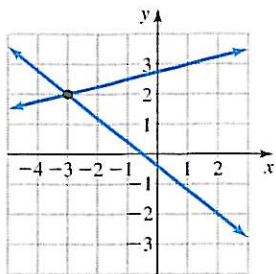
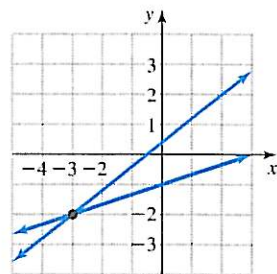


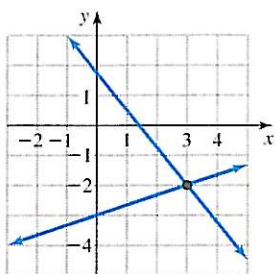
a)



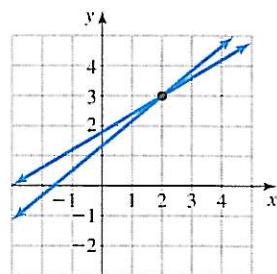
b)



c)



d)



Graph each pair of equations on a graphing calculator using a window that shows the point of intersection. Use the intersect feature to find the solution.

$$25. \begin{cases} y = 4x - 22.35 \\ y = -6x + 50.15 \end{cases}$$

$$26. \begin{cases} y = 10x - 31.32 \\ y = 5x - 13.27 \end{cases}$$

$$27. \begin{cases} y = -3x + 51 \\ y = 2x - 9 \end{cases}$$

$$28. \begin{cases} y = 5x + 98 \\ y = -7x - 70 \end{cases}$$

$$29. \begin{cases} 3.5x + y = 66 \\ 7.5x - y = 506 \end{cases}$$

$$30. \begin{cases} y - 12.5x = 1266 \\ 4.5x + y = -230 \end{cases}$$

$$31. \begin{cases} 3x - 2y = -158 \\ 5x + 4y = 1526 \end{cases}$$

$$32. \begin{cases} x - 7y = -270 \\ 2x + 15y = -1120 \end{cases}$$

$$33. \begin{cases} y = 3.1x + 452 \\ y = 3.2x + 443.6 \end{cases}$$

$$34. \begin{cases} y = 1.99x + 0.2 \\ y = 1.98x + 0.7 \end{cases}$$

3 Solving by Substitution

Solve each system by substitution. Determine whether the equations are independent, dependent, or inconsistent.

See Examples 4–7.

See the Strategy for the Substitution Method box on page 457.

$$35. \begin{cases} y = 4x - 1 \\ y = x + 8 \end{cases}$$

$$36. \begin{cases} y = -3x + 19 \\ y = 2x - 1 \end{cases}$$

$$37. \begin{cases} y = -2x \\ y = 4x + 12 \end{cases}$$

$$38. \begin{cases} y = -4x - 7 \\ y = 3x \end{cases}$$

$$39. \begin{cases} y = \frac{1}{3}x + 2 \\ y = -\frac{1}{2}x + 7 \end{cases}$$

$$40. \begin{cases} y = -\frac{2}{5}x - 2 \\ y = \frac{3}{2}x + 17 \end{cases}$$

$$41. \begin{cases} y = x - 5 \\ 2x - 5y = 1 \end{cases}$$

$$42. \begin{cases} y = x + 4 \\ 3y - 5x = 6 \end{cases}$$

$$43. \begin{cases} x = 2y - 7 \\ 3x + 2y = -5 \end{cases}$$

$$44. \begin{cases} x = y + 3 \\ 3x - 2y = 4 \end{cases}$$

$$45. \begin{cases} y = 2x - 30 \\ \frac{1}{5}x - \frac{1}{2}y = -1 \end{cases}$$

