

# Equations with Variables on Both Sides

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 24

## Quick Review

When you see a variable on *both* sides of the equals sign, the goal is to collect all the variable terms on one side and all the constants on the other. The strategy: (1) distribute and combine like terms on each side first; (2) add or subtract to move all variable terms to one side; (3) add or subtract to move constants to the other; (4) divide to finish. The two “weird” outcomes still apply here: if the variable disappears and leaves a **true** statement like  $5 = 5$ , every real number works (infinitely many solutions). If it leaves a **false** statement like  $3 = 7$ , no value works (no solution). Pro tip: move variables to whichever side will leave a positive coefficient — easier to work with.

## PRACTICE

Solve each equation. State if no solution or infinitely many.

- |                           |       |  |       |
|---------------------------|-------|--|-------|
| 1. $4x + 1 = x + 13$      | _____ | 11. $10 - x = 3x - 6$                    | _____ |
| 2. $7n - 5 = 3n + 11$     | _____ | 12. $2(3w + 5) = 3(2w + 4)$              | _____ |
| 3. $6a + 2 = 2a - 10$     | _____ | 13. $9x - 4 = 5x + 12$                   | _____ |
| 4. $5(y - 1) = 3y + 7$    | _____ | 14. $6 - 2x = 3x + 1$                    | _____ |
| 5. $2(m + 4) = 2m + 8$    | _____ | 15. $3(x + 2) + x = 4(x + 1) + 2$        | _____ |
| 6. $9 - 3k = 6k + 9$      | _____ | 16. $\frac{x + 5}{2} = x - 3$            | _____ |
| 7. $8p + 3 = 8p - 5$      | _____ | 17. $5(x - 1) - 2x = 3x - 5$             | _____ |
| 8. $3(2x - 1) = 4x + 5$   | _____ | 18. $2x + 11 = -3(x - 2)$                | _____ |
| 9. $7 + 2n = 5n - 8$      | _____ | 19. $\frac{x}{3} + 5 = \frac{2x}{3} - 1$ | _____ |
| 10. $-4(x + 2) = -4x + 1$ | _____ | 20. $4(x + 1) = 2(2x + 3)$               | _____ |

## Word Problems

21. Gym A charges \$20 per month plus a \$50 sign-up fee. Gym B charges \$30 per month with no sign-up fee. After how many months will the total cost be the same?

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22. Aiden has \$100 and saves \$15 per week. Bella has \$40 and saves \$25 per week. After how many weeks will they have the same amount?

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23. Two car rental companies: Speedy charges \$45 a day plus \$0.20 per mile. QuickCar charges \$30 a day plus \$0.35 per mile. At how many miles will both companies cost the same for a one-day rental?

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24. Jordan’s age is 4 years more than 3 times his sister’s age. The sum of their ages is 32. Find both ages.

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## Answer Keys

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1. <math>x = 4</math></li> <li>2. <math>n = 4</math></li> <li>3. <math>a = -3</math></li> <li>4. <math>y = 6</math></li> <li>5. all reals</li> <li>6. <math>k = 0</math></li> <li>7. no solution</li> <li>8. <math>x = 4</math></li> <li>9. <math>n = 5</math></li> <li>10. no solution</li> <li>11. <math>x = 4</math></li> <li>12. no solution</li> </ol> | <ol style="list-style-type: none"> <li>13. <math>x = 4</math></li> <li>14. <math>x = 1</math></li> <li>15. all reals</li> <li>16. <math>x = 11</math></li> <li>17. all reals</li> <li>18. <math>x = -1</math></li> <li>19. <math>x = 18</math></li> <li>20. no solution</li> <li>21. <math>m = 5</math></li> <li>22. <math>w = 6</math></li> <li>23. <math>m = 100</math> miles</li> <li>24. sister 7, Jordan 25</li> </ol> |
|--|---|

