SAT Math formula sheet and Desmos guide, with worked examples

The Digital SAT Math section has two modules of 22 questions, 35 minutes each. The Desmos graphing calculator is built into the Bluebook app and allowed on every Math question. This guide gives you two tools: the formulas to know by heart, domain by domain, and eight Desmos moves that turn long algebra into a few clicks. Algebra and Advanced Math each carry about 35% of the Math questions; Problem-Solving and Data Analysis and Geometry and Trigonometry carry about 15% each.

What the in-app reference sheet gives you and what it does not

Bluebook has a reference sheet you can open during Math. In our words, it covers the basics of shape measurement: areas of common flat shapes, volumes of common solids, the Pythagorean theorem, the two special right triangles and a few angle totals. Opening it costs time, so learn those formulas anyway.

Most of what the SAT tests is **not** on the sheet. You must carry these in your head:

- Slope, slope-intercept form, and the slopes of parallel and perpendicular lines.
- The rules for one, none or infinitely many solutions of a linear equation or system.
- Exponent laws, special products and difference of squares.
- The quadratic formula, the discriminant, the vertex formula, and the sum and product of roots.
- Exponential growth and decay, percent change, and repeated percent change.
- Mean, median, range, the effect of an outlier, and margin of error.
- Probability, including conditional probability from a table.
- SOH-CAH-TOA, sin x° = cos(90° – x°), and degree-radian conversion.
- Arc length, sector area and the equation of a circle.

Algebra

Linear equations in one variable

Formula or fact	What it means	When the SAT uses it
total = fixed amount + rate × units	A fee stands alone; a rate multiplies the unknown	Turning a word problem into an equation
$ax + b = cx + d$, $a \neq c$	Exactly one solution	"How many solutions?"
$a = c$, $b \neq d$ / $a = c$, $b = d$	No solution / infinitely many	Finding a constant that gives no solution

Linear functions

Formula or fact	What it means	When the SAT uses it

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$f(x) = mx + b$	m is the change per unit, b = f(0) is the start	Explaining a number in a model
$m = (y_2 - y_1)/(x_2 - x_1)$	Rise over run	Building f from two points or a table

Linear equations in two variables

Formula or fact	What it means	When the SAT uses it
$Ax + By = C$ has slope $-A/B$	Rearrange before reading the slope	Standard-form questions
$y - y_1 = m(x - x_1)$	Line through a point with slope m	Writing an equation of a line
Parallel: equal slopes. Perpendicular: $m_1 \times m_2 = -1$	Compare slopes, not intercepts	Lines in the xy-plane

Systems of two linear equations

Formula or fact	What it means	When the SAT uses it
$a_1/a_2 = b_1/b_2 \neq c_1/c_2$	Parallel lines, no solution	"No solution" constant questions
$a_1/a_2 = b_1/b_2 = c_1/c_2$	Same line, infinitely many	"Infinitely many" questions
Add or subtract the equations	Gets x + y or x – y directly	When the question asks for a combination

Linear inequalities

Formula or fact	What it means	When the SAT uses it
Multiply or divide by a negative: reverse the sign	$-3x > 12$ gives $x < -4$	Solving any inequality
at most: ≤ ; at least: ≥	Translation of budget and minimum words	Word problems with limits

Advanced Math

Equivalent expressions

Formula or fact	What it means	When the SAT uses it
$(a \pm b)^2 = a^2 \pm 2ab + b^2$	Square of a sum or difference	Expanding
$a^2 - b^2 = (a - b)(a + b)$	Difference of squares	Factoring and simplifying fractions
$x^a x^b = x^{a+b}$, $(x^a)^b = x^{ab}$, $x^{m/n}$ = n-th root of x^m	Exponent laws	Rewriting powers and roots

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Nonlinear equations and systems

Formula or fact	What it means	When the SAT uses it
$x = (-b \pm \sqrt{(b^2 - 4ac)})/(2a)$	Solves any quadratic	When factoring is slow
$b^2 - 4ac$: > 0 two, = 0 one, < 0 none	Number of real solutions	"Exactly one solution" and line-meets-parabola questions
Sum of roots $-b/a$, product c/a	No need to solve	"What is the sum of the solutions?"

