

ALGEBRA 1

Complete Study Guide

Master every core concept — from variables to quadratics

8 Units

Visual Diagrams

15 Questions/Unit

Full Answer Key

□ Easy

□ Moderate

□ SAT-Style Challenge

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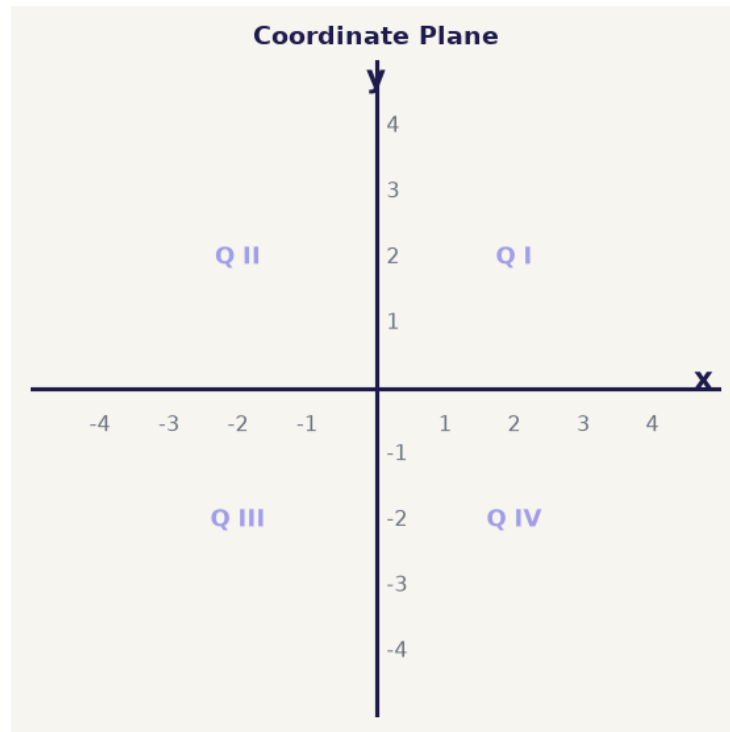
Unit 8 — Radicals & Data Analysis

Unit — — Answer Key (all 8 units)

Each unit includes: key vocabulary, formulas, visual diagrams, worked examples, and 15 practice problems (5 Easy / 5 Moderate / 5 SAT-Style Challenge).

Quick Reference — The Coordinate Plane

Every graph in Algebra 1 lives on the coordinate plane. The horizontal axis is x ; the vertical axis is y . Points are written as ordered pairs (x, y) .



UNIT 1 Foundations — The Language of Algebra

Variables, expressions, order of operations, and properties of real numbers.

1.1 Variables & Expressions

A variable is a letter representing an unknown. An algebraic expression combines variables, numbers, and operations. Unlike an equation, it has no equals sign.

Term	Definition	Example
Variable	Letter representing an unknown value	x, y, n
Coefficient	Number multiplied by a variable	3 in $3x$
Constant	A fixed number with no variable	7, -2, 100
Term	Single number, variable, or product of both	$5x, -3, 2y^2$
Expression	Combination of terms joined by + or -	$3x + 7 - 2y$
Like Terms	Same variable and exponent	$4x$ and $-x$

WORKED EXAMPLE

Problem: Simplify: $5x + 3y - 2x + 7y$

Step 1: Identify like terms: $(5x, -2x)$ and $(3y, 7y)$

Step 2: Combine x terms: $5x - 2x = 3x$

Step 3: Combine y terms: $3y + 7y = 10y$

□ Answer: $3x + 10y$

1.2 Order of Operations (PEMDAS)

PEMDAS Rule

$P \rightarrow E \rightarrow MD \rightarrow AS$

Parentheses · Exponents · Multiplication & Division (left→right) · Addition & Subtraction (left→right)

WORKED EXAMPLE

Problem: Evaluate: $3 + 4 \times 2^2 - (6 \div 3)$

Step 1: Parentheses: $6 \div 3 = 2 \rightarrow 3 + 4 \times 2^2 - 2$

Step 2: Exponents: $2^2 = 4 \rightarrow 3 + 4 \times 4 - 2$

Step 3: Multiplication: $4 \times 4 = 16 \rightarrow 3 + 16 - 2$

Step 4: Left to right: $3 + 16 = 19$, then $19 - 2$

□ Answer: 17

1.3 Properties of Real Numbers

Property	Formula	Example
Commutative (+)	$a + b = b + a$	$4 + 7 = 7 + 4$
Commutative (x)	$a \times b = b \times a$	$3 \times 5 = 5 \times 3$
Associative (+)	$(a+b)+c = a+(b+c)$	$(1+2)+3 = 1+(2+3)$
Associative (x)	$(a \times b) \times c = a \times (b \times c)$	$(2 \times 3) \times 4 = 2 \times (3 \times 4)$
Distributive	$a(b+c) = ab+ac$	$3(x+4) = 3x+12$
Identity (+)	$a + 0 = a$	$9 + 0 = 9$
Identity (x)	$a \times 1 = a$	$7 \times 1 = 7$
Zero Product	$a \times 0 = 0$	$99 \times 0 = 0$

□ Common Mistake

Students often skip PEMDAS and compute left-to-right. Always pause to check for parentheses and exponents before multiplying or adding.

Unit 1 Practice Problems

Answers for all units are compiled in the Answer Key at the back of this guide.

1 □ EASY Simplify: $6a + 2b - a + 5b$

2 □ EASY Evaluate: $2(3 + 4)^2 - 10$

3 □ EASY Simplify: $4(x - 3) + 2x$

4	EASY	Name the property: $(x + 5) + 7 = x + (5 + 7)$
5	EASY	Evaluate: $-3 \times (4 - 6)^2 + 1$
6	MODERATE	Simplify: $3(2x + 1) - 2(x - 4)$
7	MODERATE	If $a = -2$ and $b = 5$, evaluate: $a^2 - 3ab + b$
8	MODERATE	Name the property: $7(x + 3) = 7x + 21$
9	MODERATE	Simplify: $-2(3a - b) + 4(a + 2b)$
10	MODERATE	Evaluate: $[(3 + 2^2) \times 2] \div (14 - 9)$
11	SAT-STYLE CHALLENGE	If the expression $5x + 3(2 - x)$ equals 14, what is x ? (SAT-style multi-step)
12	SAT-STYLE CHALLENGE	A student writes: $4 + 3 \times 2 = 14$. Identify the error and find the correct answer.
13	SAT-STYLE CHALLENGE	Simplify: $(2a + 3b) - 3(a - b) + 5a$
14	SAT-STYLE CHALLENGE	For what value of k is the expression $k(k + 2) - 3(k - 1)$ equal to 7?
15	SAT-STYLE CHALLENGE	If $x = -3$, which is greater: x^2 or $2x + 5$? Show work and justify.

