Writing the Equation of a Parabola from Its Graph

A free worksheet on finding a quadratic equation from a graph, using vertex form and one extra point to pin down *a*

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Most quadratic practice runs one direction: here is the equation, now graph it. This worksheet runs the other way. You get the picture and have to write the algebra that produced it.

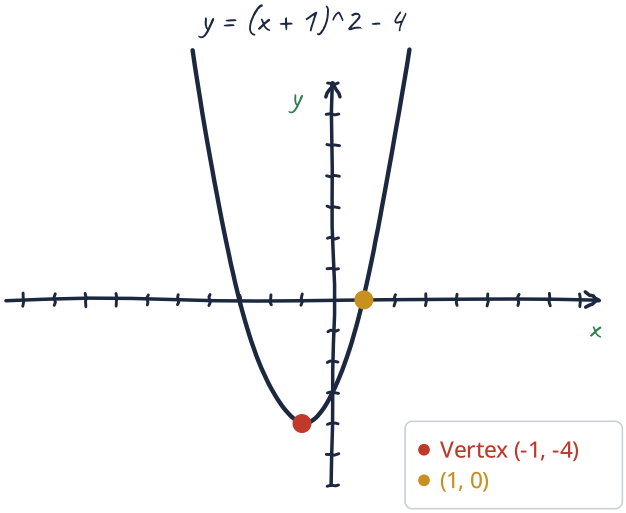
A parabola only hides two numbers once you can see it: the vertex, and how steeply it opens. A labeled graph hands you the vertex for free. From there you only need one more point on the curve to finish the equation.

> **WHAT TO LOOK FOR ON THE GRAPH**
>
> **The vertex (h, k)** — the turning point. Read it straight off the graph and drop it into vertex form.
>
> **Any other point on the curve** — usually the y-intercept. This is the only thing that finds *a*.

Start From the Vertex

Vertex form is $y = a(x - h)^2 + k$. Read the vertex, drop h and k into the equation, and the only thing left is *a*. Then substitute a second point the curve clearly passes through, and solve.

Watch the sign on h: a vertex at $x = -1$ goes into the equation as $(x + 1)^2$, not $(x - 1)^2$. The two examples below show the whole process side by side with the graph — one opening up, one opening down.



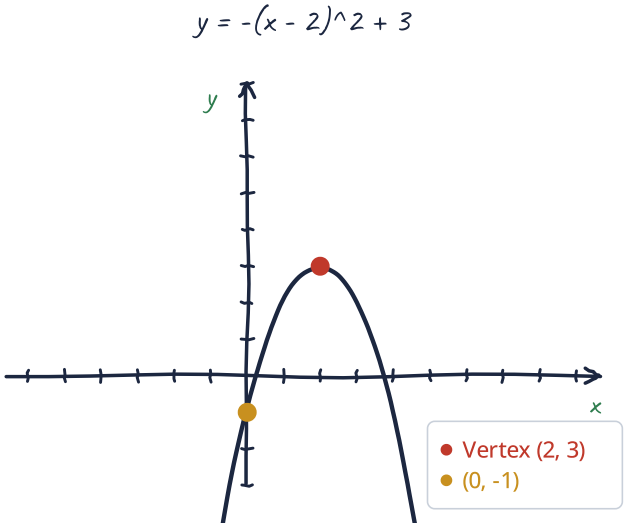
WORKED EXAMPLE · OPENS UPWARD

Start with the vertex: $y = a(x + 1)^2 - 4$.

Substitute (1, 0): $0 = a(1 + 1)^2 - 4$.

Simplify: $0 = 4a - 4$, so $a = 1$.

$y = (x + 1)^2 - 4$



WORKED EXAMPLE · OPENS DOWNWARD

Start with the vertex: $y = a(x - 2)^2 + 3$.

Substitute (0, −1): $-1 = a(0 - 2)^2 + 3$.

Simplify: $-1 = 4a + 3$, so $a = -1$.

