Digital SAT Deep Dive: Algebra and Advanced Math

A free, unofficial study guide to the two biggest Math areas, which together make up about 70% of the section. Practice with official Bluebook tests and the College Board Student Question Bank.

1. What to Expect

Algebra (about 35%): linear equations, linear functions, systems, and inequalities.

Advanced Math (about 35%): quadratics, polynomials, exponentials, functions, and equivalent expressions.

Most questions are multiple choice. Some ask you to type an answer.

You can use the Desmos graphing calculator on the whole Math section, and Bluebook includes a formula reference sheet.

Aim for about 95 seconds per question.

2. Linear Equations in One Variable

Undo operations in reverse order. Whatever you do to one side, do to the other.

Distribute first, then combine like terms.

Example: Solve 3(x − 2) = 2x + 5. Distribute: 3x − 6 = 2x + 5. Subtract 2x: x − 6 = 5. Add 6: x = 11.

Number of solutions

If both sides simplify to the same expression, there are infinitely many solutions.

If the variable terms match but the constants differ, there is no solution.

Otherwise there is exactly one solution.

Example: 2(3x + 4) = 6x + k. The left side is 6x + 8. There is no solution when k ≠ 8, and infinitely many solutions when k = 8.

3. Linear Functions and Graphs

Slope-intercept form: y = mx + b. The slope is m and the y-intercept is b.

- Slope = (y2 − y1) / (x2 − x1).

- In word problems, the slope is the rate of change per unit and the intercept is the starting value.

Example: A plumber charges a $45 call-out fee plus $30 per hour. The cost is C = 30h + 45.

The 30 is the hourly rate and the 45 is the fixed fee.

Example: Find the line through (2, 5) and (6, 13). Slope = (13 − 5) / (6 − 2) = 2. Use y − 5 = 2(x − 2), so y = 2x + 1.

Parallel lines have equal slopes. Perpendicular lines have slopes that are negative reciprocals (for example 2 and −1/2).

4. Systems of Equations

Substitution: solve one equation for a variable and plug it into the other.

Elimination: add or subtract the equations to cancel a variable.

Number of solutions: different slopes give one solution. Same slope with different intercepts gives none. Same line gives infinitely many.

Example: x + y = 10 and 2x − y = 5. Add the equations: 3x = 15, so x = 5 and y = 5.

Example (word problem): Adult tickets cost $12 and child tickets cost $7. A total of 40 tickets sold for $380. Let a be adults and c be children. a + c = 40 and 12a + 7c = 380.

Substitute c = 40 − a: 12a + 280 − 7a = 380, so 5a = 100 and a = 20. Then c = 20. Check: 240 + 140 = 380.

5. Inequalities and Absolute Value

Flip the inequality sign when you multiply or divide by a negative number.

At most means ≤. At least means ≥. More than means >. Fewer than means <.

Example: −3x + 4 > 16. Subtract 4: −3x > 12. Divide by −3 and flip: x < −4.

Example: A student has $50 and wants to buy a pen for $8 and notebooks at $3 each. 3n + 8 ≤ 50, so n ≤ 14. The most notebooks is 14.

Absolute value: |x − 3| = 5 means x − 3 = 5 or x − 3 = −5, so x = 8 or x = −2.

|x − 3| < 5 means −5 < x − 3 < 5, so −2 < x < 8.

6. Quadratics

Three forms and what each shows

Standard form: y = ax2 + bx + c. The y-intercept is c.

Factored form: y = a(x − r)(x − s). The x-intercepts are r and s.

Vertex form: y = a(x − h)2 + k. The vertex is (h, k).

Tools

Factoring: find two numbers that multiply to c and add to b.

Quadratic formula: x = (−b ± √(b2 − 4ac)) / 2a.

Vertex x-coordinate: x = −b / 2a.

Discriminant b2 − 4ac: positive gives 2 real solutions, zero gives 1, negative gives none.

Sum of solutions = −b/a. Product of solutions = c/a.

Example: Solve x2 − 5x − 14 = 0. Factor: (x − 7)(x + 2) = 0, so x = 7 or x = −2.

Example: y = x2 − 6x + 5. The vertex x is 6/2 = 3, and y(3) = 9 − 18 + 5 = −4. The vertex is (3, −4). It factors as (x − 1)(x − 5), so the x-intercepts are 1 and 5.

Example: x2 + 4x + k = 0 has exactly one real solution. Set the discriminant to zero: 16 − 4k = 0, so k = 4.

Example: A ball's height is h(t) = −16t2 + 64t + 5. The maximum occurs at t = −64 / (2 × −16) = 2. The maximum height is −16(4) + 128 + 5 = 69.

