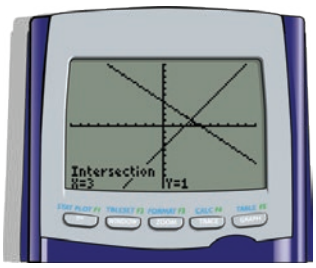
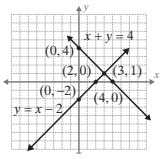
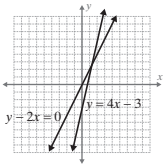


We see that the solution is $x = 3$ and $y = 1$.

(**Note:** In this case the solution shown is exact. In many cases the solution shown will be only an estimate. Thus, even with a calculator, the graphing method is limited. Also, **if the lines are parallel (an inconsistent system), the calculator will give an error message when you try to find the intersection point**.)

Margin exercise answers

1. 

2. 

3. $\left(\frac{3}{2}, 3\right)$ **4.** No solution **5.** $(2, -3)$

6. Infinite number of solutions: $(x, -2x + 5)$ or $\left(\frac{-1}{2}y + \frac{5}{2}, y\right)$ **7.** 30 kg of the 20% alloy and 10 kg of the 60% alloy **8.** \$35,000 in the savings account at 6% and \$15,000 in the stock at 10%.

9. 6 hours at job A and 14 hours at job B.

3.6 Exercises

Concept Check

Fill-in-the-Blank. Complete the sentences using information found in this chapter.

1. Two or more linear equations considered at one time are said to form a _____ of equations.
2. A system of linear equations is _____ if it has one or more solutions.
3. A system of linear equations is _____ if it has no solutions.
4. Two equations are _____ if the graphs of the equations are the same line.
5. Two equations are _____ if the graphs of the equations are different lines.
6. When a system of linear equations by substitution, substituting the value of a variable into one of the original equations to find the value of the other variable is called _____ substitution.

True/False. Determine whether each statement is true or false. If a statement is false, explain how it can be changed so the statement will be true. (**Note:** There may be more than one acceptable change.)

7. A system of equations with graphs that are parallel lines has exactly one solution.

8. A system of equations with graphs that intersect at one point has exactly one solution.

9. The method of substitution reduces the problem from one of solving two equations in two variables to solving one equation in one variable.

10. When using the method of addition, the solution only needs to be checked in one of the original equations.

Practice

Solve by graphing. See Examples 1 and 2.

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

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

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

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

5. $\begin{cases} 5x+2y=21 \\ x=y \end{cases}$

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

7. $\begin{cases} 2x+y+1=0 \\ 3x+4y-1=0 \end{cases}$

8. $\begin{cases} 4x-2y=10 \\ -6x+3y=-15 \end{cases}$

9. $\begin{cases} x-2y=11 \\ 2x-3y=18 \end{cases}$

10. $\begin{cases} 4x+3y+7=0 \\ 5x=2y-3 \end{cases}$

Use the substitution method or the addition method to solve the systems of linear equations. State whether each system is consistent, inconsistent, or dependent.