UNIT 2 Equations & Inequalities

Solve for unknowns and represent solution sets on a number line.

2.1 Solving Equations

An equation states that two expressions are equal. Isolate the variable using inverse operations — whatever you do to one side, do to both.

Golden Rule

If $A = B$, then $A + C = B + C$ and $A \times C = B \times C$

Apply any operation to BOTH sides to keep the equation balanced.

WORKED EXAMPLE

Problem: Solve: $2(x + 4) = 3x - 1$

Step 1: Distribute: $2x + 8 = 3x - 1$

Step 2: Subtract $2x$: $8 = x - 1$

Step 3: Add 1: $x = 9$

Step 4: Check: $2(9+4)=26$; $3(9)-1=26$ ✓

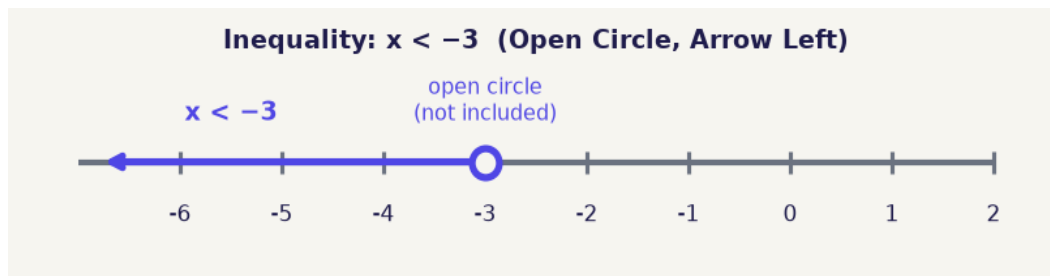
□ Answer: $x = 9$

2.2 Inequalities

Solve like equations, but: multiplying or dividing both sides by a negative flips the sign.

Symbol	Meaning	Number Line
$<$	Less than	Open circle O, arrow left
$>$	Greater than	Open circle O, arrow right
$\leq$	Less than or equal	Closed circle ●, arrow left
$\geq$	Greater than or equal	Closed circle ●, arrow right

Visual Reference — Inequality on a Number Line



WORKED EXAMPLE

Problem: Solve and graph: $-2x + 5 > 11$

Step 1: Subtract 5: $-2x > 6$

Step 2: Divide by -2 and FLIP the sign: $x < -3$

Step 3: Graph: open circle at -3 , arrow pointing left

□ Answer: $x < -3$

Note: Sign flipped because we divided by a NEGATIVE.

□ Flip Rule

Dividing or multiplying both sides by a negative number ALWAYS reverses the inequality sign. This is one of the most commonly tested concepts on the SAT.

Unit 2 Practice Problems

Answers for all units are compiled in the Answer Key at the back of this guide.

1	□ EASY	Solve: $5x + 3 = 23$
2	□ EASY	Solve: $x/3 - 4 = 2$
3	□ EASY	Solve: $2x - 7 = 11$
4	□ EASY	Solve and graph: $x + 5 > 8$
5	□ EASY	Solve: $3(x - 1) = 12$
6	□ MODERATE	Solve: $4(2x - 1) = 3x + 11$
7	□ MODERATE	Solve: $-3x + 2 \leq 14$
8	□ MODERATE	Solve: $5 - 2(x + 3) = -3$

9	□ MODERATE	Solve the compound inequality: $-1 < 2x + 3 < 9$
10	□ MODERATE	A number is doubled and then decreased by 7. The result is at least 11. Write and solve.
11	□ SAT-STYLE CHALLENGE	Solve: $(x/2) + (x/3) = 5$ (SAT-style fraction equation)
12	□ SAT-STYLE CHALLENGE	If $3x - 5 > x + 7$ and $2x + 1 < 15$, find all integer values of x .
13	□ SAT-STYLE CHALLENGE	The sum of three consecutive integers is 48. Write and solve an equation.
14	□ SAT-STYLE CHALLENGE	A taxi charges \$3.50 plus \$1.25 per mile. How many miles can you travel on \$15?
15	□ SAT-STYLE CHALLENGE	If $ 2x - 3 = 7$, find all values of x . (SAT-style absolute value)

UNIT 3 Linear Functions & Graphing

Slope, intercepts, and all three equation forms.

3.1 Slope

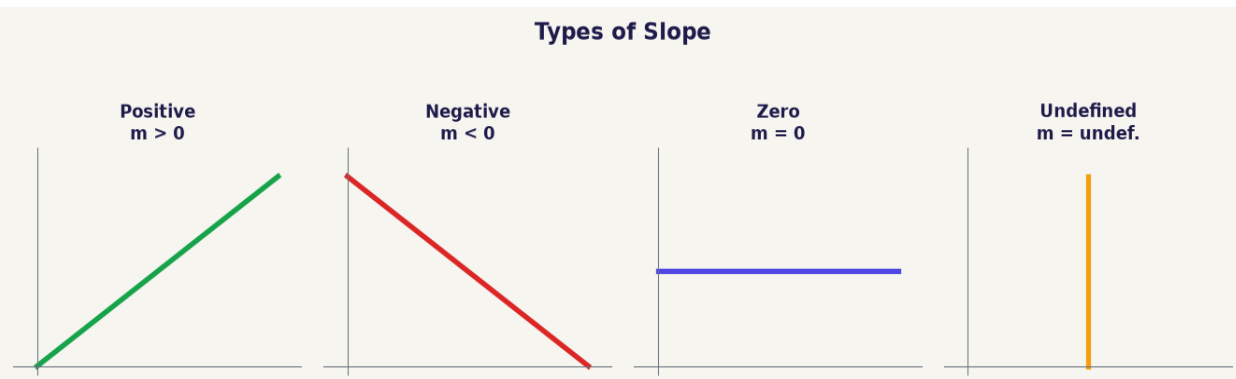
Slope (m) measures steepness and direction — the ratio of rise to run.

