

# Solving Multi-Step Equations

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

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

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## Q Quick Review

To solve a linear equation, the goal is simple: get  $x$  all alone on one side. The toolkit is the **properties of equality** — whatever you do to one side, you do to the other. Use that to **undo** the operations stacked around  $x$ , in the opposite order they were applied. A clean recipe: (1) clear any fractions by multiplying every term by the LCD (decimals? multiply by a power of 10); (2) distribute through parentheses; (3) combine like terms on each side; (4) move all  $x$ -terms to one side and constants to the other; (5) divide by the coefficient of  $x$ . Watch out for two classic traps. The *parens trap*: in  $-2(x + 3)$  the negative belongs to both pieces, so you get  $-2x - 6$ , not  $-2x + 6$ . The *fraction-bar trap*:  $\frac{x+5}{3}$  means the bar groups the entire numerator, so multiplying by 3 gives  $x + 5$ , not just  $x$ . Always plug your answer back into the original equation as a check — it catches sign slips fast.

## PRACTICE

Solve each equation for the variable. Show your work.

1. Solve  $3x + 7 = 22$ . The table shows the value of  $3x + 7$  for a few inputs to get you started. \_\_\_\_\_

$x$	1	2	3	4
$3x + 7$	10	13	16	19

2.  $2(x - 5) = 14$  \_\_\_\_\_

3.  $\frac{x}{4} + \frac{x}{2} = 6$  \_\_\_\_\_

4.  $\frac{x+5}{3} = 7$  \_\_\_\_\_

5.  $0.4x + 1.2 = 0.6x - 2.0$  \_\_\_\_\_

6.  $5(x + 3) - 2x = 4x + 11$  \_\_\_\_\_

7.  $\frac{2x-1}{4} - \frac{x+3}{6} = \frac{1}{12}$  \_\_\_\_\_

8. Solve  $125 + 8p = 365$  for  $p$ . The table lists  $125 + 8p$  at a few values of  $p$ . \_\_\_\_\_

$p$	10	20	40	50
$125 + 8p$	205	285	445	525

9.  $\frac{3}{5}(2x - 4) + 7 = \frac{x+9}{2}$  \_\_\_\_\_

10.  $7 - 2(3x - 1) = 5x - 13$  \_\_\_\_\_

11.  $A = \frac{1}{2}(b_1 + b_2)h$  for  $h$  \_\_\_\_\_

12. Solve  $4x - 3 = 2x + 9$ . The balance table tracks each side separately — find the  $x$  where they match. \_\_\_\_\_

$x$	$4x - 3$	$2x + 9$
2	5	13
4	13	17
8	29	25

13.  $\frac{x}{3} - \frac{x-2}{5} = 1$  \_\_\_\_\_

14.  $-3(2x - 4) + 5 = 2x + 1$  \_\_\_\_\_

15.  $\frac{2}{3}x + 4 = \frac{1}{2}x - 1$  \_\_\_\_\_

16.  $6 - (2x + 3) = 4x + 1$  \_\_\_\_\_



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17.  $\frac{x-1}{2} + \frac{2x+3}{4} = 5$  \_\_\_\_\_

18.  $P = 2\ell + 2w$  for  $w$  \_\_\_\_\_

19.  $5 + 3(x-4) = 2(x+1) - 5$  \_\_\_\_\_

20.  $\frac{4x+1}{3} = \frac{2x-5}{2}$  \_\_\_\_\_

**◆ Word Problems**

21. A school club charges a setup fee of \$7 plus \$3 per ticket. The total charge for a small order is \$22. How many tickets are in the order? \_\_\_\_\_

22. A music club rents a room for a fixed fee of \$125 plus \$8 per attendee. If the total cost is \$365, how many attendees are there? \_\_\_\_\_

23. Two siblings together have \$48. The older sibling has \$6 more than twice the amount of the younger. How much does each have? \_\_\_\_\_