Nonlinear functions

Formula or fact	What it means	When the SAT uses it
Vertex at $x = -b/(2a)$; $y = a(x - h)^2 + k$ has vertex (h, k)	Location of the maximum or minimum	Greatest height, least cost
$f(t) = a(b)^t$, $b = 1 \pm r/100$	Start a, multiplied by b each period	Growth and decay models
$f(x - c)$ moves right c; $f(x) + d$ moves up d	Graph shifts	Transformations

Problem-Solving and Data Analysis

Ratios, rates, proportions and units

Formula or fact	What it means	When the SAT uses it
$a/b = c/d$ gives $ad = bc$	Cross-multiply a proportion	Missing value questions
distance = speed × time	Rate times time	Travel and work rates
Scale k: area × k^2, volume × k^3	Lengths, areas and volumes scale differently	Maps, models, similar solids

Percentages

Formula or fact	What it means	When the SAT uses it
percent change = (new − old)/old × 100	Always divide by the original	Increase and decrease questions
original = new ÷ multiplier	Undo a change by dividing	"Price before the discount"
Changes in a row: multiply multipliers	+10% then −10% is 1.1 × 0.9 = 0.99	Successive changes

One-variable data

Formula or fact	What it means	When the SAT uses it
sum = mean × count	Work with totals, not means	Adding or removing values
Outlier moves the mean, hardly the median	The median resists extremes	Comparing data sets

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Standard deviation: spread around the mean	Closer to the mean, smaller SD	Comparing two dot plots

Two-variable data

Formula or fact	What it means	When the SAT uses it
Slope of a best-fit line	Predicted change in y per 1 unit of x	Interpreting a scatterplot
$y = a(b)^x$, b = 0.94 means 6% decrease per step	Equal ratios mean exponential	Linear or exponential?

Probability

Formula or fact	What it means	When the SAT uses it
P = favorable ÷ total	Count outcomes	Simple selection
P(A given B) = cell for both ÷ total for B	The denominator is the given group only	Two-way tables
P(not A) = 1 – P(A)	Complement	"At least one"

Samples, studies and margin of error

Formula or fact	What it means	When the SAT uses it
estimate ± margin of error	Plausible range for the population value	Survey results
Random sample: generalize. Random assignment: cause	Two different permissions	"Which conclusion is supported?"

Geometry and Trigonometry

Area and volume

Formula or fact	What it means	When the SAT uses it
Cylinder $\pi r^2 h$; cone $(1/3)\pi r^2 h$	A cone holds one third of the matching cylinder	Volume of solids
Sphere $(4/3)\pi r^3$	Radius cubed	Balls, tanks
Trapezoid $\frac{1}{2}(a + b)h$	Average of parallel sides × height	Composite shapes

Lines, angles and triangles

Formula or fact	What it means	When the SAT uses it
Triangle angles sum to 180°; exterior angle = sum of the two far interior angles	Angle chasing	Finding a missing angle

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Parallel lines: alternate angles equal, same-side interior sum to 180°	Transversal facts	Diagrams with parallel lines
Similar triangles: sides ratio k, areas k^2	Same shape, scaled	Missing side in nested triangles

Right triangles and trigonometry

Formula or fact	What it means	When the SAT uses it
sin = opp/hyp, cos = adj/hyp, tan = opp/adj	SOH-CAH-TOA	Any right-triangle ratio
sin x° = cos(90° − x°)	The two acute angles swap sine and cosine	"If sin A = 0.6, what is cos B?"
3-4-5, 5-12-13, 8-15-17, 7-24-25	Whole-number right triangles	Finding the third side fast

Circles

Formula or fact	What it means	When the SAT uses it
$(x - h)^2 + (y - k)^2 = r^2$	Center (h, k), radius r	Circle equations
Arc = (θ/360) × 2πr; sector = (θ/360) × πr^2	Fraction of the whole circle	Arcs and slices
$x^2 + bx = (x + b/2)^2 - (b/2)^2$	Completing the square	Finding center and radius

Desmos: eight techniques

Use Desmos when the algebra is long or when you want a check. Do not use it for one-step arithmetic you can do faster in your head.

1. Solve by intersection

Example: Solve $3(x - 4) + 7 = (x + 15)/3$.

Hand: multiply by 3: $9x - 15 = x + 15$, so $8x = 30$ and $x = 3.75$.

Desmos: type $y = 3(x - 4) + 7$ and $y = (x + 15)/3$. Click the crossing point: (3.75, 6.25). The answer is the x-coordinate.

Check: $3(-0.25) + 7 = 6.25$ and $18.75/3 = 6.25$.

