Complete Instructor Answers

Answers to selected writing exercises are provided.

Answers to Prerequisite Skills Diagnostic Test

1. 20% **2.** 51/35 **3.** $x + y = 75$ **4.** $s \geq 4p$ **5.** $-20/3$ (Sec. R.4) **6.** $-11/5$ (Sec. R.4)
7. $(-2, 5]$ (Sec. R.5) **8.** $x \leq -3$ (Sec. R.5) **9.** $y \geq -17/2$ (Sec. R.5) **10.** $p > 3/2$ (Sec. R.5)

Chapter R Algebra Reference

Exercises R.1 (page R-5–R-6)

For exercises . . .	1–8	9, 10	11–16	17–24	25–28
Refer to example . . .	2	3	4	5	6

1. $-x^2 + x + 9$ **2.** $-6y^2 + 3y + 10$ **3.** $(3/2)z^2 + (5/6)z + 2$
4. $(1/2)t^2 + (1/2)t + 2/3$ **5.** $-16q^2 + 4q + 6$ **6.** $9r^2 - 4r + 19$ **7.** $-0.327x^2 - 2.805x - 1.458$
8. $0.8r^2 + 3.6r - 1.5$ **9.** $-18m^3 - 27m^2 + 9m$ **10.** $-12x^4 + 30x^2 + 36x$ **11.** $9t^2 + 9ty - 10y^2$
12. $18k^2 - 7kq - q^2$ **13.** $4 - 9x^2$ **14.** $36m^2 - 25$ **15.** $(6/25)y^2 + (11/40)yz + (1/16)z^2$
16. $(15/16)r^2 - (7/12)rs - (2/9)s^2$ **17.** $27p^3 - 1$ **18.** $15p^3 + 13p^2 - 10p - 8$ **19.** $8m^3 + 1$
20. $12k^4 + 21k^3 - 5k^2 + 3k + 2$ **21.** $3x^2 + xy + 2xz - 2y^2 - 3yz - z^2$ **22.** $2r^2 + 2rs - 5rt - 4s^2 + 8st - 3t^2$
23. $x^3 + 6x^2 + 11x + 6$ **24.** $x^3 - 2x^2 - 5x + 6$ **25.** $x^2 + 4x + 4$ **26.** $4a^2 - 16ab + 16b^2$
27. $x^3 - 6x^2y + 12xy^2 - 8y^3$ **28.** $27x^3 + 27x^2y + 9xy^2 + y^3$

Exercises R.2 (page R-9)

For exercises . . .	1–4	5–15	16–20	21–32
Refer to example . . .	1	2,3	3, 2nd CAUTION	4

1. $7a^2(a + 2)$ **2.** $3y(y^2 + 8y + 3)$ **3.** $13p^2q(p^2q - 3p + 2q)$
4. $10m^2(6m^2 - 12mn + 5n^2)$ **5.** $(m + 2)(m - 7)$ **6.** $(x + 5)(x - 1)$ **7.** $(z + 4)(z + 5)$ **8.** $(b - 7)(b - 1)$
9. $(a - 5b)(a - b)$ **10.** $(s - 5t)(s + 7t)$ **11.** $(y - 7z)(y + 3z)$ **12.** $(3x + 7)(x - 1)$ **13.** $(3a + 7)(a + 1)$
14. $(5y + 2)(3y - 1)$ **15.** $(7m + 2n)(3m + n)$ **16.** $6(a - 10)(a + 2)$ **17.** $3m(m + 3)(m + 1)$ **18.** $2(2a + 3)(a + 1)$
19. $2a^2(4a - b)(3a + 2b)$ **20.** $12x^2(x - y)(2x + 5y)$ **21.** $(x + 8)(x - 8)$ **22.** $(3m + 5)(3m - 5)$
23. $10(x + 4)(x - 4)$ **24.** Prime **25.** $(z + 7y)^2$ **26.** $(s - 5t)^2$ **27.** $(3p - 4)^2$ **28.** $(a - 6)(a^2 + 6a + 36)$
29. $(3r - 4s)(9r^2 + 12rs + 16s^2)$ **30.** $3(m + 5)(m^2 - 5m + 25)$ **31.** $(x - y)(x + y)(x^2 + y^2)$
32. $(2a - 3b)(2a + 3b)(4a^2 + 9b^2)$

Exercises R.3 (page R-12)

For exercises . . .	1–12	13–38
Refer to example . . .	1	2

1. $v/7$ **2.** $5p/2$ **3.** $8/9$ **4.** $2/(t + 2)$ **5.** $x - 2$ **6.** $4(y + 2)$ **7.** $(m - 2)/(m + 3)$
8. $(r + 2)/(r + 4)$ **9.** $3(x - 1)/(x - 2)$ **10.** $(z - 3)/(z + 2)$ **11.** $(m^2 + 4)/4$ **12.** $(2y + 1)/(y + 1)$ **13.** $3k/5$
14. $25p^2/9$ **15.** $9/(5c)$ **16.** 2 **17.** $1/4$ **18.** $3/10$ **19.** $2(a + 4)/(a - 3)$ **20.** $2/(r + 2)$ **21.** $(k - 2)/(k + 3)$
22. $(m + 6)/(m + 3)$ **23.** $(m - 3)/(2m - 3)$ **24.** $2(2n - 1)/(3n - 5)$ **25.** 1 **26.** $(6 + p)/(2p)$
27. $(12 - 15y)/(10y)$ **28.** $137/(30m)$ **29.** $(3m - 2)/[m(m - 1)]$ **30.** $(r - 6)/[r(2r + 3)]$ **31.** $14/[3(a - 1)]$
32. $23/[20(k - 2)]$ **33.** $(7x + 1)/[(x - 2)(x + 3)(x + 1)]$ **34.** $(y^2 + 1)/[(y + 3)(y + 1)(y - 1)]$
35. $k(k - 13)/[(2k - 1)(k + 2)(k - 3)]$ **36.** $m(3m - 19)/[(3m - 2)(m + 3)(m - 4)]$ **37.** $(4a + 1)/[a(a + 2)]$
38. $(5x^2 + 4x - 4)/[x(x - 1)(x + 1)]$

Exercises R.4 (page R-17)

For exercises . . .	1–8	9–26	27–37
Refer to example . . .	2	3–5	6,7

1. -12 **2.** 3/4 **3.** 12 **4.** $-3/8$ **5.** $-7/8$ **6.** $-6/11$ **7.** 4 **8.** $-10/19$ **9.** $-3, -2$
10. $-1, 3$ **11.** 7 **12.** $-2, 5/2$ **13.** $-1/4, 2/3$ **14.** $2, 5$ **15.** $-3, 3$ **16.** $-4, 1/2$ **17.** $0, 4$
18. $(5 + \sqrt{13})/6 \approx 1.434, (5 - \sqrt{13})/6 \approx 0.232$ **19.** $(2 + \sqrt{10})/2 \approx 2.581, (2 - \sqrt{10})/2 \approx -0.581$
20. $(-1 + \sqrt{5})/2 \approx 0.618, (-1 - \sqrt{5})/2 \approx -1.618$ **21.** $5 + \sqrt{5} \approx 7.236, 5 - \sqrt{5} \approx 2.764$
22. $(4 + \sqrt{6})/5 \approx 1.290, (4 - \sqrt{6})/5 \approx 0.310$ **23.** $1, 5/2$ **24.** No real number solutions
25. $(-1 + \sqrt{73})/6 \approx 1.257, (-1 - \sqrt{73})/6 \approx -1.591$ **26.** $-1, 0$ **27.** 3 **28.** 12 **29.** $-59/6$ **30.** 6 **31.** 3 **32.** $-5/2$
33. 2/3 **34.** 1 **35.** 2 **36.** No solution **37.** No solution

Exercises R.5 (page R-22)

For exercises . . .	1–14	15–26	27–38	39–42	43–54
Refer to example . . .	Figure 1, Example 2	2	3	4	5–7

1. $(-\infty, 4)$

2. $[-3, \infty)$

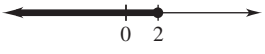
3. $[1, 2)$

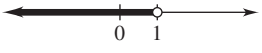
4. $[-2, 3]$ 

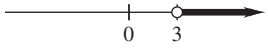
5. $(-\infty, -9)$ 

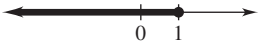
6. $[6, \infty)$ 

7. $-7 \le x \le -3$ **8.** $4 \le x < 10$ **9.** $x \le -1$ **10.** $x > 3$ **11.** $-2 \le x < 6$ **12.** $0 < x < 8$ **13.** $x \le -4$ or $x \ge 4$

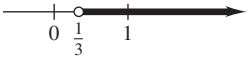
14. $x < 0$ or $x \ge 3$ **15.** $(-\infty, 2]$ 

16. $(-\infty, 1)$ 

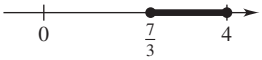
17. $(3, \infty)$ 

18. $(-\infty, 1]$ 

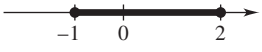
19. $(1/5, \infty)$ 

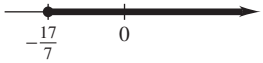
20. $(1/3, \infty)$ 

21. $(-4, 6)$ 

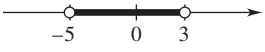
22. $[7/3, 4]$ 

23. $[-5, 3)$ 

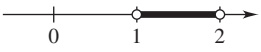
24. $[-1, 2]$ 

25. $[-17/7, \infty)$ 

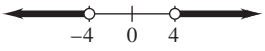
26. $(-\infty, 50/9]$ 

27. $(-5, 3)$ 

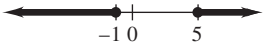
28. $(-\infty, -6] \cup [1, \infty)$ 

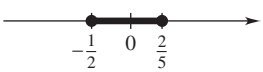
29. $(1, 2)$ 

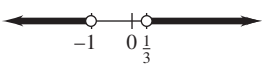
30. $(-\infty, -4) \cup (1/2, \infty)$ 

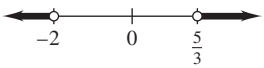
31. $(-\infty, -4) \cup (4, \infty)$ 

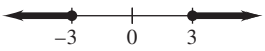
32. $[-3/2, 5]$ 

33. $(-\infty, -1] \cup [5, \infty)$ 

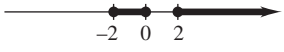
34. $[-1/2, 2/5]$ 

35. $(-\infty, -1) \cup (1/3, \infty)$ 

36. $(-\infty, -2) \cup (5/3, \infty)$ 

37. $(-\infty, -3] \cup [3, \infty)$ 

38. $(-\infty, 0) \cup (16, \infty)$ 

39. $[-2, 0] \cup [2, \infty)$ 

40. $(-\infty, -4] \cup [-3, 0]$ 

41. $(-\infty, 0) \cup (1, 6)$ 

42. $(-1, 0) \cup (4, \infty)$ 

43. $(-5, 3]$ **44.** $(-\infty, -1) \cup (1, \infty)$ **45.** $(-\infty, -2)$

46. $(-2, 3/2)$ **47.** $[-8, 5)$ **48.** $(-\infty, -3/2) \cup [-13/9, \infty)$ **49.** $[2, 3)$ **50.** $(-\infty, -1)$ **51.** $(-2, 0] \cup (3, \infty)$
52. $(-4, -2) \cup (0, 2)$ **53.** $(1, 3/2]$ **54.** $(-\infty, -2) \cup (-2, 2) \cup [4, \infty)$

Exercises R.6 (page R-26)

For exercises . . .	1–8	9–26	27–36	37–50	51–56
Refer to example . . .	1	2	3,4	5	6

