DIGITAL SAT · MATH

SAT Math Shortcuts that actually save time

Not the basics. These are the patterns, number facts and Desmos moves that turn a 2-minute problem into a 20-second one. Everything here is something the official reference sheet does **not** give you.

01 Know the test you're playing

44 Qs

2 modules × 22 questions, 35 min each. About **95 seconds** per question.

Adaptive

Module 1 decides if Module 2 is the hard one. For 1500+ you need the hard Module 2, so **accuracy in Module 1 matters most**.

Desmos

A full graphing calculator is built in for every question. Using it well is worth more than any formula on this sheet.

02 Pythagorean triples: skip the square roots

If two sides of a right triangle match a triple (or a multiple of one), the third side is free. No $a^2 + b^2 = c^2$ needed.

Base triple	×2	×3	×4	×5
3 – 4 – 5	6–8–10	9–12–15	12–16–20	15–20–25
5 – 12 – 13	10–24–26	15–36–39	20–48–52	25–60–65
8 – 15 – 17	16–30–34	24–45–51	—	
7 – 24 – 25	14–48–50	—		
20 – 21 – 29	rare, but it shows up			
9 – 40 – 41	and 11 – 60 – 61			

EXAMPLE
Legs 1.5 and 2? That's 3–4–5 divided by 2, so the hypotenuse is **2.5**.

Triples also solve trig

If $\sin A = 5/13$, draw a 5–12–13 triangle: $\cos A = 12/13$, $\tan A = 5/12$. Same for any ratio that fits a triple, including decimals: $\sin A = 0.6 \rightarrow$ 3–4–5 $\rightarrow \cos A = 0.8$.

Number curiosity worth remembering

$3^3 + 4^3 + 5^3 = 27 + 64 + 125 = 216 = 6^3$

The 3-4-5 numbers work for cubes too. Also $1^3 + 2^3 + \ldots + n^3 = (1 + 2 + \ldots + n)^2$.

TRAP
Only right triangles. If the problem doesn't say right angle (or show the box), the triple doesn't apply.

03 Triangle facts the reference sheet skips

Triangle inequality

The third side is strictly between the difference and the sum of the other two.

$|a - b| < c < a + b$

Sides 4 and 9 → third side between 5 and 13.

Exterior angle

An exterior angle equals the sum of the two interior angles that aren't next to it. One step instead of two.

Similar figures

Scale lengths by k: area scales by k^2, volume by k^3.

Side ratio 2:3 → area ratio 4:9.

Equilateral triangle

Area = $(\sqrt{3}\ /\ 4)\cdot s^2$. Height = $(\sqrt{3}\ /\ 2)\cdot s$. A regular hexagon is 6 of these.

Polygons

Interior sum $(n-2)\cdot 180°$. Exterior angles always sum to $360°$, so each one in a regular n-gon is $360°/n$.

Box diagonal

$d = \sqrt{(l^2 + w^2 + h^2)}$

Cube: $d = s\sqrt{3}$. Square: diagonal $= s\sqrt{2}$.

04 Trigonometry: the 5 ideas the SAT keeps testing

1. Complementary angles (the most common trig question)

$\sin x° = \cos(90° - x°)$

In a right triangle, the two acute angles add to 90°, so **sin A = cos B**. If $\sin(x°) = \cos(y°)$ for acute angles, then **x + y = 90**.

> **EXAMPLE**
> $\sin(2k + 10)° = \cos(4k - 10)° \rightarrow 6k = 90 \rightarrow$ **k = 15**.

2. The identity that rescues you

$\sin^2\theta + \cos^2\theta = 1 \quad \tan\theta = \sin\theta\ /\ \cos\theta$

Given one ratio, you can always get the other two. Or just draw the triangle (see triples).

3. Radians in one line

π rad = 180°. To convert degrees → radians multiply by $\pi/180$.

$3\pi/4 = 135°$ · $5\pi/6 = 150°$ · 1 rad ≈ 57.3°

4. Arc length and sector area

Both are just "fraction of the circle":

$\text{arc} = (\theta/360)\cdot 2\pi r \quad \text{sector} = (\theta/360)\cdot \pi r^2$

In radians: arc = $r\theta$, sector = $\frac{1}{2}r^2\theta$.

5. Exact values (memorize this table, it takes 2 minutes)

θ	0°	30° (π/6)	45° (π/4)	60° (π/3)	90° (π/2)
sin θ	0	1/2	√2/2	√3/2	1
cos θ	1	√3/2	√2/2	1/2	0
tan θ	0	√3/3	1	√3	undefined

Pattern: sin goes √0/2, √1/2, √2/2, √3/2, √4/2. Cos is the same list backwards. In the unit circle, sin is positive in quadrants I–II, cos in I and IV: $\sin 150° = 1/2$, $\cos 120° = -1/2$.

