Graphing Quadratic Functions: Vertex, X-Intercepts, and Y-Intercept

A free printable worksheet and guide — find the vertex, x-intercepts, and y-intercept for 20 parabolas, then sketch the curve through them

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The short version: to graph $y = ax^2 + bx + c$, find three things before you draw anything. The y-intercept is (0, c). The x-intercepts come from setting y = 0 and factoring or using the quadratic formula. The vertex sits at $x = -b/2a$, and you substitute that value back in to get its y-coordinate. Plot those points, check the sign of a to see which way the curve opens, and sketch.

THE THREE FEATURES YOU NEED

Y-intercept: set x = 0. For $y = ax^2 + bx + c$ this is simply the point (0, c) — no work required.

X-intercepts: set y = 0 and solve the quadratic. There may be two, one, or zero real roots.

Vertex: $x = -b / 2a$, then substitute that x back in to get the y-coordinate.

How to Graph a Quadratic Function: The Steps

1. Check the sign of a to see which way it opens. Positive opens upward and the vertex is the lowest point; negative opens downward and the vertex is the highest point.

2. Write down the y-intercept. It is (0, c) — two seconds of work and a guaranteed point.

3. Set y = 0 and solve for the x-intercepts. Factor if it factors, otherwise use the quadratic formula. A negative discriminant means no x-intercepts.

4. Find the vertex with x = -b / 2a, then substitute back for y. The x-value alone is not the vertex; you need the matching y-coordinate.

5. Plot everything, then sketch the curve through the points. Draw the axis of symmetry through the vertex as a light dashed line first to keep both halves even.

A SHORTCUT WORTH KNOWING

If you already have both x-intercepts, you do not need the vertex formula. The vertex sits exactly halfway between them, so average the two roots. For a parabola crossing at x = -1 and x = 5, the vertex is at x = 2, and one substitution finishes it.

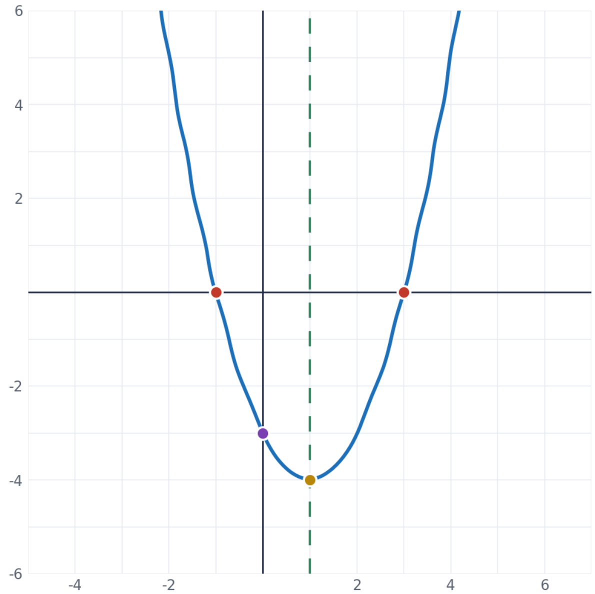
Worked Examples

One example for each case you will run into: two intercepts, a repeated intercept, and none at all.

Example 1 — two x-intercepts

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

Here a = 1, so the parabola opens upward. The y-intercept is the constant term, giving (0, -3). Setting y = 0 and factoring gives (x + 1)(x - 3) = 0, so the curve crosses at x = -1 and x = 3. For the vertex, x = -(-2) / 2(1) = 1, and substituting back gives y = 1 - 2 - 3 = -4.



With all three features plotted, the curve is drawn through them rather than guessed at.

