

Solving Systems of Linear Equations Three Ways

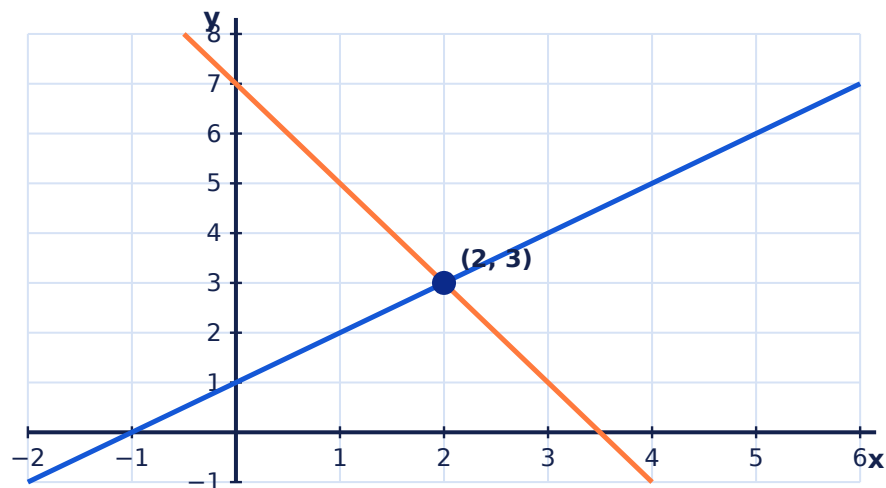
Grade 9 – Algebra 1 math · Lesson · Standards: A-REI.C.5, A-REI.C.6, A-REI.D.11, A-CED.A.3

Quick answer: To solve a system of linear equations, find the ordered pair that satisfies every equation; on a graph it is the crossing point. Graphing, substitution and elimination all work. Different slopes give exactly one solution, parallel lines give none, and two equations for the same line give infinitely many.

Standards: A-REI.C.5, A-REI.C.6, A-REI.D.11, A-CED.A.3 · **Level:** Grade 9 Algebra 1

What does it mean to solve two equations together?

Two linked equations in the same unknowns form a **system**. Its **solutions** are the pairs (x, y) that satisfy both at once, and on the graph they appear as shared points of the two lines.



The solution of the system is the crossing point $(2, 3)$.

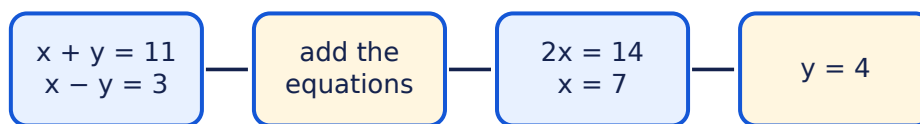
Which steps does substitution follow?

Method: solve $y = 4x$ and $x + y = 35$

1. Replace y in the second equation with $4x$: $x + 4x = 35$.
2. Solve: $5x = 35$, so $x = 7$.
3. Back-substitute: $y = 4(7) = 28$.
4. Check in both equations: $7 + 28 = 35$ and $28 = 4(7)$. The solution is **$(7, 28)$** .

How does elimination remove a variable?

Combine the equations by addition or subtraction so that one unknown drops out. When nothing cancels yet, scale one or both equations first.



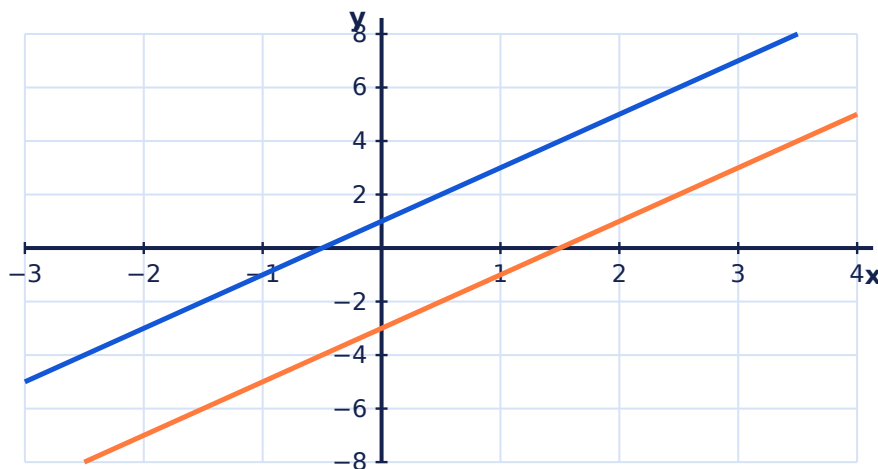
Adding eliminates y.

Why elimination works

If two equations are true at the same time, adding equal amounts to both sides keeps the equation true. So the sum of the equations is also true, and it is satisfied by the same solution.

Can a system have zero or many answers?

Graph	Slopes and intercepts	Algebra result	Solutions
lines cross	different slopes	one pair of values	exactly one
parallel lines	same slope, different intercepts	a false statement like $0 = 5$	none
same line	same slope and intercept	a true statement like $4 = 4$	infinitely many



Parallel lines: no solution.

Systems also solve real problems. Define a variable for each unknown, translate each fact into an equation, then solve by the method that needs the fewest steps.

Common mistake

Finding only x and stopping. A solution is an ordered pair, so always find y and check both equations.

Mathbot's tip

Choose substitution when a variable is already isolated, elimination when equations are in standard form, and graphing to see the picture.

Key points to remember

- A solution of a system is an ordered pair that makes all equations true.
- Substitution works best when one variable is already isolated.
- Elimination cancels a variable by adding or subtracting equations, after scaling if needed.
- Parallel lines give no solution; identical lines give infinitely many.
- Always check the ordered pair in both original equations.

Solving Systems of Linear Equations Three Ways: frequently asked questions

Why does adding two equations not change the solution?

If both equations are true for a pair (x, y) , adding equal quantities to both sides produces another true equation. So the new system is satisfied by the same pair, but with one variable removed.

How do you decide between substitution and elimination?

Use substitution when one equation already has a variable alone, like $y = 2x$. Use elimination when both equations are in standard form with matching or easily matched coefficients.

What does a false result like $0 = 5$ mean?

It means the equations contradict each other: the lines are parallel and the system has no solution. A true result like $4 = 4$ means the equations describe the same line.

How can the graph of two functions solve an equation?

To solve $f(x) = g(x)$, graph $y = f(x)$ and $y = g(x)$. The x -coordinate of each crossing point is a solution of the equation.

How do you set up a word problem as a system?

Name each unknown with a letter, then write one equation for each fact, such as the total count and the total value. Solve the system and answer with units.