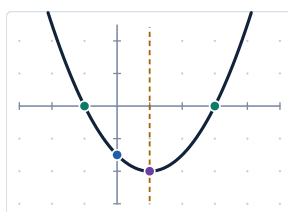


Quadratics Cheat Sheet

Every form, method, and model in a quadratics unit — on one page for the binder.

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Reviewed for accuracy before publishing · Updated August 2026

1 Anatomy of a parabola



The parabola	$y = ax^2 + bx + c$
Axis of symmetry	$x = -b / 2a$
Vertex	(h, k) with $h = -b/2a$, $k = f(h)$
x-intercepts (roots)	solve $y = 0$
y-intercept	$(0, c)$, where $x = 0$
Opens up or down	$a > 0$ up, $a < 0$ down

2 The three forms

STANDARD — READ THE Y-INTERCEPT

$$y = ax^2 + bx + c$$

y-intercept $(0, c)$. Axis $x = -b/2a$; put that x back in for k .

VERTEX — READ THE VERTEX

$$y = a(x - h)^2 + k$$

Vertex (h, k) . Signs inside flip: $(x + 3)^2$ means $h = -3$. h shifts left/right, k shifts up/down, $|a| > 1$ narrows, $0 < |a| < 1$ widens.

INTERCEPT / FACTORED — READ THE ROOTS

$$y = a(x - p)(x - q)$$

Roots p and q ; axis is halfway between: $x = (p + q)/2$.

EQUATION FROM A GRAPH

Read the vertex, write $y = a(x - h)^2 + k$, then substitute any second point (x_p, y_p) and solve $a = (y_p - k) / (x_p - h)^2$.

3 Solving a quadratic

ALWAYS FIRST

$$ax^2 + bx + c = 0$$

Move every term to one side before reading a , b , and c .

FACTORING + ZERO PRODUCT

$$(ux + v)(wx + z) = 0 \Rightarrow ux + v = 0 \text{ or } wx + z = 0$$

Patterns worth memorizing: $A^2 - B^2 = (A - B)(A + B)$ and $A^2 \pm 2AB + B^2 = (A \pm B)^2$.

COMPLETING THE SQUARE

$$x^2 + bx = (x + b/2)^2 - (b/2)^2$$

If $a \neq 1$, factor a out of the x^2 and x terms first. Then $(x - h)^2 = d \Rightarrow x = h \pm \sqrt{d}$.

QUADRATIC FORMULA — ALWAYS WORKS

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Keep the $\pm$, use $-b$ (not b), and divide the **whole** numerator by $2a$.

DISCRIMINANT $D = B^2 - 4AC$

$D > 0$	two real roots — crosses twice
$D = 0$	one repeated root — touches the axis
$D < 0$	no real roots — never crosses

4 Which method should I use?

No b term	square-root both sides
Factors fast	factor + zero product
a = 1, b even	complete the square
Ugly or decimal	quadratic formula
Roots only	check D first

5 Graphing & inequalities

SKETCH IN FOUR MOVES

- Plot the y-intercept $(0, c)$.
- Solve $y = 0$ for the roots.
- Find $x = -b/2a$, plot the vertex.
- Draw the axis, then mirror your points across it.

INEQUALITIES

- Graph the boundary curve first.
- $<$ or $>$ dashed; $\leq$ or $\geq$ solid.
- Test one point off the curve; if it works, shade that side.
- With y isolated: $y >$ shades above, $y <$ shades below.

6 Focus & directrix

OPENS UP OR DOWN

$$(x - h)^2 = 4p(y - k)$$

Focus $(h, k + p)$, directrix $y = k - p$. $p > 0$ up, $p < 0$ down.

OPENS LEFT OR RIGHT

$$(y - k)^2 = 4p(x - h)$$

Focus $(h + p, k)$, directrix $x = h - p$. $p > 0$ right, $p < 0$ left.

From $y = ax^2$, $p = 1/(4a)$. The number beside the **unsquared** side is $4p$, not p .

7 Word-problem models

PROJECTILE HEIGHT (FEET)

$$h(t) = -16t^2 + v_0t + h_0$$

Hits the ground: $h = 0$. Greatest height: the **vertex**, reached at $t = -b/2a$.

RECTANGLES, FRAMES, FENCING

$$\text{outer area} = (L + 2x)(W + 2x)$$

A uniform border adds x to **both** sides, so each dimension grows by $2x$. Given perimeter P , $L + W = P/2$.

REVENUE AND PROFIT

$$\text{revenue} = \text{price} \times \text{quantity}$$

Break-even: set the expression to 0. Maximum revenue or profit: the **vertex**.

BEFORE YOU ANSWER

- Sketch it, name one unknown x , write everything else in terms of x .
- Throw out impossible roots: negative time, negative length, a border wider than the object.
- Attach units to the final answer.

8 Name that function family

Linear $y = mx + b$ — constant **first** differences

Quadratic $y = ax^2 + bx + c$ — constant **second** differences

Exponential $y = a \cdot b^x$ — constant **ratios**

Only valid when the x -values step up by the same amount each time.

Six mistakes that cost the most points

- Reading a , b , c before moving every term to one side.
- Dropping the $\pm$, or dividing only part of the numerator by $2a$.
- Sign slips in vertex form: $(x + 3)^2$ puts the vertex at $x = -3$.
- Forgetting the second solution once one factor is set to zero.
- Keeping a negative time or length in a word-problem answer.
- Answering with the vertex x -value when the question asks for the maximum — substitute it back in.



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