Systems of Equations Word Problems

Name: _____	Date: _____	Score: _____ / 29

Quick Review

Word problems with two unknowns are systems waiting to be set up. Three steps. **Step 1: name the variables.** Be specific: "let a = number of adult tickets" — not just "let a = adult tickets," which is vague. **Step 2: write two equations.** Usually one comes from a count (total tickets, total weight, total mixture), the other from a value (total cost, total money, total mass of a substance). **Step 3: solve** the system by substitution or elimination and *check the answer in the original story*. Things to watch for: coin problems use values in cents (dimes = 10 cents); mixture problems multiply concentration by amount; speed/distance/time problems use $d = rt$, sometimes with different r each direction. **Reality check**: people, tickets, coins, and animals come in whole positive numbers. If algebra gives you 7.3 children, you set up something wrong.

PRACTICE

Set up a system, solve, and check that your answer fits the real-world story.

1. The sum of two numbers is 21. The larger number is 3 more than twice the smaller. Find both numbers. _____
2. Two siblings together have $\$50$. The older has $\$10$ more than the younger. How much does each have? _____
3. A theater sells adult tickets for $\$8$ and child tickets for $\$5$. They sold 50 tickets and collected $\$310$. How many of each were sold? The table organizes the count and value rows for you. _____

	Adult	Child	Total
Count	a	c	50
Value ($)	$8a$	$5c$	310

4. A coin jar contains nickels and dimes worth $\$3.10$ total, with 40 coins in all. How many of each coin? The table lays out counts and values in cents. _____

	Nickels	Dimes	Total
Count	n	d	40
Value (cents)	$5n$	$10d$	310

5. A coffee shop sold 20 small ($\$3$) and large ($\$5$) coffees in an hour, totaling $\$84$. How many of each size? _____
6. A boat travels 30 miles downstream in 2 hours and the same 30 miles upstream in 3 hours. Find the boat's speed in still water and the current speed. _____
7. A chemist mixes a 10% acid solution with a 30% acid solution to make 200 mL of a 25% solution. How much of each? _____
8. A father is three times as old as his daughter. In 10 years, he'll be twice as old. Find their current ages. _____
9. A rectangle has perimeter 40 in and length 4 in more than its width. Find the length and width. _____
10. Two trains leave the same station traveling in opposite directions. One goes 40 mph, the other 60 mph. After how many hours are they 250 miles apart? _____
11. A peanut-and-cashew mix sells for $\$6$/lb. Peanuts cost $\$4$/lb and cashews cost $\$10$/lb. To make 30 lb of the mix, how much of each is needed? _____
12. A pencil and an eraser cost $\$1.50$ together. The pencil costs $\$1.00$ more than the eraser. How much does each cost? _____
13. A school sold 250 tickets for a play, raising $\$1{,}475$. Student tickets cost $\$5$ and adult tickets cost $\$8$. How many of each were sold? _____
14. Two angles are complementary (sum to $90°$). One is $30°$ less than twice the other. Find both angles. _____
15. A jar contains quarters and dimes worth $\$5.50$ total, with 28 coins in all. How many quarters and how many dimes? _____

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16. The sum of two numbers is 35. Twice the larger minus the smaller is 40. Find both numbers. _____

17. A car rental costs $\$25$/day plus $\$0.20$ per mile. Another costs $\$40$/day plus $\$0.10$ per mile. For what number of miles do both cost the same for one day? _____

18. At a county fair, 3 adult tickets and 2 child tickets cost $\$24$. Also, 2 adult tickets and 4 child tickets cost $\$28$. Find the cost of each ticket type. The table organizes the two purchases. _____

Purchase	Adult (a)	Child (c)	Cost ($)
First	3	2	24
Second	2	4	28

19. A pizza shop sells small ($\$10$), medium ($\$14$), and large ($\$18$) pizzas. Today they sold only small and large pizzas, 40 in total, for $\$640$. How many of each? _____

20. A bicycle and a scooter together cost $\$300$. The bicycle costs $\$60$ more than the scooter. Find the price of each. _____

♦ Word Problems

21. A school cafeteria sold a combination of $\$2$ sandwiches and $\$3$ wraps. They sold 80 items for a total of $\$190$. How many sandwiches and how many wraps? ____

22. A train left a station at noon traveling east at 50 mph. A second train left the same station at 2 p.m. traveling east at 70 mph. How many hours after noon will the second train catch up? ____

23. A nut mixture is to be made from peanuts costing $\$3$/lb and almonds costing $\$8$/lb. To make 20 lb of mixture worth $\$5$/lb on average, how much of each nut is needed? ____

24. A pet store has parrots and rabbits. There are 25 animals in total and 80 legs altogether (parrots have 2, rabbits have 4). How many of each? ____

