Solving Multi-Step Equations

Name: _____	Date: _____	Score: _____ / 26

Quick Review

A **multi-step equation** just means more than two moves to solve. The recipe stays the same: (1) **distribute** to clear any parentheses, (2) **combine like terms** on each side, then (3) use inverse operations to peel constants off and isolate the variable. Two special things can happen at the end. If your work reduces to a **true** statement like $0 = 0$ or $5 = 5$, the equation has **infinitely many solutions** — it's true no matter what x is (an identity). If your work reduces to a **false** statement like $0 = 3$, there's **no solution** — no value of x makes the original equation work. Both endings are valid answers; you just need to recognize them.

PRACTICE

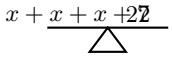
Solve each equation. State if no solution or infinitely many.

1. $3(x + 4) = 21$ _____
2. $5(2n - 1) + 3 = 18$ _____
3. $2(x + 3) + 4x = 24$ _____
4. $-2(3a - 4) = 10$ _____
5. $7 + 3(k - 1) = 22$ _____
6. $4(m + 2) - 3m = 15$ _____
7. $6(x - 1) = 6x - 6$ _____
8. $2(5y + 3) = 10y + 1$ _____
9. $\frac{3x + 6}{3} = x + 2$ _____
10. $-3(2p + 5) + p = -25$ _____
11. $8 - 2(n + 4) = 3n + 5$ _____
12. $5(x - 3) + 10 = 5x$ _____
13. $3(2x - 1) + 4 = 2(x + 5)$ _____
14. $\frac{x}{2} + \frac{x}{3} = 10$ _____
15. $-(x - 4) + 3x = 20$ _____
16. $0.4(x + 5) = 2$ _____
17. $4(2x + 1) - 3(x - 2) = 20$ _____
18. $\frac{2x - 1}{3} = \frac{x + 4}{2}$ _____
19. $6(x + 2) - 5x = x + 12$ _____
20. $3 - 2(x + 1) = -5 + x$ _____

VISUAL PRACTICE

Use the graph, table, chart, or diagram to answer the question.

21. The balance model shows $3x + 7 = 22$. Find x.



Answer: _____

22. The table shows each side of an equation. Which value makes the two sides equal?

x	1	2	3
$2(x + 3)$	8	10	12
$5x$	5	10	15

Answer: _____

Word Problems

23. Emma bought 3 identical shirts and a $\$5$ hat. She paid $\$38$ in total. Find the price of one shirt. _____

24. A rectangle's length is 3 more than twice its width w. The perimeter is 42 cm. Find the width and length. _____

25. A theater sells adult tickets for $\$12$ and child tickets for $\$8$. One night they sold 5 more child tickets than adult tickets, and total sales were $\$220$. How many adult tickets did they sell? _____

26. A number puzzle asks for three consecutive integers whose sum is 54. Write an equation for the three integers and three numbers. _____

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Answer Keys

1. $x = 3$
2. $n = 2$
3. $x = 3$
4. $a = -\frac{1}{3}$
5. $k = 6$
6. $m = 7$
7. all reals
8. no solution
9. all reals
10. $p = 2$
11. $n = -1$
12. no solution
13. $x = \frac{9}{4}$
14. $x = 12$
15. $x = 8$
16. $x = 0$
17. $x = 2$
18. $x = 14$
19. all reals
20. $x = 2$
21. $x = 5$
22. 2
23. $s = \$11$
24. $w = 6$ cm, $\ell = 15$ cm
25. $a = 9$
26. $17,\ 18,\ 19$

