERCEPTS AND SYMMETRY

Read a parabola like a map



- Vertex:** (1, -4)
- Axis:** $x = 1$ (dashed)
- Minimum value:** -4
- x-intercepts:** (-1, 0), (3, 0)
- Zeros:** -1 and 3
- y-intercept:** (0, -3)

The dots mark the vertex and intercepts. The curve continues past the graph window.

Feature	What it tells you
Vertex (h, k)	The turning point. Here it is (1, -4).
Axis $x = h$	A vertical line through the vertex, not a single point.
Zero versus x-intercept	A zero is an x-value, such as 3. The corresponding intercept is a point, (3, 0).
y-intercept	Where $x = 0$. Here $(0 - 1)^2 - 4 = -3$.

LESSON 30 | INPUTS, OUTPUTS AND RESTRICTIONS

Domain and range answer different questions

Domain: which x-values can go in?

Range: which y-values can come out? A graph window shows only part of an unrestricted quadratic.

Function	Domain	Range
$y = (x - 1)^2 - 4$	All real x	$y \geq -4$
$y = -(x + 2)^2 + 5$	All real x	$y \leq 5$
$y = x^2 + 2$	All real x	$y \geq 2$

Why the vertex gives the range

In $y = a(x - h)^2 + k$, the squared part is never negative.

a > 0: the graph opens up; its minimum value is k, so $y \geq k$.

a < 0: it opens down; its maximum value is k, so $y \leq k$.

These range rules assume the full, unrestricted quadratic.

A parabola may have two, one or no real zeros

$y = x^2 - 1$: crosses the x-axis twice, at $x = -1$ and $x = 1$.

$y = x^2$: touches the x-axis at $x = 0$.

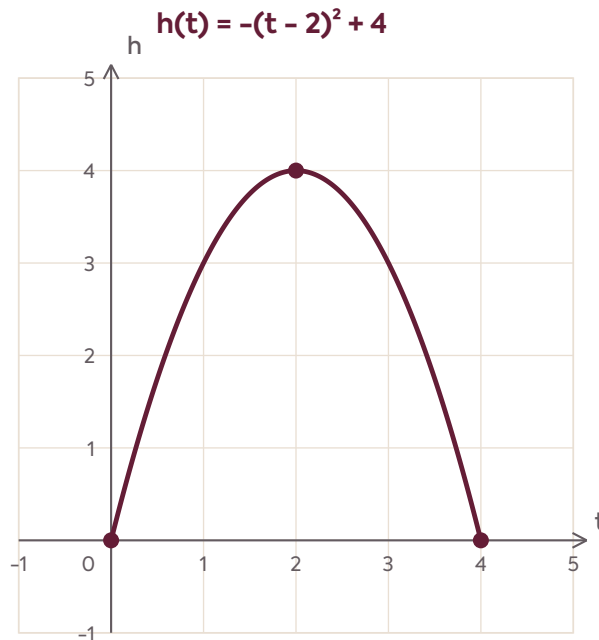
$y = x^2 + 2$: never reaches the x-axis; there are no real zeros.

For an unrestricted quadratic, all real x may also be written $-\infty < x < \infty$. Infinity is not a number you substitute into the function.

LESSON 30 | A SIMPLE HEIGHT MODEL

A story can restrict the graph

A fictional model describes an object rising from the ground and returning to it: $h(t) = -(t - 2)^2 + 4$. Time t is in seconds; height h is in meters. Use the model only from launch to return.



Time t : seconds
Height h : meters

Start: $(0, 0)$
Highest point: $(2, 4)$
Return: $(4, 0)$

Only the part from $t = 0$ to $t = 4$ is used in this model.

Read the restrictions from the situation

Domain: $0 \leq t \leq 4$. The modeled time starts at launch and ends on return.

Range: $0 \leq h \leq 4$. The object stays between ground level and its maximum height in this interval.

The full formula would give $h(5) = -5$. That does not mean this story continues five meters below ground: $t = 5$ is outside the chosen model. A formula can be defined beyond the part that makes sense in a situation.

LESSON 30 | READ, CALCULATE AND EXPLAIN

Your turn

Use a table or graphing tool if helpful. State exact values for these examples. These are study checks, not the graded unit checkpoint.

1. For $y = (x - 2)^2 - 1$, make a table for $x = 0, 1, 2, 3, 4$. Identify the vertex, axis, intercepts and zeros.

2. For the unrestricted function in Question 1, state the domain, range and minimum value.

3. For $y = -(x + 1)^2 + 4$, identify the vertex, axis, maximum value, range and y-intercept.

4. Does $y = x^2 + 3$ have real zeros? Explain without trying every x-value.

5. In the height model on the previous page, find the height at $t = 1$ and $t = 3$. Explain the equal heights and why $t = 6$ should not be used.

LESSON 30 | WORKED ANSWERS

Check the feature, not just the number

1. The y-values are **3, 0, -1, 0, 3**. Vertex: **(2, -1)**; axis: **$x = 2$** . The x-intercepts are **(1, 0), (3, 0)**, so the zeros are **1 and 3**. The y-intercept is **(0, 3)**.
2. Domain: **all real x**. The graph opens up and its lowest output is -1, so the range is **$y \geq -1$** and its minimum value is **-1**.
3. Vertex: **(-1, 4)**; axis: **$x = -1$** ; maximum value: **4**. The full graph opens down, so its range is **$y \leq 4$** . At $x = 0$, $y = -(1)^2 + 4 = 3$, giving **(0, 3)**.
4. **No real zeros**. Since $x^2 \geq 0$ for every real x , $x^2 + 3 \geq 3$. The graph stays above the x-axis.
5. $h(1) = -(-1)^2 + 4 = 3$ **meters**; $h(3) = -(1)^2 + 4 = 3$ **meters**. The times are equally far from $t = 2$, the axis of symmetry. **$t = 6$ is outside $0 \leq t \leq 4$** , the chosen time interval.

When using a graphing tool

Enter parentheses exactly. Adjust the window until you can see the vertex and relevant intercepts. An off-screen point is not a missing point. Use a table or substitution to confirm coordinates.

I can...

- ☐ Distinguish a vertex point from its minimum or maximum value.
- ☐ Read intercepts, zeros and the axis of symmetry.
- ☐ Keep a context domain separate from a graph window.

Next class: transform the parent parabola. Curriculum focus: A.6A, A.7A.