1. 1/64 **2.** 1/81 **3.** 1 **4.** 1 **5.** $-1/9$ **6.** 1/9 **7.** 36 **8.** 27/64
9. 1/64 **10.** 8^5 **11.** $1/10^8$ **12.** 7 **13.** x^2 **14.** 1 **15.** $8k^3$ **16.** $1/(3z^7)$ **17.** $x^5/(3y^3)$ **18.** $m^3/5^4$ **19.** a^3b^6
20. $49/(c^6d^4)$ **21.** $(a + b)/(ab)$ **22.** $(1 - ab^2)/b^2$ **23.** $2(m - n)/[mn(m + n^2)]$ **24.** $(3n^2 + 4m)/(mn^2)$
25. $xy/(y - x)$ **26.** $y^4/(xy - 1)^2$ **27.** 11 **28.** 3 **29.** 4 **30.** -25 **31.** 1/2 **32.** 4/3 **33.** 1/16 **34.** 1/5 **35.** 4/3
36. 1000/1331 **37.** 9 **38.** 3 **39.** 64 **40.** 1 **41.** x^4/y^4 **42.** b/a^3 **43.** r **44.** $12^3/y^8$ **45.** $3k^{3/2}/8$ **46.** $1/(2p^2)$
47. $a^{2/3}b^2$ **48.** $y^2/(x^{1/6}z^{5/4})$ **49.** $h^{1/3}t^{1/5}/k^{2/5}$ **50.** m^3p/n **51.** $3x(x^2 + 3x)^2(x^2 - 5)$ **52.** $6x(x^3 + 7)(-2x^3 - 5x + 7)$
53. $5x(x^2 - 1)^{-1/2}(x^2 + 1)$ **54.** $3(6x + 2)^{-1/2}(27x + 5)$ **55.** $(2x + 5)(x^2 - 4)^{-1/2}(4x^2 + 5x - 8)$
56. $(4x^2 + 1)(2x - 1)^{-1/2}(36x^2 - 16x + 1)$

Exercises R.7 (page R-30)

For exercises . . .	1–22	23–26	27–40	41–44
Refer to example . . .	1,2	3	4	5

1. 5 **2.** 6 **3.** -5 **4.** $5\sqrt{2}$ **5.** $20\sqrt{5}$ **6.** $4y^2\sqrt{2y}$ **7.** 9 **8.** 8
9. $7\sqrt{2}$ **10.** $9\sqrt{3}$ **11.** $9\sqrt{7}$ **12.** $-2\sqrt{7}$ **13.** $5\sqrt[3]{2}$ **14.** $3\sqrt[3]{5}$ **15.** $xyz^2\sqrt{2x}$ **16.** $4r^3s^4t^6\sqrt{10rs}$ **17.** $4xy^2z^3\sqrt[3]{2y^2}$
18. $x^2yz^2\sqrt[4]{y^3z^3}$ **19.** $ab\sqrt{ab}(b - 2a^2 + b^3)$ **20.** $p^2\sqrt{pq}(pq - q^4 + p^2)$ **21.** $\sqrt[6]{a^5}$ **22.** $b^2\sqrt[4]{b}$ **23.** $|4 - x|$
24. $|3y + 5|$ **25.** Cannot be simplified **26.** Cannot be simplified **27.** $5\sqrt{7}/7$ **28.** $\sqrt{10}/2$ **29.** $-\sqrt{3}/2$ **30.** $\sqrt{2}$
31. $-3(1 + \sqrt{2})$ **32.** $-5(2 + \sqrt{6})/2$ **33.** $3(2 - \sqrt{2})$ **34.** $(5 - \sqrt{10})/3$ **35.** $(\sqrt{r} + \sqrt{3})/(r - 3)$
36. $5(\sqrt{m} + \sqrt{5})/(m - 5)$ **37.** $\sqrt{y} + \sqrt{5}$ **38.** $(z + \sqrt{5z} - \sqrt{z} - \sqrt{5})/(z - 5)$ **39.** $-2x - 2\sqrt{x(x + 1)} - 1$
40. $[p^2 + p + 2\sqrt{p(p^2 - 1)} - 1]/(-p^2 + p + 1)$ **41.** $-1/[2(1 - \sqrt{2})]$ **42.** $1/(3 + \sqrt{3})$
43. $-1/[2x - 2\sqrt{x(x + 1)} + 1]$ **44.** $2/[p + \sqrt{p(p - 2)}]$

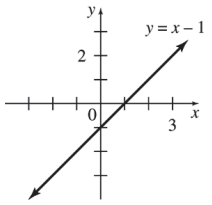
Chapter 1 Linear Functions

Exercises 1.1 (page 13–17)

For exercises . . .	5–8	9–12	17,33,34	18,35–38	19–21	22,31	23–28	29,30	32	49–64	65–79
Refer to example . . .	1	3	8	9	4	7	5	2	6	11,12	10,13

W1. -3 **W2.** $y = -2x - 13$
W3. $y = (2/5)x + 19/30$
W4. $y = (2/3)x - 7/3$
1. False **2.** True **3.** False **4.** False **5.** $3/5$ **6.** $-7/4$ **7.** Not defined **8.** 0 **9.** 1 **10.** 3 **11.** $5/9$ **12.** $-4/7$
13. Not defined **14.** 0 **15.** 0 **16.** 0 **17.** 2 **18.** $-1/4$ **19.** $y = -2x + 5$ **20.** $y = -x + 6$ **21.** $y = -7$ **22.** $x = -8$
23. $y = -(1/3)x + 10/3$ **24.** $y = -x + 7$ **25.** $y = 6x - 7/2$ **26.** $y = (21/32)x + 33/16$ **27.** $x = -8$ **28.** $y = 3$
29. $x + 2y = -6$ **30.** $2x - y = -4$ **31.** $x = -6$ **32.** $y = 7$ **33.** $3x + 2y = 0$ **34.** $2x - y = 9$ **35.** $x - y = 7$
36. $3x + 2y = 6$ **37.** $5x - y = -4$ **38.** $3x + 6y = -2$ **39.** No **40.** **(a)** $k = -1/2$ **(b)** $k = -7/2$ **43.** (a) **44.** (f)
45. -4 **46.** $1/2$ **48.** **(a)** $y = -(b/a)x + b$ **(b)** a and b

49.



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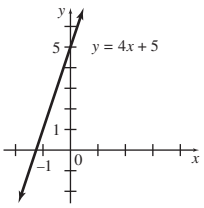

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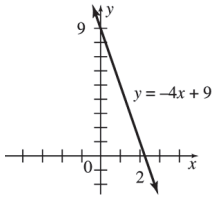

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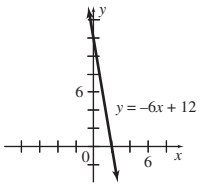

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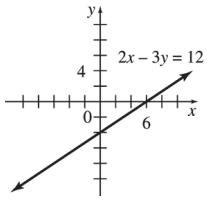

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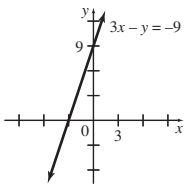

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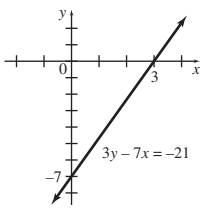
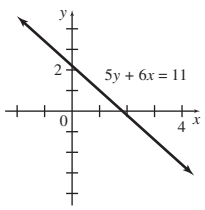
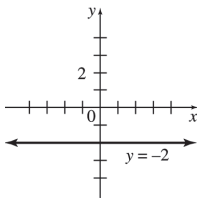


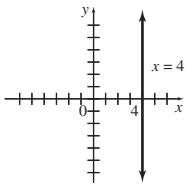
56.



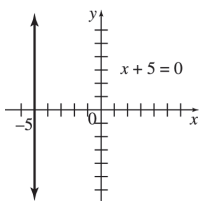
57.



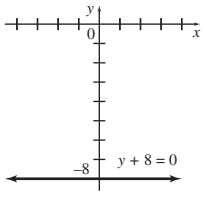
58.



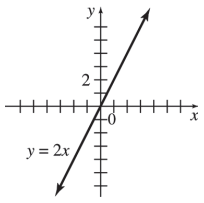
59.



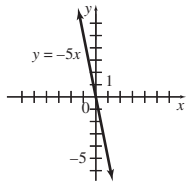
60.



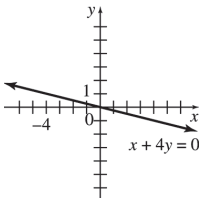
61.



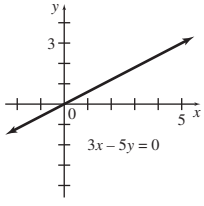
62.



63.

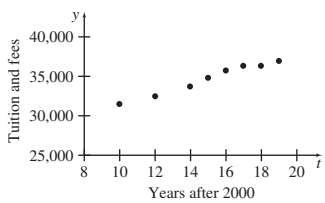


64.



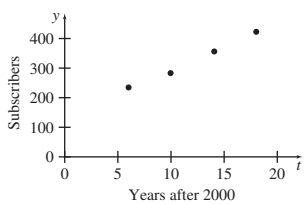
65. **(a)** 12,000; $y = 12{,}000x + 3000$ **(b)** 8 years 1 month **66.** **(a)** 0.9; each additional cupcake costs \$0.90
(b) $y = 0.9x + 36$ **(c)** \$198

67. **(a)**



Yes **(b)** $y = 598t + 25{,}522$; the slope indicates that the annual cost of tuition and fees at private four-year colleges is increasing by about \$598 per year. **(c)** The year 2035 is too far in the future to rely on this equation to predict costs; too many other factors may influence these costs by then.

68. **(a)**



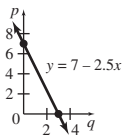
The number of subscribers appears to be increasing at a nearly linear rate.
(b) $y = 15.729t + 138.67$ **(c)** $y = 15.688t + 139.42$
(e) 390.33 million; 390.43 million

69. (a) $y = 4.317t + 87.049$ **(b)** 173.4, which is slightly more than the actual CPI **(c)** It is increasing at a rate of approximately 4.3 per year. **70. (a)** $y = 0.53t - 0.043$ **(b)** About 10.2 yr **71. (a)** $u = 0.85(220 - x) = 187 - 0.85x$, $l = 0.7(220 - x) = 154 - 0.7x$ **(b)** 140 to 170 beats per minute **(c)** 126 to 153 beats per minute **(d)** The women are 16 and 52. Their pulse is 143 beats per minute. **72.** Approximately 4.3 m/sec **73.** About 86 yr **74. (a)** $y = -1.93t + 267$ **(b)** 2026 **75. (a)** $y = 13{,}104.18t - 406{,}022$ **(b)** About 1,166,480 **76. (a)** $y = 0.12t + 25.12$ **(b)** $y = 0.14t + 22.54$ **(c)** Women **(d)** 2038 **(e)** 30.6 **77. (a)** There appears to be a linear relationship. **(b)** $y = 76.9x$ **(c)** About 780 megaparsecs (about 1.5×10^{22} mi) **(d)** About 12.4 billion yr **78. (a)** $T = 0.03t + 15$ **(b)** About 2103 **(c)** $T = 0.02t + 15$; about 2170 **79. (a)** $y_o = 4.625t - 19.25$ **(b)** $y = 4.75t - 41.5$ **(c)** The percent of Americans who had listened to online radio in the previous month increased by 4.625% per year, while the percent of U.S. cellphone users who had ever listened to online radio in a car using a phone increased by 4.75% per year.

