

Every Formula You Need for SAT Math

44 QUESTIONS • 70 MINUTES • 2 ADAPTIVE MODULES

Built-in Desmos graphing calculator available on every question. ~75% multiple choice, ~25% student-produced response.

Algebra ~35% of the test • 13-15 questions

Linear Equations

SLOPE-INTERCEPT FORM

$$y = mx + b$$

m = slope (rate of change), b = y-intercept (starting value). Most common form on the SAT.

POINT-SLOPE FORM

$$y - y_1 = m(x - x_1)$$

Use when you know a point and slope. Convert to slope-intercept to match answer choices.

STANDARD FORM

$$Ax + By = C$$

x -int: set $y = 0$. y -int: set $x = 0$. Slope = $-A/B$. SAT loves asking you to rewrite between forms.

SLOPE FORMULA

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

Positive: up-right. Negative: down-right. Zero: horizontal. Undefined: vertical.

PARALLEL & PERPENDICULAR

Parallel: same slope ($m_1 = m_2$). **Perpendicular:** negative reciprocal ($m_1 \cdot m_2 = -1$). Example: slope $\frac{2}{3}$ is perpendicular to slope $-\frac{3}{2}$.

INTERPRETING IN CONTEXT

The slope is the **rate** ("per unit" change). The y-intercept is the **starting value** (when $x = 0$). SAT asks: "What does the 12 represent in $y = 3x + 12$?"

WATCH OUT

Slope is **undefined** for vertical lines ($x = c$), not zero. Horizontal lines ($y = c$) have slope **zero**. Don't confuse them.

Systems of Linear Equations

ELIMINATION

Add/subtract equations to cancel a variable. Multiply one equation by a constant to align coefficients. Generally faster than substitution on SAT.

SUBSTITUTION

Solve one equation for a variable, plug into the other. Best when one variable is already isolated (like $y = 3x + 2$).

NUMBER OF SOLUTIONS

One: different slopes (lines cross). **None:** same slope, different intercept (parallel). **Infinite:** same line. Compare $\frac{a_1}{a_2} = \frac{b_1}{b_2}$.

Desmos shortcut: Type both equations into Desmos and click the intersection point to find the solution instantly. For "no solution" problems, check if the lines are parallel (same slope).

Linear Inequalities

SOLVING

Solve like equations. **Flip the sign when multiplying or dividing by a negative.** Open circle: $<$, $>$. Closed circle: $\leq$, $\geq$.

GRAPHING & SYSTEMS

$y >$: shade above (dashed for strict). $y <$: shade below. Systems of inequalities: find the overlapping shaded region. Compound: $a < x < b$ means x is between a and b .

Exponent Rules

$$x^a \cdot x^b = x^{a+b}$$

$$\frac{x^a}{x^b} = x^{a-b}$$

$$(x^a)^b = x^{ab}$$

$$x^0 = 1$$

$$x^{-n} = \frac{1}{x^n}$$

$$x^{1/n} = \sqrt[n]{x}$$

$$x^{m/n} = (\sqrt[n]{x})^m$$

WATCH OUT

$(xy)^n = x^n y^n$ but $(x + y)^n \neq x^n + y^n$. You **cannot** distribute exponents over addition!

Equivalent Expressions & Factoring

KEY IDENTITIES

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

$$(a + b)^2 = a^2 + 2ab + b^2$$

$$(a - b)^2 = a^2 - 2ab + b^2$$

$$a^2 - b^2 = (a + b)(a - b)$$

FACTORING METHODS

GCF: always try first — pull out the greatest common factor.

Trinomial: find two numbers that multiply to ac and add to b .

Difference of squares: $a^2 - b^2 = (a + b)(a - b)$.

Grouping: for 4+ terms, group in pairs and factor each.

Rational Expressions

SIMPLIFY

Factor numerator & denominator, cancel common factors. Never cancel terms that are added/subtracted — only factors.

ADD / SUBTRACT

Find the LCD (least common denominator), rewrite each fraction, combine numerators, simplify.

MULTIPLY / DIVIDE

Multiply: straight across. Divide: flip the second fraction, then multiply. Always simplify at the end.

Radicals

$\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$. Simplify by factoring out perfect squares:
 $\sqrt{72} = \sqrt{36 \cdot 2} = 6\sqrt{2}$.

