

# Solving Multi-Step Linear Equations

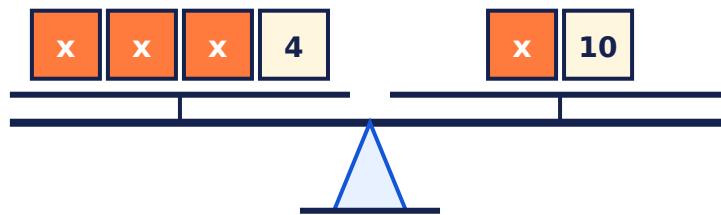
Grade 8 math · Lesson · Standards: 8.EE.C.7a, 8.EE.C.7b

**Quick answer:** To solve a linear equation, distribute, combine like terms, collect the variable on one side and undo operations in reverse order, keeping both sides balanced. If the variable disappears, a false statement means no solution and a true statement means infinitely many solutions.

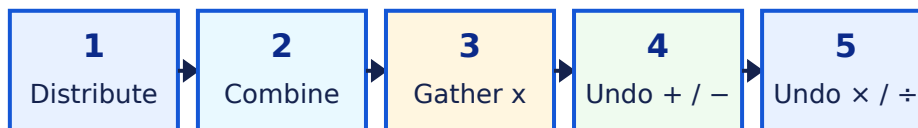
**Standards:** 8.EE.C.7a, 8.EE.C.7b · **Level:** Grade 8

## How do you solve a multi-step linear equation?

An equation is a balance: whatever you do to one side, you must do to the other. Rational coefficients such as  $\frac{2}{3}$  or 0.4 follow the same rules as whole numbers.



The scale models  $3x + 4 = x + 10$ . Taking one  $x$  from each pan keeps it balanced.



Work through the five boxes from left to right; skip a box if it is not needed.

### Method

1. Distribute any parentheses.
2. Combine like terms on each side.
3. Add or subtract to collect the variable on one side.
4. Undo addition and subtraction to isolate the variable term.
5. Divide by the coefficient and check the solution.

**Example:**  $2(3x - 4) = 4x + 10$

Distribute:  $6x - 8 = 4x + 10$ . Subtract  $4x$ :  $2x - 8 = 10$ . Add 8:  $2x = 18$ . Divide by 2:  $x = 9$ .

Check:  $2(27 - 4) = 46$  and  $4 \cdot 9 + 10 = 46$ .

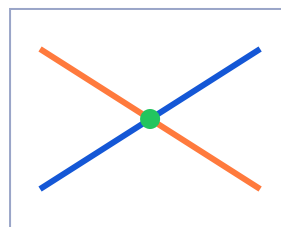
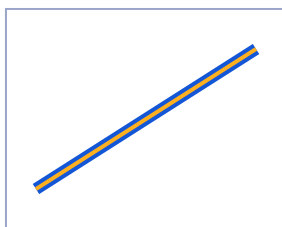
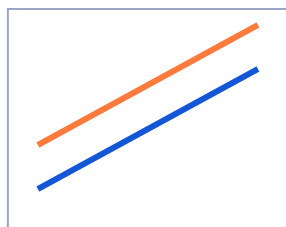
## How do you clear fractions and decimals?

Multiply every term by the least common denominator, or by a power of 10 for decimals. For  $\frac{x}{2} + \frac{x}{3} = 10$ , multiply by 6 to get  $3x + 2x = 60$ .

## When does an equation have no solution or infinitely many?

After simplifying, a variable may disappear. A false statement such as  $5 = 9$  means **no solution**. A true statement such as  $7 = 7$  means **infinitely many solutions**. If you reach  $x = \text{a number}$ , there is exactly one solution.

| Equation            | After simplifying | Solutions       |
|---------------------|-------------------|-----------------|
| $5x + 3 = 2x + 12$  | $x = 3$           | One             |
| $4x + 1 = 4x + 6$   | $1 = 6$           | None            |
| $3(x + 2) = 3x + 6$ | $6 = 6$           | Infinitely many |



**A: no solution    B: infinitely many    C: one solution**

*Each side of an equation can be drawn as a line. Where the lines meet gives the solutions.*

### Common mistake

Forgetting to multiply every term inside parentheses:  $3(x + 4)$  is  $3x + 12$ , not  $3x + 4$ .

### Mathbot's tip

Beep! Always substitute your answer back into the original equation. Both sides must print the same value.

### Key points to remember

- Do the same operation to both sides to keep the equation balanced.
- Distribute and combine like terms before moving variables.
- Clear fractions by multiplying by the least common denominator.
- A false result like  $5 = 9$  means no solution; a true result like  $7 = 7$  means infinitely many.

- Check by substituting the answer into the original equation.

## **Solving Multi-Step Linear Equations: frequently asked questions**

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### **What is the first step in solving $3(x + 5) = 2x + 20$ ?**

Distribute the 3 to get  $3x + 15 = 2x + 20$ . Then subtract  $2x$  from both sides and subtract 15 to find  $x = 5$ .

### **How do you solve an equation with variables on both sides?**

Subtract the smaller variable term from both sides so the variable appears once. Then undo the addition or subtraction and divide by the coefficient.

### **How can an equation have no solution?**

If the variable terms cancel and leave a false statement, such as  $4x + 1 = 4x + 6$  becoming  $1 = 6$ , no number makes the equation true.

### **What does infinitely many solutions mean?**

Both sides are the same expression after simplifying, so every number works. For example  $3(x + 2) = 3x + 6$  turns into  $6 = 6$ .

### **How do you remove fractions from an equation?**

Multiply every term on both sides by the least common denominator. For denominators 2 and 3, multiply by 6, and the fractions disappear.