2. Count solutions

Example: How many real solutions does $x^2 - 6x + 11 = 2x - 5$ have?

Hand: $x^2 - 8x + 16 = 0$, so $(x - 4)^2 = 0$: exactly one solution, $x = 4$.

Desmos: graph $y = x^2 - 6x + 11$ and $y = 2x - 5$. The line just touches the parabola at (4, 3): one point, one solution. No crossing would mean no real solution.

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3. Find the vertex and zeros

Example: $f(x) = -2x^2 + 8x + 10$. Find the zeros and the maximum value.

Hand: $f(x) = -2(x^2 - 4x - 5) = -2(x - 5)(x + 1)$, so the zeros are -1 and 5. Vertex $x = -8/(2 \times -2) = 2$, and $f(2) = -8 + 16 + 10 = 18$.

Desmos: type the function and click the gray points: $(-1, 0)$, $(5, 0)$ and the top $(2, 18)$. The maximum value is 18, not 2.

4. Regression from a table

Example: $x = 0, 1, 2, 3$ gives $y = 500, 400, 320, 256$. Find the model.

Hand: each y is 0.8 times the one before, so $y = 500(0.8)^x$, a 20% decrease per step.

Desmos: add a table (columns x_1 and y_1), enter the data, then type $y_1 \sim ab^{x_1}$. Desmos reports $a = 500$ and $b = 0.8$. For a line, type $y_1 \sim mx_1 + b$.

5. Systems

Example: $3x + 4y = 7$ and $5x - 2y = 29$.

Hand: double the second: $10x - 4y = 58$. Add to the first: $13x = 65$, so $x = 5$. Then $4y = 7 - 15 = -8$, so $y = -2$.

Desmos: type both equations as written (no need to solve for y). Click the intersection: $(5, -2)$.

Check: $15 - 8 = 7$ and $25 + 4 = 29$.

6. Inequalities and shading

Example: Which point satisfies $y \geq 2x - 3$ and $y < -x + 6$: $(4, 2)$, $(0, 7)$, $(3, 2)$ or $(1, 4)$?

Desmos: type both inequalities (use >= for ≥). The double-shaded region is the solution set; the < boundary is dashed, so points on it do not count. Type the four points; only $(1, 4)$ sits in the overlap.

Hand check: $4 \geq 2(1) - 3 = -1$ and $4 < -1 + 6 = 5$. Both true.

7. Checking answer choices

Example: Which is equivalent to $(2x - 3)^2 - (x - 1)^2$?

Hand: $4x^2 - 12x + 9 - (x^2 - 2x + 1) = 3x^2 - 10x + 8 = (3x - 4)(x - 2)$.

Desmos: graph the original, then graph each choice. The equivalent choice lies exactly on top of the original curve.

Check with x = 0: $9 - 1 = 8$ and $(-4)(-2) = 8$.

8. Sliders

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Example: For what positive value of k does the line $y = kx$ meet $y = x^2 + 4$ at exactly one point?

Desmos: type $y = kx$ and accept the slider for k. Drag until the line just touches the parabola: $k = 4$, touching at (2, 8).

Hand: $x^2 - kx + 4 = 0$ needs discriminant $k^2 - 16 = 0$, so $k = 4$.

Practice set

Questions 1 to 4, 6 and 7 are multiple choice. Questions 5 and 8 are student-produced responses: type your answer.

1. A cone has a radius of 6 centimeters and a height of 10 centimeters. What is the volume of the cone, in cubic centimeters?

   A) 20π
   B) 120π
   C) 200π
   D) 360π

2. In the xy-plane, how many points do the graphs of $y = x^2 - 4x + 1$ and $y = -2x - 3$ have in common?

   A) 0
   B) 1
   C) 2
   D) Infinitely many

3. The graph of $x^2 + y^2 - 10x + 6y + 18 = 0$ in the xy-plane is a circle. What is the radius of the circle?

   A) $\sqrt{18}$
   B) 16
   C) 4
   D) $\sqrt{52}$

4. A town's population is modeled by an exponential function. The table gives the population P, t years after 2020.

t	0	2	4
P	6,400	7,744	9,370.24

   By what percent does the population increase each year?

   A) 21%
   B) 10.5%
   C) 1.1%
   D) 10%

5. The mean of 8 test scores is 72. When one score is removed, the mean of the remaining 7 scores is 70. What score was removed?