Rationalizing: multiply by $\frac{\sqrt{x}}{\sqrt{x}}$ to clear radical from denominator. For $\frac{1}{a+\sqrt{b}}$, multiply by the conjugate $\frac{a-\sqrt{b}}{a-\sqrt{b}}$.

Solving Nonlinear Equations

RADICAL EQUATIONS

Isolate the radical, square both sides, solve. **Always check for extraneous solutions** by plugging back in — squaring can create false answers.

RATIONAL EQUATIONS

Multiply every term by the LCD to clear fractions, then solve. **Check that your answer doesn't make any denominator zero** — those are extraneous.

ABSOLUTE VALUE

$|x| = a$: split into $x = a$ or $x = -a$. $|x| < a$: $-a < x < a$.
 $|x| > a$: $x < -a$ or $x > a$.

NONLINEAR SYSTEMS

Linear-quadratic systems (line + parabola): use substitution. Can have 0, 1, or 2 solutions. Solutions = intersection points.

The Three Forms of a Quadratic — What Each One Reveals

Every quadratic can be written in three forms. The SAT tests your ability to *choose the right form* for the question being asked.

FORM	EQUATION	WHAT IT REVEALS	WHEN THE SAT USES IT
Standard	$f(x) = ax^2 + bx + c$	y-intercept = c (the constant term) Direction: $a > 0$ opens up, $a < 0$ opens down	"What is the y-intercept?" or "What is $f(0)$?" Starting point for factoring or quadratic formula
Vertex	$f(x) = a(x - h)^2 + k$	Vertex at (h, k) Min/max value = k Axis of symmetry : $x = h$	"What is the minimum/maximum value?" "At what value of x does $f(x)$ reach its min/max?"
Factored	$f(x) = a(x - r)(x - s)$	x-intercepts (zeros/roots) at $x = r$ and $x = s$ These are the solutions to $f(x) = 0$	"What are the solutions?" or "Where does the graph cross the x-axis?"

The bridge between forms: The x-coordinate of the vertex is the **average of the x-intercepts**: $h = \frac{r+s}{2}$. If you know the roots from factored form, you instantly know where the vertex sits. Then plug h back in to find k . This connects factored form directly to vertex form without expanding to standard first.

Converting Between Forms

STANDARD → FACTORED

Factor the expression: find two numbers that multiply to ac and add to b , then factor by grouping. Or use the quadratic formula to find the roots, then write $a(x - r)(x - s)$.

STANDARD → VERTEX

Complete the square or use the formula:
 $h = -\frac{b}{2a}$, then $k = f(h)$. The vertex is at $(-\frac{b}{2a}, f(-\frac{b}{2a}))$.

FACTORED/VERTEX → STANDARD

Expand: FOIL or distribute, then combine like terms. This always works and is straightforward.

Desmos shortcut: Type any quadratic into Desmos. Click the vertex to read (h, k) . Click x-intercepts to read the roots. Read the y-intercept where the curve crosses the y-axis.

The Quadratic Formula & Discriminant

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

WHEN TO USE IT

Use the formula when factoring is difficult or impossible. Works on **every** quadratic. Plug in a , b , and c from standard form $ax^2 + bx + c = 0$.

THE DISCRIMINANT: $\Delta = B^2 - 4AC$

$\Delta > 0$: **two** distinct real solutions (graph crosses x-axis twice)
 $\Delta = 0$: **one** repeated real solution (graph touches x-axis)
 $\Delta < 0$: **no** real solutions (graph doesn't reach x-axis)

Key Quadratic Properties

AXIS OF SYMMETRY

$x = -\frac{b}{2a}$ or $x = \frac{r + s}{2}$ (midpoint of the two roots). The parabola is symmetric about this line — if you know one root, you can find the other.

SUM & PRODUCT OF ROOTS

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

Sum: $r + s = -\frac{b}{a}$
Product: $r \cdot s = \frac{c}{a}$

Useful when the question asks about roots without you actually solving.

DIRECTION & WIDTH

$a > 0$: opens **up** (vertex is a minimum). $a < 0$: opens **down** (vertex is a maximum). Larger $|a|$: narrower parabola. Smaller $|a|$: wider parabola.