Exercises 1.2 (page 24–27)

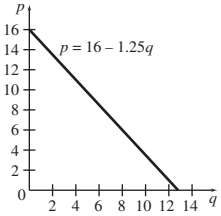
For exercises . . .	9–18	23–26	27–30,41,42,49,50	31–36	37–40,43–48	51–53
Refer to example . . .	1	4	5,6	2,3	7	8

W1. 60 **W2.**

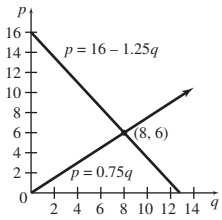


1. True **2.** False **3.** True **4.** True **5.** False **6.** True **7.** True **8.** True **9.** -3 **10.** -13 **11.** 22 **12.** 12 **13.** 0 **14.** 2 **15.** -4 **16.** $-9/2$ **17.** $7 - 5t$ **18.** $2k^2 - 3$ **23.** If $R(x)$ is the cost of renting a snowboard for x hours, then $R(x) = 2.25x + 10$. **24.** If $C(x)$ is the cost of downloading x songs, then $C(x) = 0.99x + 10$. **25.** If $C(x)$ is the cost of parking a car for x hours, then $C(x) = 0.75x + 2$. **26.** If $R(x)$ is the cost of renting a car for x miles, then $R(x) = 44 + 0.28x$. **27.** $C(x) = 30x + 100$ **28.** $C(x) = 45x + 35$ **29.** $C(x) = 75x + 550$ **30.** $C(x) = 120x + 12{,}500$ **31. (a)** \$16 **(b)** \$11 **(c)** \$6 **(d)** 640 watches **(e)** 480 watches **(f)** 320 watches

(g)



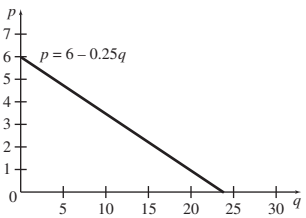
(h) 0 watches **(i)** About 1333 watches **(j)** About 2667 watches **(k)**



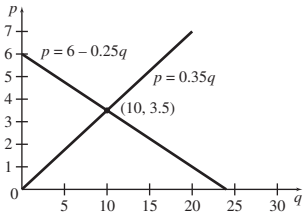
(l) 800 watches, \$6

32. (a) \$6 **(b)** \$5 **(c)** \$3.90 **(d)** 600 quarts **(e)** 1100 quarts **(f)** 1440 quarts

(g)

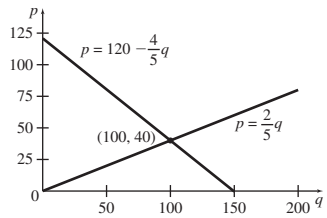


(h) 0 quarts **(i)** 800 quarts **(j)** 1800 quarts **(k)**

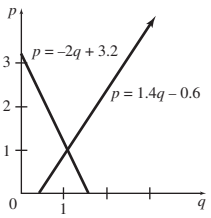


(l) 1000 quarts; \$3.50

33. (a)



(b) 100 tubs, \$40 **34. (a)**



(b) About 1120 lb; about \$0.96

35. $D(q) = 6.9 - 0.4q$ **36.** $D(q) = 9 - 0.35q$ **37. (a)** 2 units **(b)** \$980 **(c)** 52 units **38. (a)** 3 units **(b)** \$3211 **(c)** 13 units **39. (a)** $C(x) = 3.50x + 90$ **(b)** 17 shirts **(c)** 108 shirts **40. (a)** $C(x) = 2.15x + 525$ **(b)** 188 **(c)** 545 books **41. (a)** $C(x) = 0.097x + 1.32$ **(b)** \$1.32 **(c)** \$98.32 **(d)** \$98.417 (or \$98.42) **(e)** 9.7¢ **(f)** 9.7¢, the cost of producing one additional cup of coffee would be 9.7¢. **42. (a)** $C(x) = 500{,}000 + 4.75x$ **(b)** \$500,000 **(c)** \$975,000 **(d)** \$4.75; each additional item costs \$4.75 to produce. **43.** Break-even quantity is 45 units; don't produce; $P(x) = 20x - 900$ **44.** Break-even quantity is about 41 units; produce; $P(x) = 145x - 6000$ **45.** Break-even quantity is -50 units; impossible to make a profit when $C(x) > R(x)$ for all positive x; $P(x) = -10x - 500$ (always a loss) **46.** Break-even quantity is -50 units; impossible to make a profit when $C(x) > R(x)$ for all positive x; $P(x) = -100x - 5000$ (always a loss). **47.** 5 **48.** 26

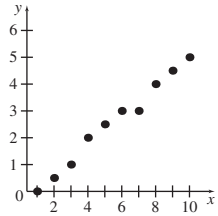
49. **(a)** About 23 acorns per square meter **(b)** 34; the number of deer tick larvae per 400 squares meters in the spring will increase by 34 for each additional acorn per square meter in the preceding fall. **50.** **(a)** $f_t(t) = 2.8t + 35$ **(b)** $f_d(t) = -2.2t + 100$ **(c)** 2003 **51.** **(a)** 14.4°C **(b)** −28.9°C **(c)** 122°F **52.** **(a)** 98.6°F **(b)** 97.7°F to 99.5°F **53.** −40° **54.** **(a)** $C(x) = 3.308 \times 10^9 + 7.17x$ **(b)** \$4.168 billion **(c)** 166 million MWh

Exercises 1.3 (page 33–40)

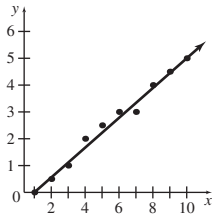
For exercises . . .	7(b),8,11(a), 14(d),15(d), 16(e),17(e),18(e), 20(b),21(b),22(b), 23(d), 24(b),25(d), 26(c),27(b),29(d), 30(c),32(a),33(d), 34(d),35(d),36	7(c),14(a),15(a), 16(a),17(a),18(a), 20(c),21(a)(c), 22(a)(c), 23(b),24(c), 25(a),26(a),27(c), 29(a),30(b),31(a), 32(b),33(a)(b), 34(a)(b),35(c)	7(d),14(b), 15(b),16(c), 17(c),18(c), 25(b),26(b), 27(d), 29(b)(c), 31(b)(c), 32(c)	9(a)(b), 10(a)(b), 12(a), 19(b)(d), 28(a)(b)	9(c),10(c), 20(d)	14(c),15(c), 16(d),17(d), 18(d),19(f), 25(c),33(c), 34(c)
Refer to example . . .	4	1	2	1,4	5	3

1. True **2.** False **3.** False **4.** True

7. **(a)**

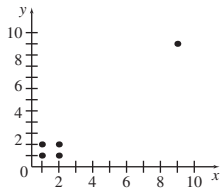


(b) 0.993 **(c)** $Y = 0.555x - 0.5$

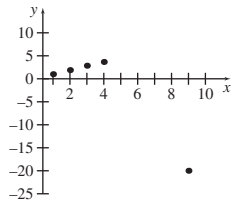


(d) 5.6

8. (c) **9.** **(a)** $Y = 0.9783x + 0.0652$; 0.9783 **(b)** $Y = 1.5$; 0 **(c)** The point (9, 9) is an outlier that has a strong effect on the least squares line and the correlation coefficient.

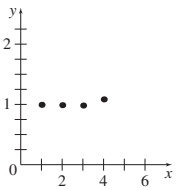


10. **(a)** $Y = -2.887x + 8.969$; −0.8880 **(b)** $Y = x$; 1 **(c)**

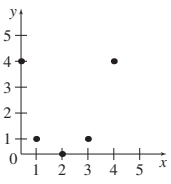


The point $(9, -20)$ is an outlier that has a strong effect on the least squares line and the correlation coefficient.

11. **(a)** 0.7746 **(b)**



12. **(a)** $Y = 2$; 0 **(b)**



14. **(a)** $Y = 0.06815x + 1.844$ **(b)** \$3.548 trillion **(c)** 2061 **(d)** 0.7907; fairly strong positive correlation

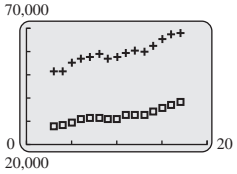
15. **(a)** $Y = -0.2333x + 8.872$ **(b)** About 2900 **(c)** 2030 **(d)** −0.9991; strong negative correlation

16. **(a)** $Y = 0.815x + 19.4$ **(b)** By about 0.815 per year **(c)** 40.6 **(d)** 2032 **(e)** 0.9953; strong positive correlation

17. **(a)** $Y = -3.21x + 98.7$ **(b)** By about 3.21 percent per year **(c)** 21.7% **(d)** 2025 **(e)** −0.9896; strong negative correlation

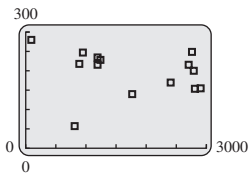
18. **(a)** $Y = 176.84x + 812.28$ **(b)** By about \$176.84 billion per year **(c)** About \$6117 billion **(d)** 2035 **(e)** 0.9952; strong positive correlation.

19. **(a)**



Yes **(b)** $Y = 615.16x + 26{,}104$; 0.9516; strong positive correlation **(c)** By about \$615 per year **(d)** $Y = 1071.91x + 48{,}383$; 0.9568; strong positive correlation **(e)** By about \$1072 per year **(f)** 2088; 2030

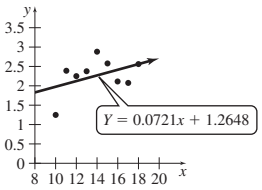
20. **(a)**



No **(b)** −0.2050; there is a negative correlation between the price and the distance. **(c)** Philadelphia; 0.0006244 **(d)** $Y = 3.964 \times 10^{-5}x + 191.16$; 3.964×10^{-5} dollars (much less than a penny)

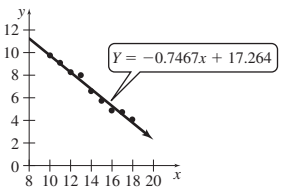
21. **(a)** $Y = 0.0721x + 1.2648$ **(b)** 0.4298

(c)

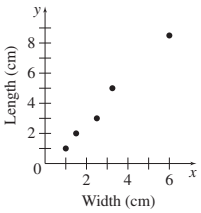


22. **(a)** $Y = -0.7467x + 17.264$ **(b)** -0.9900

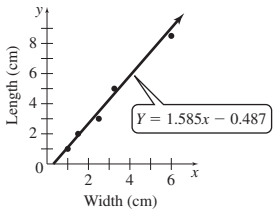
(c)



23. **(a)**

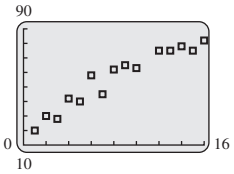


Yes **(b)** $Y = 1.585x - 0.487$

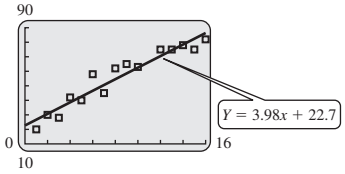


(c) No; it gives negative values for small widths. **(d)** 0.999

24. **(a)**



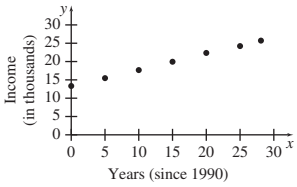
(b) 0.959, yes **(c)**



25. **(a)** $Y = 0.212x - 0.309$
(b) 15.2 chirps per second
(c) 86.4°F **(d)** 0.835

26. **(a)** $Y = -0.06857x + 17.53$ **(b)** 15.1 **(c)** -0.7286; fairly strong negative correlation

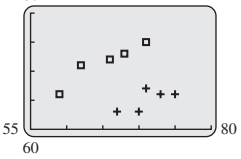
27. **(a)**



Yes **(b)** 0.9998; yes **(c)** $Y = 0.4411x + 13.335$ **(d)** About $30,979

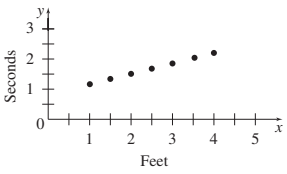
28. **(a)** $Y = -0.08915x + 74.28$; $r = -0.1035$. The taller the student, the shorter is the ideal partner's height.
(b) Females: $Y = 0.6674x + 27.89$; $r = 0.9459$; males: $Y = 0.4348x + 34.04$; $r = 0.7049$

(c)

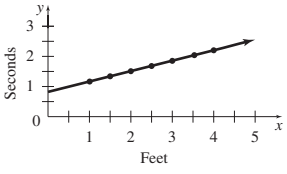


29. **(a)** $Y = -0.0067x + 14.75$ **(b)** 12 **(c)** 11 **(d)** -0.13 **(e)** There is no linear relationship.

30. **(a)**



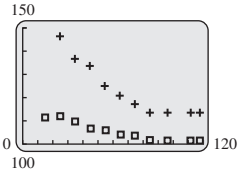
(b)



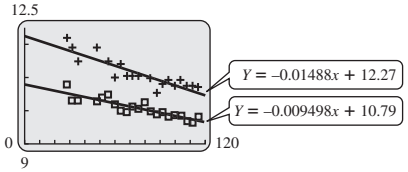
$Y = 0.366x + 0.803$; the line seems to fit the data.
(c) $r = 0.995$ indicates a good fit, which confirms the conclusion in part (b).