$y = -(x - 2)^2 + 3$

WATCH THE SIGN

A vertex at $x = -1$ gives $(x + 1)^2$, not $(x - 1)^2$. Reading h straight off the graph without flipping the sign is the most common mistake in this whole topic.

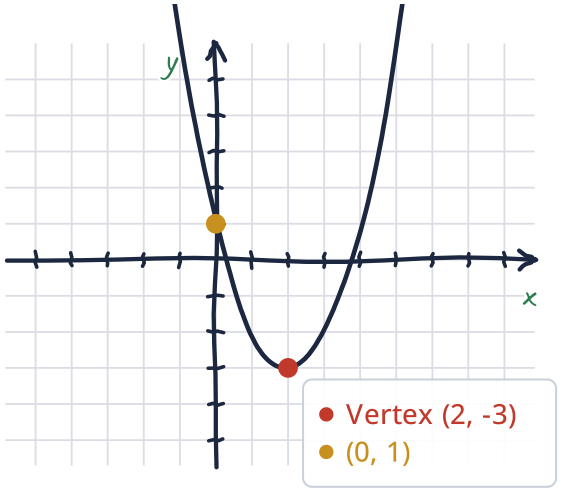
Quick check: put the second point back into your finished equation. If it does not come out right, the sign is the first place to look.

Practice Problems: Writing Equations from Graphs

Part A gives you graphs with the vertex marked — write each equation in vertex form. Part B has no graph, only the vertex and one point, the same features you would have read off one.

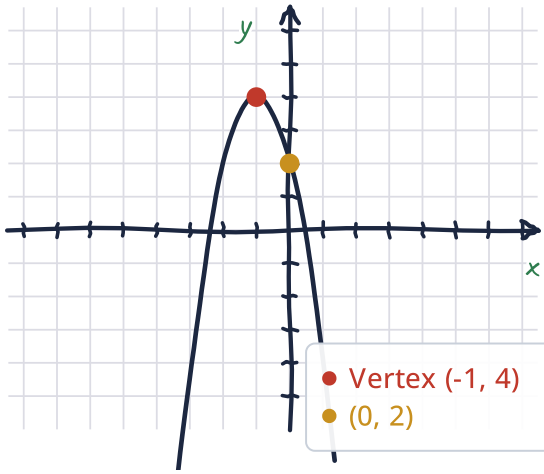
Part A — write the equation in vertex form

