

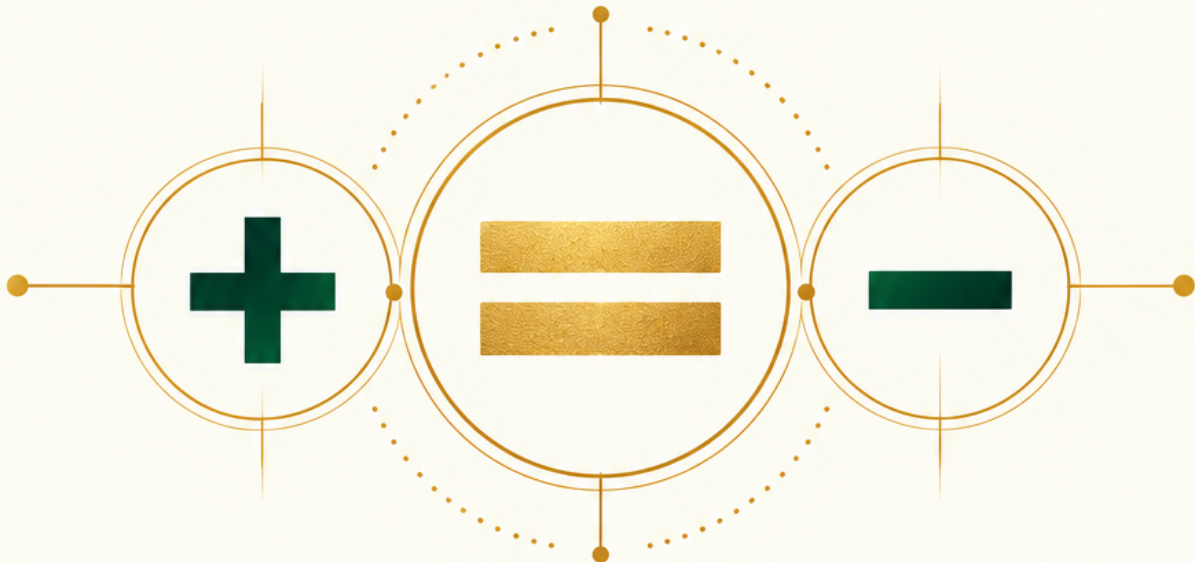


PRE - ALGEBRA

CLASS 13

One-Step Equations

Addition and Subtraction



Understand • Solve • Check

Build confidence. Strengthen foundations.

Math learning for Grades 1–12

schoolofmath.us



CLASS 13 • ONE-STEP EQUATIONS

What Is an Equation?

An equation states that two expressions have the same value.

Parts of an equation

$$x + 5 = 12$$

Left side

Equal sign

Right side

x is the **variable**: it represents an unknown number.

The equal sign means “**has the same value as.**”

Expression or equation?

$$x + 5$$

Expression: no equal sign

$$x + 5 = 12$$

Equation: includes an equal sign

What is a solution?

A **solution** is a value that makes the equation true.

If $x = 7$: $7 + 5 = 12$ ✓

If $x = 6$: $6 + 5 = 11$, not 12 ✗

Equality works both ways

$$x + 5 = 12 \text{ means the same as } 12 = x + 5$$

Try it

Which are equations?

A. $8 + 4$

B. $y - 3 = 9$

C. $6 + 2 = 8$

Answers: B and C. An equation does not need a variable.

One-Step Equations

Image 1 practice: What is an equation?

Q1. Which is an equation: $14 - 6$ or $14 - 6 = 8$? Explain your choice.

Q2. For $t + 8 = 21$, identify the variable, the left side, and the right side.

Q3. Is $17 = 10 + 7$ a true equation? Does an equation have to contain a variable?

Q4. Which value makes $a + 11 = 19$ true: $a = 7$ or $a = 8$? Show both substitutions.