31. **(a)** $Y = 14.9x + 2820$ **(b)** 5060, compared to actual 5000; 6990, compared to actual 7000; 9080, compared to actual 9000
(c) 6250 BTUs; 6500 BTU air conditioner **32.** **(a)** -0.995; yes **(b)** $Y = -0.0769x + 5.91$ **(c)** 2.07 points
33. **(a)** $Y = -0.1178x + 113.10$ **(b)** $Y = -0.3441x + 147.89$ **(c)** $x \approx 154$; the women will catch up to the men in the year 2054. **(d)** $r_{men} = -0.9608$; $r_{women} = -0.9208$; both sets of data points closely fit a line with negative slope.

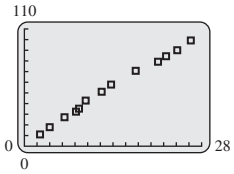
(e)



34. **(a)** $Y = -0.009498x + 10.79$ **(b)** $Y = -0.01488x + 12.27$ **(c)** $x \approx 275$; the women will catch up to the men in the year 2175. **(d)** $r_{men} = -0.8834$; $r_{women} = -0.8915$; both sets of data points closely fit a line with negative slope. **(e)**



35. **(a)** 3.816 miles per hour **(b)**



Yes **(c)** $Y = 3.714x + 3.809$ **(d)** 0.9969; yes **(e)** 3.714 miles per hour

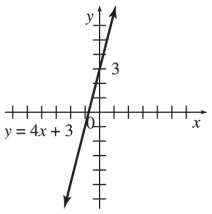
36. **(a)** 0.5259 **(b)** 0.2926 **(c)** −0.0956

Chapter 1 Review Exercises (page 42–46)

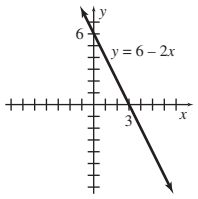
For exercises . . .	1–6,15–47,57(a)(b), 63(a)(b)	7–10,13, 48–56,59,62	11,12,14,57(c)(f),58, 60,61,63(c)(e),64,65
Refer to section . . .	1	2	3

1. False **2.** False **3.** True **4.** False **5.** True **6.** False **7.** True **8.** False **9.** False **10.** False **11.** False
12. True **14.** Σx, Σy, Σxy, Σx^2, Σy^2, and n. **15.** 1 **16.** 2 **17.** $-2/11$ **18.** Undefined **19.** $-4/3$ **20.** 4
21. 0 **22.** 0 **23.** 5 **24.** 1/5 **25.** $y = (2/3)x - 13/3$ **26.** $y = -(1/4)x + 2$ **27.** $y = -x - 3$ **28.** $y = -(7/5)x - 1/5$
29. $y = -10$ **30.** $y = 5$ **31.** $2x - 7 = 10$ **32.** $5x - 8y = -40$ **33.** $x = -1$ **34.** $x = 7$ **35.** $y = -5$ **36.** $x = -3$

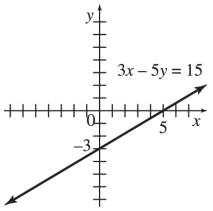
37.



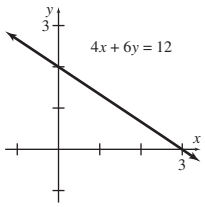
38.



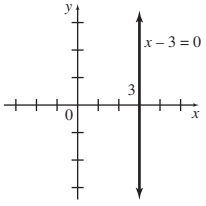
39.



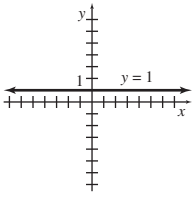
40.



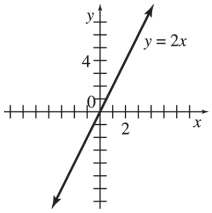
41.



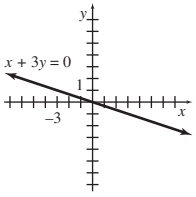
42.



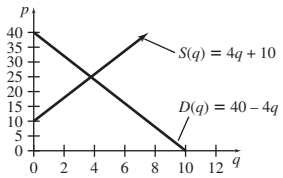
43.



44.

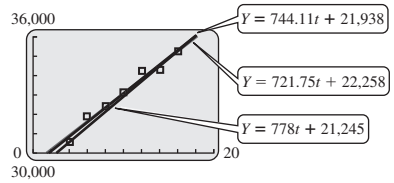


45. **(a)** $y = 24.4t + 100$ **(b)** Imports from China are increasing by about $24.4 billion per year. **(c)** $588 billion **(d)** 2027
46. **(a)** $y = 5.78t + 16$ **(b)** Exports to China are increasing by about $5.78 billion per year. **(c)** $132 billion **(d)** 2041
47. **(a)** $y = 1187t - 76{,}887$ **(b)** The median income for all U.S. households is increasing by about $1187 per year. **(c)** $71,488
(d) 2033 **48.** **(a)** 2.5 lb; 5 lb **(b)** 3.5 lb; 4 lb **(c)** 5.5 lb; 2 lb **(d)**



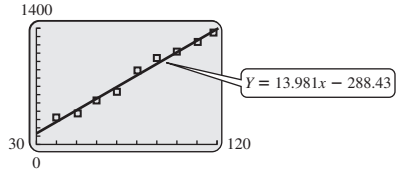
(e) $25 per pound **(f)** 3.75 lb

49. **(a)** $p = S(q) = 0.5q + 10$ **(b)** $p = D(q) = -0.5q + 72.50$ **(c)** $41.25, 62.5 dietary supplement pills
50. $C(x) = 30x + 60$ **51.** $C(x) = 180x + 2000$ **52.** $C(x) = 30x + 85$ **53.** $C(x) = 46x + 120$ **54.** **(a)** 5 cartons
(b) $2000 **55.** **(a)** 40 pounds **(b)** $280 **56.** **(a)** $E(x) = 352 + 42x$ (where x is in thousands) **(b)** $R(x) = 130x$ (where x is in thousands) **(c)** More than 4000 chips **57.** **(a)** $y = 778t + 21{,}245$ **(b)** $y = 721.75t + 22{,}258$ **(c)** $y = 744.11t + 21{,}938$
(d)

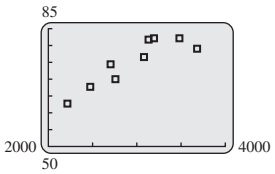


(f) 0.9888

58. **(a)** $Y = 13.981x - 288.43$ **(b)** $1459.20
(c)



Yes **(d)** 0.9928; strong positive correlation
59. **(a)** $b(t) = -0.725t + 64.5$; $p(t) = -0.075t + 47.8$; $c(t) = 0.556t + 54.2$ **(b)** Beef is decreasing by about 0.725 lb/year; pork is decreasing by about 0.075 lb/yr; chicken is increasing by about 0.556 lb/yr **(c)** 2009 **(d)** Beef: 50.0 lb; pork: 46.3 lb; chicken: 65.3 lb

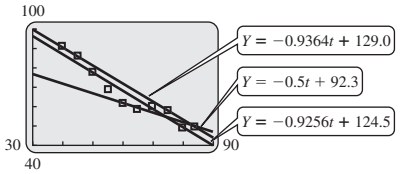
60. **(a)** 0.8988; yes **(b)** 

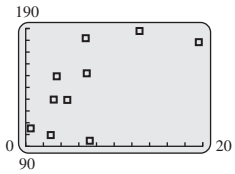
Yes **(c)** $Y = 0.01315t + 35.92$ **(d)** 81.87

61. **(a)** $Y = 0.9724x + 31.43$ **(b)** About 216 **(c)** 0.93

62. **(a)** $m(t) = 0.2t + 29.6$ **(b)** The percent of never-married males is increasing by about 0.2 percent per year. **(c)** $f(t) = 0.24t + 22.8$ **(d)** The percent of never-married females is increasing by about 0.24 percent per year. **(e)** Males: 35.6%; females: 30.0%

63. **(a)** $y = -0.9364t + 129.0$ **(b)** $y = -0.5t + 92.3$ **(c)** $Y = -0.9256t + 124.5$



(e) −0.9614 **64.** **(a)** 0.6683; yes, but the fit is not very good. **(b)** 

(c) $Y = 4.159t + 112.78$ **(d)** $4159 **65.** **(a)** 0.4529 **(b)** 0.3955 **(c)** −0.4768

Extended Application: Predicting Life Expectancy (page 46)

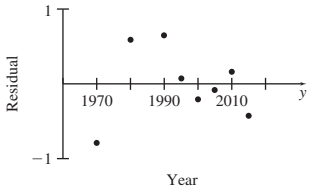
1. $Y = 0.134t - 188.63$

2. 66.09 years

3. The poor prediction isn't surprising, since we were extrapolating far beyond the range of the original data.

5.

x	y	Predicted value	Residual
1970	74.7	75.48	−0.78
1980	77.4	76.82	0.58
1990	78.8	78.16	0.64
1995	78.9	78.83	0.07
2000	79.3	79.50	−0.20
2005	80.1	80.17	−0.07
2010	81.0	80.84	0.16
2015	81.1	81.51	−0.41



6. You'll get 0 slope and 0 intercept, because you've already subtracted out the linear component of the data.

7. A cubic would fit the data: $Y = 0.0001052x^3 - 0.6303x^2 + 12.5936x - 838{,}720.8$.

Chapter 2 Systems of Linear Equations and Matrices

Exercises 2.1 (page 56–58)

For exercises . . .	5–16,21–24	17,18	19,20,29–36	39–42,48–53	43,44	45–47
Refer to example . . .	1	2	3	4(a)	4(b)	5

1. False **2.** False **3.** True **4.** False **5.** $(3, 2)$

6. $(2, 1)$ **7.** $(1, 3)$ **8.** $(3, -2)$ **9.** $(-2, 0)$ **10.** $(-1, 1)$ **11.** $(0, 2)$ **12.** $(-1, 1)$ **13.** $(3, -2)$ **14.** $(2, 3)$

15. $(2, -2)$ **16.** $(-6, -4)$ **17.** No solution **18.** No solution **19.** $((2y - 4)/3, y)$ **20.** $((-5y - 2)/3, y)$ **21.** $(4, 1)$

22. $(5, 10)$ **23.** $(7, -2)$ **24.** $(-3, 4)$ **25.** No **26.** An infinite set of ordered pairs **29.** $(8z - 4, 3 - 5z, z)$

30. $((-2z - 7)/5, (11z + 21)/5, z)$ **31.** $(3 - z, 4 - z, z)$ **32.** $((-4z + 28)/5, (z - 7)/5, z)$ **33.** 4 **34.** 5 **35.** 3

36. 6 **39.** $27 **40.** 11 new releases and 22 older songs **41.** 400 main floor, 200 balcony **42.** 260 pants and 270 shirts

43. Not possible; inconsistent system **44.** Not possible; inconsistent system **45.** **(a)** 15 **(b)** No fives, 44 tens, and 26 twenties **(c)** 28 fives, 2 tens, and 40 twenties **46.** 12 EZ models, 16 compact models, and 0 commercial models; 10 EZ models, 8 compact models, and 3 commercial models; or 8 EZ models, 0 compact models, and 6 commercial models. **47.** Either 10 buffets, 5 chairs, and no tables, or 11 buffets, 1 chair, and 1 table **48.** **(a)** About 51.8 weeks; about $959,091 **49.** **(a)** March 23, March 19 **(b)** 1991

50. **(a)** 0.056057, 1.06657 **(b)** 228 ft **51.** 36 field goals, 28 foul shots **52.** Flight time is 7 hr and the difference in time zones is 6 hr.

53. **(a)** One possible system is $\begin{cases} x + y = 3 \\ 3x + 2y = 8 \end{cases}$ with solution $(2, 1)$. Substituting $x = 2$ and $y = 1$, the numbers on the card are 3, 8, 8, and 9. To make 24, combine the number as $(9 - 8) \cdot 3 \cdot 8 = 24$.