Slope Formula

$$m = (y_2 - y_1) / (x_2 - x_1) = \text{rise} / \text{run}$$

Use any two points on the line.

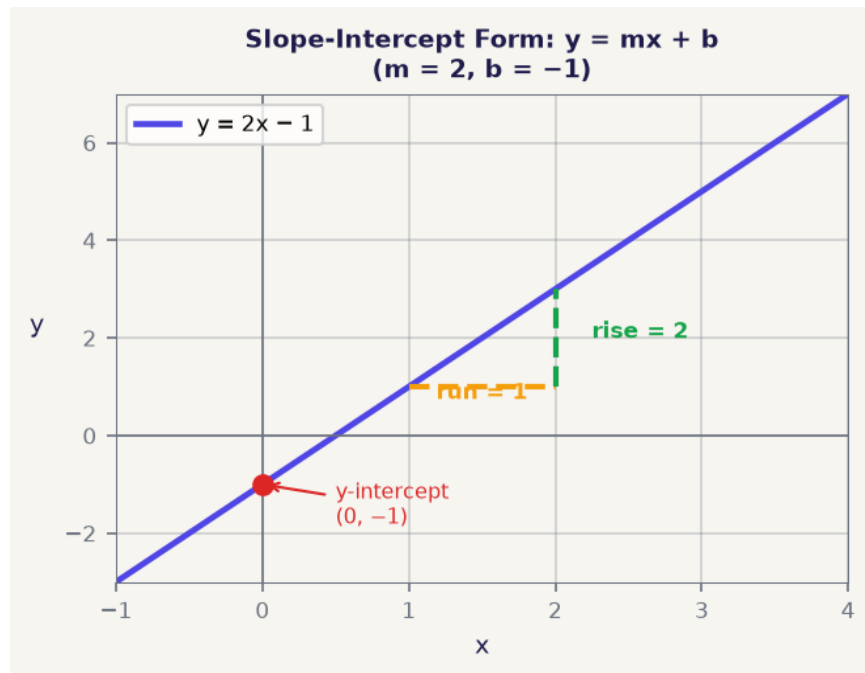
Visual Reference — Four Types of Slope



3.2 Equation Forms

Form	Equation	Best Used When...
Slope-Intercept	$y = mx + b$	Know slope m and y -intercept b
Point-Slope	$y - y_1 = m(x - x_1)$	Know slope and one point
Standard Form	$Ax + By = C$	A, B, C integers; required by some tests

Visual Reference — Slope-Intercept Graph

**WORKED EXAMPLE**

Problem: Write the equation through (1, -2) with slope 3

Step 1: Point-slope: $y - (-2) = 3(x - 1)$

Step 2: Simplify: $y + 2 = 3x - 3$

Step 3: Slope-intercept: $y = 3x - 5$

□ Answer: $y = 3x - 5$

□ Parallel & Perpendicular Lines

Parallel lines have the SAME slope. Perpendicular lines have slopes that are NEGATIVE RECIPROCALS (e.g., $m = 2$ and $m = -1/2$). Highly tested on the SAT.

Unit 3 Practice Problems

Answers for all units are compiled in the Answer Key at the back of this guide.

- | | | |
|---|--------|--|
| 1 | □ EASY | Find the slope through (0, 0) and (3, 6) |
| 2 | □ EASY | Write in slope-intercept form: slope = -2, y-intercept = 5 |
| 3 | □ EASY | Find the y-intercept of: $y = 4x - 8$ |
| 4 | □ EASY | Is (2, 3) on the line $y = 2x - 1$? |

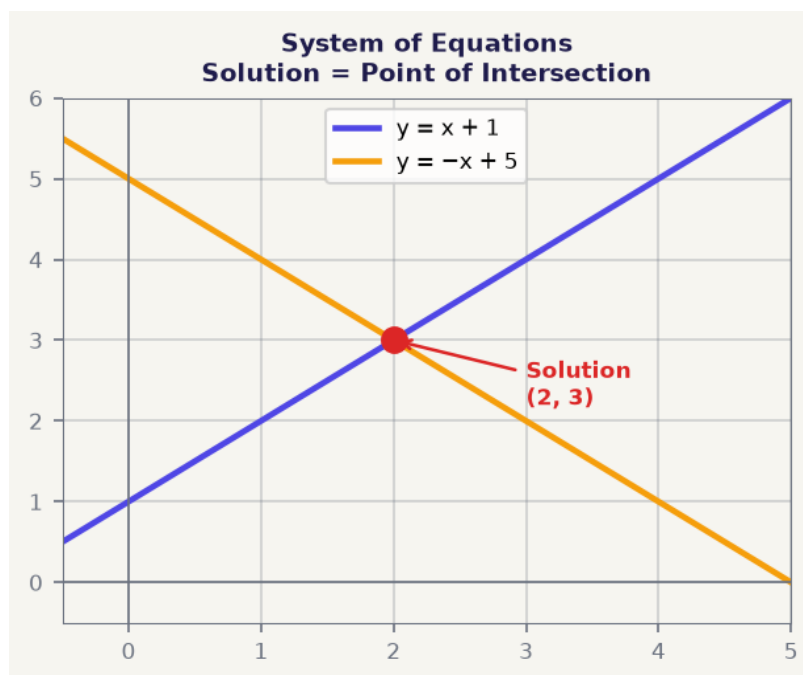
5	EASY	What is the slope of a horizontal line?
6	MODERATE	Find the slope through $(-1, 4)$ and $(3, 12)$
7	MODERATE	Write the equation through $(2, 7)$ with slope 4
8	MODERATE	Find the x-intercept of: $3x + 2y = 12$
9	MODERATE	Are $y = 3x + 1$ and $y = 3x - 5$ parallel, perpendicular, or neither?
10	MODERATE	Write the equation of the line through $(0, 4)$ and $(3, 1)$
11	SAT-STYLE CHALLENGE	A line passes through $(-2, 5)$ and $(4, -7)$. Write its equation in standard form.
12	SAT-STYLE CHALLENGE	Line A: $2x - 4y = 8$. Line B passes through $(1, 3)$ and is perpendicular to A. Find B's equation.
13	SAT-STYLE CHALLENGE	For the line $y = (2/3)x - 4$, find three ordered pairs that satisfy the equation.
14	SAT-STYLE CHALLENGE	Two lines intersect at $(3, -1)$. One has slope 2. The other has slope $-1/2$. Write both equations.
15	SAT-STYLE CHALLENGE	A runner starts 10 miles from home and runs at 6 mph toward home. Write a linear equation for distance d after t hours, and find when she arrives home.