Q5. Write an equation for 'a number increased by 13 is 31.' Rewrite it with the sides reversed, then solve.



CLASS 13 • ONE-STEP EQUATIONS

Understanding the Unknown

A variable is a letter that represents an unknown number.

Find the missing value

$$x + 4 = 10$$

What number plus 4 equals 10?

$$6 + 4 = 10 \quad x = 6$$

Solving an equation means **finding the value that makes it true.**

Different letters, same idea

The unknown can be represented by different letters.

$$x + 4 = 10 \quad | \quad n + 4 = 10 \quad | \quad a + 4 = 10$$

In each equation, the unknown is 6.

An unknown can appear on either side

$$y - 3 = 8 \quad \text{or} \quad 8 = y - 3$$

Both equations have the solution $y = 11$.

$$\text{Check: } 11 - 3 = 8 \quad \checkmark$$

Read the variable carefully

In $x + 4 = 10$, x is a letter—not a multiplication sign.

Try it

Find the unknown in each equation.

$$\text{A. } m + 2 = 9 \quad \text{B. } p - 5 = 7 \quad \text{C. } 12 = k + 4$$

$$\text{Answers: A. } m = 7 \quad \text{B. } p = 12 \quad \text{C. } k = 8$$

One-Step Equations

Image 2 practice: Understanding the unknown

Q6. In $b + 9 = 23$, what number does b represent?

Q7. Find the unknown in $c - 8 = 16$.

Q8. Solve $28 = 12 + m$. Explain why m does not have to appear first.

Q9. Solve $r + 15 = 9$. Can an unknown represent a negative number?

Q10. A jar has an unknown number of marbles. After 18 are added, there are 43. Define a variable for the starting number, write an equation, and solve.



CLASS 13 • ONE-STEP EQUATIONS

Keeping Both Sides Balanced

Add or subtract the same number on both sides to keep an equation true.

The balance rule

Left side = Right side

Whatever you do to one side, do to the other side.

Equal changes preserve equality.

Subtract from both sides

$$x + 3 = 8$$

$$x + 3 - 3 = 8 - 3$$

$$x = 5$$

Subtract 3 from each side.

Check: $5 + 3 = 8$ ✓

Add to both sides

$$y - 4 = 6$$

$$y - 4 + 4 = 6 + 4$$

$$y = 10$$

Add 4 to each side.

Check: $10 - 4 = 6$ ✓

Why both sides?

Start with a true statement: $7 = 7$.

Subtract 2 from both sides: $5 = 5$ ✓

Subtract 2 from only one side: $5 \neq 7$ ✗

Try it

Choose the operation, then solve.

A. $n + 6 = 14$

A. Subtract 6 from both sides; $n = 8$.

B. $p - 5 = 9$

B. Add 5 to both sides; $p = 14$.

One-Step Equations

Image 3 practice: Keeping both sides balanced

Q11. Starting with $18 = 18$, subtract 7 from each side. What equation remains?

Q12. Complete both blanks using the same number, then solve: $x + 14 - \underline{\hspace{1cm}} = 32$
 $- \underline{\hspace{1cm}}.$

Q13. Show the same operation on both sides to solve $y - 12 = 23$.

Q14. A student changes $z + 16 = 27$ into $z = 27$ by subtracting 16 only on the left. Explain the error and correct it.

Q15. Solve $-9 = p - 17$ by keeping the equation balanced. Show your check with the variable on the right.



CLASS 13 • ONE-STEP EQUATIONS

Using Inverse Operations

Addition and subtraction undo each other. They are inverse operations.

Undo an operation

Add 7 → Subtract 7

Subtract 7 → Add 7

$$5 + 7 = 12$$

$$12 - 7 = 5$$

Adding 7 and then subtracting 7 returns you to 5.

Use the inverse operation to **isolate the variable**.

What does isolate mean?

Isolate the variable means get the letter by itself on one side of the equation.

$$x = 8$$

The variable is by itself.

