

Equations with Variables on Both Sides

Name: _____

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Q 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?

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?

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?

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

- | | |
|-----------------|-------------------------|
| 1. $x = 4$ | 13. $x = 4$ |
| 2. $n = 4$ | 14. $x = 1$ |
| 3. $a = -3$ | 15. all reals |
| 4. $y = 6$ | 16. $x = 11$ |
| 5. all reals | 17. all reals |
| 6. $k = 0$ | 18. $x = -1$ |
| 7. no solution | 19. $x = 18$ |
| 8. $x = 4$ | 20. no solution |
| 9. $n = 5$ | 21. $m = 5$ |
| 10. no solution | 22. $w = 6$ |
| 11. $x = 4$ | 23. $m = 100$ miles |
| 12. no solution | 24. sister 7, Jordan 25 |

Step-by-Step Tutor Notes

- 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 $x = 4$.
- 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 $n = 4$.
- 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 $a = -3$.
- Distribute the left: $5y - 5 = 3y + 7$. Subtract $3y$: $2y - 5 = 7$. Add 5: $2y = 12$. Divide by 2: $y = 6$.
- 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.
- Add $3k$ to both sides: $9 = 9k + 9$. Subtract 9: $0 = 9k$. Divide by 9: $k = 0$. (Zero is a real, valid answer.)
- 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.
- Distribute the left: $6x - 3 = 4x + 5$. Subtract $4x$: $2x - 3 = 5$. Add 3: $2x = 8$. Divide by 2: $x = 4$.
- 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 $n = 5$.
- Distribute the left: $-4x - 8 = -4x + 1$. Add $4x$ to both sides: $-8 = 1$. False, so no solution.
- 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 $x = 4$.
- 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.
- 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 $x = 4$.
- 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 $x = 1$.
- 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.
- Multiply both sides by 2: $x + 5 = 2(x - 3)$. Distribute: $x + 5 = 2x - 6$. Subtract x : $5 = x - 6$. Add 6: $x = 11$.
- Distribute: $5x - 5 - 2x = 3x - 5$. Combine left: $3x - 5 = 3x - 5$. Both sides identical, so infinitely many solutions.
- Distribute the right: $2x + 11 = -3x + 6$. Add $3x$: $5x + 11 = 6$. Subtract 11: $5x = -5$. Divide by 5: $x = -1$.
- Multiply everything by 3 to clear fractions: $x + 15 = 2x - 3$. Subtract x : $15 = x - 3$. Add 3: $x = 18$.
- 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.
- 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.
- Set savings equal: $100 + 15w = 40 + 25w$. Subtract $15w$: $100 = 40 + 10w$. Subtract 40: $60 = 10w$. Divide by 10: $w = 6$ weeks.
- 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.
- 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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