COMPLETING THE SQUARE

$x^2 + bx + (\frac{b}{2})^2 = (x + \frac{b}{2})^2$

Take half of b , square it, add it to both sides. This converts standard form to vertex form.

COMMON MISTAKES WITH QUADRATICS

Vertex form $(x - 3)^2$ means vertex at $x = +3$ — the sign flips! | Forgetting to set the equation = 0 before using the quadratic formula. | The discriminant tells you the *number* of solutions, not the solutions themselves.

Exponential Functions

GROWTH & DECAY

$$f(t) = a \cdot b^t$$

a = initial value (when $t = 0$), b = growth/decay factor.

Growth: $b > 1$ (e.g., 5% increase: $b = 1.05$). **Decay:** $0 < b < 1$ (e.g., 10% decrease: $b = 0.90$).

COMPOUND INTEREST

$$A = P\left(1 + \frac{r}{n}\right)^{nt}$$

P = principal, r = annual rate (decimal), n = times compounded per year, t = years.

$n = 1$: annually. $n = 12$: monthly. $n = 365$: daily.

LINEAR VS. EXPONENTIAL

Linear: constant *amount* added each step (arithmetic). **Exponential:** constant *ratio* multiplied each step (geometric). Check: do differences or ratios between consecutive values stay constant?

INTERPRETING IN CONTEXT

In $f(t) = 500(1.03)^t$: the 500 is the starting amount, the 1.03 means a 3% increase per time period. SAT asks: "What does the 1.03 represent?"

WATCH OUT

Exponential growth is NOT "doubles every period" unless $b = 2$. A 100% increase doubles ($b = 2$). A 5% increase uses $b = 1.05$, not $b = 5$.

Function Concepts

EVALUATION

$f(x)$: plug x into the function. $f(3)$: replace every x with 3.

$f(a) = b$ means the point (a, b) is on the graph. Evaluate from equations, tables, or graphs.

COMPOSITION

$f(g(x))$: evaluate $g(x)$ first, plug result into f . Work from the inside out. Can compose from formulas, tables, or graphs.

DOMAIN & RANGE

Domain: all valid x -inputs. Restrictions: no division by zero ($\frac{1}{x-3}$: $x \neq 3$), no even roots of negatives ($\sqrt{x}$: $x \geq 0$).

Range: all possible y -outputs.

ZEROS / ROOTS / X-INTERCEPTS

These are all the same thing: values where $f(x) = 0$. Set the function equal to zero and solve. On the graph, these are where the curve crosses the x -axis.

Graph Transformations

SHIFTS

$f(x) + k$: up k . $f(x) - k$: down k .

$f(x + h)$: LEFT h (opposite!). $f(x - h)$: RIGHT h .

Horizontal shifts go opposite to the sign; vertical shifts go the same direction.

REFLECTIONS & STRETCHES

$-f(x)$: flip over x -axis (negate outputs).

$f(-x)$: flip over y -axis (negate inputs).

$af(x)$: vertical stretch ($a > 1$) or compress ($0 < a < 1$).

WATCH OUT

$f(x + 3)$ shifts LEFT 3, not right! The horizontal direction is always **opposite** to the sign inside the parentheses. Vertical shifts work the way you'd expect.

Polynomial & Rational Functions

POLYNOMIALS

Degree = highest exponent $\rightarrow$ determines number of possible x -intercepts and end behavior. **End behavior:** even degree: both ends same direction. Odd degree: opposite directions. Leading coefficient positive: right side goes up.

RATIONAL FUNCTIONS

Vertical asymptotes: set denominator = 0. **Hole:** if a factor cancels from top and bottom.

Horizontal asymptote: compare degrees of numerator and denominator. Same degree: ratio of leading coefficients.

Problem-Solving & Data Analysis ~15% of the test • 5-7 questions

Ratios, Rates & Proportions

PROPORTIONS

$$\frac{\text{part}_1}{\text{whole}_1} = \frac{\text{part}_2}{\text{whole}_2}$$

Cross multiply to solve: $ad = bc$.

UNIT RATES

"Per unit" — divide to find the rate. Compare rates by making the denominator 1.

Keywords: "per," "each," "every."