$$46. \begin{cases} 3x - 5y = 4 \\ y = \frac{3}{4}x - 2 \end{cases}$$

$$47. \begin{cases} 2x + y = 9 \\ 2x - 5y = 15 \end{cases}$$

$$48. \begin{cases} 3y - x = 0 \\ x - 4y = -2 \end{cases}$$

$$49. \begin{cases} x - y = 0 \\ 2x + 3y = 35 \end{cases}$$

$$50. \begin{cases} 2y = x + 6 \\ -3x + 2y = -2 \end{cases}$$

$$51. \begin{cases} x + y = 40 \\ 0.2x + 0.8y = 23 \end{cases}$$

$$52. \begin{cases} x - y = 10 \\ 0.1x + 0.5y = 13 \end{cases}$$

$$53. \begin{cases} y = 2x - 5 \\ y + 1 = 2(x - 2) \end{cases}$$

$$54. \begin{cases} 2x - y = 3 \\ 2y = 4x - 6 \end{cases}$$

$$55. \begin{cases} x - y = 5 \\ 2x = 2y + 14 \end{cases}$$

$$56. \begin{cases} 2x - y = 4 \\ 2x - y = 3 \end{cases}$$

$$57. \begin{cases} y = \frac{5}{7}x \\ x = -\frac{2}{3}y \end{cases}$$

$$58. \begin{cases} 7y = 9x \\ -3x = 4y \end{cases}$$

$$59. \begin{cases} 3(y - 1) = 2(x - 3) \\ 3y - 2x = -3 \end{cases}$$

$$60. \begin{cases} y = 3(x - 4) \\ 3x - y = 12 \end{cases}$$

$$61. \begin{cases} y = 3x \\ y = 3x + 1 \end{cases}$$

$$62. \begin{cases} y = 3x - 4 \\ y = 3x + 4 \end{cases}$$

Solve each system by the substitution method.

$$63. \begin{cases} y = \frac{5}{2}x \\ x + 3y = 3 \end{cases}$$

$$64. \begin{cases} 6x - 3y = 3 \\ 10x = y + 7 \end{cases}$$

$$65. \begin{cases} x + y = 4 \\ x - y = 5 \end{cases}$$

$$66. \begin{cases} 3x - 6y = 5 \\ 2y = 4x - 6 \end{cases}$$

$$\begin{aligned} 67. \quad 2x - 4y &= 0 \\ 6x + 8y &= 5 \end{aligned}$$

$$\begin{aligned} 69. \quad 3x + y &= 2 \\ -x - 3y &= 6 \end{aligned}$$

$$\begin{aligned} 71. \quad -9x + 6y &= 3 \\ 18x + 30y &= 1 \end{aligned}$$

$$\begin{aligned} 73. \quad y &= -2x \\ 3y - x &= 1 \end{aligned}$$

$$\begin{aligned} 75. \quad x &= -6y + 1 \\ 2y &= -5x \end{aligned}$$

$$\begin{aligned} 77. \quad x - y &= 0.1 \\ 2x - 3y &= -0.5 \end{aligned}$$

$$\begin{aligned} 68. \quad -3x + 10y &= 4 \\ 6x - 5y &= 1 \end{aligned}$$

$$\begin{aligned} 70. \quad x + 3y &= 2 \\ -x + y &= 1 \end{aligned}$$

$$\begin{aligned} 72. \quad x + 6y &= -2 \\ 5x - 20y &= 5 \end{aligned}$$

$$\begin{aligned} 74. \quad y &= 2x \\ 15x - 10y &= -2 \end{aligned}$$

$$\begin{aligned} 76. \quad x &= -3y + 2 \\ 7y &= 3x \end{aligned}$$

$$\begin{aligned} 78. \quad y - 2x &= -7.5 \\ 3x - 5y &= 3.2 \end{aligned}$$

4 Applications

Write a system of two equations in two unknowns for each problem. Solve each system by substitution. See Examples 8 and 9.



79. **Rectangular patio.** The length of a rectangular patio is 12 feet greater than the width. If the perimeter is 84 feet, then what are the length and width?

80. **Rectangular notepad.** The length of a rectangular notepad is 2 cm longer than twice the width. If the perimeter is 34 cm, then what are the length and width?

