

# Applications of Systems of Equations

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

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## Q Quick Review

Word problems that involve two unknowns often become systems of equations. **Strategy:** (1) identify the two unknowns and pick variables; (2) write two equations — usually one for totals (sum, count) and one for value (cost, weight, money); (3) solve by substitution or elimination; (4) check the answer in the original problem context, not just the equations. Classic types: **mixture problems** (acid/water, coffee blends), **rate problems** (boat/plane with current/wind), **number problems** (digit sums, ages), **coin problems** (count + value), **break-even problems** (cost = revenue). Pick the form (substitution vs. elimination) that has less fraction-juggling.

## PRACTICE

Set up and solve each problem with a system.

- The art club keeps money in two envelopes for supplies. Together the envelopes hold \$30. The larger envelope has \$8 more than the smaller envelope. How much money is in each envelope?  
\_\_\_\_\_
- Two fundraising teams sold raffle tickets after school. Together they collected \$50. Team B collected three times as much money as Team A. How much money did each team collect?  
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- A rectangular garden has a perimeter of 24 feet. Its length is 2 feet more than its width. Find the length and width of the garden.  
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- Maya has 20 coins in a jar. The coins are only nickels and quarters, and their total value is \$3.40. How many nickels and how many quarters does Maya have?  
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- A community theater sold 15 tickets for a matinee. Adult tickets cost \$12 each and child tickets cost \$6 each. If the total ticket sales were \$132, how many adult tickets and child tickets were sold?  
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- A boat travels 24 miles downstream in 2 hours. The same boat travels 24 miles upstream in 3 hours. Find the boat's speed in still water and the speed of the current.  
\_\_\_\_\_
- A small plane flies 600 miles with the wind in 4 hours. Flying back against the same wind, it takes 5 hours to travel 600 miles. Find the plane's speed in still air and the wind speed.  
\_\_\_\_\_
- The length and width of a rectangular patio add to 22 feet. The patio has area 105 square feet. What are the two dimensions?  
\_\_\_\_\_
- A school concert sold 100 tickets. Student tickets cost \$5 and adult tickets cost \$10. The total revenue was \$750. How many student tickets and adult tickets were sold?  
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- A lab needs 100 mL of a 50% solution. The lab has a 30% solution and a 60% solution available. How many milliliters of each solution should be mixed?  
\_\_\_\_\_



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11. A classroom store sold 30 writing tools. Pencils cost \$0.50 each and pens cost \$1.00 each. If the total sales were \$22, how many pencils and pens were sold?  
\_\_\_\_\_
12. Car A starts at mile marker 0 and drives at 60 miles per hour. Car B starts at mile marker 90 and drives in the same direction at 45 miles per hour. After how many hours will Car A catch Car B?  
\_\_\_\_\_
13. Two siblings' ages add to 50 years. The older sibling is 20 years older than the younger sibling. How old is each sibling?  
\_\_\_\_\_
14. A father is 4 times as old as his son. In 10 years, the father will be twice as old as his son. How old are they now?  
\_\_\_\_\_
15. Phone Plan A charges a \$30 monthly fee plus \$0.10 per text. Phone Plan B charges a flat \$50 per month. For how many texts will the two plans cost the same?  
\_\_\_\_\_
16. A rectangular banner has a length that is 3 times its width. The perimeter of the banner is 64 inches. Find the width and length.  
\_\_\_\_\_
17. An investor splits \$1000 between two accounts. One account earns 5% simple interest and the other earns 7% simple interest. After one year, the total interest is \$60. How much was invested in each account?  
\_\_\_\_\_
18. Pool A starts with 200 gallons of water and drains at 20 gallons per hour. Pool B starts with 150 gallons and drains at 15 gallons per hour. After how many hours will the pools contain the same amount of water?  
\_\_\_\_\_
19. A quiz has 20 yes/no questions. A correct "yes" answer earns 2 points, and an incorrect "no" answer loses 1 point. A student has a score of 28 points. How many yes answers and no answers are represented?  
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20. A two-digit number has digits whose sum is 9. When the digits are reversed, the new number is 27 greater than the original number. What is the original number?  
\_\_\_\_\_



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## ◆ Word Problems

21. A school sold 300 tickets to a play. Adult tickets cost \$8 and student tickets \$5. Total revenue was \$1,920. How many of each?