7. Polynomials

Factor theorem: if p(a) = 0, then (x − a) is a factor of p(x).

Remainder theorem: the remainder when p(x) is divided by (x − a) is p(a).

Zeros of the polynomial are the x-intercepts of its graph.

End behavior depends on the leading term: an even degree with a positive coefficient rises on both ends, and an odd degree with a positive coefficient falls on the left and rises on the right.

Example: p(x) = x3 − 2x2 − 5x + 6. Since p(1) = 1 − 2 − 5 + 6 = 0, (x − 1) is a factor.

8. Exponential Functions and Exponent Rules

Growth: y = a(1 + r)^t. Decay: y = a(1 − r)^t.

The base is the growth factor: 8% growth gives 1.08, and 8% decay gives 0.92.

Doubling every d units: y = a · 2^(t/d).

Example: A population of 500 grows 8% per year, so P = 500(1.08)^t. After 3 years, P = 500 × 1.259712 ≈ 630.

Exponent rules

am · an = am+n

(am)n = amn

a−n = 1 / an

a^(1/2) = √a

Example: (x3)2 · x−4 = x6 · x−4 = x2.

9. Functions

f(x) notation means plug the input into the rule. If f(x) = 2x2 − 3x + 1, then f(3) = 18 − 9 + 1 = 10.

Transformations: f(x) + k shifts up by k. f(x − h) shifts right by h. −f(x) reflects over the x-axis. f(−x) reflects over the y-axis.

Composition: f(g(x)) means plug g(x) into f. If f(x) = x + 2 and g(x) = 3x, then f(g(2)) = f(6) = 8.

10. Equivalent Expressions

Factor to simplify rational expressions. (x2 − 9) / (x − 3) = x + 3, for x ≠ 3.

Simplify radicals by pulling out perfect squares. √50 = 5√2.

Combine fractions over a common denominator before simplifying.

11. Nonlinear Systems

To find where a line meets a parabola, set the expressions equal and solve.

Example: y = x2 and y = 2x + 3. Set x2 = 2x + 3, so x2 − 2x − 3 = 0 and (x − 3)(x + 1) = 0. The

solutions are x = 3 and x = −1, giving the points (3, 9) and (−1, 1).

12. Desmos and Shortcuts

Graph both sides of an equation as two functions and click the intersection.

Graph a system and click where the lines cross.

Click the vertex, zeros, and intercepts of a parabola instead of calculating them.

Use a slider for an unknown constant such as k and watch how the graph changes.

Backsolve: plug answer choices into the equation, starting with a middle value.

Pick numbers: for expressions with variables, test easy values like 2 or 10.

13. Common Traps

Solving for x when the question asks for 2x + 1 or for y.

Forgetting to flip the inequality sign when dividing by a negative.

Reading the intercept of a graph incorrectly.

Mixing up growth factor (1.08) and growth rate (8%).

Giving only the x-value when the question asks for a point or for the larger solution.

14. Practice Drills

1. Solve 5(x − 1) = 3x + 9.

2. For what value of k does 3x + 12 = 3x + k have infinitely many solutions?

3. A gym charges a $25 sign-up fee plus $18 per month. What is the total cost for 6 months?

4. Solve the system y = 2x + 1 and 3x + y = 16.

5. Solve −2x + 5 ≤ 11.

6. What is the sum of the solutions of x2 + 3x − 10 = 0?

7. A ball's height is h(t) = −5t2 + 20t. What is its maximum height?

8. How many real solutions does 2x2 − 4x + 5 = 0 have?

9. A culture of 200 bacteria triples every day. How many bacteria are there after 2 days?

10. If f(x) = x2 − 4 and g(x) = x + 1, what is f(g(3))?

Answers

1. x = 7. Distribute: 5x − 5 = 3x + 9, so 2x = 14.

2. k = 12. Both sides must match.

3. $133. 25 + 18 × 6 = 133.

4. (3, 7). Substitute: 3x + 2x + 1 = 16, so x = 3 and y = 7.

5. x ≥ −3. Divide by −2 and flip the sign.

6. −3. Sum of solutions is −b/a = −3. The solutions are −5 and 2.

7. t. The maximum is at t = 2, and h(2) = −20 + 40 = 20.

8. None. The discriminant is 16 − 40 = −24, which is negative.

9. 1,800. 200 × 32 = 1,800.

10. I. g(3) = 4, and f(4) = 16 − 4 = 12.

Next step: work through 30 official Algebra and Advanced Math questions in the College Board Student Question Bank, solving each by hand first and then checking with Desmos.