81. **Rectangular table.** The width of a rectangular table is 1 ft less than half of the length. If the perimeter is 28 ft, then what are the length and width?

82. **Rectangular painting.** The width of a rectangular painting is two-thirds of its length. If the perimeter is 60 in., then what are the length and width?

83. **Sum and difference.** The sum of two numbers is 10 and their difference is 3. Find the numbers.

84. **Sum and difference.** The sum of two numbers is 51 and their difference is 26. Find the numbers.

85. **Sum and difference.** The sum of two numbers is 1 and their difference is 20. Find the numbers.

86. **Sum and difference.** The sum of two numbers is 5 and their difference is 30. Find the numbers.

87. **Flying to Vegas.** Two hundred people were on a charter flight to Las Vegas. Some paid \$200 for their tickets and some paid \$250. If the total revenue for the flight was \$44,000 then how many tickets of each type were sold?

88. **Annual concert.** A total of 150 tickets were sold for the annual concert to students and nonstudents. Student tickets were \$5 and nonstudent tickets were \$8. If the total revenue for the concert was \$930, then how many tickets of each type were sold?

89. **Annual play.** There were twice as many tickets sold to nonstudents than to students for the annual play. Student tickets were \$6 and nonstudent tickets were \$11. If the total revenue for the play was \$1540, then how many tickets of each type were sold?

90. **Soccer game.** There were 1000 more students at the soccer game than nonstudents. Student tickets were \$8.50 and nonstudent tickets were \$13.25. If the total revenue for the game was \$75,925, then how many tickets of each type were sold?

91. **Mixing investments.** Helen invested \$40,000 and received a total of \$2300 in interest after one year. If part of the money returned 5% and the remainder 8%, then how much did she invest at each rate?

92. **Investing her bonus.** Donna invested her \$33,000 bonus and received a total of \$970 in interest after one year. If part of the money returned 4% and the remainder 2.25%, then how much did she invest at each rate?

93. **Mixing acid.** A chemist wants to mix a 5% acid solution with a 25% acid solution to obtain 50 liters of a 20% acid solution. How many liters of each solution should be used?

94. **Mixing fertilizer.** A farmer wants to mix a liquid fertilizer that contains 2% nitrogen with one that contains 10% nitrogen to obtain 40 gallons of a fertilizer that contains 8% nitrogen. How many gallons of each fertilizer should be used?

95. **Different interest rates.** Mrs. Brighton invested \$30,000 and received a total of \$2300 in interest. If she invested part of the money at 10% and the remainder at 5%, then how much did she invest at each rate?

96. **Different growth rates.** The combined population of Marysville and Springfield was 25,000 in 2000. By 2005 the population of Marysville had increased by 10%, while Springfield had increased by 9%. If the total population increased by 2380 people, then what was the population of each city in 2000?

- To solve system (a) by addition, we simply add the equations.
- To solve system (a) by addition, we can multiply the first equation by 2 and the second by 3 and then add.
- To solve system (b) by addition, we can multiply the second equation by 2 and then add.
- Both $(0, -10)$ and $(5, 0)$ are in the solution set to system (b).
- The solution set to system (b) is the set of all real numbers.
- System (c) has no solution.
- Both the addition method and substitution method are used to eliminate a variable from a system of two linear equations in two variables.
- For the addition method, both equations must be in standard form.
- To eliminate fractions in an equation, we multiply each side by the least common denominator of all fractions involved.
- We can eliminate either variable by using the addition method.

7.2 Exercises



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Study Tips

- Don't expect to understand a topic the first time you see it. Learning mathematics takes time, patience, and repetition.
- Keep reading the text, asking questions, and working problems. Someone once said, "All math is easy once you understand it."

Reading and Writing After reading this section, write out the answers to these questions. Use complete sentences.

- What method is presented in this section for solving a system of linear equations?
- What are we trying to accomplish by adding the equations?
- What must we sometimes do before we add the equations?
- How can you recognize an inconsistent system when solving by addition?
- How can you recognize a dependent system when solving by addition?