1



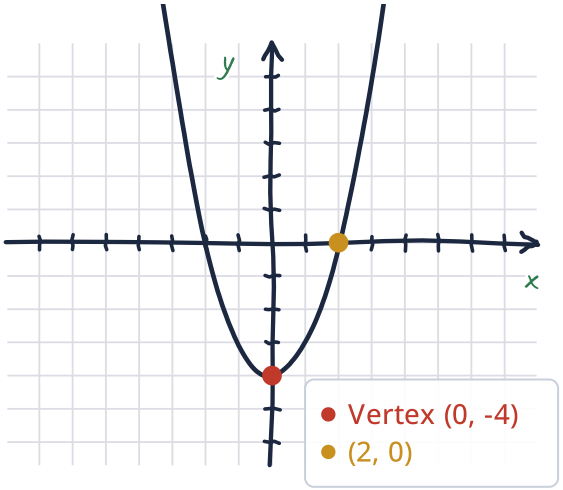
y =

2



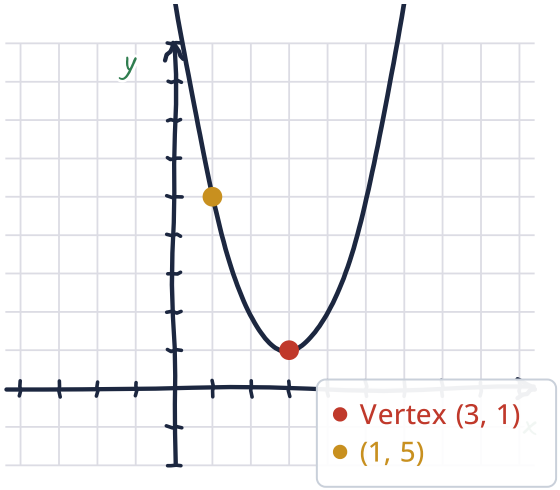
y =

3



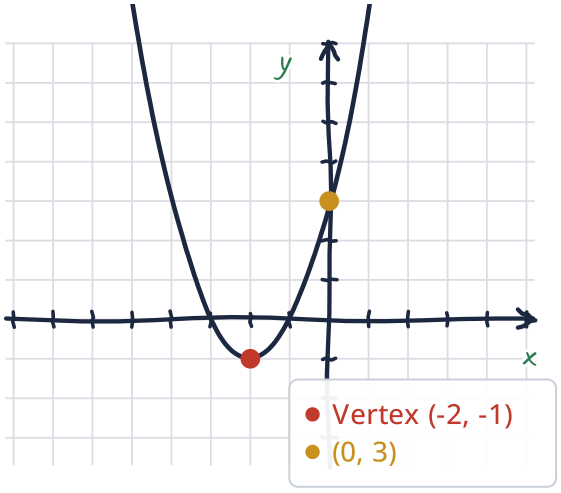
y =

4



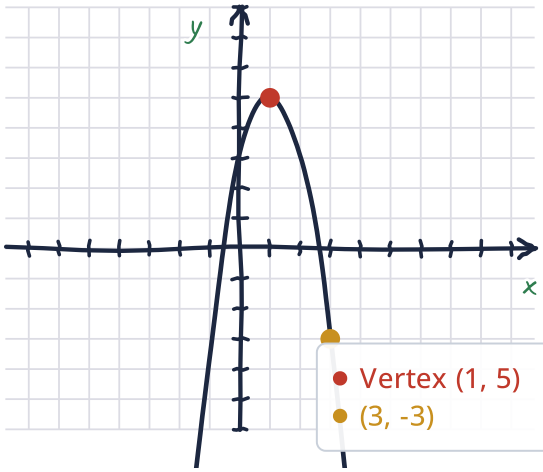
y =

5



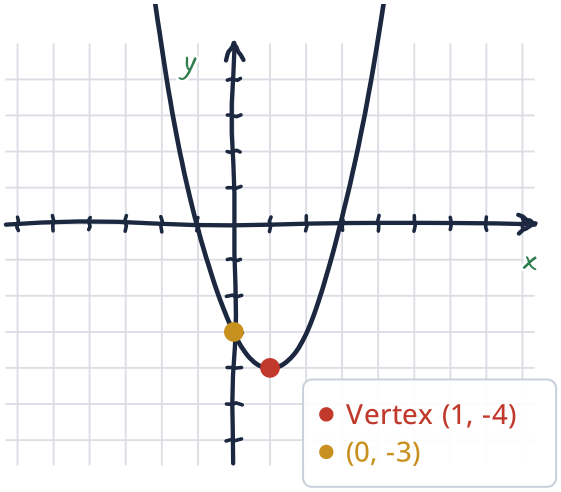
y =

6



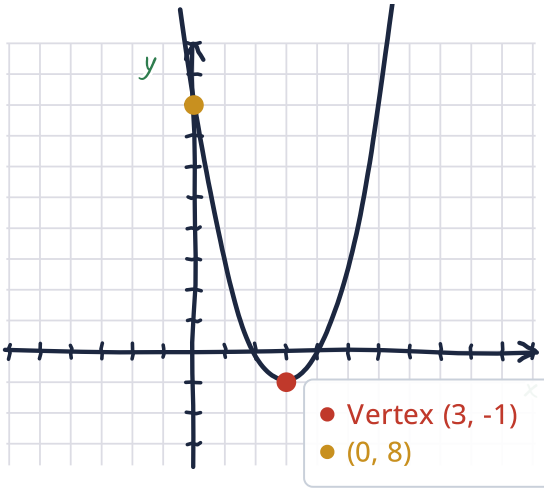
y =

7



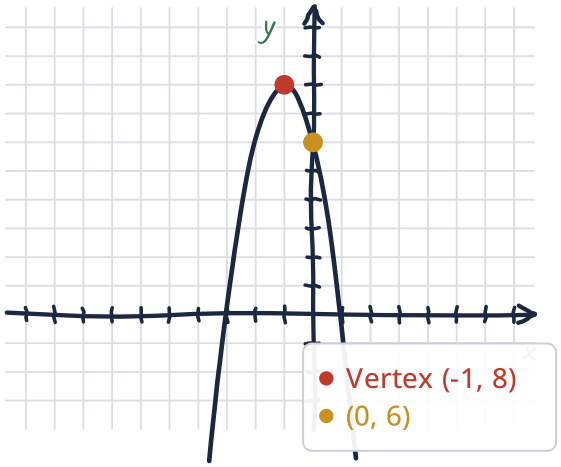
y =

8



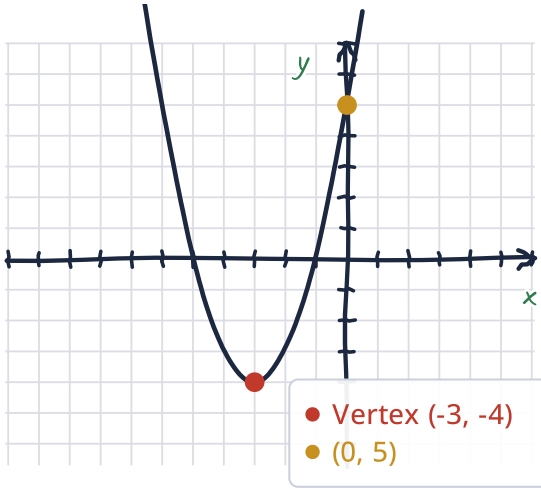
y =

9



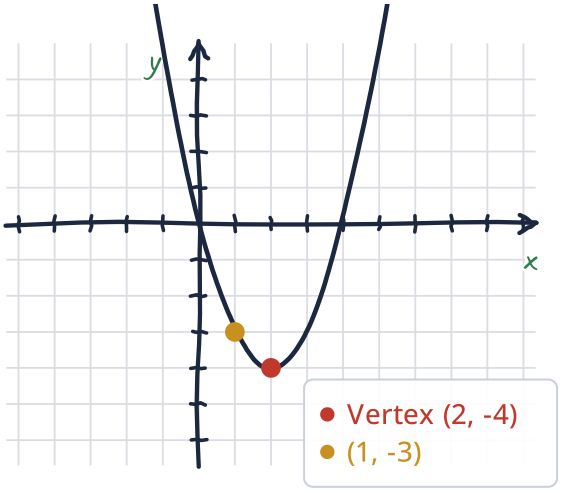
y =

10



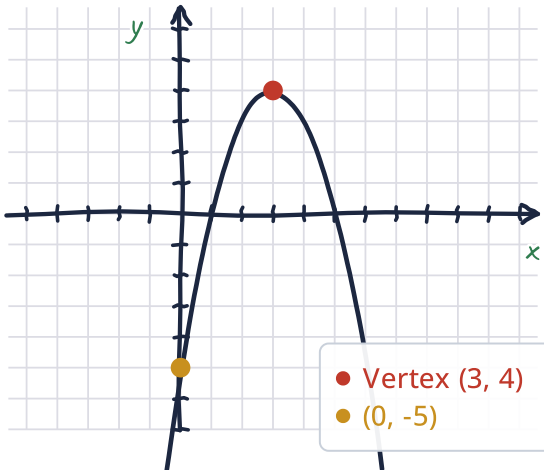
y =

11



y =

12



y =

Part B — write an equation from the features given

13. Vertex (4, −2), and the curve passes through (5, 1).

    y =

14. Vertex (−2, −16), and the curve passes through (0, −12).

    y =

15. Vertex (−3, 0), and the curve passes through (−1, −8).

    y =

16. Vertex (5, −4), and the curve passes through (3, 0).

    y =

17. Vertex (0, 6), and the curve passes through (2, −6).

    y =

18. Vertex (2, 8), and the curve passes through (0, 6).

    y =

19. Vertex (1, −8), and the curve passes through (3, 0).

    y =

20. Vertex (2, 0), and the curve passes through (0, 8).

    y =

Answer Key

Every problem is worked below. Each one is the same two moves: write vertex form, then substitute a point to find *a*.