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

22. A boat travels 40 miles downstream in 2 hours and 40 miles upstream in 4 hours. Find the boat's still-water speed and the current.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

23. A chemist needs 50 L of a 40% acid solution. She mixes a 30% and a 60% solution. How many liters of each?

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

24. At a fundraiser, 80 items sold (cookies \$2 each, brownies \$3 each). Total raised: \$190. How many of each?

Model: \_\_\_\_\_

Answer: \_\_\_\_\_



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## Answer Keys

- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1. \$19, \$11</li> <li>2. \$12.50, \$37.50</li> <li>3. <math>w = 5, \ell = 7</math></li> <li>4. 8 N, 12 Q</li> <li>5. <math>a = 7, c = 8</math></li> <li>6. <math>b = 10, c = 2</math></li> <li>7. <math>p = 135, w = 15</math></li> <li>8. 7, 15</li> <li>9. 50, 50</li> <li>10. 33.3, 66.7</li> <li>11. 16 pencils, 14 pens</li> <li>12. <math>t = 6</math></li> </ol> | <ol style="list-style-type: none"> <li>13. 35, 15</li> <li>14. <math>f = 20, s = 5</math></li> <li>15. <math>t = 200</math></li> <li>16. <math>w = 8, \ell = 24</math></li> <li>17. \$500, \$500</li> <li>18. <math>t = 10</math></li> <li>19. 16 yes, 4 no</li> <li>20. 36</li> <li>21. 140 adult, 160 student</li> <li>22. <math>b = 15, c = 5</math></li> <li>23. 33.3 L 30%, 16.6 L 60%</li> <li>24. 50 cookies, 30 brownies</li> </ol> |
|---|---|