- For which systems is the addition method easier to use than substitution?

1 The Addition Method

Solve each system by addition.

See Examples 1–3.

See the Strategy for the Addition Method box on page 468.

$$\begin{aligned} 7. \quad x - y &= 1 \\ x + y &= 7 \end{aligned}$$

$$\begin{aligned} 9. \quad 3x - 4y &= 11 \\ -3x + 2y &= -7 \end{aligned}$$



$$\begin{aligned} 11. \quad x - y &= 12 \\ 2x + y &= 3 \end{aligned}$$

$$\begin{aligned} 13. \quad 3x - y &= 5 \\ 5x + y &= -2 \end{aligned}$$

$$\begin{aligned} 8. \quad x + y &= 7 \\ x - y &= 9 \end{aligned}$$

$$\begin{aligned} 10. \quad 7x - 5y &= -1 \\ -3x + 5y &= 9 \end{aligned}$$

$$\begin{aligned} 12. \quad x - 2y &= -1 \\ -x + 5y &= 4 \end{aligned}$$

$$\begin{aligned} 14. \quad -x + 2y &= 4 \\ x - 5y &= 1 \end{aligned}$$



$$15. \begin{cases} 2x - y = -5 \\ 3x + 2y = 3 \end{cases}$$

$$17. \begin{cases} -3x + 5y = 1 \\ 9x - 3y = 5 \end{cases}$$

$$19. \begin{cases} 2x - 5y = 13 \\ 3x + 4y = -15 \end{cases}$$

$$21. \begin{cases} 2x = 3y + 11 \\ 7x - 4y = 6 \end{cases}$$

$$23. \begin{cases} x + y = 48 \\ 12x + 14y = 628 \end{cases}$$

$$16. \begin{cases} 3x + 5y = -11 \\ x - 2y = 11 \end{cases}$$

$$18. \begin{cases} 7x - 4y = -3 \\ x + 2y = 3 \end{cases}$$

$$20. \begin{cases} 3x + 4y = -5 \\ 5x + 6y = -7 \end{cases}$$

$$22. \begin{cases} 2x = 2 - y \\ 3x + y = -1 \end{cases}$$

$$24. \begin{cases} x + y = 13 \\ 22x + 36y = 356 \end{cases}$$

$$37. \begin{cases} \frac{1}{3}x + \frac{1}{2}y = \frac{1}{3} \\ \frac{5}{6}x - \frac{3}{4}y = \frac{1}{6} \end{cases}$$

$$39. \begin{cases} 0.05x + 0.10y = 1.30 \\ x + y = 19 \end{cases}$$

$$41. \begin{cases} x + y = 1200 \\ 0.12x + 0.09y = 120 \end{cases}$$

$$43. \begin{cases} 1.5x - 2y = -0.25 \\ 3x + 1.5y = 6.375 \end{cases}$$

$$45. \begin{cases} 0.24x + 0.6y = 0.58 \\ 0.8x - 0.12y = 0.52 \end{cases}$$

$$38. \begin{cases} \frac{2}{3}x + \frac{5}{6}y = \frac{1}{4} \\ \frac{1}{5}x - \frac{1}{10}y = -\frac{1}{10} \end{cases}$$

$$40. \begin{cases} 0.1x + 0.06y = 9 \\ 0.09x + 0.5y = 52.7 \end{cases}$$

$$42. \begin{cases} x - y = 100 \\ 0.20x + 0.06y = 150 \end{cases}$$

$$44. \begin{cases} 3x - 2.5y = 7.125 \\ 2.5x - 3y = 7.3125 \end{cases}$$

$$46. \begin{cases} 0.18x + 0.27y = 0.09 \\ 0.06x - 0.54y = -0.04 \end{cases}$$

Solve each system by the addition method. Determine whether the equations are independent, dependent, or inconsistent. See Example 4.

