SAT Math Essentials

Every topic on Digital SAT Math, explained in plain steps, with a worked example for each one.

Ronak

4 CHAPTERS · 2ND EDITION

WORKED EXAMPLE FINDING A COEFFICIENT FOR INFINITELY MANY SOLUTIONS

Find the value of b such that $2x + 5 = bx + 5$ is true for **all** values of x.

1 For every x to work, the coefficients of x must match and so mu constants.

2 $2x - bx = 5 - 5$, so $(2 - b)x = 0$.

3 The coefficient must be 0: $2 - b = 0$.

Answer: $b = 2$

SMART MOVE

For infinitely many solutions, the coefficients of x must be equal **and** the consta equal.

QUICK SUMMARY

Compare both sides after simplifying:

- **One solution:** the coefficients of x are different.
- **No solution:** the coefficients of x are equal, the constants are different.
- **Infinitely many:** the coefficients of x are equal and the constants are equal.

WORKED EXAMPLE NO SOLUTION, ONE MORE TIME

If $4x - 3 = 2ax + 5$ has no solution, what is the value of a?

1 $4x - 2ax = 5 + 3$, so $(4 - 2a)x = 8$.

2 For no solution the coefficient of x must be 0: $4 - 2a = 0$.

Answer: $a = 2$

1.2 Linear functions

Slope as rate of change

The slope m of a line is the rate of change of y with respect to x:

$$m = \frac{\text{change in } y}{\text{change in } x} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

WORKED EXAMPLE NO SOLUTION

What is the nature of the system $3x - 2y = 8$, $6x - 4y = 5$?

1 $\frac{a_1}{a_2} = \frac{3}{6} = \frac{1}{2}$, $\frac{b_1}{b_2} = \frac{-2}{-4} = \frac{1}{2}$, $\frac{c_1}{c_2} = \frac{8}{5}$.

2 $\frac{1}{2} = \frac{1}{2} \neq \frac{8}{5}$, so the lines are parallel and distinct.

Answer: No solution

WORKED EXAMPLE INFINITELY MANY SOLUTIONS

What is the nature of the system $2x + y = 3$, $4x + 2y = 6$?

1 $\frac{a_1}{a_2} = \frac{2}{4} = \frac{1}{2}$, $\frac{b_1}{b_2} = \frac{1}{2}$, $\frac{c_1}{c_2} = \frac{3}{6} = \frac{1}{2}$.

2 All three ratios are equal, so both equations describe the same line.

Answer: Infinitely many solutions

Parallel and perpendicular lines

- **Parallel:** $m_1 = m_2$ (with different intercepts for distinct lines).
- **Perpendicular:** $m_1 \cdot m_2 = -1$, so $m_2 = -\frac{1}{m_1}$.

SAT TRAP

Perpendicular slopes are **negative reciprocals**, not just negatives. Slopes 2 and $-\frac{1}{2}$ are perpendicular; 2 and -2 are not.

WORKED EXAMPLE PARALLEL LINES

Which line is parallel to $y = 3x - 2$?

A) $y = 3x + 5$ B) $y = -3x + 1$ C) $y = \frac{1}{3}x - 4$ D) $y = -\frac{1}{3}x + 7$

1 Parallel lines have the same slope. The given line has slope 3.

2 Only choice A has slope 3.

Answer: A) $y = 3x + 5$

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SAT Math Essentials

The whole Digital SAT Math syllabus in one book.

Ronak · Second Edition, 2026

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START HERE

How to use this book

This is your quick-reference companion for Digital SAT Math. It is not a textbook: it is the methods, formulas and patterns you need, each with a worked example.

The four chapters

Chapter	What it covers
1 · Algebra	Linear equations, linear functions, systems and inequalities
2 · Advanced Math	Equivalent expressions, quadratics, exponentials, polynomials, radicals, rational and complex numbers, functions
3 · Problem-Solving and Data Analysis	Ratios, rates, units, percentages, statistics, scatterplots, probability, sampling and studies
4 · Geometry and Trigonometry	Area and volume, lines, angles and triangles, right-triangle trigonometry, circles

The three boxes

SMART MOVE
A faster or safer way to get the mark.

SAT TRAP
A mistake the test is built to catch. Learn to spot it before test day.

QUICK SUMMARY
The few lines worth rereading the night before.

How to study with it

1. **Work every example with a pencil.** Cover the solution, try it, then compare.
2. **Reread the question before you choose.** Many mistakes come from answering a different question.
3. **Write out the choices** on paper or in your head; don't take the first one that looks right.
4. **Use the Smart Move boxes** as your checklist during the test.
5. **Keep the book nearby** as you practise, and look things up when you are stuck.