UNIT 4 Systems of Equations

Find the intersection of two lines using three methods.

Method	How It Works	Best When...
Graphing	Graph both lines; find where they cross	A visual answer is needed
Substitution	Solve one equation for a variable; plug into the other	One variable is already isolated
Elimination	Add/subtract equations to cancel a variable	Coefficients are easy to match

Visual Reference — Graphing Method



WORKED EXAMPLE

Problem: Substitution: $y = 2x - 1$ and $3x + y = 14$

Step 1: Sub $y=2x-1$ into 2nd: $3x + (2x-1) = 14$

Step 2: $5x - 1 = 14 \rightarrow 5x = 15 \rightarrow x = 3$

Step 3: Find y : $y = 2(3)-1 = 5$

□ Answer: (3, 5)

WORKED EXAMPLE

Problem: Elimination: $2x + 3y = 12$ and $4x - 3y = 6$

Step 1: y terms (+3y and -3y) cancel when added

Step 2: Add: $6x = 18 \rightarrow x = 3$

Step 3: Back-substitute: $2(3) + 3y = 12 \rightarrow y = 2$

□ Answer: (3, 2)

□ Infinite vs. No Solution

TRUE leftover ($0 = 0$) $\rightarrow$ Infinite solutions (same line). FALSE leftover ($3 = 7$) $\rightarrow$ No solution (parallel lines).

Unit 4 Practice Problems

Answers for all units are compiled in the Answer Key at the back of this guide.

1	□ EASY	Solve by graphing (describe the intersection): $y = x + 1$ and $y = -x + 5$
2	□ EASY	Solve by substitution: $y = 2x$ and $x + y = 9$
3	□ EASY	Solve: $x + y = 10$ and $x - y = 4$
4	□ EASY	Solve by elimination: $3x + y = 7$ and $x - y = 1$
5	□ EASY	How many solutions does a system of parallel lines have?
6	□ MODERATE	Solve: $2x + 3y = 12$ and $4x - 3y = 6$
7	□ MODERATE	Solve: $y = 3x - 2$ and $2x + y = 8$
8	□ MODERATE	Solve: $x/2 + y = 5$ and $x - y = 1$
9	□ MODERATE	A system has the same line twice. How many solutions?
10	□ MODERATE	Two numbers add to 30. Three times the larger minus the smaller equals 50. Find both.
11	□ SAT-STYLE CHALLENGE	Solve: $3x - 2y = 4$ and $6x - 4y = 8$. Classify the solution.
12	□ SAT-STYLE CHALLENGE	A movie ticket costs \$x for adults and \$y for children. 2 adults + 3 kids = \$31. 3 adults + 1 kid = \$28. Find x and y.

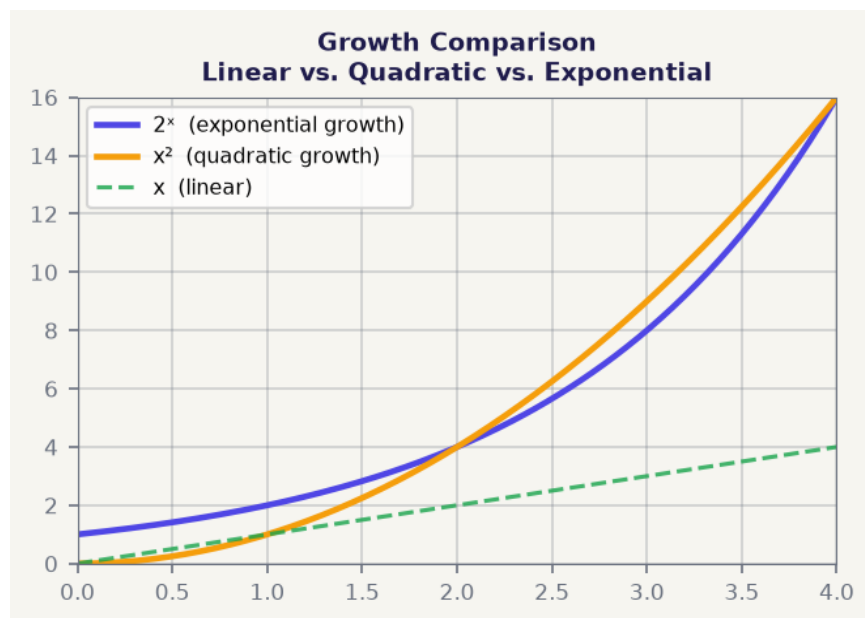
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| 13 | ▮ SAT-STYLE CHALLENGE | Solve: $0.5x + 0.25y = 3$ and $2x - y = 4$. (SAT-style decimals) |
| 14 | ▮ SAT-STYLE CHALLENGE | For what value of k does $kx + 2y = 6$ and $3x + y = 4$ have no solution? |
| 15 | ▮ SAT-STYLE CHALLENGE | A plane flies 600 mi with the wind in 2 h, and 600 mi against the wind in 3 h. Find the wind speed and plane speed. |

UNIT 5 Exponents & Polynomials

Laws of exponents, polynomial operations, and FOIL.