Additional Practice

25. Solve: $2x + y = 7$ and $x - y = 2$. _____

26. Solve: $x + y = 10$ and $x - y = 4$. _____

27. Solve: $3x - 2y = 4$ and $x + y = 6$. _____

28. Classify: $2x + 4y = 8$ and $x + 2y = 4$. _____

29. Classify: $y = 3x + 1$ and $y = 3x - 5$. _____

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Answer Keys

1. smaller 6, larger 15
2. younger \$20, older \$30
3. 20 adult, 30 child
4. 18 nickels, 22 dimes
5. 8 small, 12 large
6. boat 12.5 mph, current 2.5 mph
7. 50 mL of 10%, 150 mL of 30%
8. daughter 10, father 30
9. width 8 in, length 12 in
10. 2.5 hours
11. 20 lb peanuts, 10 lb cashews
12. eraser \$0.25, pencil \$1.25
13. 175 student, 75 adult
14. $40°$ and $50°$
15. 18 quarters, 10 dimes
16. 10 and 25
17. 150 miles
18. adult \$5, child \$4.50
19. 10 small, 30 large
20. scooter \$120, bicycle \$180
21. 50 sandwiches, 30 wraps
22. 7 hours after noon
23. 12 lb peanuts, 8 lb almonds
24. 10 parrots, 15 rabbits

Additional Practice Answers

25. $(3, 1)$
26. $(7, 3)$
27. $(\frac{16}{5}, \frac{14}{5})$
28. infinitely many
29. no solution

Additional Practice: Answers for all numbered items, including the added practice, are shown in the grid above.