Undo addition

$$x + 7 = 15$$

$$x + 7 - 7 = 15 - 7$$

$$x = 8$$

Subtract 7 from both sides.

Undo subtraction

$$y - 6 = 9$$

$$y - 6 + 6 = 9 + 6$$

$$y = 15$$

Add 6 to both sides.

Why does it work?

$$7 - 7 = 0 \quad \text{and} \quad -6 + 6 = 0$$

The added or subtracted number cancels to zero, leaving the variable alone.

Try it

Name the inverse operation, then solve.

A. $n + 8 = 20$

A. Subtract 8 from both sides; $n = 12$.

B. $p - 9 = 4$

B. Add 9 to both sides; $p = 13$.

One-Step Equations

Image 4 practice: Using inverse operations

Q16. What operation undoes adding 19? Use it to solve $n + 19 = 44$.

Q17. What operation undoes subtracting 13? Use it to solve $a - 13 = 22$.

Q18. Solve $36 = k + 24$. Name the inverse operation before calculating.

Q19. Solve $v + 18 = -7$. Explain why adding 18 would not isolate v .

Q20. Compare the inverse operations needed for $a + 3.5 = 10.2$ and $b - 3.5 = 10.2$. Solve both.



CLASS 13 • ONE-STEP EQUATIONS

Solving Addition Equations

To isolate the variable, subtract the number added to it from both sides.

Undo addition with subtraction.

Step by step

$$x + 9 = 15$$

1. Identify the added number: 9.
2. Subtract 9 from both sides:

$$x + 9 - 9 = 15 - 9$$

3. Simplify:

$$x = 6$$

$$\text{Check: } 6 + 9 = 15 \quad \checkmark$$

— The variable can come second —

$$7 + n = 12$$

$$7 + n - 7 = 12 - 7$$

$$n = 5$$

$$\text{Check: } 7 + 5 = 12 \quad \checkmark$$

— The answer can be negative —

$$y + 8 = 3$$

$$y + 8 - 8 = 3 - 8$$

$$y = -5$$

$$\text{Check: } -5 + 8 = 3 \quad \checkmark$$

A real-life example

You had some books and received 4 more. Now you have 13. How many did you have at first?

Let b = the number of books you had at first.

$$b + 4 = 13$$

$$b = 13 - 4 = 9 \text{ books}$$

Try it

Subtract from both sides, then check.

A. $a + 6 = 17$

B. $5 + p = 14$

C. $q + 9 = 4$

Answers: **A.** $a = 11$ **B.** $p = 9$ **C.** $q = -5$

One-Step Equations

Image 5 practice: Solving addition equations

Q21. Solve $x + 17 = 38$ and check.

Q22. Solve $26 + n = 61$ and check.

Q23. Solve $y + 23 = 8$ and check.

Q24. Solve $t + 4.75 = 12.3$. Show the decimal subtraction.

Q25. Solve $p + 5/6 = 1/3$ and check using a common denominator.



CLASS 13 • ONE-STEP EQUATIONS

Solving Subtraction Equations

When a number is subtracted from the variable, add that number to both sides.

Undo subtraction with addition.

Step by step

$$x - 6 = 11$$

1. Identify the subtracted number: 6.
2. Add 6 to both sides:

$$x - 6 + 6 = 11 + 6$$

3. Simplify:

$$x = 17$$

$$\text{Check: } 17 - 6 = 11 \quad \checkmark$$

— The variable can be on the right —

$$9 = n - 4$$

$$9 + 4 = n - 4 + 4$$

$$13 = n$$

$$\text{Check: } 9 = 13 - 4 \quad \checkmark$$

— Working with a negative number —

$$y - 8 = -3$$

$$y - 8 + 8 = -3 + 8$$

$$y = 5$$

$$\text{Check: } 5 - 8 = -3 \quad \checkmark$$

A real-life example

You gave away 5 pencils and have 8 left:
How many pencils did you have at first?
Let p = the number of pencils you had at first.

$$p - 5 = 8$$

$$p = 8 + 5 = 13$$

You had 13 pencils.