Law	Formula	Example
Product Rule	$x^m \cdot x^n = x^{(m+n)}$	$x^3 \cdot x^4 = x^7$
Quotient Rule	$x^m \div x^n = x^{(m-n)}$	$x^6 \div x^2 = x^4$
Power Rule	$(x^m)^n = x^{(m \times n)}$	$(x^3)^2 = x^6$
Zero Exponent	$x^0 = 1 \ (x \neq 0)$	$7^0 = 1$
Negative Exponent	$x^{-n} = 1/x^n$	$2^{-3} = 1/8$
Power of Product	$(xy)^n = x^n \cdot y^n$	$(2x)^3 = 8x^3$
Power of Quotient	$(x/y)^n = x^n/y^n$	$(x/3)^2 = x^2/9$

Visual Reference — Growth Rates



FOIL Method

$$(a + b)(c + d) = ac + ad + bc + bd$$

First · Outer · Inner · Last — then combine like terms

WORKED EXAMPLE

Problem: Expand: $(x + 3)(x - 5)$

Step 1: First: $x \cdot x = x^2$

Step 2: Outer: $x \cdot (-5) = -5x$

Step 3: Inner: $3 \cdot x = 3x$

Step 4: Last: $3 \cdot (-5) = -15$

Step 5: Combine: $x^2 + (-5x + 3x) - 15$

□ Answer: $x^2 - 2x - 15$

Unit 5 Practice Problems

Answers for all units are compiled in the Answer Key at the back of this guide.

1	□ EASY	Simplify: $x^5 \cdot x^3$
2	□ EASY	Simplify: $(3x^2)^3$
3	□ EASY	Simplify: $12x^6 \div 4x^2$
4	□ EASY	Evaluate: 5^0
5	□ EASY	Simplify: $x^{-2} \cdot x^5$
6	□ MODERATE	Expand: $(x + 4)(x + 2)$
7	□ MODERATE	Expand: $(2x - 1)(x + 5)$
8	□ MODERATE	Simplify: $(2x^3y^2)^2$
9	□ MODERATE	Subtract: $(3x^2 + 2x - 1) - (x^2 - 4x + 3)$
10	□ MODERATE	Expand: $(x + 3)^2$
11	□ SAT-STYLE CHALLENGE	Expand and simplify: $(x + 2)(x - 2)(x + 1)$
12	□ SAT-STYLE CHALLENGE	Simplify: $(3x^2y)^3 \div (9xy^2)$
13	□ SAT-STYLE CHALLENGE	If $x = -2$, evaluate: $2x^3 - x^2 + 3x - 5$

- 14 ▮ SAT-STYLE CHALLENGE Write a polynomial with roots at $x=2$ and $x=-3$ in standard form.
- 15 ▮ SAT-STYLE CHALLENGE Simplify: $(x^n \cdot x^{(n+1)}) / x^{(2n-1)}$. Express in terms of n . (SAT-style)

UNIT 6

Factoring

GCF, trinomials, and special product patterns.

6.1 Always Factor GCF First

WORKED EXAMPLE

Problem: Factor: $6x^3 + 9x^2 - 3x$

Step 1: GCF of 6,9,3 = 3; lowest power of $x = x^1 \rightarrow$ GCF = $3x$

Step 2: Divide each term: $2x^2, 3x, -1$

□ Answer: $3x(2x^2 + 3x - 1)$

6.2 Factoring Trinomials $ax^2 + bx + c$ (when $a=1$)

Find two numbers that multiply to c and add to b .

WORKED EXAMPLE

Problem: Factor: $x^2 + 7x + 12$

Step 1: Need: product = 12, sum = 7

Step 2: Try pairs: $3 \times 4 = 12$ and $3 + 4 = 7 \checkmark$

□ Answer: $(x + 3)(x + 4)$

6.3 Special Products

Pattern	Formula	Example
Difference of Squares	$(a+b)(a-b) = a^2 - b^2$	$(x+4)(x-4) = x^2 - 16$
Perfect Square (+)	$(a+b)^2 = a^2 + 2ab + b^2$	$(x+5)^2 = x^2 + 10x + 25$
Perfect Square (-)	$(a-b)^2 = a^2 - 2ab + b^2$	$(x-3)^2 = x^2 - 6x + 9$

□ Factoring Strategy Checklist

1. Always factor out GCF first. 2. Check if it's a difference of squares. 3. Check if it's a perfect square trinomial. 4. Use the product-sum method for $ax^2 + bx + c$.

Unit 6 Practice Problems

Answers for all units are compiled in the Answer Key at the back of this guide.

1	EASY	Factor: $8x^2 - 12x$
2	EASY	Factor: $x^2 + 9x + 20$
3	EASY	Factor: $x^2 - 49$
4	EASY	Factor: $x^2 - 8x + 16$
5	EASY	Factor: $x^2 - 5x - 14$
6	MODERATE	Factor: $2x^2 + 7x + 3$
7	MODERATE	Factor completely: $3x^2 - 12$
8	MODERATE	Factor: $x^2 + 4x - 21$
9	MODERATE	Factor: $4x^2 - 25$
10	MODERATE	Factor: $5x^3 - 20x$
11	SAT-STYLE CHALLENGE	Factor completely: $6x^2 + 7x - 3$
12	SAT-STYLE CHALLENGE	Factor: $x^4 - 16$
13	SAT-STYLE CHALLENGE	Factor: $2x^3 + 6x^2 - 8x$
14	SAT-STYLE CHALLENGE	For what value of k is $x^2 + kx + 9$ a perfect square trinomial?
15	SAT-STYLE CHALLENGE	Factor: $x^2 + 6x + 9 - y^2$. (SAT-style grouped factoring)