UNIT CONVERSION

Multiply by conversion factors so units cancel:

$$60 \frac{\text{mi}}{\text{hr}} \times \frac{5280 \text{ ft}}{1 \text{ mi}} \times \frac{1 \text{ hr}}{3600 \text{ s}}$$

Percentages

BASIC

$$\% = \frac{\text{part}}{\text{whole}} \times 100$$

"is / of": $x\%$ of $y = \frac{x}{100} \cdot y$

INCREASE / DECREASE

$$\% \text{ change} = \frac{\text{new} - \text{old}}{\text{old}} \times 100$$

Increase: $\times (1 + r)$. Decrease: $\times (1 - r)$.

SUCCESSIVE CHANGES

Multiply the multipliers: 20% up then 10% down = $1.20 \times 0.90 = 1.08$ (net 8% up, not 10%).

Statistics: Center & Spread

MEAN & MEDIAN

$$\text{Mean} = \frac{\text{sum of all values}}{\text{number of values}}$$

Median: middle value when data is ordered. Even count: average the two middle values.

Mean is pulled toward outliers; median is resistant to outliers.

STANDARD DEVIATION (CONCEPTUAL)

Measures spread — how far data values are from the mean on average.

Larger SD = more spread out. Smaller SD = more clustered.

Add a constant to all values: mean shifts, SD unchanged.

Multiply all values by a constant: mean and SD both scale.

Two-Variable Data & Scatterplots

LINE OF BEST FIT

Slope = rate of change in context. y -intercept = predicted value when $x = 0$. Use the equation to predict values (interpolation within the data range is reliable; extrapolation beyond it is not).

CORRELATION VS. CAUSATION

Positive/negative/no correlation from scatterplots. **Correlation does NOT imply causation** — just because two variables are related doesn't mean one causes the other.

Probability & Two-Way Tables

BASIC PROBABILITY

$$P(\text{event}) = \frac{\text{favorable outcomes}}{\text{total outcomes}}$$

Always between 0 and 1. $P(\text{not } A) = 1 - P(A)$.

CONDITIONAL PROBABILITY

$P(A | B)$: probability of A given B has occurred.

From a two-way table: restrict to the row/column of the given condition, then find the fraction. $P(A | B) = \frac{P(A \text{ and } B)}{P(B)}$.

Statistical Inference & Study Design

MARGIN OF ERROR

Sample statistic $\pm$ margin of error = confidence interval. **Larger sample** → smaller margin of error. **Higher confidence** → larger margin of error. The true population value is likely within this interval.

STUDY DESIGN

Random sample → can generalize to population.

Random assignment (to treatment groups) → can establish causation.

Neither → can only describe the sample, not generalize or claim causation.

Observational study = no treatment applied (can find correlation only). *Experiment* = treatment applied with random assignment (can establish causation). SAT loves asking what conclusions a study supports.

Geometry & Trigonometry ~15% of the test • 5-7 questions

On the SAT Reference Sheet (provided during the test)

AREAS & CIRCUMFERENCE

Circle: $A = \pi r^2$, $C = 2\pi r$

Rectangle: $A = lw$

Triangle: $A = \frac{1}{2}bh$

VOLUMES

Rect. prism: $V = lwh$

Cylinder: $V = \pi r^2 h$ | Cone: $V = \frac{1}{3}\pi r^2 h$

Sphere: $V = \frac{4}{3}\pi r^3$ | Pyramid: $V = \frac{1}{3}lwh$

PYTHAGOREAN THEOREM

$$a^2 + b^2 = c^2$$

45-45-90 TRIANGLE

Sides: $x : x : x\sqrt{2}$

30-60-90 TRIANGLE

Sides: $x : x\sqrt{3} : 2x$

Also provided: a circle has 360° or 2π radians, and a triangle's angles sum to 180° . *Everything below this line you must memorize.*

Must-Memorize Geometry

MORE AREAS

Trapezoid: $A = \frac{1}{2}(b_1 + b_2)h$

Parallelogram: $A = bh$

Shaded region = total area — unshaded area

ANGLE RELATIONSHIPS

Supplementary: sum to 180° . **Complementary:** sum to 90° . **Vertical angles:** equal.

Parallel lines + transversal: corresponding angles equal, alternate interior angles equal.

TRIANGLE PROPERTIES

Interior angles sum to 180° . Exterior angle = sum of two non-adjacent interior angles.

Isosceles: 2 equal sides $\rightarrow$ 2 equal base angles. **Equilateral:** all 60° .