Try it

Add to both sides, then check.

A. $a - 7 = 12$

B. $b - 4 = -2$

C. $6 = c - 9$

Answers: **A.** $a = 19$ **B.** $b = 2$ **C.** $c = 15$

One-Step Equations

Image 6 practice: Solving subtraction equations

Q26. Solve $x - 15 = 26$ and check.

Q27. Solve $18 = n - 27$ and check.

Q28. Solve $y - 14 = -22$ and check.

Q29. Solve $r - 6.85 = -1.4$. Show how you align decimal places.

Q30. Solve $s - 7/8 = -1/4$ and check using eighths.



CLASS 13 • ONE-STEP EQUATIONS

Checking Your Solution

Substitute your answer into the original equation. Then compare both sides.

A solution makes the original equation true.

Check step by step

Original equation: $x - 4 = 9$ Proposed solution: $x = 13$

1. Replace x with 13: $13 - 4 = 9$
2. Simplify each side: $9 = 9$
3. Compare:

Both sides are equal, so $x = 13$ is correct. ✓

Checking addition

Equation: $n + 6 = 14$

Test $n = 8$.

$$\begin{aligned} 8 + 6 &= 14 \\ 14 &= 14 \quad \checkmark \end{aligned}$$

$n = 8$ is a solution.

Spotting an incorrect answer

Equation: $n + 6 = 14$

Test $n = 7$.

$$\begin{aligned} 7 + 6 &= 13 \\ 13 &\neq 14 \end{aligned}$$

$n = 7$ is **not** a solution.

Check a negative solution

Equation: $y + 8 = 3$

Test $y = -5$:

$$\begin{aligned} -5 + 8 &= 3 \\ 3 &= 3 \quad \checkmark \end{aligned}$$

$y = -5$ is correct.

Always check in the original equation.

Try it

Is the proposed value a solution?

- A. $a + 5 = 12$; test $a = 7$
- B. $b - 3 = 8$; test $b = 5$
- C. $c + 9 = 4$; test $c = -5$

Answers: A. Yes: $7 + 5 = 12$.
B. No: $5 - 3 = 2$, not 8.
C. Yes: $-5 + 9 = 4$.

One-Step Equations

Image 7 practice: Checking your solution

Q31. Is $x = 15$ a solution of $x + 12 = 27$? Show the substitution.

Q32. Is $n = 19$ a solution of $n - 11 = 9$? If not, find the correct value.

Q33. Test $y = -16$ in $y + 21 = 5$. Explain why a negative value can be correct.

Q34. A student says $r = 7.4$ solves $r - 2.65 = 4.85$. Check the claim, then correct it if needed.

Q35. For $u + \frac{3}{4} = \frac{1}{8}$, two students propose $u = \frac{7}{8}$ and $u = -\frac{5}{8}$. Check both and identify the solution.



CLASS 13 • ONE-STEP EQUATIONS

Writing Equations from Word Problems

Turn a real-life situation into an equation with an unknown.

Define the variable • Write • Solve • Check

Example 1: Giving away pencils

You gave away 5 pencils and have 8 left. How many pencils did you have at first?

1. **Define:** Let p be the number of pencils you had at first.

2. **Write:** $p - 5 = 8$

3. **Solve:** $p - 5 + 5 = 8 + 5$

$$p = 13$$

4. **Check:** $13 - 5 = 8$ ✓

You had 13 pencils at first.

Example 2: Saving money

You had some money and saved \$12 more. Now you have \$30. How much did you have at first?

1. **Define:** Let m be the number of dollars you had at first.

2. **Write:** $m + 12 = 30$

3. **Solve:** $m + 12 - 12 = 30 - 12$

$$m = 18$$

4. **Check:** $18 + 12 = 30$ ✓

You had \$18 at first.