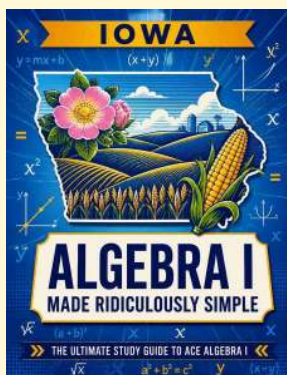
### Step-by-Step Tutor Notes

1. Let  $x$  and  $y$  be the account balances. The system is  $x + y = 30$  and  $x - y = 8$ . Adding the equations gives  $2x = 38$ , so  $x = 19$  and  $y = 11$ .
2. Let Team A collect  $x$  dollars, so Team B collects  $3x$ . Then  $x + 3x = 50$ , so  $4x = 50$  and  $x = 12.50$ . Team B collected  $3(12.50) = 37.50$  dollars.
3. Use the labels on the display first; they tell you which count or total belongs in the answer.  $2(\ell + w) = 24$ ,  $\ell = w + 2$ .  $\ell + w = 12$ ,  $(w + 2) + w = 12 \Rightarrow w = 5$ ,  $\ell = 7$ . This gives  $w = 5$ ,  $\ell = 7$ .
4. Let  $n$  be nickels and  $q$  be quarters. Then  $n + q = 20$  and  $0.05n + 0.25q = 3.40$ . Substitute  $n = 20 - q$ :  $0.05(20 - q) + 0.25q = 3.40$ , so  $1 + 0.20q = 3.40$ . That gives  $q = 12$  quarters and  $n = 8$  nickels.
5. Let  $a$  be adult tickets and  $c$  be child tickets. Use  $a + c = 15$  and  $12a + 6c = 132$ . Since  $c = 15 - a$ ,  $12a + 6(15 - a) = 132$ , so  $6a = 42$  and  $a = 7$ . Then  $c = 8$ .
6. Keep the order of operations in view, then simplify without skipping the sign check.  $b + c = 12$ ,  $b - c = 8$ . Add:  $b = 10$ ,  $c = 2$  mph. After simplifying, the answer is  $b = 10$ ,  $c = 2$ .
7. Take it one clear step at a time and keep the original question in mind.  $p + w = 150$ ,  $p - w = 120$ .  $p = 135$ ,  $w = 15$  mph. So the answer is  $p = 135$ ,  $w = 15$ .
8. Use the structure of the expression to find the important point, then check that it fits the context.  $x + y = 22$ ,  $xy = 105$ . Try factor pairs:  $7 \cdot 15 = 105$  and  $7 + 15 = 22$ .  $\checkmark$ . That leads to 7, 15.
9. Use the labels on the display first; they tell you which count or total belongs in the answer.  $s + a = 100$ ,  $5s + 10a = 750 \Rightarrow s + 2a = 150$ . Subtract:  $a = 50$ ,  $s = 50$ . This gives 50, 50.
10.  $x + y = 100$ ,  $0.30x + 0.60y = 50$ . From first:  $x = 100 - y$ . Sub:  $0.30(100 - y) + 0.60y = 50 \Rightarrow 30 + 0.30y = 50 \Rightarrow y \approx 66.7$ ,  $x \approx 33.3$  mL.
11. For a table question, slow down and locate the exact row, column, or cell before calculating.  $p + n = 30$ ,  $0.50p + n = 22$ . Subtract:  $0.50p = 8 \Rightarrow p = 16$ ,  $n = 14$ . This gives 16 pencils, 14 pens.
12. Read the table by matching the correct row and column first, then use the count or total that fits the question.  $60t = 90 + 45t \Rightarrow 15t = 90 \Rightarrow t = 6$  hours. This gives  $t = 6$ .
13. Start with the definition the problem is testing, then apply it directly.  $x + y = 50$ ,  $x - y = 20$ .  $x = 35$ ,  $y = 15$ . So the answer is 35, 15.
14.  $f = 4s$  and  $f + 10 = 2(s + 10) \Rightarrow 4s + 10 = 2s + 20 \Rightarrow s = 5$ ,  $f = 20$ .
15. Use the labels on the display first; they tell you which count or total belongs in the answer.  $30 + 0.10t = 50 \Rightarrow t = 200$  texts (break-even). This gives  $t = 200$ .
16. For a table question, slow down and locate the exact row, column, or cell before calculating.  $\ell = 3w$ ,  $2(\ell + w) = 64 \Rightarrow \ell + w = 32 \Rightarrow 3w + w = 32 \Rightarrow w = 8$ ,  $\ell = 24$ . This gives  $w = 8$ ,  $\ell = 24$ .
17.  $a + b = 1000$ ,  $0.05a + 0.07b = 60$ . From first:  $b = 1000 - a$ .  $0.05a + 0.07(1000 - a) = 60 \Rightarrow 70 - 0.02a = 60 \Rightarrow a = 500$ ,  $b = 500$ .
18. Read the table by matching the correct row and column first, then use the count or total that fits the question.  $200 - 20t = 150 - 15t \Rightarrow 50 = 5t \Rightarrow t = 10$  hours. This gives  $t = 10$ .
19. For a table question, slow down and locate the exact row, column, or cell before calculating.  $y + n = 20$ ,  $2y - n = 28$ . Add:  $3y = 48 \Rightarrow y = 16$ ,  $n = 4$ . This gives 16 yes, 4 no.
20. Digits  $t, u$ :  $t + u = 9$  and  $(10u + t) - (10t + u) = 27 \Rightarrow 9u - 9t = 27 \Rightarrow u - t = 3$ . So  $u = 6$ ,  $t = 3$ . Number is 36.
21.  $a + s = 300$ ,  $8a + 5s = 1920$ . From first:  $s = 300 - a$ . Sub:  $8a + 5(300 - a) = 1920 \Rightarrow 3a = 420 \Rightarrow a = 140$ ,  $s = 160$ .
22. Down:  $b + c = 20$ . Up:  $b - c = 10$ . Add:  $2b = 30$ , so  $b = 15$  mph; current  $c = 5$  mph.
23.  $x + y = 50$ ,  $0.30x + 0.60y = 0.40(50) = 20$ . Sub  $x = 50 - y$ :  $0.30(50 - y) + 0.60y = 20 \Rightarrow 15 + 0.30y = 20 \Rightarrow y = \frac{50}{3} \approx 16.67$  L,  $x \approx 33.33$  L.
24.  $c + b = 80$ ,  $2c + 3b = 190$ . Sub  $c = 80 - b$ :  $2(80 - b) + 3b = 190 \Rightarrow 160 + b = 190 \Rightarrow b = 30$ ,  $c = 50$ .



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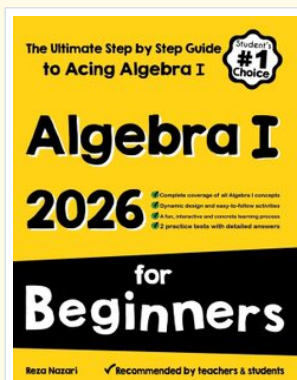
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