Exercises 2.2 (page 70–75)

For exercises . . .	5–12,15–24,29,30,33, 34,38,40–42,45,46	25,26,31,36	27,28,32,35, 37,39,43,44	48–77
Refer to example . . .	1,2	3	4,5	6

W1. $(24 + 3z, 10 - 2z, z)$; 6
W2. $(25 - 2z, -14 + 3z, z)$; 8

1. True **2.** False **3.** False **4.** True **5.** $\left[\begin{array}{cc|c} 3 & 1 & 6 \\ 2 & 5 & 15 \end{array}\right]$ **6.** $\left[\begin{array}{cc|c} 4 & -2 & 8 \\ 0 & -7 & -12 \end{array}\right]$ **7.** $\left[\begin{array}{ccc|c} 2 & 1 & 1 & 3 \\ 3 & -4 & 2 & -7 \\ 1 & 1 & 1 & 2 \end{array}\right]$

8. $\left[\begin{array}{ccc|c} 2 & -5 & 3 & 4 \\ -4 & 2 & -7 & -5 \\ 3 & -1 & 0 & 8 \end{array}\right]$ **9.** $x = 2, y = 3$ **10.** $x = 5, y = -3$ **11.** $x = 4, y = -5, z = 1$ **12.** $x = 4, y = 2, z = 3$

13. Row operations **15.** $\left[\begin{array}{ccc|c} 3 & 7 & 4 & 10 \\ 0 & 1 & -5 & -8 \\ 0 & 4 & 5 & 11 \end{array}\right]$ **16.** $\left[\begin{array}{ccc|c} 3 & 2 & 6 & 18 \\ 2 & -2 & 5 & 7 \\ 0 & -2 & 9 & 42 \end{array}\right]$ **17.** $\left[\begin{array}{ccc|c} 1 & 0 & 0 & -3 \\ 0 & 3 & 2 & 5 \\ 0 & 5 & 3 & 7 \end{array}\right]$ **18.** $\left[\begin{array}{ccc|c} -3 & 0 & 0 & -48 \\ 0 & 6 & 5 & 30 \\ 0 & 0 & 12 & 15 \end{array}\right]$

19. $\left[\begin{array}{ccc|c} 1 & 0 & 0 & 6 \\ 0 & 5 & 0 & 9 \\ 0 & 0 & 4 & 8 \end{array}\right]$ **20.** $\left[\begin{array}{ccc|c} 1 & 0 & 0 & 30 \\ 0 & 1 & 0 & 17 \\ 0 & 0 & 1 & 27 \end{array}\right]$ **21.** $(2, 3)$ **22.** $(-3, 4)$ **23.** $(1, 6)$ **24.** $(11/8, 5/4)$ **25.** No solution

26. No solution **27.** $((3y + 1)/6, y)$ **28.** $(y + 1, y)$ **29.** $(4, 1, 0)$ **30.** $(-1, 2, -2)$ **31.** No solution
32. $(z - 3, -z + 9, z)$ **33.** $(-1, 23, 16)$ **34.** $(-8, 3, 0)$ **35.** $((-9z + 5)/23, (10z - 3)/23, z)$ **36.** No solution
37. $((-2z + 62)/35, (3z + 5)/7, z)$ **38.** $(-2, -3, 4)$ **39.** $((9 - 3y - z)/2, y, z)$ **40.** $(-3, -2, 5)$
41. $(0, 2, -2, 1)$; the answers are given in the order x, y, z, w. **42.** $(0, 2, -2, 1)$ **43.** $(-w - 3, -4w - 19, -3w - 2, w)$
44. $(1.5 + 0.5z + 2w, -5 + z + 3w, z, w)$ **45.** $(28.9436, 36.6326, 9.6390, 37.1036)$ **46.** $(11.844, -1.153, 0.609, 14.004)$
47. row 1: 3/8, 1/6, 11/24; row 2: 5/12, 1/3, 1/4; row 3: 5/24, 1/2, 7/24 **48.** Hire the Garcia firm for 20 hr and the Wong firm for 15 hr **49.** \$2000 in U.S. Savings bonds, \$4000 in mutual funds, \$4000 in money market **50.** 10 inkjet printers, 12 LCD monitors, and 24 memory chips **51.** 2000 chairs, 1600 cabinets, and 2500 buffets **52.** 120 vans, 60 small trucks, and 20 large trucks
53. (a) \$12,000 at 8%, \$7000 at 9%, and \$6000 at 10% **(b)** The amount borrowed at 10% must be less than or equal to \$9500. If $z = \$5000$, they borrowed \$11,000 at 8% and \$9000 at 9%. **(c)** No solution **(d)** The total annual interest would be \$2220, not \$2190, as specified as one of the conditions. **54. (a)** 10 deluxe, 4 super-deluxe, 15 ultra **(b)** None **(c)** 5
55. (a) 5 trucks, 2 vans, and 3 SUVs **(b)** Use 2 trucks, 6 vans, and 1 SUV, or use 5 trucks, 2 vans, and 3 SUVs.
56. 11 two-person, 9 four-person, and 8 six-person **57.** The first supplier should send 40 units to Roseville and 35 units to Akron. The second supplier should send 0 units to Roseville and 40 units to Akron. **58.** Send 12 cars from I to A, 8 cars from II to A, 16 cars from I to B, and no cars from II to B. **59.** 18,000 packages of Italian style, 15,000 packages of French style, 54,000 packages of Oriental style, and 22,000 packages of Combo style **60.** 12,500 packages of Triple Berry, 11,400 packages of Summer Blend, 15,200 packages of Berry Banana, and 12,100 packages of Strawberry Banana Chunk **61. (a)** 400 / 9 g of group A, 400 / 3 g of group B, and 2000 / 9 g of group C. **(b)** For any nonnegative number z of grams of group C, there should be z grams less than 800 / 3 g of group A and 400 / 3 g of group B. **(c)** No **62.** Four possibilities: no cases of A and D, 12 cases of B, 8 cases of C; or 1 case of A, 8 cases of B, 9 cases of C, 1 case of D; or 2 cases of A, 4 cases of B, 10 cases of C, 2 cases of D; or 3 cases of A, no cases of B, 11 cases of C, 3 cases of D **63.** About 243 fish of species A, 40 fish of species B, and 101 fish of species C.
64. 2340 of the first species, 10,128 of the second species, and 224 of the third species (all are rounded) **65.** **(a)** No **(b)** Yes; 150 acres for honeydews, 50 acres for onions, and 20 acres for lettuce **66. (a)** $a = 0.11, b = -1.91, c = 193.7$ **(b)** 189.8 **(c)** $a = -0.007867, b = 0.228, c = -2.303, d = 193.7$ **67. (b)** 7,206,360 white cows, 4,893,246 black cows, 3,515,820 spotted cows, and 5,439,213 brown cows **68. (a)** $x_2 + x_3 = 700, x_3 + x_4 = 600$
(b) $(1000 - x_4, 100 + x_4, 600 - x_4, x_4)$ **(c)** $0 \le x_4 \le 600$ **(d)** $400 \le x_1 \le 1000; 100 \le x_2 \le 700; 0 \le x_3 \le 600$
69. (a) $r = 175{,}000, b = 375{,}000$ **70.** 18 foul shots, 21 field goals, 7 three pointers **71.** 225 singles, 24 doubles, 5 triples, and 8 home runs **72. (a)** $y = -0.032x^2 + 0.852x + 0.632$ **(b)** $y = -0.032x^2 + 0.852x + 0.632$ **73. (a)** 24 balls, 57 dolls, and 19 cars **(b)** None **(c)** 48 **(d)** 5 balls, 95 dolls, and 0 cars **(e)** 52 balls, 1 doll, and 47 cars **74.** 8.15 calories, 4.23 calories, 3.15 calories **75. (a)** (1,1,1,1); the strategy required to turn all the lights out is to push every button one time. **(b)** (0,1,1,0); the strategy required to turn all the lights out is to push the button in the first row, second column, and push the button in the second row, first column. **76. (a)** $3x + 2y + z = 39; 2x + 3y + z = 34; x + 2y + 3z = 26$ **(b)** 9.25 dou for top grade, 4.25 dou for medium grade, and 2.75 dou for low grade **77. (a)** $5x + 4y + 3z + 2w = 1496; 4x + 2y + 6z + 3w = 1175;$ $3x + y + 7z + 5w = 958; 2x + 3y + 5z + w = 861$ **(b)** 177 coins for a sheep, 121 for a dog, 23 for a hen, and 29 for a rabbit

Exercises 2.3 (page 79–82)

For exercises . . .	3–5,8,17–22	6,7,9–14	15,16,23–34	41,43,44,46	42,47	45,50	48–51
Refer to example . . .	3	2	4,6	5,7	5	1	7

1. False **2.** True **3.** False **4.** False
5. True **6.** False **7.** True **8.** False **9.** 2×2; square **10.** 2×3 **11.** 3×4 **12.** 1×5; row **13.** 2×1; column
14. 1×1; square, row, column **15.** Undefined **16.** K is a 5×2 matrix and all entries of K must be 0.

17. $x = 4, y = -8, z = 1$ **18.** $y = 8$ **19.** $s = 10, t = 0, r = 7$ **20.** $m = 12, n = 2, r = 8$

21. $a = 20, b = 5, c = 0, d = 4, f = 1$ **22.** $a = 2, z = -3, m = 8, k = 5/3$ **23.** $\begin{bmatrix} 10 & 4 & -5 & -6 \\ 4 & 5 & 3 & 11 \end{bmatrix}$ **24.** $\begin{bmatrix} 3 & 8 \\ 10 & 2 \\ 2 & 16 \end{bmatrix}$

25. Not possible **26.** $\begin{bmatrix} 7 & 5 & -5 \\ -2 & 10 & 3 \end{bmatrix}$ **27.** $\begin{bmatrix} 1 & 5 & 6 & -9 \\ 5 & 7 & 2 & 1 \\ -7 & 2 & 2 & -7 \end{bmatrix}$ **28.** Not possible **29.** $\begin{bmatrix} 3 & 4 \\ 4 & 8 \end{bmatrix}$ **30.** $\begin{bmatrix} 4 & 3 \\ 1 & 6 \end{bmatrix}$

31. $\begin{bmatrix} 10 & -2 \\ 10 & 9 \end{bmatrix}$ **32.** $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ **33.** $\begin{bmatrix} -12x + 8y & -x + y \\ x & 8x - y \end{bmatrix}$ **34.** $\begin{bmatrix} -k - 14y \\ 4z - 8x \\ -2k - a \\ -8m + 4n \end{bmatrix}$ **35.** $\begin{bmatrix} -x & -y \\ -z & -w \end{bmatrix}$

40. All of these properties are valid for matrices that are not square, as long as all necessary sums and differences exist.