> **TRAP**
> Desmos defaults to radians. If the question is in degrees, switch to degrees in the settings (wrench icon) before typing sin or cos.

05 Circles

From messy equation to center and radius

For $x^2 + y^2 + Dx + Ey + F = 0$:

$$\text{center} = (-D/2, -E/2) \quad r^2 = (D/2)^2 + (E/2)^2 - F$$

EXAMPLE
$x^2 + y^2 - 6x + 8y = 11 \rightarrow$ center $(3, -4)$,
$r^2 = 9 + 16 + 11 = 36$, **r = 6**. No completing the square on paper.

Angle and chord rules

- Inscribed angle = **half** the central angle on the same arc.
- Angle inscribed in a semicircle = **90°**.
- A tangent is **perpendicular** to the radius at the touch point (look for a hidden right triangle).
- The perpendicular from the center to a chord **bisects** it.
- Square inscribed in a circle: its diagonal is the diameter.

TRAP
Standard form uses r^2. In $(x - 2)^2 + (y + 1)^2 = 49$ the radius is 7, and the center is $(2, -1)$: signs flip.

06 Quadratics without solving them

Sum and product of the roots

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

$$\text{sum} = -b/a \quad \text{product} = c/a$$

Whenever the question asks for the *sum* or *product* of solutions, don't find them.

EXAMPLE
Sum of solutions of $2x^2 - 8x + 3 = 0$? $-(-8)/2 =$ **4**.

Vertex in one step

$$x = -b \,/\, (2a)$$

Then plug it in for the min/max. The axis of symmetry is also the **average of the two roots**.

EXAMPLE
$y = 2x^2 - 12x + 5 \rightarrow x = 3 \rightarrow$ minimum
$18 - 36 + 5 =$ **−13**.

Discriminant = number of solutions

$\mathbf{b^2 - 4ac} > 0 \rightarrow$ two · $= 0 \rightarrow$ one · $< 0 \rightarrow$ none (real)

EXAMPLE
$x^2 + kx + 9 = 0$ has exactly one solution $\rightarrow k^2 = 36 \rightarrow$ **k = ±6**.

Line meets parabola

Set them equal, move everything to one side, use the discriminant. "Intersect at exactly one point" means $= 0$.

EXAMPLE
$y = x^2 + c$ and $y = 2x$ touch once $\rightarrow$
$x^2 - 2x + c = 0 \rightarrow 4 - 4c = 0 \rightarrow$ **c = 1**.

Read the form, read the feature

- **Vertex form** $a(x - h)^2 + k$: vertex (h, k).
- **Factored form** $a(x - r)(x - s)$: x-intercepts r and s.
- **Standard form** $ax^2 + bx + c$: y-intercept c.
- $a > 0$ opens up (has a minimum).

Remainder theorem

The remainder of $p(x) \div (x - a)$ is $p(a)$. If $p(a) = 0$, then $(x - a)$ is a factor.

EXAMPLE
$x^3 - 2x^2 + kx - 6$ divisible by $x - 3 \rightarrow$
$27 - 18 + 3k - 6 = 0 \rightarrow$ **k = −1**.

07 "No solution" vs "infinitely many": the ratio test

For $ax + by = c$ and $dx + ey = f$:

Condition	Solutions	Graph
$a/d \neq b/e$	exactly one	lines cross
$a/d = b/e \neq c/f$	**none**	parallel
$a/d = b/e = c/f$	**infinitely many**	same line

EXAMPLE
$3x + ky = 5$, $6x + 10y = 7$, no solution → $3/6 = k/10$ → **k = 5**.

Same idea for one-variable equations

After simplifying to $Ax + B = Cx + D$:

- $A = C$ and $B \neq D$ → **no solution**
- $A = C$ and $B = D$ → **infinitely many**

Lines from standard form

$Ax + By = C$: slope $-A/B$, y-intercept C/B, x-intercept C/A. Perpendicular slopes multiply to -1.

08 Algebra patterns that unlock "hard" questions

Difference of squares

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

If $a + b = 7$ and $a - b = 3$, then $a^2 - b^2 = 21$. No need to find a or b.

The x + 1/x trick

$x^2 + 1/x^2 = (x + 1/x)^2 - 2$

If $x + 1/x = 5$, then $x^2 + 1/x^2 = 23$.