### Step-by-Step Tutor Notes

1. Move carefully through the arithmetic; one clean operation usually unlocks the next one. Subtract  $x$ :  $3x + 1 = 13$ . Subtract 1:  $3x = 12$ . Divide by 3:  $x = 4$ . After simplifying, the answer is  $x = 4$ .
2. Work one inverse operation at a time and keep both sides balanced. Subtract  $3n$ :  $4n - 5 = 11$ . Add 5:  $4n = 16$ . Divide by 4:  $n = 4$ . After simplifying, the answer is  $n = 4$ .
3. Keep the order of operations in view, then simplify without skipping the sign check. Subtract  $2a$ :  $4a + 2 = -10$ . Subtract 2:  $4a = -12$ . Divide by 4:  $a = -3$ . After simplifying, the answer is  $a = -3$ .
4. Distribute the left:  $5y - 5 = 3y + 7$ . Subtract  $3y$ :  $2y - 5 = 7$ . Add 5:  $2y = 12$ . Divide by 2:  $y = 6$ .
5. Take it one clear step at a time and keep the original question in mind. Distribute:  $2m + 8 = 2m + 8$ . Both sides identical — infinitely many solutions. So the answer is all reals.
6. Add  $3k$  to both sides:  $9 = 9k + 9$ . Subtract 9:  $0 = 9k$ . Divide by 9:  $k = 0$ . (Zero is a real, valid answer.)
7. Move carefully through the arithmetic; one clean operation usually unlocks the next one. Subtract  $8p$  from both sides:  $3 = -5$ . False, so no solution. After simplifying, the answer is no solution.
8. Distribute the left:  $6x - 3 = 4x + 5$ . Subtract  $4x$ :  $2x - 3 = 5$ . Add 3:  $2x = 8$ . Divide by 2:  $x = 4$ .
9. Keep the order of operations in view, then simplify without skipping the sign check. Subtract  $2n$ :  $7 = 3n - 8$ . Add 8:  $15 = 3n$ . Divide by 3:  $n = 5$ . After simplifying, the answer is  $n = 5$ .
10. Distribute the left:  $-4x - 8 = -4x + 1$ . Add  $4x$  to both sides:  $-8 = 1$ . False, so no solution.
11. Move carefully through the arithmetic; one clean operation usually unlocks the next one. Add  $x$ :  $10 = 4x - 6$ . Add 6:  $16 = 4x$ . Divide by 4:  $x = 4$ . After simplifying, the answer is  $x = 4$ .
12. Keep the order of operations in view, then simplify without skipping the sign check. Distribute both:  $6w + 10 = 6w + 12$ . Subtract  $6w$ :  $10 = 12$ . False, so no solution. After simplifying, the answer is no solution.
13. Work one inverse operation at a time and keep both sides balanced. Subtract  $5x$ :  $4x - 4 = 12$ . Add 4:  $4x = 16$ . Divide by 4:  $x = 4$ . After simplifying, the answer is  $x = 4$ .
14. Keep the order of operations in view, then simplify without skipping the sign check. Add  $2x$ :  $6 = 5x + 1$ . Subtract 1:  $5 = 5x$ . Divide by 5:  $x = 1$ . After simplifying, the answer is  $x = 1$ .
15. Distribute both sides and combine like terms: the left becomes  $4x + 6$ , and the right also becomes  $4x + 6$ . Since the two sides match exactly, every real value of  $x$  makes the equation true.
16. Multiply both sides by 2:  $x + 5 = 2(x - 3)$ . Distribute:  $x + 5 = 2x - 6$ . Subtract  $x$ :  $5 = x - 6$ . Add 6:  $x = 11$ .
17. Distribute:  $5x - 5 - 2x = 3x - 5$ . Combine left:  $3x - 5 = 3x - 5$ . Both sides identical, so infinitely many solutions.
18. Distribute the right:  $2x + 11 = -3x + 6$ . Add  $3x$ :  $5x + 11 = 6$ . Subtract 11:  $5x = -5$ . Divide by 5:  $x = -1$ .
19. Multiply everything by 3 to clear fractions:  $x + 15 = 2x - 3$ . Subtract  $x$ :  $15 = x - 3$ . Add 3:  $x = 18$ .
20. Keep the order of operations in view, then simplify without skipping the sign check. Distribute both:  $4x + 4 = 4x + 6$ . Subtract  $4x$ :  $4 = 6$ . False, so no solution. After simplifying, the answer is no solution.
21. Set the two costs equal:  $20m + 50 = 30m$ . Subtract  $20m$ :  $50 = 10m$ . Divide by 10:  $m = 5$  months. That's the break-even point — before 5 months, Gym B is cheaper; after, Gym A wins.
22. Set savings equal:  $100 + 15w = 40 + 25w$ . Subtract  $15w$ :  $100 = 40 + 10w$ . Subtract 40:  $60 = 10w$ . Divide by 10:  $w = 6$  weeks.
23. Set costs equal:  $45 + 0.20m = 30 + 0.35m$ . Subtract  $0.20m$ :  $45 = 30 + 0.15m$ . Subtract 30:  $15 = 0.15m$ . Divide by 0.15:  $m = 100$  miles.
24. Let  $s$  be sister's age. Jordan's age is  $3s + 4$ . Sum:  $s + (3s + 4) = 32$ . Combine:  $4s + 4 = 32$ . Subtract 4:  $4s = 28$ . Divide by 4:  $s = 7$ . Then Jordan is  $3(7) + 4 = 25$ .



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