UNIT 7

Quadratic Equations

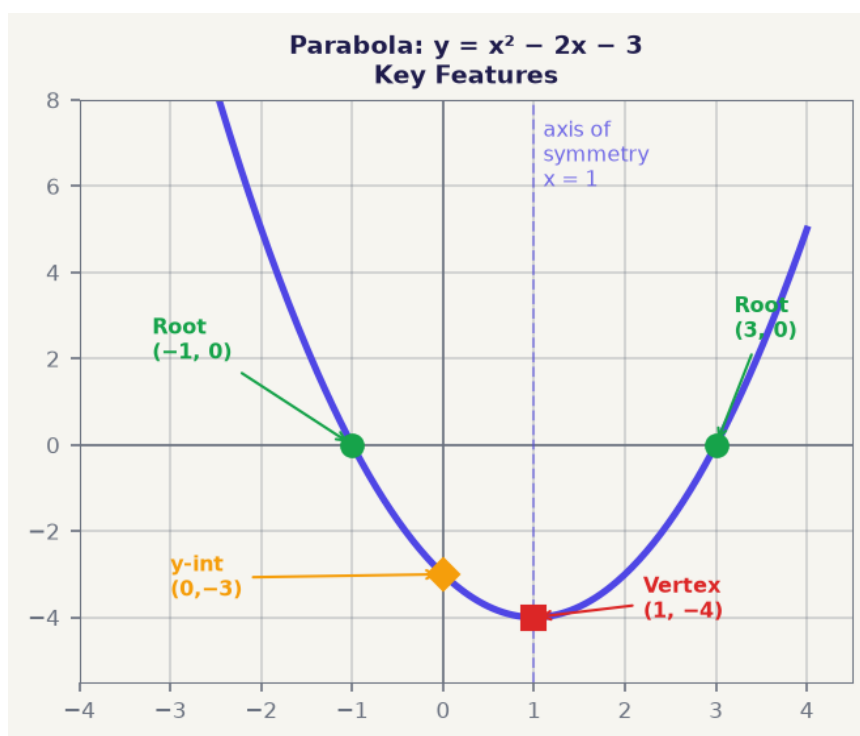
Solve by factoring, quadratic formula, and discriminant analysis.

Quadratic Formula

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

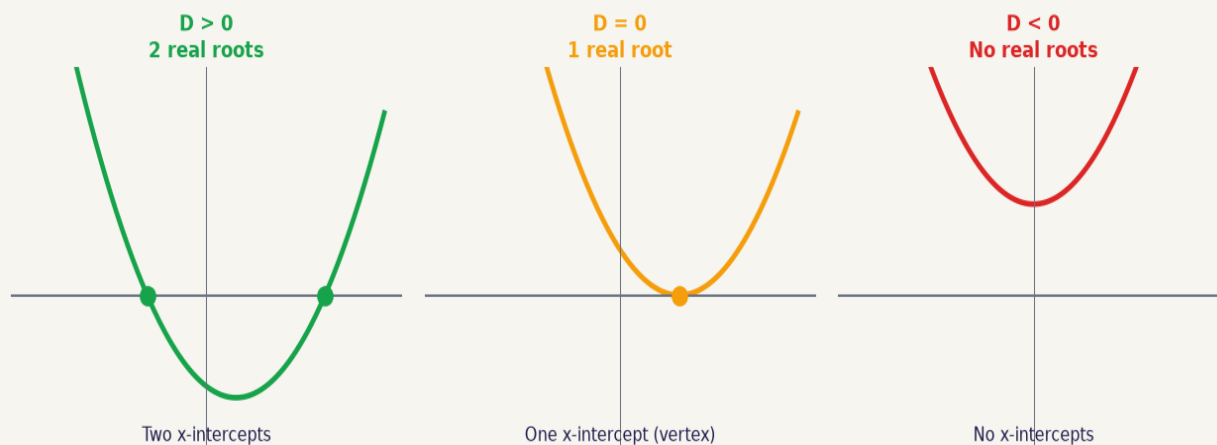
For any equation $ax^2 + bx + c = 0$. The $\pm$ gives two possible solutions.

Visual Reference — Parabola Features



Visual Reference — Discriminant Cases

Discriminant: $b^2 - 4ac$ determines number of real roots



Discriminant $b^2 - 4ac$	Number of Solutions	Graph
Greater than 0 ($D > 0$)	2 real solutions	Crosses x-axis twice
Equal to 0 ($D = 0$)	1 real solution	Touches x-axis at vertex
Less than 0 ($D < 0$)	No real solutions	Does not touch x-axis

WORKED EXAMPLE

Problem: Solve: $2x^2 - 4x - 6 = 0$

Step 1: $a=2$, $b=-4$, $c=-6$

Step 2: $x = (4 \pm \sqrt{(16+48)}) / 4 = (4 \pm \sqrt{64}) / 4 = (4 \pm 8) / 4$

Step 3: $x = (4+8)/4 = 3$ or $x = (4-8)/4 = -1$

□ Answer: $x = 3$ or $x = -1$

□ Vertex of a Parabola

The vertex x-coordinate is $-b/(2a)$. Plug it back in to find y. The vertex is always the minimum (opens up) or maximum (opens down) of the parabola — heavily tested on SAT.

Unit 7 Practice Problems

Answers for all units are compiled in the Answer Key at the back of this guide.

1

□ EASY

Solve by factoring: $x^2 - x - 12 = 0$

2	EASY	Solve: $x^2 - 25 = 0$
3	EASY	Solve: $x^2 + 6x + 9 = 0$
4	EASY	What is the discriminant of $x^2 + 4x + 4 = 0$?
5	EASY	How many solutions does $x^2 + 1 = 0$ have?
6	MODERATE	Solve using the quadratic formula: $x^2 + 5x + 6 = 0$
7	MODERATE	Solve: $2x^2 - 3x - 2 = 0$
8	MODERATE	Find the discriminant and number of roots: $3x^2 - 2x + 5 = 0$
9	MODERATE	Find the vertex of: $y = x^2 - 4x + 3$
10	MODERATE	A ball's height is $h = -16t^2 + 48t$. When does it hit the ground?
11	SAT-STYLE CHALLENGE	Solve: $(x+1)(x-3) = 5$. (SAT-style — don't skip expanding)
12	SAT-STYLE CHALLENGE	For what values of k does $x^2 + kx + 9 = 0$ have exactly one solution?
13	SAT-STYLE CHALLENGE	A rectangular garden has area 40 m^2 . The length is 3 m more than the width. Find both dimensions.
14	SAT-STYLE CHALLENGE	The sum of the roots of $ax^2 + bx + c = 0$ equals $-b/a$. Find the sum of roots of $2x^2 - 6x + 1 = 0$.
15	SAT-STYLE CHALLENGE	Solve: $x^4 - 5x^2 + 4 = 0$. (SAT-style — treat x^2 as a substitution variable)

UNIT 8

Radicals & Data Analysis

Simplify radicals and interpret data sets with statistics.