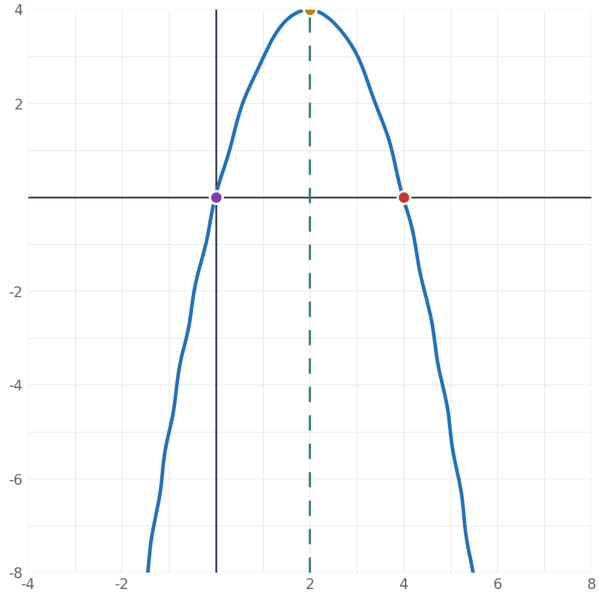
Color	What it marks
Blue curve	the parabola
Green dashed	axis of symmetry
Gold	vertex
Red	x-intercepts
Purple	y-intercept
Vertex	(1, -4)

> **Vertex (1, -4) · X-intercepts (-1, 0) and (3, 0) · Y-intercept (0, -3).** The vertex x-value of 1 is exactly halfway between the roots -1 and 3, which is a useful check that nothing went wrong.

Example 2 — the y-intercept sits on a root

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

This one opens downward because a is negative, so the vertex is the maximum. There is no constant term, so c = 0 and the y-intercept is the origin. Factoring gives x(-x + 4) = 0, so the roots are x = 0 and x = 4 — the y-intercept and one x-intercept are the same point. The vertex sits at x = -4 / 2(-1) = 2, and substituting gives y = -4 + 8 = 4.



A negative leading coefficient flips the parabola, so the vertex becomes the highest point.

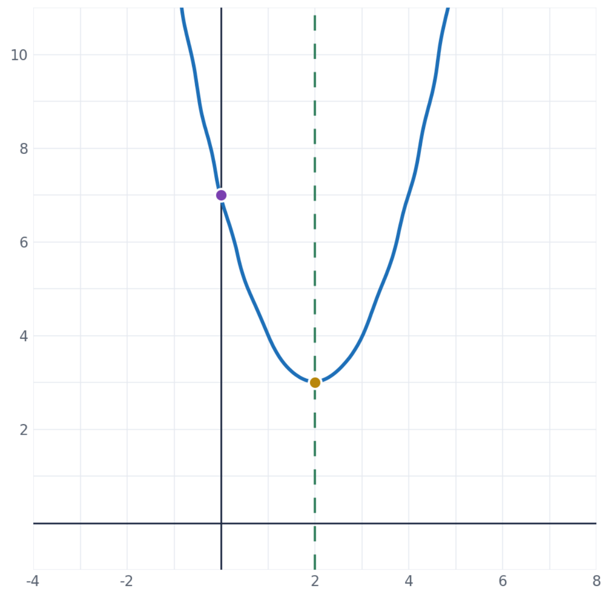
Color	What it marks
Blue curve	the parabola
Green dashed	axis of symmetry
Gold	vertex
Red	x-intercepts
Purple	y-intercept
Vertex	(2, 4)

> **Vertex (2, 4) · X-intercepts (0, 0) and (4, 0) · Y-intercept (0, 0).** When a quadratic has no constant term, the origin is always on the curve.

Example 3 — no x-intercepts at all

$$y = x^2 - 4x + 7$$

The y-intercept is (0, 7). Trying to solve y = 0 gives a discriminant of $b^2 - 4ac = 16 - 28 = -12$, which is negative, so there are no real roots and the parabola never touches the x-axis. That is not a dead end — you still have the vertex. It sits at $x = -(-4) / 2(1) = 2$, with $y = 4 - 8 + 7 = 3$.



A negative discriminant means no x-intercepts, but the vertex and y-intercept still fix the curve.