41. (a) $\begin{bmatrix} 15 & 15 \\ 36 & 25 \end{bmatrix}$ **(b)** $\begin{bmatrix} 32 & 27 \\ 60 & 43 \end{bmatrix}$ **(c)** $\begin{bmatrix} -2 & 3 \\ 12 & 7 \end{bmatrix}$ **42. (a)** $\begin{bmatrix} 88 & 105 & 60 \\ 48 & 72 & 40 \\ 16 & 21 & 0 \\ 112 & 147 & 50 \end{bmatrix}$ **(b)** $\begin{bmatrix} 110 & 140 & 66 \\ 60 & 96 & 44 \\ 20 & 28 & 0 \\ 140 & 196 & 55 \end{bmatrix}$

(c) $\begin{bmatrix} 198 & 245 & 126 \\ 108 & 168 & 84 \\ 36 & 49 & 0 \\ 252 & 343 & 105 \end{bmatrix}$ **43. (a)** $\begin{bmatrix} 21.7 & 23.0 \\ 7.3 & 13.8 \\ 26.9 & 89.4 \\ 32.8 & 27.3 \\ 34.9 & 42.6 \\ 134.4 & 91.1 \end{bmatrix}$ **(b)** $\begin{bmatrix} 15.2 & 22.7 \\ 7.5 & 2.1 \\ 34.5 & 15.8 \\ 30.1 & 7.4 \\ 33.8 & 22.8 \\ 116.0 & 223.4 \end{bmatrix}$ **(c)** $\begin{bmatrix} 36.9 & 45.7 \\ 14.8 & 15.9 \\ 61.4 & 105.2 \\ 62.9 & 34.7 \\ 68.7 & 65.4 \\ 250.4 & 314.5 \end{bmatrix}$ **(d)** $\begin{bmatrix} 6.5 & 0.3 \\ -0.2 & 11.7 \\ -7.6 & 73.6 \\ 2.7 & 19.9 \\ 1.1 & 19.8 \\ 18.4 & -132.3 \end{bmatrix}$

44. (a) $\begin{bmatrix} 41.8 & 243.5 \\ 211.3 & 287.9 \\ 120.0 & 170.2 \\ 55.4 & 138.1 \\ 34.1 & 84.8 \end{bmatrix}$ **(b)** $\begin{bmatrix} 120.3 & 539.5 \\ 298.7 & 318.5 \\ 265.0 & 346.5 \\ 75.0 & 142.6 \\ 57.7 & 125.9 \end{bmatrix}$ **(c)** $\begin{bmatrix} 78.5 & 296.0 \\ 87.4 & 30.6 \\ 145.0 & 176.3 \\ 19.6 & 4.5 \\ 23.6 & 41.1 \end{bmatrix}$ **45. (a)** $\begin{bmatrix} 2 & 1 & 2 & 1 \\ 3 & 2 & 2 & 1 \\ 4 & 3 & 2 & 1 \end{bmatrix}$ **(b)** $\begin{bmatrix} 5 & 0 & 7 \\ 0 & 10 & 1 \\ 0 & 15 & 2 \\ 10 & 12 & 8 \end{bmatrix}$

(c) $\begin{bmatrix} 8 \\ 4 \\ 5 \end{bmatrix}$ **46. (a)** $\begin{bmatrix} 5.6 & 6.4 & 6.9 & 7.6 & 6.1 \\ 114 & 138 & 149 & 152 & 146 \end{bmatrix}$ **(b)** $\begin{bmatrix} 10.2 & 11.4 & 11.4 & 12.7 & 10.8 \\ 196 & 196 & 225 & 250 & 230 \end{bmatrix}$ **(c)** $\begin{bmatrix} 4.6 & 5.0 & 4.5 & 5.1 & 4.7 \\ 52 & 58 & 76 & 98 & 84 \end{bmatrix}$

(d) $\begin{bmatrix} 12.0 & 12.9 & 13.7 & 14.5 & 12.8 \\ 221 & 218 & 254 & 283 & 250 \end{bmatrix}$ **47. (a)** 8 **(b)** 3 **(c)** $\begin{bmatrix} 85 & 15 \\ 27 & 73 \end{bmatrix}$ **(d)** Yes **48. (a)** $\begin{bmatrix} 71 & 17 \\ 41 & 2 \\ 77 & 8 \\ 84 & 6 \end{bmatrix}, \begin{bmatrix} 71 & 11 \\ 58 & 8 \\ 75 & 8 \\ 84 & 11 \end{bmatrix}$

(b) $\begin{bmatrix} 0 & -6 \\ 17 & 6 \\ -2 & 0 \\ 0 & 5 \end{bmatrix}$ **49. (a)** $\begin{bmatrix} 62.4 & 71.3 \\ 65.0 & 73.4 \\ 65.2 & 73.9 \\ 69.5 & 76.2 \\ 72.2 & 78.5 \end{bmatrix}$ **(b)** $\begin{bmatrix} 69.5 & 77.3 \\ 71.8 & 78.7 \\ 73.4 & 79.6 \\ 75.5 & 80.5 \\ 76.6 & 81.3 \end{bmatrix}$ **(c)** $\begin{bmatrix} -7.1 & -6.0 \\ -6.8 & -5.3 \\ -8.2 & -5.7 \\ -6.0 & -4.3 \\ -4.4 & -2.8 \end{bmatrix}$ **50. (a)** $\begin{bmatrix} 66.8 & 19.7 \\ 76.4 & 24.0 \\ 82.8 & 26.5 \\ 85.9 & 30.1 \\ 89.4 & 34.6 \end{bmatrix}$

(b) $\begin{bmatrix} 65.2 & 12.2 \\ 76.0 & 17.0 \\ 82.9 & 22.4 \\ 87.2 & 28.8 \\ 90.2 & 35.3 \end{bmatrix}$ **(c)** $\begin{bmatrix} 1.6 & 7.5 \\ 0.4 & 7.0 \\ -0.1 & 4.1 \\ -1.3 & 1.3 \\ -0.8 & -0.7 \end{bmatrix}$ **51. (a)** $\begin{bmatrix} 47.6 & 7.2 \\ 63.5 & 11.2 \\ 76.0 & 14.7 \\ 83.0 & 19.6 \\ 87.9 & 25.2 \end{bmatrix}$ **(b)** $\begin{bmatrix} 40.8 & 7.0 \\ 51.0 & 10.1 \\ 55.5 & 11.0 \\ 62.3 & 13.2 \\ 71.6 & 18.3 \end{bmatrix}$ **(c)** $\begin{bmatrix} 6.8 & 0.2 \\ 12.5 & 1.1 \\ 20.5 & 3.7 \\ 20.7 & 6.4 \\ 16.3 & 6.9 \end{bmatrix}$

52. (a) $\begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 \\ 0 & 1 & 1 & 1 \end{bmatrix}$ **(b)** $\begin{bmatrix} 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix}$

Exercises 2.4 (page 89–93)

For exercises . . .	5–10,55,58,59	11–16	19–39,47,48,60,61	51–54,56,57
Refer to example . . .	1	4	2,3,5	6

1. True **2.** False **3.** False **4.** False **5.** $\begin{bmatrix} -4 & 8 \\ 0 & 6 \end{bmatrix}$

6. $\begin{bmatrix} 18 & -6 \\ -12 & 0 \end{bmatrix}$ **7.** $\begin{bmatrix} 12 & -24 \\ 0 & -18 \end{bmatrix}$ **8.** $\begin{bmatrix} -30 & 10 \\ 20 & 0 \end{bmatrix}$ **9.** $\begin{bmatrix} -22 & -6 \\ 20 & -12 \end{bmatrix}$ **10.** $\begin{bmatrix} -36 & 2 \\ 28 & -9 \end{bmatrix}$ **11.** 2×2; 2×2 **12.** 3×3; 3×3

13. 3×4; BA does not exist. **14.** 4×6; BA does not exist. **15.** AB does not exist; 3×2. **16.** AB does not exist; 1×2.

17. columns; rows **18.** rows; columns **19.** $\begin{bmatrix} 8 \\ -1 \end{bmatrix}$ **20.** $\begin{bmatrix} 4 \\ 42 \end{bmatrix}$ **21.** $\begin{bmatrix} 14 \\ -23 \end{bmatrix}$ **22.** $\begin{bmatrix} 9 & 18 & 4 \\ 19 & 22 & 12 \\ 1 & 4 & 0 \end{bmatrix}$ **23.** $\begin{bmatrix} -7 & 2 & 8 \\ 27 & -12 & 12 \end{bmatrix}$

24. $\begin{bmatrix} 6 \\ 5 \\ 8 \end{bmatrix}$ **25.** $\begin{bmatrix} -2 & 10 \\ 0 & 8 \end{bmatrix}$ **26.** $\begin{bmatrix} -10 \\ 2 \end{bmatrix}$ **27.** $\begin{bmatrix} 13 & 5 \\ 25 & 15 \end{bmatrix}$ **28.** $\begin{bmatrix} 2 & 8 \\ -7 & 5 \end{bmatrix}$ **29.** $\begin{bmatrix} 13 \\ 29 \end{bmatrix}$ **30.** $\begin{bmatrix} 2 & 0 & -2 \\ -9 & 0 & 9 \\ 12 & 0 & -12 \end{bmatrix}$ **31.** $\begin{bmatrix} 7 \\ -33 \\ 4 \end{bmatrix}$

32. $\begin{bmatrix} 7 \\ -33 \\ 4 \end{bmatrix}$ **33.** $\begin{bmatrix} 22 & -8 \\ 11 & -4 \end{bmatrix}$ **34.** $\begin{bmatrix} 22 & -8 \\ 11 & -4 \end{bmatrix}$ **35.** $\begin{bmatrix} 19 & -10 \\ -6 & 15 \end{bmatrix}$ **36.** $\begin{bmatrix} 0.39 & 0.08 \\ 0.28 & 0.15 \end{bmatrix}$ **37.** $\begin{bmatrix} 37 & -66 & 69 \\ -59 & 83 & -109 \\ 81 & -91 & 95 \end{bmatrix}$

38. $\begin{bmatrix} -8 & 3 & -9 \\ -3 & 4 & 3 \\ 10 & -4 & -5 \end{bmatrix}$ **39. (a)** $\begin{bmatrix} 16 & 22 \\ 7 & 19 \end{bmatrix}$ **(b)** $\begin{bmatrix} 5 & -5 \\ 0 & 30 \end{bmatrix}$ **(c)** No **(d)** No **44. (a)** $IP = P, PI = P, IX = X$ **(b)** T

(c) I maintains the identity of any 2×2 matrix under multiplication. **46.** $(-4, 0)$

47. (a) $\begin{bmatrix} 6 & 106 & 158 & 222 & 28 \\ 120 & 139 & 64 & 75 & 115 \\ -146 & -2 & 184 & 144 & -129 \\ 106 & 94 & 24 & 116 & 110 \end{bmatrix}$ **(b)** Does not exist **(c)** No **48. (a)** $\begin{bmatrix} 44 & 75 & -60 & -33 & 11 \\ 20 & 169 & -164 & 18 & 105 \\ 113 & -82 & 239 & 218 & -55 \\ 119 & 83 & 7 & 82 & 106 \\ 162 & 20 & 175 & 143 & 74 \end{bmatrix}$

(b) $\begin{bmatrix} 110 & 96 & 30 & 226 & 37 \\ -94 & 127 & 134 & -87 & -33 \\ -52 & 126 & 193 & 153 & 22 \\ 117 & 56 & -55 & 147 & 57 \\ 54 & 69 & 58 & 37 & 31 \end{bmatrix}$ **(c)** No **49. (a)** $\begin{bmatrix} -1 & 5 & 9 & 13 & -1 \\ 7 & 17 & 2 & -10 & 6 \\ 18 & 9 & -12 & 12 & 22 \\ 9 & 4 & 18 & 10 & -3 \\ 1 & 6 & 10 & 28 & 5 \end{bmatrix}$ **(b)** $\begin{bmatrix} -2 & -9 & 90 & 77 \\ -42 & -63 & 127 & 62 \\ 413 & 76 & 180 & -56 \\ -29 & -44 & 198 & 85 \\ 137 & 20 & 162 & 103 \end{bmatrix}$

(c) $\begin{bmatrix} -56 & -1 & 1 & 45 \\ -156 & -119 & 76 & 122 \\ 315 & 86 & 118 & -91 \\ -17 & -17 & 116 & 51 \\ 118 & 19 & 125 & 77 \end{bmatrix}$ **(d)** $\begin{bmatrix} 54 & -8 & 89 & 32 \\ 114 & 56 & 51 & -60 \\ 98 & -10 & 62 & 35 \\ -12 & -27 & 82 & 34 \\ 19 & 1 & 37 & 26 \end{bmatrix}$ **(e)** $\begin{bmatrix} -2 & -9 & 90 & 77 \\ -42 & -63 & 127 & 62 \\ 413 & 76 & 180 & -56 \\ -29 & -44 & 198 & 85 \\ 137 & 20 & 162 & 103 \end{bmatrix}$ **(f)** Yes

50. Distributive property **51. (a)** $\begin{array}{c} \\ \text{Dept. 1} \\ \text{Dept. 2} \\ \text{Dept. 3} \\ \text{Dept. 4} \end{array} \begin{array}{c} \begin{array}{cc} \text{A} & \text{B} \end{array} \\ \begin{bmatrix} 57 & 70 \\ 41 & 54 \\ 27 & 40 \\ 39 & 40 \end{bmatrix} \end{array}$ **(b)** Supplier A: \$164; Supplier B: \$204; Supplier A

52. (a) $\begin{array}{c} \\ \text{S} \\ \text{C} \end{array} \begin{array}{c} \begin{array}{ccc} \text{CC} & \text{MM} & \text{AD} \end{array} \\ \begin{bmatrix} 0.5 & 0.4 & 0.3 \\ 0.2 & 0.3 & 0.3 \end{bmatrix} \end{array}$ **(b)** $\begin{array}{c} \\ \text{SD} \\ \text{MC} \\ \text{M} \end{array} \begin{array}{c} \begin{array}{cc} \text{S} & \text{C} \end{array} \\ \begin{bmatrix} 4 & 3 \\ 2 & 5 \\ 1 & 7 \end{bmatrix} \end{array}$ **(c)** $CA = \begin{array}{c} \\ \text{SD} \\ \text{MC} \\ \text{M} \end{array} \begin{array}{c} \begin{array}{ccc} \text{CC} & \text{MM} & \text{AD} \end{array} \\ \begin{bmatrix} 2.6 & 2.5 & 2.1 \\ 2 & 2.3 & 2.1 \\ 1.9 & 2.5 & 2.4 \end{bmatrix} \end{array}$ **(d)** \$2.50 **(e)** Mexico City

53. (a) $\begin{bmatrix} 80 & 40 & 120 \\ 60 & 30 & 150 \end{bmatrix}$ **(b)** $\begin{bmatrix} 1/2 & 1/5 \\ 1/4 & 1/5 \\ 1/4 & 3/5 \end{bmatrix}$ **(c)** $PF = \begin{bmatrix} 80 & 96 \\ 75 & 108 \end{bmatrix}$; the rows give the average price per pair of footwear sold by each store, and the columns give the state. **(d)** \$108 **54. (a)** $\begin{bmatrix} 610 \\ 2430 \end{bmatrix}$; the rows represent the cost of materials for each type of house.