24. A car rental costs a flat \$32 per day plus \$0.25 per mile. Maya's total bill for one day is \$72. How many miles did she drive? \_\_\_\_\_



## Answer Keys

1.  $x = 5$

2.  $x = 12$

3.  $x = 8$

4.  $x = 16$

5.  $x = 16$

6.  $x = 4$

7.  $x = \frac{5}{2}$

8.  $p = 30$

9.  $x = -\frac{1}{7}$

10.  $x = 2$

11.  $h = \frac{2A}{b_1 + b_2}$

12.  $x = 6$

13.  $x = \frac{9}{2}$

14.  $x = 2$

15.  $x = -30$

16.  $x = \frac{1}{3}$

17.  $x = \frac{19}{4}$

18.  $w = \frac{P - 2\ell}{2}$

19.  $x = 4$

20.  $x = -\frac{17}{2}$

21. 5 tickets

22. 30 attendees

23. Younger \$14, Older \$34

24. 160 miles

## Step-by-Step Explanations

1. Subtract 7:  $3x = 15$ . Divide by 3:  $x = 5$ . Check:  $3(5) + 7 = 22$ . (The table climbs by 3 each step, so to reach 22 from 19 you need one more step —  $x = 5$ . Don't divide the 22 by 3 first; the +7 is in the way.)

2. Two roads work. Distribute:  $2x - 10 = 14$ , so  $2x = 24$  and  $x = 12$ . Or divide first:  $x - 5 = 7$ , so  $x = 12$ . Same answer.

3. Common denominator on the left is 4:  $\frac{x}{4} + \frac{2x}{4} = \frac{3x}{4} = 6$ . Multiply by 4:

$3x = 24$ , so  $x = 8$ . Quick check:  $\frac{8}{4} + \frac{8}{2} = 2 + 4 = 6$ .

4. Multiply both sides by 3 first to clear the bar:  $x + 5 = 21$ , so  $x = 16$ . The fraction bar groups the whole  $x + 5$  — don't just multiply the  $x$ .

5. Clear decimals by multiplying by 10:  $4x + 12 = 6x - 20$ . Subtract  $4x$ :  $12 = 2x - 20$ . Add 20:  $32 = 2x$ , so  $x = 16$ . (Multiplying both sides by 10 scales every term, including the  $-20$ .)

6. Distribute:  $5x + 15 - 2x = 4x + 11$ , so  $3x + 15 = 4x + 11$ . Move  $x$ -terms together:  $15 - 11 = 4x - 3x$ , giving  $4 = x$ . Plug back:  $5(7) - 2(4) = 35 - 8 = 27$  and  $4(4) + 11 = 27$ . Match.

7. Multiply every term by the LCD, 12:  $3(2x - 1) - 2(x + 3) = 1$ . Distribute carefully (watch the minus on the second piece):  $6x - 3 - 2x - 6 = 1$ . Combine:  $4x - 9 = 1$ , so  $4x = 10$  and  $x = \frac{5}{2}$ .

8. Subtract 125:  $8p = 240$ . Divide by 8:  $p = 30$ . (The table shows 285 at  $p = 20$  and 445 at  $p = 40$ , so 365 lands right between — at  $p = 30$ . Don't divide 365 by 8 first; the 125 fixed fee is in the way.)

9. Multiply everything by 10 (the LCD of 5 and 2):  $6(2x - 4) + 70 = 5(x + 9)$ . Distribute:  $12x - 24 + 70 = 5x + 45$ , so  $12x + 46 = 5x + 45$ . Subtract  $5x$  and 46:  $7x = -1$ ,  $x = -\frac{1}{7}$ .

10. Distribute the  $-2$  first:  $7 - 6x + 2 = 5x - 13$ , so  $9 - 6x = 5x - 13$ . Add  $6x$  and 13:  $22 = 11x$ . Divide:  $x = 2$ .