Color	What it marks
Blue curve	the parabola
Green dashed	axis of symmetry
Gold	vertex (2, 3)
Purple	y-intercept (0, 7)
No red	no x-intercepts

> DO NOT STOP HERE
>
> **Vertex (2, 3) · No x-intercepts · Y-intercept (0, 7).** Students often decide the problem is broken when the roots come out imaginary. The graph exists perfectly well; it just sits entirely above the x-axis.

Practice Problems

For each quadratic below, find the y-intercept, the x-intercepts, and the vertex, then sketch the parabola. A few have no real x-intercepts, and one has a repeated root where the vertex sits directly on the axis — those are there on purpose.

Name: ______________________________ Date: ______________

1. $y = x^2 - 4x + 3$ Y-int: ___________ X-int: ___________ Vertex: ___________ Opens: ___________	**2.** $y = x^2 + 2x - 8$ Y-int: ___________ X-int: ___________ Vertex: ___________ Opens: ___________
3. $y = x^2 - 6x + 5$ Y-int: ___________ X-int: ___________ Vertex: ___________ Opens: ___________	**4.** $y = x^2 + 4x + 3$ Y-int: ___________ X-int: ___________ Vertex: ___________ Opens: ___________
5. $y = -x^2 + 2x + 3$ Y-int: ___________ X-int: ___________ Vertex: ___________ Opens: ___________	**6.** $y = x^2 - 2x - 15$ Y-int: ___________ X-int: ___________ Vertex: ___________ Opens: ___________
7. $y = 2x^2 - 8x + 6$ Y-int: ___________ X-int: ___________ Vertex: ___________ Opens: ___________	**8.** $y = x^2 + 6x + 8$ Y-int: ___________ X-int: ___________ Vertex: ___________ Opens: ___________
9. $y = x^2 - 9$ Y-int: ___________ X-int: ___________ Vertex: ___________ Opens: ___________	**10.** $y = x^2 - 8x + 16$ Y-int: ___________ X-int: ___________ Vertex: ___________ Opens: ___________
11. $y = -x^2 + 6x - 8$ Y-int: ___________ X-int: ___________ Vertex: ___________ Opens: ___________	**12.** $y = x^2 + 3x - 4$ Y-int: ___________ X-int: ___________ Vertex: ___________ Opens: ___________

13. $y = x^2 - 4x + 7$ Y-int: _____________ X-int: _____________ Vertex: _____________ Opens: _____________	**14.** $y = 2x^2 + 4x - 6$ Y-int: _____________ X-int: _____________ Vertex: _____________ Opens: _____________
15. $y = x^2 - 5x + 6$ Y-int: _____________ X-int: _____________ Vertex: _____________ Opens: _____________	**16.** $y = -2x^2 + 4x + 6$ Y-int: _____________ X-int: _____________ Vertex: _____________ Opens: _____________
17. $y = x^2 + 8x + 15$ Y-int: _____________ X-int: _____________ Vertex: _____________ Opens: _____________	**18.** $y = x^2 - x - 12$ Y-int: _____________ X-int: _____________ Vertex: _____________ Opens: _____________
19. $y = 3x^2 - 6x - 9$ Y-int: _____________ X-int: _____________ Vertex: _____________ Opens: _____________	**20.** $y = x^2 + 2x + 5$ Y-int: _____________ X-int: _____________ Vertex: _____________ Opens: _____________

Answer Key

Every problem is worked out below, not just answered.