11. $\begin{cases} x+4y=6 \\ 2x+y=5 \end{cases}$

12. $\begin{cases} 2x+y=0 \\ x-2y=-10 \end{cases}$

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

14. $\begin{cases} 7x-y=18 \\ x+2y=9 \end{cases}$

15. $\begin{cases} x+2y=3 \\ 4x+8y=8 \end{cases}$

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

17. $\begin{cases} 6x+2y=16 \\ 3x+y=8 \end{cases}$

18. $\begin{cases} 4x-y=18 \\ 3x+5y=2 \end{cases}$

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

20. $\begin{cases} x=-7+4y \\ 2x=8y-14 \end{cases}$

21. $\begin{cases} 2x+y=4 \\ 4x+5y=11 \end{cases}$

22. $\begin{cases} 2x-3y=18 \\ 5x+4y=-1 \end{cases}$

23. $\begin{cases} 3x+4y=6 \\ x-8y=9 \end{cases}$

24. $\begin{cases} 3x+5y=3 \\ 9x-y=-7 \end{cases}$

25. $\begin{cases} 2x=5y-1 \\ 4x-10y=0 \end{cases}$

26. $\begin{cases} 6x+2y=5 \\ 2x+y=1 \end{cases}$

27. $\begin{cases} 4x+12y=5 \\ 5x-6y=1 \end{cases}$

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

29. $\begin{cases} x+y=7 \\ 2x+3y=16 \end{cases}$

30. $\begin{cases} 5x-7y=8 \\ 3x+11y=-12 \end{cases}$

31. $\begin{cases} 6x-y=15 \\ 1.2x-0.2y=3 \end{cases}$

32. $\begin{cases} 3x+y=14 \\ 0.1x-0.2y=1.4 \end{cases}$

33. $\begin{cases} x+y=12 \\ 0.05x+0.25y=1.6 \end{cases}$

34. $\begin{cases} x+y=20 \\ 0.1x+2.5y=3.8 \end{cases}$

35. $\begin{cases} 0.6x+0.5y=5.9 \\ 0.8x+0.4y=6 \end{cases}$

36. $\begin{cases} 0.5x+0.2y=7 \\ 1.5x+0.6y=2 \end{cases}$

Applications

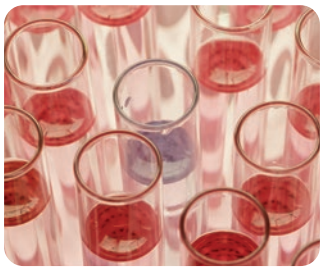
Solve.

37. How many liters each of a 12% iodine solution and a 30% iodine solution must be used to produce a total mixture of 90 liters of a 22% iodine solution?

38. A meat market has ground beef that is 40% fat and extra lean ground beef that is only 15% fat. How many pounds of each (ground beef and extra lean) must be ground together to get a total of 50 pounds of "lean" ground beef that is 25% fat?

39. A dairy needs 360 gallons of milk containing 4% butterfat. How many gallons each of milk containing 5% butterfat and milk containing 2% butterfat must be used to obtain the desired 360 gallons?

40. A druggist has two solutions of alcohol. One is 25% alcohol. The other is 45% alcohol. He wants to mix these two solutions to get 36 ounces that will be 30% alcohol. How many ounces of each of these two solutions should he mix together?



41. Investing: Pam inherited $124,000 from her Uncle Harold. She invested a portion in bonds and the remainder in a long-term certificate account. The amount invested in bonds was $24,000 less than 3 times the amount invested in certificates. How much was invested in bonds and how much in certificates?

42. Sang has invested $48,000, part at 6% and the rest in a higher risk investment at 10%. How much did she invest at each rate to receive $4000 in interest after one year?

43. An investor bought 500 shares of stock, some at $3.50 per share and some at $6.00 per share. If the total cost was $2187.50, how many shares of each stock did the investor buy?

44. Inez has 20 coins consisting of dimes and quarters. How many of each type does she have if all together she has $4.10?

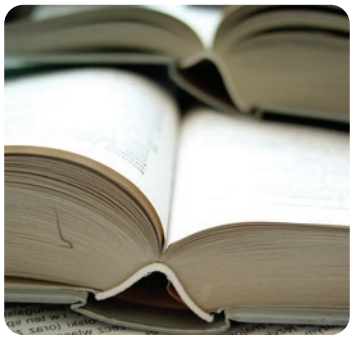
45. A confectioner is going to mix candy worth $3.90 per pound with candy worth $2.50 per pound to obtain 70 pounds of candy worth $3.30 per pound. How many pounds of each kind should she use?