CHAPTER 1

Algebra

Linear equations, linear functions, systems and inequalities. About a third of SAT Math sits here, and most of it is fast marks once the patterns are automatic.

1.1 Linear equations in one variable

A linear equation in one variable has the form $ax + b = c$. To solve it:

1. Combine like terms on each side.
2. Move the variable terms to one side and the constants to the other.
3. Divide by the coefficient of the variable.

SMART MOVE

Always check your answer by plugging it back into the original equation.

SAT focus: special cases with coefficients

The SAT often asks for a coefficient that makes an equation have **no solution** or **infinitely many solutions**. Compare the coefficients of x and the constants on both sides.

WORKED EXAMPLE FINDING A COEFFICIENT FOR NO SOLUTION

Find the value of a such that $ax + 7 = 3x + 9$ has **no solution**.

1 For no solution, the x-terms must cancel and leave a false statement. Move the x-terms together: $ax - 3x = 9 - 7$, so $(a - 3)x = 2$.

2 The coefficient of x must be 0 while the constant is not: $a - 3 = 0$.

Answer: $a = 3$

SAT TRAP

For no solution, the coefficients of x must be equal but the constants must be different.

WORK SPACE

WORKED EXAMPLE FINDING A COEFFICIENT FOR INFINITELY MANY SOLUTIONS

Find the value of b such that $2x + 5 = bx + 5$ is true for **all** values of x.

1 For every x to work, the coefficients of x must match and so must the constants.

2 $2x - bx = 5 - 5$, so $(2 - b)x = 0$.

3 The coefficient must be 0: $2 - b = 0$.

Answer: $b = 2$

SMART MOVE

For infinitely many solutions, the coefficients of x must be equal **and** the constants must be equal.

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Compare both sides after simplifying:

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Answer: $a = 2$

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Slope as rate of change

The slope m of a line is the rate of change of y with respect to x:

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For example, through $(3, 3)$ and $(5, 6)$ the slope is $\dfrac{6-3}{5-3} = \dfrac{3}{2}$. In $y = mx + b$, m is the slope and b is the y-intercept.

Systems of linear equations in two variables

A system of two linear equations

$$\begin{cases} a_1 x + b_1 y = c_1 \\ a_2 x + b_2 y = c_2 \end{cases}$$

can have exactly one solution (the lines cross), no solution (parallel, distinct lines) or infinitely many solutions (the same line). Compare the ratios of the coefficients:

Condition	Type of solution
$\dfrac{a_1}{a_2} \neq \dfrac{b_1}{b_2}$	**One solution** (the lines intersect)
$\dfrac{a_1}{a_2} = \dfrac{b_1}{b_2} \neq \dfrac{c_1}{c_2}$	**No solution** (parallel, distinct)
$\dfrac{a_1}{a_2} = \dfrac{b_1}{b_2} = \dfrac{c_1}{c_2}$	**Infinitely many** (the same line)

SAT TRAP

If the ratios of the a's and b's are equal, the lines are parallel **or** the same line. Check the c's to tell which.

WORKED EXAMPLE ONE SOLUTION

Does the system $2x + 3y = 7$, $4x - y = 5$ have one solution, no solution or infinitely many?

1 Compare ratios: $\dfrac{a_1}{a_2} = \dfrac{2}{4} = \dfrac{1}{2}$ and $\dfrac{b_1}{b_2} = \dfrac{3}{-1} = -3$.

2 Since $\dfrac{1}{2} \neq -3$, the lines cross at exactly one point.

Answer: One solution

WORK SPACE

WORKED EXAMPLE NO SOLUTION

What is the nature of the system $3x - 2y = 8, 6x - 4y = 5$?

1 $\frac{a_1}{a_2} = \frac{3}{6} = \frac{1}{2}, \frac{b_1}{b_2} = \frac{-2}{-4} = \frac{1}{2}, \frac{c_1}{c_2} = \frac{8}{5}.$

2 $\frac{1}{2} = \frac{1}{2} \neq \frac{8}{5}$, so the lines are parallel and distinct.

Answer: No solution

WORKED EXAMPLE INFINITELY MANY SOLUTIONS

What is the nature of the system $2x + y = 3, 4x + 2y = 6$?

1 $\frac{a_1}{a_2} = \frac{2}{4} = \frac{1}{2}, \frac{b_1}{b_2} = \frac{1}{2}, \frac{c_1}{c_2} = \frac{3}{6} = \frac{1}{2}.$

2 All three ratios are equal, so both equations describe the same line.

Answer: Infinitely many solutions

Parallel and perpendicular lines

- **Parallel:** $m_1 = m_2$ (with different intercepts for distinct lines).
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1 Parallel lines have the same slope. The given line has slope 3.

2 Only choice A has slope 3.

Answer: A) $y = 3x + 5$