Radical Product Rule

$$\sqrt{(a \cdot b)} = \sqrt{a} \cdot \sqrt{b}$$

Factor out perfect squares: 4, 9, 16, 25, 36, 49, 64, 81, 100...

WORKED EXAMPLE

Problem: Simplify: $\sqrt{72}$

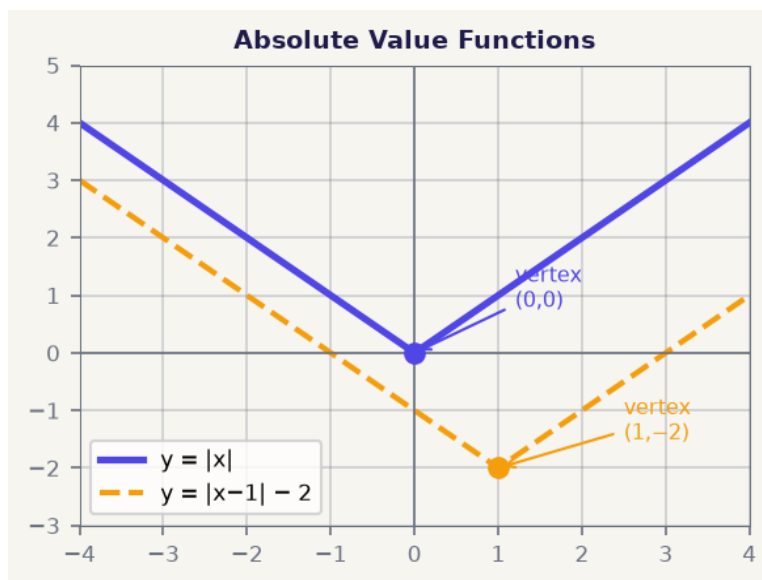
Step 1: Factor: $72 = 36 \times 2$

Step 2: Apply rule: $\sqrt{72} = \sqrt{36} \cdot \sqrt{2}$

Step 3: Simplify $\sqrt{36} = 6$

□ Answer: $6\sqrt{2}$

Visual Reference — Absolute Value Functions



8.2 Key Statistics

Measure	What It Tells You	How to Calculate
Mean	Average	Sum all values ÷ count

Median	Middle value	Order data; pick middle (avg two middles if even count)
Mode	Most frequent	Value that appears most often
Range	Spread	Max – Min
IQR	Middle 50% spread	$Q3 - Q1$
Outlier	Unusual value	Below $Q1 - 1.5 \times IQR$ or above $Q3 + 1.5 \times IQR$

Unit 8 Practice Problems

Answers for all units are compiled in the Answer Key at the back of this guide.

1	EASY	Simplify: $\sqrt{48}$
2	EASY	Simplify: $\sqrt{100}$
3	EASY	Find the mean: {4, 7, 9, 2, 8}
4	EASY	Find the median: {3, 7, 1, 9, 4}
5	EASY	Find the range: {15, 3, 22, 8, 17}
6	MODERATE	Simplify: $\sqrt{200}$
7	MODERATE	Simplify: $3\sqrt{12} + 2\sqrt{3}$
8	MODERATE	Find the mode and median: {2, 5, 3, 5, 7, 1, 5}
9	MODERATE	Simplify: $\sqrt{(50x^2)}$
10	MODERATE	The mean of 5 numbers is 12. Four of them are 10, 14, 8, 16. Find the 5th.
11	SAT-STYLE CHALLENGE	Simplify: $\sqrt{(18)} \cdot \sqrt{(2)}$. Do not leave a radical in your answer.
12	SAT-STYLE CHALLENGE	Solve: $\sqrt{(x+5)} = 4$. Check for extraneous solutions.
13	SAT-STYLE CHALLENGE	A data set has $Q1=10$ and $Q3=22$. What is the IQR? Is 40 an outlier?
14	SAT-STYLE CHALLENGE	Simplify: $(2\sqrt{3} + \sqrt{5})(\sqrt{3} - 2\sqrt{5})$. (SAT-style radical multiplication)
15	SAT-STYLE CHALLENGE	The average of x , $x+4$, and $x+8$ is 20. Find x . Then find the median.

Quick Reference — All Key Formulas

Topic	Formula
Slope	$m = (y_2 - y_1) / (x_2 - x_1)$
Slope-Intercept	$y = mx + b$
Point-Slope	$y - y_1 = m(x - x_1)$
Standard Form	$Ax + By = C$
FOIL	$(a+b)(c+d) = ac + ad + bc + bd$
Difference of Squares	$a^2 - b^2 = (a+b)(a-b)$
Perfect Square (+)	$(a+b)^2 = a^2 + 2ab + b^2$
Perfect Square (-)	$(a-b)^2 = a^2 - 2ab + b^2$
Quadratic Formula	$x = (-b \pm \sqrt{b^2 - 4ac}) / 2a$
Discriminant	$D = b^2 - 4ac \rightarrow D > 0: 2 \text{ roots}, D = 0: 1 \text{ root}, D < 0: \text{none}$
Product Rule	$x^m \cdot x^n = x^{(m+n)}$
Quotient Rule	$x^m \div x^n = x^{(m-n)}$
Power Rule	$(x^m)^n = x^{(m \times n)}$
Negative Exponent	$x^{-n} = 1/x^n$
Radical Product	$\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$
Mean	$\text{Sum} \div \text{Count}$
Range	$\text{Max} - \text{Min}$
IQR	$Q3 - Q1$
Outlier bounds	$\text{Below } Q1 - 1.5 \cdot \text{IQR} \text{ or Above } Q3 + 1.5 \cdot \text{IQR}$

Answer Key

Difficulty key: ● Easy ◆ Moderate ★ SAT-Style Challenge

Unit 1 — Foundations

- 1. $5a + 7b$
- 2. 88
- 3. $6x - 12$
- 4. Associative Property of Addition
- 5. -11
- ◆ 6. $4x + 11$
- ◆ 7. $4 - (-30) + 5 = 43$ [$a^2=4$, $-3ab=30$, $b=5 \rightarrow 4+30+5=39$... Recompute: $4-3(-2)(5)+5 = 4+30+5 = 39$]
- ◆ 8. Distributive Property
- ◆ 9. $-2a + 10b$
- ◆ 10. $[(3+4) \times 2] \div 5 = 14 \div 5 = 2.8$
- ★ 11. $x = 4$
- ★ 12. Error: did not follow order of operations. Correct: $4 + 6 = 10$
- ★ 13. $4a + 6b$
- ★ 14. $k = 2$
- ★ 15. $x^2 = 9$; $2x+5 = -1$. x^2 is greater.