46. The postal service charges 42¢ for letters that weigh 1 ounce or less and 17¢ more for letters that weigh between 1 and 2 ounces. Jeff, testing his father's math skills, gave his father $42.10 and asked him to purchase 80 stamps for his stamp collection, some 42¢ stamps and some 59¢ stamps. How many of each type of stamp did his dad buy?

47. Mike wants to mix two kinds of nuts to be eaten at a party he and his fraternity brothers are hosting tonight. One kind sells for 70 cents per pound, and the other sells for $1.30 per pound. He wants to mix a total of 20 pounds and pay a total of 82 cents per pound. How many pounds of each kind should he use in the mix?

48. A manufacturing plant is going to use two different stamping machines to complete an order of 975 units. One produces 100 units per hour, while the other produces 75 units per hour. How long must each machine operate to complete the order if, during the process, the faster machine is shut down for 2.5 hours for repairs?

49. The bookstore can buy a popular book as a paperback or a hardback. A hardback book costs $3.50 more than the paperback book. What is the cost of each if 90 paperback books cost the same as 55 hardback books?



50. In an election, the winner received 430 votes more than twice as many votes as the loser. If there was a total of 2290 votes cast, how many did each candidate receive?

51. A bill was defeated in the house of representatives after 25 more people voted against it than voted in favor of it. If one-tenth of those voting against the bill had voted in favor of it, then 21 more people would have voted in favor of it than against it. How many legislators voted in favor of the bill?

52. A private jet flies the same distance in 6 hours that a commercial jet flies in 2.5 hours. If the speed of the commercial jet was 75 mph less than three times the speed of the private jet, find the speed of each jet.

53. A manufacturer produces two new action figures, Ferocious Frank and Mighty Marcel. Ferocious Frank takes 4 hours to produce and costs $8 each. Mighty Marcel takes 3 hours to produce and costs $7 each. If the manufacturer allots a total of 5800 hours and $12,600 for production each week, how many of each model will be produced?

54. A car parts company has begun manufacturing two new products. One requires 2.5 hours of labor, 3 pounds of raw materials, and costs \$42.40 each to produce. The second product requires 4 hours of labor, 4 pounds of raw materials, and costs \$64 each to produce. Find the cost of labor per hour and the cost of raw materials per pound.

55. A furniture shop refinishes chairs. Employees use two methods to refinish a chair. Method I takes 1 hour, and the material costs \$6. Method II takes an hour and a half, and the material costs \$3. Next week, they plan to spend 144 hours in labor and \$600 in material refinishing chairs. How many chairs should they plan to refinish by each method?

56. A large feed lot uses two feed supplements, Ration I and Ration II. Each pound of Ration I contains 4 units of protein and 2 units of carbohydrates. Each pound of Ration II contains 3 units of protein and 6 units of carbohydrates. If the dietary requirement calls for 42 units of protein and 30 units of carbohydrates, how many pounds of each ration should be used to satisfy the requirements?

57. Two years ago, Sue was half as old as Pat. Eight years from now, Sue will be two-thirds as old as Pat. How old is each of them now?

58. George is 8 years older than his brother Kurt. Four years from now, he will be twice as old as Kurt. How old is each brother at this time?

In Exercises 59–66, use a graphing calculator and the `CALC` and `5:intersect` commands to find the solutions to the given systems of linear equations. If necessary, round values to four decimal places. (Remember to solve each equation for y. Use both `Y1` and `Y2` in the Y= menu.)

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

60. $\begin{cases} 3x+y=6 \\ 2x+y=-1 \end{cases}$

61. $\begin{cases} 8x-2y=8 \\ y=-2x \end{cases}$

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

63. $\begin{cases} x-3y=6 \\ -2x+y=-1 \end{cases}$

64. $\begin{cases} x+\frac{1}{2}y=0 \\ 6x-y=3 \end{cases}$

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

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

Writing & Thinking

67. Explain, in your own words, why the answer to a consistent system of linear equations is written as an ordered pair.