55. $\begin{bmatrix} 17 & 13 \\ 31 & 21 \end{bmatrix}$ **56. (a)** $\begin{bmatrix} 5/4 \\ 4/3 \\ 11/10 \end{bmatrix}$ **(b)** $\begin{bmatrix} 316 \\ 200 \\ 48 \\ 391 \end{bmatrix}$ **57. (a)** $\begin{bmatrix} 20 & 52 & 27 \\ 25 & 62 & 35 \\ 30 & 72 & 43 \end{bmatrix}$; the rows give the amounts of fat, carbohydrates, and protein, respectively, in each of the daily meals. **(b)** $\begin{bmatrix} 75 \\ 45 \\ 70 \\ 168 \end{bmatrix}$; the rows give the number of calories in one exchange of each of the food groups. **(c)** $\begin{bmatrix} 503 \\ 623 \\ 743 \end{bmatrix}$; the rows give the number of calories in each meal. **58.** $\begin{bmatrix} 71 & 14 \\ 49.5 & 5 \\ 76 & 8 \\ 84 & 8.5 \end{bmatrix}$ **59.** $\begin{bmatrix} 68.3 & 76.3 \\ 70.7 & 77.8 \\ 72.0 & 78.7 \\ 74.5 & 79.8 \\ 75.9 & 80.8 \end{bmatrix}$

60. (a) 3819; 3824; 3763; 3698; 3638 **(b)** Extinction **(c)** 4017; 4154; 4280; 4399; 4524; does not become extinct

61. (a) $\begin{bmatrix} 0.0346 & 0.0118 \\ 0.0174 & 0.0073 \\ 0.0189 & 0.0059 \\ 0.0135 & 0.0083 \\ 0.0099 & 0.0103 \end{bmatrix}$; $\begin{bmatrix} 361 & 2038 & 286 & 227 & 460 \\ 473 & 2494 & 362 & 252 & 484 \\ 627 & 2978 & 443 & 278 & 499 \\ 803 & 3435 & 524 & 314 & 511 \\ 1013 & 3824 & 591 & 344 & 522 \end{bmatrix}$ **(b)**

	Births	*Deaths*
1970	60.98	27.45
1980	74.80	33.00
1990	90.58	39.20
2000	106.75	45.51
2010	122.57	51.59

Exercises 2.5 (page 101–103)

For exercises . . .	5–12	15–30,55–59	31–46,60–62	63–67	68–71
Refer to example . . .	1	2,3	4,6	5	7

W1. $(2, -1)$ **W2.** $(2, 1, -3)$ **W3.** $\begin{bmatrix} 3.8 \\ 5.0 \end{bmatrix}$ **W4.** $\begin{bmatrix} -3 \\ -9 \\ 16 \end{bmatrix}$

1. True **2.** True **3.** False **4.** False **5.** Yes **6.** Yes **7.** No **8.** No **9.** No **10.** No **11.** Yes **12.** Yes

13. No; the row of all zeros makes it impossible to get all the 1's in the diagonal of the identity matrix, no matter what matrix is used as an inverse. **14.** A **15.** $\begin{bmatrix} 0 & 1/2 \\ -1 & 1/2 \end{bmatrix}$ **16.** $\begin{bmatrix} 3 & -1 \\ -2 & 1 \end{bmatrix}$ **17.** $\begin{bmatrix} 2 & 1 \\ 5 & 3 \end{bmatrix}$ **18.** $\begin{bmatrix} -3 & -8 \\ 1 & 3 \end{bmatrix}$ **19.** No inverse **20.** No inverse

21. $\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ -1 & 0 & 1 \end{bmatrix}$ **22.** $\begin{bmatrix} 4 & -6 & -3 \\ -1 & 2 & 1 \\ -2 & 3 & 2 \end{bmatrix}$ **23.** $\begin{bmatrix} 15 & 4 & -5 \\ -12 & -3 & 4 \\ -4 & -1 & 1 \end{bmatrix}$ **24.** $\begin{bmatrix} 2/3 & -1/4 & -1/12 \\ -1/3 & 1/2 & 1/6 \\ 1 & -1/2 & -1/2 \end{bmatrix}$ **25.** No inverse

26. No inverse **27.** $\begin{bmatrix} -11/2 & -1/2 & 5/2 \\ 1/2 & 1/2 & -1/2 \\ -5/2 & 1/2 & 1/2 \end{bmatrix}$ **28.** $\begin{bmatrix} 1/20 & 11/20 & 3/20 \\ -2/5 & 3/5 & -1/5 \\ -3/10 & 7/10 & 1/10 \end{bmatrix}$ **29.** $\begin{bmatrix} 1/2 & 1/2 & -1/4 & 1/2 \\ -1 & 4 & -1/2 & -2 \\ -1/2 & 5/2 & -1/4 & -3/2 \\ 1/2 & -1/2 & 1/4 & 1/2 \end{bmatrix}$

30. $\begin{bmatrix} 1/2 & 0 & 1/2 & -1 \\ 1/10 & -2/5 & 3/10 & -1/5 \\ -7/10 & 4/5 & -11/10 & 12/5 \\ 1/5 & 1/5 & -2/5 & 3/5 \end{bmatrix}$ **31.** $(5, 1)$ **32.** $(-11, 2)$ **33.** $(2, 1)$ **34.** $(40, -24)$ **35.** $(15, 21)$

36. $(-1, -2/3)$ **37.** No inverse, $(-8y - 12, y)$ **38.** No inverse, $((14 - 7y)/2, y)$ **39.** $(-8, 6, 1)$ **40.** $(-2, 5, -7)$

41. $(-36, 8, -8)$ **42.** $(10, -3, 5)$ **43.** No inverse, no solution for system **44.** No inverse, no solution for system

45. $(-7, -34, -19, 7)$ **46.** $(1, 0, 2, 1)$ **50.** $\dfrac{1}{ad - bc}\begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$ **55.** $\begin{bmatrix} -0.0447 & -0.0230 & 0.0292 & 0.0895 & -0.0402 \\ 0.0921 & 0.0150 & 0.0321 & 0.0209 & -0.0276 \\ -0.0678 & 0.0315 & -0.0404 & 0.0326 & 0.0373 \\ 0.0171 & -0.0248 & 0.0069 & -0.0003 & 0.0246 \\ -0.0208 & 0.0740 & 0.0096 & -0.1018 & 0.0646 \end{bmatrix}$

56. $\begin{bmatrix} 0.010146 & -0.011883 & 0.002772 & 0.020724 & -0.012273 \\ 0.006353 & 0.014233 & -0.001861 & -0.029146 & 0.019225 \\ -0.000638 & 0.006782 & -0.004823 & -0.022658 & 0.019344 \\ -0.005261 & 0.003781 & 0.006192 & 0.004837 & -0.006910 \\ -0.012252 & -0.001177 & -0.006126 & 0.006744 & 0.002792 \end{bmatrix}$

57. $\begin{bmatrix} 0.0394 & 0.0880 & 0.0033 & 0.0530 & -0.1499 \\ -0.1492 & 0.0289 & 0.0187 & 0.1033 & 0.1668 \\ -0.1330 & -0.0543 & 0.0356 & 0.1768 & 0.1055 \\ 0.1407 & 0.0175 & -0.0453 & -0.1344 & 0.0655 \\ 0.0102 & -0.0653 & 0.0993 & 0.0085 & -0.0388 \end{bmatrix}$ **58.** No **59.** Yes **60.** $\begin{bmatrix} 1.18519 \\ -0.95960 \\ -1.30976 \end{bmatrix}$ **61.** $\begin{bmatrix} 1.51482 \\ 0.053479 \\ -0.637242 \\ 0.462629 \end{bmatrix}$

62. $\begin{bmatrix} 0.489558 \\ 1.00104 \\ 2.11853 \\ -1.20793 \\ -0.961346 \end{bmatrix}$ **63. (a)** $\begin{bmatrix} 72 \\ 48 \\ 60 \end{bmatrix}$ **(b)** $\begin{bmatrix} 2 & 4 & 2 \\ 2 & 1 & 2 \\ 2 & 1 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 72 \\ 48 \\ 60 \end{bmatrix}$ **(c)** 8 type I, 8 type II, and 12 type III

64. (a) 100 transistors, 110 resistors, and 90 computer chips **(b)** 95 transistors, 100 resistors, and 90 computer chips **(c)** 140 transistors, 130 resistors, and 100 computer chips **65. (a)** \$10,000 at 6%, \$10,000 at 6.5%, and \$5000 at 8% **(b)** \$14,000 at 6%, \$9000 at 6.5%, and \$7000 at 8% **(c)** \$24,000 at 6%, \$4000 at 6.5%, and \$12,000 at 8% **66. (a)** 60 lb of pretzels, 30 lb of dried fruit, 50 lb of nuts **(b)** 20 lb of pretzels, 10 lb of dried fruit, 70 lb of nuts **(c)** 50 lb of pretzels, 25 lb of dried fruit, 50 lb of nuts **67. (a)** 50 Super Vim, 75 Multitab, and 100 Mighty Mix **(b)** 75 Super Vim, 50 Multitab, and 60 Mighty Mix **(c)** 80 Super Vim, 100 Multitab, and 50 Mighty Mix **68. (a)** 85, 50, 40, 130, 120, 145, 49, 63, 121, 171, 117, 99, 159, 113, 91, 145, 105, 100, 90, 40, 75, 134, 113, 91, 98, 101, 112 **(b)** I love you **69. (a)** 123, 81, 72, 102, 79, 58, 38, 61, 112, 158, 111, 122, 134, 123, 146 **(b)** One more time

70. (a) −50, 111, 71, −26, 53, 63, 17, −49, 38, −9, 39, −44, 17, −48, 35 **(b)** $\begin{bmatrix} 8 & 3 & 1 \\ 10 & 4 & 1 \\ 7/2 & 3/2 & 1/2 \end{bmatrix}$ **(c)** I want more pie

71. (a) 262, −161, −12, 186, −103, −22, 264, −168, −9, 208, −134, −5, 224, −152, 5, 92, −50, −3 **(b)** $\begin{bmatrix} 1.75 & 2.5 & 3 \\ -0.25 & -0.5 & 0 \\ -0.25 & -0.5 & -1 \end{bmatrix}$ **(c)** Happy birthday **72. (a)** $\begin{bmatrix} -1/15 & -1/15 & 13/3 \\ 4/15 & 1/15 & -40/3 \\ -1/5 & 0 & 10 \end{bmatrix}$ **(b)** $\begin{bmatrix} 0 & 1 & 40 \\ -1 & 0 & 60 \\ 0 & 0 & 1 \end{bmatrix}$

(c) The shape is a sideways T whose vertical and horizontal intersection is at the mark $(60, 10)$.