Unit 2 — Equations & Inequalities

- 1. $x = 4$
- 2. $x = 18$
- 3. $x = 9$
- 4. $x > 3$
- 5. $x = 5$
- ◆ 6. $x = 3$
- ◆ 7. $x \geq -4$
- ◆ 8. $x = 1$
- ◆ 9. $-2 < x < 3$
- ◆ 10. $2n - 7 \geq 11$; $n \geq 9$
- ★ 11. $x = 6$
- ★ 12. $x = 7$ (only integer satisfying both)
- ★ 13. $n + (n+1) + (n+2) = 48$; $n=15$, so 15,16,17
- ★ 14. 9.2 miles (rounded to 9 full miles on \$15 budget)
- ★ 15. $x = 5$ or $x = -2$

Unit 3 — Linear Functions & Graphing

- 1. $m = 2$
- 2. $y = -2x + 5$
- 3. (0, -8)
- 4. Yes: $2(2) - 1 = 3$ ✓
- 5. 0
- ◆ 6. $m = 2$
- ◆ 7. $y = 4x - 1$
- ◆ 8. (4, 0)
- ◆ 9. Parallel (same slope, $m=3$)
- ◆ 10. $y = -x + 4$
- ★ 11. $2x + y = 1$
- ★ 12. $y = -(1/2)x + 3.5$
- ★ 13. (0, -4), (3, -2), (6, 0)
- ★ 14. $y = 2x - 7$ and $y = -(1/2)x + (1/2)$
- ★ 15. $d = -6t + 10$; arrives at $t = 5/3$ hours (≈ 1 hr 40 min)

Unit 4 — Systems of Equations

- 1. Intersection at (2, 3)
- 2. (3, 6)
- 3. (7, 3)
- 4. (2, 1)
- 5. No solution
- ◆ 6. (3, 2)
- ◆ 7. (2, 4)
- ◆ 9. Infinite solutions
- ◆ 10. Larger=20, Smaller=10
- ★ 11. Infinite solutions (same line)
- ★ 12. $x=\$7$, $y=\$5.67 \rightarrow$ Adult \$7, Child $\$17/3 \approx \5.67
- ★ 13. $x=2$, $y=0$
- ★ 14. $k = 6$ (makes lines parallel)
- ★ 15. Plane speed=250 mph, Wind speed=50 mph

◆ 8. (4, 3)

Unit 5 — Exponents & Polynomials

- | | |
|----------------------|----------------------------|
| ● 1. x^8 | ◆ 9. $2x^2 + 6x - 4$ |
| ● 2. $27x^6$ | ◆ 10. $x^2 + 6x + 9$ |
| ● 3. $3x^4$ | ★ 11. $x^3 + x^2 - 4x - 4$ |
| ● 4. 1 | ★ 12. $3x^5y$ |
| ● 5. x^3 | ★ 13. -27 |
| ◆ 6. $x^2 + 6x + 8$ | ★ 14. $x^2 + x - 6$ |
| ◆ 7. $2x^2 + 9x - 5$ | ★ 15. x^2 |
| ◆ 8. $4x^6y^4$ | |

Unit 6 — Factoring

- | | |
|--------------------|---------------------------|
| ● 1. $4x(2x - 3)$ | ◆ 9. $(2x+5)(2x-5)$ |
| ● 2. $(x+4)(x+5)$ | ◆ 10. $5x(x+2)(x-2)$ |
| ● 3. $(x+7)(x-7)$ | ★ 11. $(3x-1)(2x+3)$ |
| ● 4. $(x-4)^2$ | ★ 12. $(x^2+4)(x+2)(x-2)$ |
| ● 5. $(x-7)(x+2)$ | ★ 13. $2x(x+4)(x-1)$ |
| ◆ 6. $(2x+1)(x+3)$ | ★ 14. $k = 6$ or $k = -6$ |
| ◆ 7. $3(x+2)(x-2)$ | ★ 15. $(x+3+y)(x+3-y)$ |
| ◆ 8. $(x+7)(x-3)$ | |

Unit 7 — Quadratic Equations

- | | |
|------------------------------|--|
| ● 1. $x=4$ or $x=-3$ | ◆ 9. Vertex at (2, -1) |
| ● 2. $x=5$ or $x=-5$ | ◆ 10. $t=0$ and $t=3$ seconds |
| ● 3. $x=-3$ (double root) | ★ 11. $x=1+\sqrt{6}$ or $x=1-\sqrt{6}$ |
| ● 4. $D=0$ | ★ 12. $k=6$ or $k=-6$ |
| ● 5. No real solutions | ★ 13. Width=5m, Length=8m |
| ◆ 6. $x=-2$ or $x=-3$ | ★ 14. Sum = 3 |
| ◆ 7. $x=2$ or $x=-1/2$ | ★ 15. $x=\pm 1$ or $x=\pm 2$ |
| ◆ 8. $D=-56$; no real roots | |

Unit 8 — Radicals & Data

- | | |
|-----------------------------|---|
| ● 1. $4\sqrt{3}$ | ◆ 9. $5x\sqrt{2}$ |
| ● 2. 10 | ◆ 10. 12 |
| ● 3. 6 | ★ 11. 6 |
| ● 4. 4 (ordered: 1,3,4,7,9) | ★ 12. $x=11$ (check: $\sqrt{16}=4$ ✓) |
| ● 5. 19 | ★ 13. IQR=12; yes, $40 > 22+18=40$, borderline outlier |
| ◆ 6. $10\sqrt{2}$ | ★ 14. $6-4\sqrt{15}+\sqrt{15}-2(5) = -4-3\sqrt{15}$ |
| ◆ 7. $8\sqrt{3}$ | ★ 15. $x=16$; median=20 |
| ◆ 8. Mode=5, Median=5 | |

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