Part A — vertex form

1. Vertex (2, −3): $y = a(x - 2)^2 - 3$. Sub (0, 1): $1 = 4a - 3$, so $a = 1$. **$y = (x - 2)^2 - 3$**

2. Vertex (−1, 4): $y = a(x + 1)^2 + 4$. Sub (0, 2): $2 = a + 4$, so $a = -2$. **$y = -2(x + 1)^2 + 4$**

3. Vertex (0, −4): $y = ax^2 - 4$. Sub (2, 0): $0 = 4a - 4$, so $a = 1$. **$y = x^2 - 4$**

4. Vertex (3, 1): $y = a(x - 3)^2 + 1$. Sub (1, 5): $5 = 4a + 1$, so $a = 1$. **$y = (x - 3)^2 + 1$**

5. Vertex (−2, −1): $y = a(x + 2)^2 - 1$. Sub (0, 3): $3 = 4a - 1$, so $a = 1$. **$y = (x + 2)^2 - 1$**

6. Vertex (1, 5): $y = a(x - 1)^2 + 5$. Sub (3, −3): $-3 = 4a + 5$, so $a = -2$. **$y = -2(x - 1)^2 + 5$**

7. Vertex (1, −4): $y = a(x - 1)^2 - 4$. Sub (0, −3): $-3 = a - 4$, so $a = 1$. **$y = (x - 1)^2 - 4$**

8. Vertex (3, −1): $y = a(x - 3)^2 - 1$. Sub (0, 8): $8 = 9a - 1$, so $a = 1$. **$y = (x - 3)^2 - 1$**

9. Vertex (−1, 8): $y = a(x + 1)^2 + 8$. Sub (0, 6): $6 = a + 8$, so $a = -2$. **$y = -2(x + 1)^2 + 8$**

10. Vertex (−3, −4): $y = a(x + 3)^2 - 4$. Sub (0, 5): $5 = 9a - 4$, so $a = 1$. **$y = (x + 3)^2 - 4$**

11. Vertex (2, −4): $y = a(x - 2)^2 - 4$. Sub (1, −3): $-3 = a - 4$, so $a = 1$. **$y = (x - 2)^2 - 4$**

12. Vertex (3, 4): $y = a(x - 3)^2 + 4$. Sub (0, −5): $-5 = 9a + 4$, so $a = -1$. **$y = -(x - 3)^2 + 4$**

Part B — from features

13. $y = a(x - 4)^2 - 2$. Sub (5, 1): $1 = a - 2$, so $a = 3$. **$y = 3(x - 4)^2 - 2$**

14. $y = a(x + 2)^2 - 16$. Sub (0, −12): $-12 = 4a - 16$, so $a = 1$. **$y = (x + 2)^2 - 16$**

15. $y = a(x + 3)^2$. Sub (−1, −8): $-8 = 4a$, so $a = -2$. **$y = -2(x + 3)^2$**

16. $y = a(x - 5)^2 - 4$. Sub (3, 0): $0 = 4a - 4$, so $a = 1$. **$y = (x - 5)^2 - 4$**

17. $y = ax^2 + 6$. Sub (2, −6): $-6 = 4a + 6$, so $a = -3$. **$y = -3x^2 + 6$**

18. $y = a(x - 2)^2 + 8$. Sub (0, 6): $6 = 4a + 8$, so $a = -\frac{1}{2}$. **$y = -\frac{1}{2}(x - 2)^2 + 8$**

19. $y = a(x - 1)^2 - 8$. Sub (3, 0): $0 = 4a - 8$, so $a = 2$. **$y = 2(x - 1)^2 - 8$**

20. $y = a(x - 2)^2$. Sub (0, 8): $8 = 4a$, so $a = 2$. **$y = 2(x - 2)^2$**