Step-by-Step Tutor Notes

1. Divide by 3 first: $x + 4 = 7$. Subtract 4: $x = 3$. (Or you could distribute first — same answer.).
2. Distribute: $10n - 5 + 3 = 18$. Combine: $10n - 2 = 18$. Add 2: $10n = 20$. Divide by 10: $n = 2$.
3. Distribute: $2x + 6 + 4x = 24$. Combine x-terms: $6x + 6 = 24$. Subtract 6: $6x = 18$. Divide by 6: $x = 3$.
4. Distribute: $-6a + 8 = 10$. Subtract 8: $-6a = 2$. Divide by -6: $a = -\frac{2}{6} = -\frac{1}{3}$.
5. Distribute: $7 + 3k - 3 = 22$. Combine: $3k + 4 = 22$. Subtract 4: $3k = 18$. Divide by 3: $k = 6$.
6. Work one inverse operation at a time and keep both sides balanced. Distribute: $4m + 8 - 3m = 15$. Combine: $m + 8 = 15$. Subtract 8: $m = 7$. After simplifying, the answer is $m = 7$.
7. Distribute the left: $6x - 6 = 6x - 6$. Both sides are identical, so the equation is true for any x. Infinitely many solutions (an identity).
8. Distribute: $10y + 6 = 10y + 1$. Subtract $10y$ from both sides: $6 = 1$. That's false, so no value of y works. No solution.
9. Simplify the left: $\frac{3x+6}{3} = x+2$. Both sides are equal already, so the equation is true for every x.
10. Distribute: $-6p - 15 + p = -25$. Combine: $-5p - 15 = -25$. Add 15: $-5p = -10$. Divide by -5: $p = 2$.
11. Distribute: $8 - 2n - 8 = 3n + 5$. Combine left: $-2n = 3n + 5$. Subtract $3n$: $-5n = 5$. Divide by -5: $n = -1$.
12. Distribute first: $5x - 15 + 10 = 5x$. Combine the constants on the left to get $5x - 5 = 5x$. Now subtract $5x$ from both sides: $-5 = 0$, which is false. Since the variables cancel and the remaining statement is impossible, there is no solution.
13. Distribute both sides: $6x-3+4 = 2x+10$. Combine left: $6x+1 = 2x+10$. Subtract $2x$: $4x + 1 = 10$. Subtract 1: $4x = 9$. Divide by 4: $x = \frac{9}{4}$.
14. Multiply both sides by 6 (the LCD) to clear fractions: $3x + 2x = 60$. Combine: $5x = 60$. Divide by 5: $x = 12$. (Clearing fractions early saves a lot of pain.).
15. Distribute the leading minus: $-x + 4 + 3x = 20$. Combine x-terms: $2x + 4 = 20$. Subtract 4: $2x = 16$. Divide by 2: $x = 8$.
16. Distribute: $0.4x + 2 = 2$. Subtract 2: $0.4x = 0$. Divide by 0.4: $x = 0$. (Yes, 0 is a perfectly fine answer.).
17. Distribute both: $8x + 4 - 3x + 6 = 20$. Combine: $5x + 10 = 20$. Subtract 10: $5x = 10$. Divide by 5: $x = 2$. (Notice the $-3(x - 2)$ gave $+6$ at the end — minus times minus.).
18. Cross-multiply: $2(2x - 1) = 3(x + 4)$. Distribute: $4x - 2 = 3x + 12$. Subtract $3x$: $x - 2 = 12$. Add 2: $x = 14$.
19. Distribute: $6x + 12 - 5x = x + 12$. Combine left: $x + 12 = x + 12$. Both sides identical, so infinitely many solutions.
20. Distribute: $3-2x-2 = -5+x$. Combine left: $-2x+1 = -5+x$. Subtract x: $-3x + 1 = -5$. Subtract 1: $-3x = -6$. Divide by -3: $x = 2$.
21. Work one inverse operation at a time and keep both sides balanced. Subtract 7 to get $3x = 15$, then divide by 3. So $x = 5$. After simplifying, the answer is $x = 5$.
22. Start with the definition the problem is testing, then apply it directly. The two sides match when $x = 2$. So the answer is 2.
23. Let s be the shirt price. Three shirts plus the $\$5$ hat: $3s + 5 = 38$. Subtract 5: $3s = 33$. Divide by 3: $s = \$11$ per shirt.
24. Length $= 2w + 3$. Perimeter $= 2(\ell) + 2(w) = 2(2w + 3) + 2w = 42$. Distribute: $4w+6+2w = 42$. Combine: $6w+6 = 42$. Subtract 6: $6w = 36$. Divide by 6: $w = 6$. Then $\ell = 2(6) + 3 = 15$ cm.
25. Let a be the adult tickets. Then child tickets is $a + 5$. Total sales: $12a + 8(a + 5) = 220$. Distribute: $12a + 8a + 40 = 220$. Combine: $20a + 40 = 220$. Subtract 40: $20a = 180$. Divide by 20: $a = 9$ adult tickets.
26. Let the smallest be n. Then the next two are $n + 1$ and $n + 2$. Sum: $n + (n + 1) + (n + 2) = 54$. Combine: $3n + 3 = 54$. Subtract 3: $3n = 51$. Divide by 3: $n = 17$. The integers are $17, 18, 19$. Quick check: $17 + 18 + 19 = 54$. ✓.

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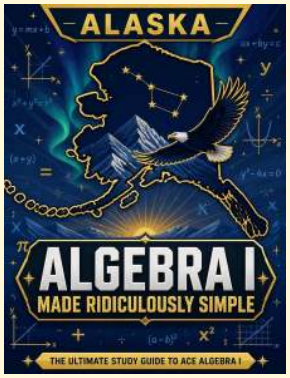

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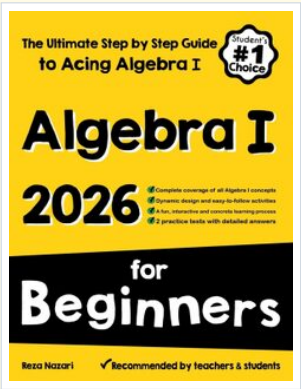

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