Similar triangles (AA): two equal angles $\rightarrow$ proportional sides.

PYTHAGOREAN TRIPLES

Common triples: 3-4-5, 5-12-13, 8-15-17, 7-24-25

Multiples work: 6-8-10, 9-12-15. Recognizing these saves time over using the formula.

Short leg opp 30° , long leg opp 60° , hyp opp 90° .

SOHCAHTOA

SOH

$$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}}$$

CAH

$$\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

TOA

$$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$$

Complementary: $\sin(x^\circ) = \cos(90^\circ - x^\circ)$. **Radians:** $\pi \text{ rad} = 180^\circ$. $\text{Deg} \rightarrow \text{rad}: \times \frac{\pi}{180}$. $\text{Rad} \rightarrow \text{deg}: \times \frac{180}{\pi}$.

Circles

ARCS & SECTORS

Arc length = $\frac{\theta}{360^\circ} \times 2\pi r$

Sector area = $\frac{\theta}{360^\circ} \times \pi r^2$

Inscribed angle = $\frac{1}{2}$ central angle.

EQUATION OF A CIRCLE

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

Center (h, k) , radius r . Watch the signs: $(x - 3)^2$ means center at $x = 3$, not -3 .

Complete the square to convert from general form.

Coordinate Geometry

DISTANCE FORMULA

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

It's the Pythagorean theorem on the coordinate plane.

MIDPOINT FORMULA

$$M = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$$

Average the x 's, average the y 's.

SAT Math Strategy & Quick Reference

Desmos Graphing Calculator — Power Moves

SYSTEMS OF EQUATIONS

Type both equations into Desmos. Click the intersection point to read the solution. For "no solution," lines will be parallel (no intersection).

QUADRATICS

Type the quadratic to see vertex, x-intercepts, and y-intercept instantly. Click key points to read exact coordinates. Faster than solving algebraically for many problems.

TESTING ANSWER CHOICES

Use the table feature (icon at top-left of an equation) to plug in x-values and see outputs. Or substitute answer choices directly into the equation.

REGRESSION

Create a table of data points. Desmos can fit a line or curve. Type $y_1 \sim mx_1 + b$ for linear regression or $y_1 \sim ax_1^2 + bx_1 + c$ for quadratic.

Student-Produced Response (Grid-In) Rules

Answers can be integers, decimals, or fractions (like $7/2$). No mixed numbers — enter $\frac{3}{2}$, not $1\frac{1}{2}$.

If multiple answers work, enter any one of them. Don't round unless told to — enter exact values. Negative answers are possible on the digital SAT.

If you get a repeating decimal, enter as many digits as the box allows. Example: $\frac{2}{3} = 0.6667$ (truncate or round, don't leave as 0.6 or 0.67).

Must-Memorize Checklist

ALGEBRA & ADVANCED MATH

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

Three forms of a line (slope-intercept, point-slope, standard)

Slope formula | All exponent rules

Compound interest: $A = P(1 + r/n)^{nt}$

GEOMETRY & TRIG

SOHCAHTOA | $\sin(x) = \cos(90^\circ - x)$

Circle: $(x - h)^2 + (y - k)^2 = r^2$

Distance: $d = \sqrt{(\Delta x)^2 + (\Delta y)^2}$

Midpoint: average the coordinates

Percent change: $\frac{\text{new} - \text{old}}{\text{old}} \times 100$

Geometry formulas (areas, volumes, Pythagorean theorem, special right triangles) are provided on the SAT. See page 6 for full list.

SAT Math — Domain Weight at a Glance

DOMAIN	QUESTIONS	% OF TEST	KEY FOCUS
Algebra	13-15	~35%	Linear equations, systems, inequalities, interpreting in context
Advanced Math	13-15	~35%	Quadratics, exponents, exponential functions, transformations
Problem-Solving & Data	5-7	~15%	Ratios, percents, statistics, probability, study design
Geometry & Trig	5-7	~15%	Area/volume, angles, right triangles, circles, coordinates

Adaptive strategy: The SAT has two math modules (22 questions each, 35 minutes each). Your performance on Module 1 determines the difficulty of Module 2. **Accuracy on Module 1 matters more than speed.** Take your time on Module 1 — a harder Module 2 means a higher potential score.