1. $y = x^2 - 4x + 3$ Y-intercept (0, 3). Factors to $(x - 1)(x - 3)$, so roots are 1 and 3. Vertex: $x = 4/2 = 2$, $y = 4 - 8 + 3 = -1$ **Y-int (0, 3) · X-int (1, 0) and (3, 0) · Vertex (2, -1) · opens upward**	**2. $y = x^2 + 2x - 8$** Y-intercept (0, -8). Factors to $(x + 4)(x - 2)$, so roots are -4 and 2. Vertex: $x = -2/2 = -1$, $y = 1 - 2 - 8 = -9$ **Y-int (0, -8) · X-int (-4, 0) and (2, 0) · Vertex (-1, -9) · opens upward**
3. $y = x^2 - 6x + 5$ Y-intercept (0, 5). Factors to $(x - 1)(x - 5)$, so roots are 1 and 5. Vertex: $x = 6/2 = 3$, $y = 9 - 18 + 5 = -4$ **Y-int (0, 5) · X-int (1, 0) and (5, 0) · Vertex (3, -4) · opens upward**	**4. $y = x^2 + 4x + 3$** Y-intercept (0, 3). Factors to $(x + 1)(x + 3)$, so roots are -1 and -3. Vertex: $x = -4/2 = -2$, $y = 4 - 8 + 3 = -1$ **Y-int (0, 3) · X-int (-3, 0) and (-1, 0) · Vertex (-2, -1) · opens upward**
5. $y = -x^2 + 2x + 3$ Y-intercept (0, 3). Factoring out -1 gives $-(x - 3)(x + 1)$, so roots are 3 and -1. Vertex: $x = -2/-2 = 1$, $y = -1 + 2 + 3 = 4$ **Y-int (0, 3) · X-int (-1, 0) and (3, 0) · Vertex (1, 4) · opens downward, so this is a maximum**	**6. $y = x^2 - 2x - 15$** Y-intercept (0, -15). Factors to $(x - 5)(x + 3)$, so roots are 5 and -3. Vertex: $x = 2/2 = 1$, $y = 1 - 2 - 15 = -16$ **Y-int (0, -15) · X-int (-3, 0) and (5, 0) · Vertex (1, -16) · opens upward**
7. $y = 2x^2 - 8x + 6$ Y-intercept (0, 6). Factor out 2 first: $2(x^2 - 4x + 3) = 2(x - 1)(x - 3)$, so roots are 1 and 3. Vertex: $x = 8/4 = 2$, $y = 8 - 16 + 6 = -2$ **Y-int (0, 6) · X-int (1, 0) and (3, 0) · Vertex (2, -2) · opens upward, narrower than usual since a = 2**	**8. $y = x^2 + 6x + 8$** Y-intercept (0, 8). Factors to $(x + 2)(x + 4)$, so roots are -2 and -4. Vertex: $x = -6/2 = -3$, $y = 9 - 18 + 8 = -1$ **Y-int (0, 8) · X-int (-4, 0) and (-2, 0) · Vertex (-3, -1) · opens upward**
9. $y = x^2 - 9$ Y-intercept (0, -9). Difference of squares: $(x - 3)(x + 3)$, so roots are 3 and -3. Vertex: $b = 0$, so $x = 0$, $y = -9$. **Y-int (0, -9) · X-int (-3, 0) and (3, 0) · Vertex (0, -9) · vertex and y-intercept are the same point**	**10. $y = x^2 - 8x + 16$** Y-intercept (0, 16). A perfect square, $(x - 4)^2$, so one repeated root at $x = 4$. Vertex: $x = 8/2 = 4$, $y = 16 - 32 + 16 = 0$ **Y-int (0, 16) · X-int (4, 0) only · Vertex (4, 0) · the curve touches the axis without crossing**
11. $y = -x^2 + 6x - 8$ Y-intercept (0, -8). Factoring out -1 gives $-(x - 4)(x - 2)$, so roots are 4 and 2. Vertex: $x = -6/-2 = 3$, $y = -9 + 18 - 8 = 1$ **Y-int (0, -8) · X-int (2, 0) and (4, 0) · Vertex (3, 1) · opens downward, so this is a maximum**	**12. $y = x^2 + 3x - 4$** Y-intercept (0, -4). Factors to $(x + 4)(x - 1)$, so roots are -4 and 1. Vertex: $x = -3/2$, $y = 9/4 - 9/2 - 4 = -25/4$ **Y-int (0, -4) · X-int (-4, 0) and (1, 0) · Vertex (-3/2, -25/4) · opens upward**