6. In right triangle ABC, angle C is a right angle and $\cos A = 8/17$. What is the value of $\tan B$?

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A) 8/15
B) 15/8
C) 15/17
D) 8/17

7. The height, in feet, of a ball t seconds after it is thrown is $h(t) = -16t^2 + 64t + 5$. What is the maximum height of the ball, in feet?

   A) 2
   B) 5
   C) 64
   D) 69

8. The line $y = 3x + c$ and the parabola $y = x^2 - 5x + 20$ intersect at exactly one point. What is the value of c?

Solutions

1. B

Hand: $V = (1/3)\pi r^2 h = (1/3)\pi(36)(10) = 120\pi$. A forgets to square the radius, C swaps radius and height ($(1/3)\pi(100)(6) = 200\pi$), D is the cylinder (no 1/3).

Desmos: type $(1/3)\pi \cdot 6^2 \cdot 10$ and 120π; both give about 376.99.

Skill: Area and volume

2. A

Hand: set equal: $x^2 - 4x + 1 = -2x - 3$, so $x^2 - 2x + 4 = 0$. Discriminant: $(-2)^2 - 4(1)(4) = 4 - 16 = -12 < 0$. No real solution, so no common points.

Desmos: graph both. The parabola's lowest point is (2, –3), while the line is at –7 when x = 2; the line passes below the parabola and never meets it.

Skill: Nonlinear equations and systems

3. C

Hand: group: $(x^2 - 10x) + (y^2 + 6y) = -18$. Complete the squares: $(x - 5)^2 - 25 + (y + 3)^2 - 9 = -18$, so $(x - 5)^2 + (y + 3)^2 = 16$. Radius $\sqrt{16} = 4$. B forgets the square root, A uses the constant 18 as r^2, D adds 18 instead of subtracting it (25 + 9 + 18 = 52).

Desmos: type the equation. The circle runs from x = 1 to x = 9, a diameter of 8, so the radius is 4.

Skill: Circles

4. D

Hand: $P = 6{,}400b^t$. At t = 2: $6{,}400b^2 = 7{,}744$, so $b^2 = 1.21$ and b = 1.1, a 10% increase each year. Check: 7,744 × 1.21 = 9,370.24. A is the two-year increase, B halves it (percents do not halve over time), C reads the multiplier as a percent.

Desmos: table $x_1 = 0, 2, 4$ and $y_1 = 6400, 7744, 9370.24$, then $y_1 \sim ab^{x_1}$ gives a = 6,400 and b = 1.1.

Skill: Nonlinear functions (exponential growth)

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5. 86

Hand: sum of 8 scores = 8 × 72 = 576. Sum of 7 scores = 7 × 70 = 490. Removed score = 576 − 490 = 86. Check: (490 + 86)/8 = 72.

Desmos: type 8·72 − 7·70, which gives 86.

Accepted answer: 86 only.

Skill: One-variable data

6. A

Hand: cos A = AC/AB = 8/17, so take AC = 8 and AB = 17. Then BC = $\sqrt{(17^2 - 8^2)}$ = $\sqrt{(289 - 64)}$ = $\sqrt{225}$ = 15 (an 8-15-17 triangle). For angle B, the opposite side is AC = 8 and the adjacent side is BC = 15, so tan B = 8/15. B is tan A, C is sin A, D is sin B (equal to cos A).

Desmos: type $\sqrt{(17^2 - 8^2)}$ to get 15, then build the ratio.

Skill: Right triangles and trigonometry

7. D

Hand: the vertex is at t = −b/(2a) = −64/(2 × −16) = 2. h(2) = −16(4) + 64(2) + 5 = −64 + 128 + 5 = 69. A is the time, not the height. B is the starting height. C drops the + 5.

Desmos: type $y = -16x^2 + 64x + 5$ and click the top point: (2, 69).

Skill: Nonlinear functions

8. 4

Hand: set equal: $x^2 - 5x + 20 = 3x + c$, so $x^2 - 8x + (20 - c) = 0$. One point means discriminant 0: $64 - 4(20 - c) = 0$, so $64 - 80 + 4c = 0$, $4c = 16$ and $c = 4$. Check: $x^2 - 8x + 16 = (x - 4)^2$, touching at x = 4, where both give y = 16.

Desmos: type $y = x^2 - 5x + 20$ and $y = 3x + c$, add the slider, and drag c until the line just touches the parabola: c = 4.

Accepted answer: 4 only.

Skill: Nonlinear equations and systems

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