Think about the relationship

Starting amount + amount gained = final amount

Starting amount - amount lost = final amount

Try it

You lent 4 books to a friend and have 9 books left. How many books did you have before lending them?

Define b , write an equation, and solve.

b = original number of books; $b - 4 = 9$; $b = 13$.

Check: $13 - 4 = 9$. You had 13 books.

One-Step Equations

Image 8 practice: Writing equations from word problems

Q36. Leah receives 9 postcards and now has 34. How many did she have before? Define a variable, write an equation, and solve.

Q37. A theater sells 28 tickets, leaving 47 unsold. How many tickets were available at first? Write and solve an equation.

Q38. A weather station records a temperature rise of 9°C . The new temperature is 2°C . What was the earlier temperature?

Q39. After paying \$8.65 for supplies, Mina has \$14.20 left. How much money did she have before paying? Write and solve an equation.

Q40. After a tank receives $\frac{3}{8}$ liter of water, it contains $1\frac{1}{4}$ liters. How much water was in it before? Write an equation and check.

One-Step Equations

Homework review: R1–R5

R1. Image 1: Explain why $n - 18$ is an expression but $n - 18 = 29$ is an equation. Find the solution of the equation.

R2. Image 2: A game score rises by 16 points to reach 45. Define a variable for the earlier score, write an equation, and solve.

R3. Image 3: Show the same operation on both sides to solve $b - 24 = 13$. Explain why changing only one side is not valid.

R4. Image 4: Name the inverse operation and solve $-11 = r + 7$.

R5. Image 5: Solve $a + 6.35 = 14.8$ and check.

One-Step Equations

Homework review: R6–R8

R6. Image 6: Solve $k - 5/6 = -1/2$ and check.

R7. Image 7: A student proposes $x = -12$ for $x + 19 = 6$. Check the claim and find the correct solution.

R8. Image 8: A rope is shortened by 2.75 meters and is now 6.40 meters long. Define the unknown, write an equation, and find its original length.

One-Step Equations

Homework word problems: W1–W5

W1. Owen adds 6 shells to his collection and now has 22. How many shells did he have before? Write an equation and solve.

W2. A bakery sells 17 muffins and has 26 left. How many muffins did it have before the sale? Write an equation and solve.

W3. A club needs 85 points for an award. It has 58 points now. How many more points does it need? Define the missing amount and solve an equation.

W4. A blue ribbon is 14 centimeters longer than a red ribbon. The blue ribbon is 53 centimeters long. Find the red ribbon's length using an equation.

W5. Nina's new reading time is 38 minutes, which is 12 minutes less than her previous time. What was her previous time? Write an equation that matches 'less than.'

One-Step Equations

Homework word problems: W6–W10

W6. A gift card has \$24.50 after \$9.75 is added. What was the balance before the addition? Write and solve an equation.

W7. A container loses 1.85 liters of water and now holds 3.60 liters. How much did it hold before the loss? Write and solve an equation.

W8. Overnight the temperature falls by 13°C and reaches -4°C . What was the temperature before the drop? Write an equation and check the sign.

W9. A diver rises 8.5 meters to reach an elevation of -3.25 meters relative to the water surface. What was the starting elevation, and how far below the surface was that?

W10. A recipe bowl contains $1\frac{1}{6}$ cups of flour after $\frac{3}{4}$ cup is added. How much flour was in the bowl before? Write and solve an equation using twelfths.

One-Step Equations

Homework word problems: W11–W12

W11. A game deducts $5\frac{1}{2}$ points from a player's score, leaving $-2\frac{3}{4}$ points. What was the score before the penalty? Write an equation, solve, and explain whether the earlier score was positive.

W12. A sensor reading is corrected by adding 1.75°C . The corrected reading is -0.60°C . Leo says the original reading was 1.15°C . Write the correction equation, test Leo's answer, and find the actual original reading.