

Graphing parabolas 1

Notes & Steps



Key idea

A parabola in vertex form can be written as $y = a(x - h)^2 + k$. The vertex is (h, k) , the axis is $x = h$, and a controls the opening direction and how steep or wide the graph looks.

What you can read fast

1. If $a > 0$, the graph opens upward.
2. If $a < 0$, the graph opens downward.
3. If $|a| > 1$, the graph is narrower than $y = x^2$.
4. If $0 < |a| < 1$, the graph is wider than $y = x^2$.

Common mistake

Thinking a bigger a moves the vertex. It does not. Changing a changes the shape and direction, but the vertex stays at (h, k) .

Useful reminders

5. The vertex stays (h, k) even when $a \neq 1$.
6. Points the same distance from the axis still have the same y -value.
7. Use the vertex first, then one point on each side, then intercepts if needed.
8. A negative a reflects the graph across the x -axis.

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Example 1: reading the graph

For $y = 2(x - 1)^2 - 3$, the vertex is $(1, -3)$ and the axis is $x = 1$. Because $a = 2$, the graph opens upward and is narrower than $y = x^2$.

Example 2: using symmetry

Still using $y = 2(x - 1)^2 - 3$:

$$y(0) = 2(0-1)^2 - 3 = -1, \quad y(2) = 2(2-1)^2 - 3 = -1$$

The inputs 0 and 2 are both one unit from the axis, so they match.

Try these

1. State the vertex and axis of $y = -3(x + 2)^2 + 4$.
2. Is $y = \frac{1}{2}(x - 5)^2 + 1$ wider or narrower than $y = x^2$?
3. Find y when $x = 0$ for $y = 2(x - 3)^2 - 4$.

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Example 3: finding roots

For $y = 2(x - 1)^2 - 8$, set $y = 0$:

$$2(x - 1)^2 = 8 \Rightarrow (x - 1)^2 = 4$$

So $x - 1 = \pm 2$, giving roots $x = -1$ and $x = 3$.

Example 4: finding a

If the vertex is $(2, -1)$ and the graph passes through $(3, 1)$, then

$$1 = a(3 - 2)^2 - 1$$

so $1 = a - 1$, giving $a = 2$. The equation is $y = 2(x - 2)^2 - 1$.

Common mistake

Using only the vertex to sketch and forgetting to test another point. Different values of a can share the same vertex but have very different widths.