Step-by-Step Explanations

1. Let s be the smaller, L the larger. Then $s + L = 21$ and $L = 2s + 3$. Plug: $s + (2s + 3) = 21 \Rightarrow 3s = 18 \Rightarrow s = 6$. Then $L = 15$. Check: $6 + 15 = 21$ and $15 = 2(6) + 3$.
2. Let y, o be amounts. $y + o = 50$ and $o = y + 10$. Substitute: $y + (y + 10) = 50 \Rightarrow 2y = 40 \Rightarrow y = 20,\ o = 30$.
3. One steady path is: $a + c = 50,\ 8a + 5c = 310$. Substitute $c = 50 - a$: $8a + 5(50 - a) = 310 \Rightarrow 3a = 60 \Rightarrow a = 20,\ c = 30$. Both whole and positive — realistic. That gives a quick check on the answer.
4. Let n, d be counts. $n + d = 40,\ 5n + 10d = 310$ (cents). Divide the value equation by 5: $n + 2d = 62$. Subtract the count equation: $d = 22$, so $n = 18$. Both whole positive — good.
5. A careful way to see it: $s + \ell = 20,\ 3s + 5\ell = 84$. Substitute: $3s + 5(20 - s) = 84 \Rightarrow -2s = -16 \Rightarrow s = 8,\ \ell = 12$. That gives a quick check on the answer.
6. Let b be boat speed, c current. Downstream: $b + c = 15$. Upstream: $b - c = 10$. Add: $2b = 25 \Rightarrow b = 12.5$. Then $c = 2.5$.
7. One steady path is: $x + y = 200,\ 0.10x + 0.30y = 0.25(200) = 50$. From first: $x = 200 - y$. Plug: $0.10(200 - y) + 0.30y = 50 \Rightarrow 20 + 0.20y = 50 \Rightarrow y = 150,\ x = 50$. That gives a quick check on the answer.
8. Let f, d be current ages. $f = 3d$ and $f + 10 = 2(d + 10)$. Substitute: $3d + 10 = 2d + 20 \Rightarrow d = 10,\ f = 30$. Check: in 10 years, father 40, daughter 20, and $40 = 2 \cdot 20$.
9. A careful way to see it: $2\ell + 2w = 40 \Rightarrow \ell + w = 20$, and $\ell = w + 4$. Substitute: $w + 4 + w = 20 \Rightarrow 2w = 16 \Rightarrow w = 8,\ \ell = 12$. That gives a quick check on the answer.
10. Combined separation rate is $40 + 60 = 100$ mph. To open up 250 miles: $100t = 250 \Rightarrow t = 2.5$ hours.
11. One steady path is: $p + c = 30,\ 4p + 10c = 6 \cdot 30 = 180$. Substitute $p = 30 - c$: $4(30 - c) + 10c = 180 \Rightarrow 6c = 60 \Rightarrow c = 10,\ p = 20$. That gives a quick check on the answer.
12. Start with the key idea: $p + e = 1.50,\ p = e + 1.00$. Substitute: $(e + 1.00) + e = 1.50 \Rightarrow 2e = 0.50 \Rightarrow e = 0.25,\ p = 1.25$. (Classic riddle — it's easy to guess \$1.00 + \$0.50, but that doesn't fit the "one dollar more" constraint.) That gives a quick check on the answer.
13. A careful way to see it: $s + a = 250,\ 5s + 8a = 1475$. Substitute $s = 250 - a$: $5(250 - a) + 8a = 1475 \Rightarrow 3a = 225 \Rightarrow a = 75,\ s = 175$. That gives a quick check on the answer.
14. Let x, y be the angles. $x + y = 90$ and $y = 2x - 30$. Substitute: $x + (2x - 30) = 90 \Rightarrow 3x = 120 \Rightarrow x = 40,\ y = 50$.
15. One steady path is: $q + d = 28,\ 25q + 10d = 550$ (cents). From first $d = 28 - q$. Plug: $25q + 10(28 - q) = 550 \Rightarrow 15q + 280 = 550 \Rightarrow 15q = 270 \Rightarrow q = 18,\ d = 10$. That gives a quick check on the answer.
16. Let y be the larger, x the smaller. Then $x + y = 35$ and $2y - x = 40$. Add the two equations: $3y = 75 \Rightarrow y = 25$. So $x = 10$. Check: $25 + 10 = 35$ and $2(25) - 10 = 40$. Match.
17. A careful way to see it: $25 + 0.20m = 40 + 0.10m \Rightarrow 0.10m = 15 \Rightarrow m = 150$. This is the part to check before moving on, because it keeps the answer tied to the original question.
18. Keep the rule visible: $3a + 2c = 24,\ 2a + 4c = 28$. Multiply first by 2: $6a + 4c = 48$. Subtract second: $4a = 20 \Rightarrow a = 5$. Then $2(5) + 4c = 28 \Rightarrow c = 4.5$. That gives a quick check on the answer.
19. One steady path is: $s + \ell = 40,\ 10s + 18\ell = 640$. Substitute $s = 40 - \ell$: $10(40 - \ell) + 18\ell = 640 \Rightarrow 8\ell = 240 \Rightarrow \ell = 30,\ s = 10$. That gives a quick check on the answer.
20. Start with the key idea: $b + s = 300,\ b = s + 60$. Substitute: $(s + 60) + s = 300 \Rightarrow 2s = 240 \Rightarrow s = 120,\ b = 180$. That gives a quick check on the answer.
21. Let s, w. $s + w = 80,\ 2s + 3w = 190$. Substitute $s = 80 - w$: $2(80 - w) + 3w = 190 \Rightarrow w = 30,\ s = 50$. Both whole positive — realistic.
22. Let t = hours after noon. Train 1: distance $50t$. Train 2 leaves at $t = 2$ at 70 mph, so distance $70(t - 2)$. Set equal: $50t = 70(t - 2) \Rightarrow 50t = 70t - 140 \Rightarrow 20t = 140 \Rightarrow t = 7$. So 7 p.m. (Train 2 travels 5 hr, covers 350 mi; Train 1 travels 7 hr, covers 350 mi — they meet.)
23. One steady path is: $p + a = 20,\ 3p + 8a = 5 \cdot 20 = 100$. From first $p = 20 - a$: $3(20 - a) + 8a = 100 \Rightarrow 5a = 40 \Rightarrow a = 8,\ p = 12$. Realistic positive amounts. That gives a quick check on the answer.
24. Start with the key idea: $p + r = 25,\ 2p + 4r = 80$. From first $p = 25 - r$: $2(25 - r) + 4r = 80 \Rightarrow 2r = 30 \Rightarrow r = 15,\ p = 10$. Whole, positive, sensible. That gives a quick check on the answer.

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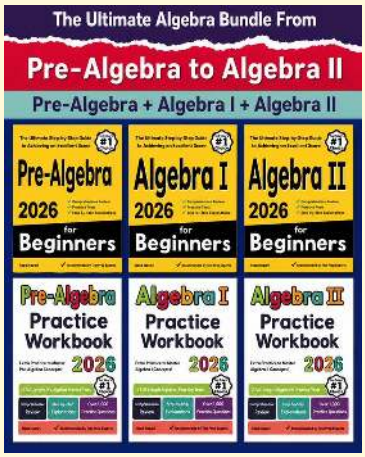

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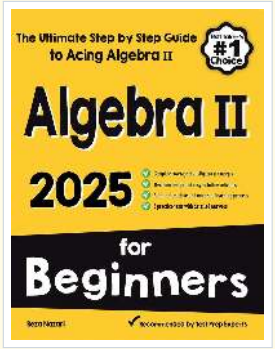

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