Same base

Rewrite both sides with the same base, then set exponents equal.

$2^x = 8^{x-1} = 2^{3x-3}$ → $x = 3/2$.

Absolute value inequality

$|x - a| < b \iff a - b < x < a + b$

a is the center, b the distance.
$|x - 4| < 3$ → $1 < x < 7$.

Transformations

$f(x - h)$ moves **right** h (opposite sign). $f(x) + k$ moves up k. $-f(x)$ flips over the x-axis.

Extraneous solutions

With square roots or variables in a denominator, **plug your answers back in**. The SAT loves offering the extraneous one as a choice.

09 Percents and exponential growth

Think in multipliers, not percents

- Increase 15% → ×1.15 · Decrease 15% → ×0.85
- +20% then −20% → $1.2 \times 0.8 = 0.96$: a **4% loss**, not zero.
- Original before a 25% increase → **divide** by 1.25.
- Percent change = (new − old) / old.

Reading exponential models

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

- a = starting value. $b > 1$ growth by $(b - 1) \cdot 100\%$; $b < 1$ decay.
- Doubles every d years: $a \cdot 2^{(t/d)}$. Half-life h: $a \cdot (1/2)^{(t/h)}$.
- $100(1.21)^t = 100(1.1)^{2t}$: 21% per year is 10% every half year.

TRAP
Linear grows by the same **amount**; exponential by the same **percent**. That's the whole question in half the "which model" items.

10 Statistics and probability: concept questions

What changes the mean, median and SD

Action	Mean / Median	Std. dev. / Range
Add k to every value	+ k	no change
Multiply every value by k	× k	× |k|
Add a high outlier	mean ↑ a lot, median barely	↑
Add a value equal to the mean	mean same	SD ↓

Change one value by Δ → mean changes by Δ/n. Sum = mean × n.

The rules behind the wording

- **"Given"** in a two-way table: the denominator is that row or column total, not the grand total.
- Results generalize only to the **population that was randomly sampled**.
- Cause and effect needs **random assignment** to groups.
- Bigger sample → smaller **margin of error**.
- Median of n values sits at position $(n + 1)/2$ (use cumulative counts in frequency tables).

11 Desmos moves that replace algebra

Solve any equation by graphing

Type the left side as y = … and the right side as y = …. Click the intersection: its x-value is the solution. Count intersections for "how many solutions".

Sliders for "what value of k"

Type the equation with k in it, accept the slider, and drag until the graph does what the question asks (touches once, is parallel, passes through a point).

Check equivalent expressions

Graph the original and each answer choice. The one that lands exactly on top is equivalent.

Regression from a table

Add a table (x_1, y_1), then type $y_1 \sim mx_1 + b$ (or $\sim a \cdot b^{x1}$). Desmos gives the best-fit values.

Stats in one line

$\text{mean}([...])$, $\text{median}([...])$, $\text{stdev}([...])$ for sample SD, $\text{stdevp}([...])$ for population SD.

Vertex, roots, max/min

Click the curve: Desmos marks the vertex, the x-intercepts and the y-intercept as gray points. Click one to read its coordinates.

WHEN NOT TO USE DESMOS
If the algebra is one step (like sum of roots = −b/a), doing it by hand is faster. Desmos is for the problems that would take 3+ steps.

12 Answer-choice strategies

Plug in numbers

For variables in the answers, pick $x = 2$ or 3 (not 0 or 1), compute the target, test each choice.

Backsolve

For numeric choices, start with the middle value. If it's too big, you know which way to go.

Read the last line twice

"What is $2x$?" or "what is $x + 3$?" The value of x is often a wrong choice on purpose.

13 Student-produced responses (type-in answers)

- Up to **5 characters** for a positive answer, **6** for a negative one (the minus sign counts).
- **No mixed numbers**: type 7/2 or 3.5, never "3 1/2".
- No $, % or commas.
- If there are several correct answers, enter just one.

Long decimals

Fill all the spaces. For 2/3 these are accepted: 2/3, .6666, .6667, 0.666, 0.667. **0.67 is marked wrong.** When in doubt, type the fraction.

14 Numbers worth knowing by heart

n	11	12	13	14	15	16	17	18	19	20	25
n^2	121	144	169	196	225	256	289	324	361	400	625

n	2	3	4	5	6	7	8	9	10
n^3	8	27	64	125	216	343	512	729	1000
2^n	4	8	16	32	64	128	256	512	1024

√2 ≈ 1.414 · √3 ≈ 1.732 · π ≈ 3.1416 · 1 rad ≈ 57.3°