13. $y = x^2 - 4x + 7$ Y-intercept (0, 7). Discriminant is $16 - 28 = -12$, which is negative, so there are no real x-intercepts. Vertex: $x = 4/2 = 2$, $y = 4 - 8 + 7 = 3$ **Y-int (0, 7) · no x-intercepts · Vertex (2, 3) · opens upward and floats entirely above the x-axis**	**14. $y = 2x^2 + 4x - 6$** Y-intercept (0, -6). Factor out 2: $2(x^2 + 2x - 3) = 2(x + 3)(x - 1)$, so roots are -3 and 1. Vertex: $x = -4/4 = -1$, $y = 2 - 4 - 6 = -8$ **Y-int (0, -6) · X-int (-3, 0) and (1, 0) · Vertex (-1, -8) · opens upward**
15. $y = x^2 - 5x + 6$ Y-intercept (0, 6). Factors to $(x - 2)(x - 3)$, so roots are 2 and 3. Vertex: $x = 5/2$, $y = 25/4 - 25/2 + 6 = -1/4$ **Y-int (0, 6) · X-int (2, 0) and (3, 0) · Vertex (5/2, -1/4) · opens upward**	**16. $y = -2x^2 + 4x + 6$** Y-intercept (0, 6). Factor out -2: $-2(x^2 - 2x - 3) = -2(x - 3)(x + 1)$, so roots are 3 and -1. Vertex: $x = -4/-4 = 1$, $y = -2 + 4 + 6 = 8$ **Y-int (0, 6) · X-int (-1, 0) and (3, 0) · Vertex (1, 8) · opens downward, so this is a maximum**
17. $y = x^2 + 8x + 15$ Y-intercept (0, 15). Factors to $(x + 3)(x + 5)$, so roots are -3 and -5. Vertex: $x = -8/2 = -4$, $y = 16 - 32 + 15 = -1$ **Y-int (0, 15) · X-int (-5, 0) and (-3, 0) · Vertex (-4, -1) · opens upward**	**18. $y = x^2 - x - 12$** Y-intercept (0, -12). Factors to $(x - 4)(x + 3)$, so roots are 4 and -3. Vertex: $x = 1/2$, $y = 1/4 - 1/2 - 12 = -49/4$ **Y-int (0, -12) · X-int (-3, 0) and (4, 0) · Vertex (1/2, -49/4) · opens upward**
19. $y = 3x^2 - 6x - 9$ Y-intercept (0, -9). Factor out 3: $3(x^2 - 2x - 3) = 3(x - 3)(x + 1)$, so roots are 3 and -1. Vertex: $x = 6/6 = 1$, $y = 3 - 6 - 9 = -12$ **Y-int (0, -9) · X-int (-1, 0) and (3, 0) · Vertex (1, -12) · opens upward and is narrower since a = 3**	**20. $y = x^2 + 2x + 5$** Y-intercept (0, 5). Discriminant is $4 - 20 = -16$, which is negative, so there are no real x-intercepts. Vertex: $x = -2/2 = -1$, $y = 1 - 2 + 5 = 4$ **Y-int (0, 5) · no x-intercepts · Vertex (-1, 4) · opens upward and sits entirely above the x-axis**

How This Worksheet Was Built

The 20 problems here are drawn from the ones I actually assign in sessions, prepared from previous class notes and assigned homework. The ordering is deliberate: the first eight factor cleanly so students build the routine, then the fractional vertices, repeated root, and negative discriminants come later, because those are the three places where students most often conclude they have made a mistake when they have not. Every answer was checked for accuracy before publishing.

Related Worksheets

Vertex and Axis of Symmetry — burketutoringinfremont.com/vertex-and-axis-of-symmetry-worksheet/

Solving Quadratics by Factoring — burketutoringinfremont.com/worksheets-solving-quadratics-by-factoring/

Using the Discriminant to Find the Number of Roots — burketutoringinfremont.com/discriminant-number-of-roots/

Vertex Form and Intercept Form — burketutoringinfremont.com/vertex-form-and-intercept-form-worksheet/

Equation of a Parabola From a Graph — burketutoringinfremont.com/parabola-equation-from-a-graph-worksheet/

Graphing Quadratic Inequalities — burketutoringinfremont.com/graphing-quadratic-inequalities-worksheet/