

# Solving Multi-Step Equations

Name: \_\_\_\_\_

Date: \_\_\_\_\_

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## 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

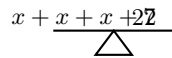
Solve each equation. State if no solution or infinitely many.

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

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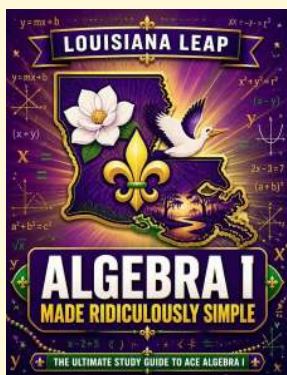
### Step-by-Step Tutor Notes

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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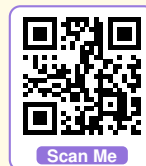
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