11. Multiply both sides by 2:  $2A = (b_1 + b_2)h$ . Then divide by the whole group  $b_1 + b_2$ :  $h = \frac{2A}{b_1 + b_2}$ . (Keep the parentheses group intact — don't split it.)

12. Subtract  $2x$ :  $2x - 3 = 9$ . Add 3:  $2x = 12$ , so  $x = 6$ . (Notice the left side is smaller at  $x = 4$  but larger at  $x = 8$ , so the two sides cross somewhere in

between — right at  $x = 6$ .)

13. LCD is 15. Multiply through:  $5x - 3(x - 2) = 15$ . Distribute:  $5x - 3x + 6 = 15$ , so  $2x + 6 = 15$  and  $2x = 9$ , giving  $x = \frac{9}{2}$ .

14. Distribute the  $-3$ :  $-6x + 12 + 5 = 2x + 1$ , so  $-6x + 17 = 2x + 1$ . Add  $6x$ , subtract 1:  $16 = 8x$ , so  $x = 2$ .

15. Multiply by 6:  $4x + 24 = 3x - 6$ . Subtract  $3x$  and 24:  $x = -30$ . (Yes, it's allowed to be negative — a quick plug-back gives  $-20 + 4 = -16$  and  $-15 - 1 = -16$ . Check.)

16. Distribute the implicit  $-1$ :  $6 - 2x - 3 = 4x + 1$ , so  $3 - 2x = 4x + 1$ . Add  $2x$ , subtract 1:  $2 = 6x$ ,  $x = \frac{1}{3}$ .

17. LCD is 4:  $2(x - 1) + (2x + 3) = 20$ . Distribute:  $2x - 2 + 2x + 3 = 20$ , so  $4x + 1 = 20$  and  $4x = 19$ , giving  $x = \frac{19}{4}$ .

18. Keep the rule visible: Subtract  $2\ell$ :  $P - 2\ell = 2w$ . Divide by 2:  $w = \frac{P - 2\ell}{2}$  (equivalently  $\frac{P}{2} - \ell$ ). That gives a quick check on the answer.

19. Distribute both sides:  $5 + 3x - 12 = 2x + 2 - 5$ , so  $3x - 7 = 2x - 3$ . Subtract  $2x$ , add 7:  $x = 4$ .

20. Cross-multiply:  $2(4x + 1) = 3(2x - 5)$ , so  $8x + 2 = 6x - 15$ . Subtract  $6x$  and 2:  $2x = -17$ ,  $x = -\frac{17}{2}$ .

21. Let  $x$  be the ticket count. Cost:  $3x + 7 = 22$ . Subtract 7:  $3x = 15$ . Divide by 3:  $x = 5$  tickets. Check:  $3(5) + 7 = 22$ . (Five tickets isn't fractional — that matches the real-world setup.)

22. Set  $125 + 8p = 365$ . Subtract 125:  $8p = 240$ . Divide by 8:  $p = 30$  attendees. Plug back:  $125 + 8(30) = 365$ .

23. Let  $y$  be the younger sibling's amount. The older has  $2y + 6$ . Together:  $y + (2y + 6) = 48$ , so  $3y + 6 = 48$  and  $3y = 42$ , giving  $y = 14$ . Older:  $2(14) + 6 = 34$ . Check:  $14 + 34 = 48$ .

24. Let  $m$  be the miles. Bill:  $32 + 0.25m = 72$ . Subtract 32:  $0.25m = 40$ . Divide by 0.25 (same as multiplying by 4):  $m = 160$ . (Whole number of miles — the answer should look reasonable for one day's driving.)



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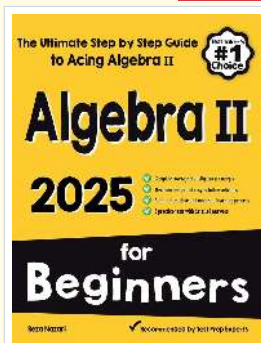
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