$$25. \begin{cases} 3x - 4y = 9 \\ -3x + 4y = 12 \end{cases}$$

$$27. \begin{cases} 5x - y = 1 \\ 10x - 2y = 2 \end{cases}$$

$$29. \begin{cases} 2x - y = 5 \\ 2x + y = 5 \end{cases}$$

$$26. \begin{cases} x - y = 3 \\ -6x + 6y = 17 \end{cases}$$

$$28. \begin{cases} 4x + 3y = 2 \\ -12x - 9y = -6 \end{cases}$$

$$30. \begin{cases} -3x + 2y = 8 \\ 3x + 2y = 8 \end{cases}$$

<2> Equations Involving Fractions or Decimals

Solve each system by the addition method. See Examples 5 and 6.

$$31. \begin{cases} \frac{1}{4}x + \frac{1}{3}y = 5 \\ x - y = 6 \end{cases}$$

$$33. \begin{cases} \frac{x}{4} - \frac{y}{3} = -4 \\ \frac{x}{8} + \frac{y}{6} = 0 \end{cases}$$

$$32. \begin{cases} \frac{3x}{2} - \frac{2y}{3} = 10 \\ \frac{1}{2}x + \frac{1}{2}y = -1 \end{cases}$$

$$34. \begin{cases} \frac{x}{3} - \frac{y}{2} = -\frac{5}{6} \\ \frac{x}{5} - \frac{y}{3} = -\frac{3}{5} \end{cases}$$



$$35. \begin{cases} \frac{1}{8}x + \frac{1}{4}y = 5 \\ \frac{1}{16}x + \frac{1}{2}y = 7 \end{cases}$$

$$36. \begin{cases} \frac{3}{7}x + \frac{5}{9}y = 27 \\ \frac{1}{9}x + \frac{2}{7}y = 7 \end{cases}$$

Miscellaneous

Solve each system by substitution or addition, whichever is easier.

$$47. \begin{cases} y = x + 1 \\ 2x - 5y = -20 \end{cases}$$

$$49. \begin{cases} x - y = 19 \\ 2x + y = -13 \end{cases}$$

$$51. \begin{cases} 2y = x + 2 \\ x = y - 1 \end{cases}$$

$$53. \begin{cases} 2y - 3x = -1 \\ 5y + 3x = 29 \end{cases}$$

$$55. \begin{cases} 6x + 3y = 4 \\ y = \frac{2}{3}x \end{cases}$$

$$57. \begin{cases} y = 3x + 1 \\ x = \frac{1}{3}y + 5 \end{cases}$$

$$59. \begin{cases} x - y = 0 \\ x + y = 2x \end{cases}$$

$$48. \begin{cases} y = 3x - 4 \\ x + y = 32 \end{cases}$$

$$50. \begin{cases} x + y = 3 \\ 7x - y = 29 \end{cases}$$

$$52. \begin{cases} 2y - x = 3 \\ x = 3y - 5 \end{cases}$$

$$54. \begin{cases} y - 5 = 2x \\ y - 9 = -2x \end{cases}$$

$$56. \begin{cases} 3x - 2y = 2 \\ x = \frac{2}{9}y \end{cases}$$

$$58. \begin{cases} y = -\frac{2}{3}x - 3 \\ x = -\frac{3}{2}y + 9 \end{cases}$$

$$60. \begin{cases} 5x - 4y = 9 \\ 8y - 10x = -18 \end{cases}$$

For each system find the value of a so that the solution set to the system is $\{(2, 3)\}$.

$$61. \begin{cases} x + y = 5 \\ x - y = a \end{cases}$$

$$62. \begin{cases} 2x - y = 1 \\ ax + y = 13 \end{cases}$$

For each system find the values of a and b so that the solution set to the system is $\{(5, 12)\}$.

$$63. \begin{cases} y = ax + 2 \\ y = bx + 17 \end{cases}$$

$$64. \begin{cases} y = 3x + a \\ y = -2x + b \end{cases}$$