Exercises 2.6 (page 109–111)

For exercises . . .	5–10,13–16,21–29,34	11,12,30–33	17–20
Refer to example . . .	4	5	3,4

W1. $\begin{bmatrix} 1 & 2 \\ 1 & 3 \end{bmatrix}$ **W2.** $\begin{bmatrix} 15 & 14 & -12 \\ 5 & 5 & -4 \\ -1 & -1 & 1 \end{bmatrix}$ **1.** True

2. False **3.** False **4.** True **5.** $\begin{bmatrix} 60 \\ 50 \end{bmatrix}$ **6.** $\begin{bmatrix} 4.4 \\ 13.3 \end{bmatrix}$ **7.** $\begin{bmatrix} 6.43 \\ 26.12 \end{bmatrix}$ **8.** $\begin{bmatrix} 108.91 \\ 224.49 \end{bmatrix}$ **9.** $\begin{bmatrix} 19 \\ 27 \\ 28 \end{bmatrix}$ **10.** $\begin{bmatrix} 16.21 \\ 9.18 \\ 6.06 \end{bmatrix}$ **11.** 33: 47: 23

12. 23: 31: 33 **13.** $\begin{bmatrix} 7697 \\ 4205 \\ 6345 \\ 4106 \end{bmatrix}$ (rounded) **14.** $\begin{bmatrix} 7022 \\ 4854 \\ 5116 \\ 4647 \end{bmatrix}$ **15.** About 1440 metric tons of wheat and 1938 metric tons of oil

16. About 893 metric tons of wheat and about 1179 metric tons of oil **17.** About 1506 units of agriculture, 1713 units of manufacturing, and 1412 units of transportation (or 1505, 1712, and 1411, respectively, if rounded matrix used) **18.** About 1696 units of agriculture, about 1565 units of manufacturing, and about 1391 units of transportation **19.** About 3077 units of agriculture, about 2564 units of manufacturing, and about 3179 units of transportation **20.** About 1538 units of agriculture, about 1282 units of manufacturing, and about 1590 units of transportation **21. (a)** 7/4 bushels of yams and 15/8 $\approx$ 2 pigs **(b)** 167.5 bushels of yams and 153.75 $\approx$ 154 pigs **22.** About 3179 units of oil, about 3043 units of corn, and about 1630 units of coffee **23.** About 848 units of agriculture, about 516 units of manufacturing, and about 2970 units of households **24.** About \$18.2 billion of agriculture, about \$73.2 billion of manufacturing, and about \$66.7 billion of households **25.** About 195 million pounds of agriculture, about 26 million pounds of manufacturing, and about 13.6 million pounds of energy **26. (a)** About 183,000 for agriculture, about 304,000 for industry/construction, and about 42,000 for transportation/commerce **27.** In millions of dollars, the amounts are about 532 for natural resources, about 481 for manufacturing, about 805 for trade and services, and about 1185 for personal consumption.

28. (a) A \$3 million production increase in natural resources, a \$60 million production increase in manufacturing, a \$27 million production increase in trade and services, a \$42 million production increase in personal consumption, and 1002 new jobs

29. (a) $\begin{bmatrix} 1.67 & 0.56 & 0.56 \\ 0.19 & 1.17 & 0.06 \\ 3.15 & 3.27 & 4.38 \end{bmatrix}$ **(b)** These multipliers imply that if the demand for one community's output increases by \$1, then the output in the other community will increase by the amount in the row and column of that matrix. For example, if the demand for Hermitage's output increases by \$1, then output from Sharon will increase by \$0.56, Farrell by \$0.06, and Hermitage by \$4.38.

30. Produce 2 units of yams for every 3 units of pigs **31.** 3 units of coal to every 4 units of steel **32.** 3 units of agriculture to every 4 units of manufacturing and 8 units of transportation **33.** 6 units of mining to every 8 units of manufacturing and 5 units of communication **34.** 13,436 of manufacturing, 5352 of finance, and 799 of services

Chapter 2 Review Exercises (page 113–118)

For exercises . . .	1,19–22, 66,79,80, 83,85	2–5,17,23–28, 67–70,76,77, 81,82,84	6,7,29–33, 36,71,75	8,9,18,34,35, 37–43,78	10–15,44–62, 72,76	16,63,64, 73,74
Refer to section . . .	1	2	3	4	5	6

1. True **2.** True **3.** False
4. False **5.** True **6.** False
7. False **8.** True **9.** False
10. False **11.** True **12.** False **13.** False **14.** True **15.** False **16.** True **19.** $(1, -4)$ **20.** $(8, -4)$
21. $((34 - 28z)/50, (53 - z)/25, z)$ **22.** $(z - 2, 3 - 2z, z)$ **23.** $(-9, 3)$ **24.** $(22, 3)$ **25.** $(7, -9, -1)$ **26.** $(2, -1, 3)$
27. $(6 - 7z/3, 1 + z/3, z)$ **28.** No solution **29.** 2×2 (square); $a = 2, b = 3, c = 5, q = 9$
30. 3×2; $a = 2, x = -1, y = 4, p = 5, z = 7$ **31.** 1×4 (row); $m = 6, k = 3, z = -3, r = -9$
32. 3×3 (square); $a = -12, b = 1, k = 9/2, c = 3/4, d = 3, l = -3/4, m = -1, p = 3, q = 9$

33. $\begin{bmatrix} 9 & 10 \\ -3 & 0 \\ 10 & 16 \end{bmatrix}$ **34.** $\begin{bmatrix} 0 & -16 \\ -10 & -18 \end{bmatrix}$ **35.** $\begin{bmatrix} 23 & 20 \\ -7 & 3 \\ 24 & 39 \end{bmatrix}$ **36.** Not possible **37.** $\begin{bmatrix} -17 & 20 \\ 1 & -21 \\ -8 & -17 \end{bmatrix}$ **38.** $\begin{bmatrix} 2 & 50 \\ 1 & -15 \\ -3 & 45 \end{bmatrix}$

39. Not possible **40.** $\begin{bmatrix} 6 & 18 & -24 \\ 1 & 3 & -4 \\ 0 & 0 & 0 \end{bmatrix}$ **41.** $[9]$ **42.** $\begin{bmatrix} 15 \\ 16 \\ 1 \end{bmatrix}$ **43.** $[-14 \quad -19]$ **44.** $\begin{bmatrix} -7/19 & 4/19 \\ 3/19 & 1/19 \end{bmatrix}$ **45.** No inverse

46. No inverse **47.** $\begin{bmatrix} 7 & -3 \\ -2 & 1 \end{bmatrix}$ **48.** $\begin{bmatrix} -1/4 & 1/6 \\ 0 & 1/3 \end{bmatrix}$ **49.** No inverse **50.** No inverse **51.** $\begin{bmatrix} 2/3 & 0 & -1/3 \\ 1/3 & 0 & -2/3 \\ -2/3 & 1 & 1/3 \end{bmatrix}$

52. $\begin{bmatrix} 1/4 & 1/2 & 1/2 \\ 1/4 & -1/2 & 1/2 \\ 1/8 & -1/4 & -1/4 \end{bmatrix}$ **53.** No inverse **54.** No inverse **55.** $X = \begin{bmatrix} 1 \\ -13 \end{bmatrix}$ **56.** Matrix A has no inverse. Solution: $(-2y + 5, y)$

57. $X = \begin{bmatrix} -22 \\ -18 \\ 15 \end{bmatrix}$ **58.** $X = \begin{bmatrix} 6 \\ 15 \\ 16 \end{bmatrix}$ **59.** $(2, 1)$ **60.** $(34, -9)$ **61.** $(-1, 0, 2)$ **62.** $(1, 2, 3)$ **63.** $\begin{bmatrix} 218.1 \\ 318.3 \end{bmatrix}$ **64.** $\begin{bmatrix} 725.7 \\ 305.9 \\ 166.7 \end{bmatrix}$

65. (a) $(2, 3, -1)$ **(b)** $(2, 3, -1)$ **(c)** $\begin{bmatrix} 1 & 2 & 1 \\ 2 & -1 & -1 \\ 3 & -3 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 7 \\ 2 \\ -5 \end{bmatrix}$ **(d)** $\begin{bmatrix} 5/22 & 7/22 & 1/22 \\ 7/22 & 1/22 & -3/22 \\ 3/22 & -9/22 & 5/22 \end{bmatrix}$ **(e)** $(2, 3, -1)$

66. 8000 standard, 6000 extra-large **67.** 5 blankets, 3 rugs, 8 skirts **68.** 150,000 gal were produced at Tulsa, 225,000 gal at New Orleans, and 180,000 gal at Ardmore **69. (a)** $\begin{aligned} 1.5x + 0.5y + z &= 380 \\ 1.2x + 0.6y + 0.9z &= 330 \end{aligned}$ **(b)** $(210 - 0.5z, 130 - 0.5z, z)$ **(c)** $0, 1, 2, \ldots, 260$ **(d)** 80 football, 0 basketball, and 260 baseball jerseys **70. (a)** 2600 reserved, 1300 box, and 1100 infield seats **(b)** No

71. (a) $\begin{bmatrix} 9 & 19 & 92 & 47 \\ 11 & 24 & 100 & 44 \\ 7 & 19 & 81 & 38 \\ 6 & 14 & 75 & 30 \end{bmatrix}, \begin{bmatrix} 7 & 18 & 100 & 49 \\ 8 & 20 & 108 & 50 \\ 8 & 17 & 102 & 41 \\ 6 & 15 & 87 & 44 \end{bmatrix}$ **(b)** $\begin{bmatrix} -2 & -1 & 8 & 2 \\ -3 & -4 & 8 & 6 \\ 1 & -2 & 21 & 3 \\ 0 & 1 & 12 & 14 \end{bmatrix}$ **72. (a)** $\begin{bmatrix} 3170 \\ 2360 \\ 1800 \end{bmatrix}$ **(b)** $\begin{bmatrix} x \\ y \\ z \end{bmatrix}$

(c) $\begin{bmatrix} 10 & 5 & 8 \\ 12 & 0 & 4 \\ 0 & 10 & 5 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 3170 \\ 2360 \\ 1800 \end{bmatrix}$ **(d)** $\begin{bmatrix} 150 \\ 110 \\ 140 \end{bmatrix}$ **73. (a)** $\begin{matrix} & c & g \\ c & 0 & 1/2 \\ g & 2/3 & 0 \end{matrix}$ **(b)** 1200 units of cheese; 1600 units of goats

74. (a) $\begin{bmatrix} 1.300 & 0.045 & 0.567 & 0.012 & 0.068 & 0.020 \\ 0.204 & 1.030 & 0.183 & 0.004 & 0.022 & 0.006 \\ 0.155 & 0.038 & 1.120 & 0.020 & 0.114 & 0.034 \\ 0.018 & 0.021 & 0.028 & 1.080 & 0.016 & 0.033 \\ 0.537 & 0.525 & 0.483 & 0.279 & 1.730 & 0.419 \\ 0.537 & 0.346 & 0.497 & 0.536 & 0.087 & 1.940 \end{bmatrix}$;
every \$1 of increased demand for livestock will result in an increase of production demand of \$0.204 in crops.
(b) In millions of dollars, produce \$3855 in livestock, \$1476 in crops, \$2726 in food products, \$1338 in mining and manufacturing, \$8439 in households, and \$10,256 in other business sectors.

75. $\begin{bmatrix} 8 & 8 & 8 \\ 10 & 5 & 9 \\ 7 & 10 & 7 \\ 8 & 9 & 7 \end{bmatrix}$ **76. (a)** $b + c$ **(b)** A is tumorous, B is bone, and C is healthy **(c)** For patient X, A and C are healthy; B is tumorous. For patient Y, A and B are tumorous; C is bone. For patient Z, A could be healthy or tumorous; B and C are healthy.
77. (a) No **(b) (i)** 0.23, 0.37, 0.42; A is healthy; B and D are tumorous; C is bone. **(ii)** 0.33, 0.27, 0.32; A and C are tumorous, B could be healthy or tumorous, D is bone. **(c)** 0.2, 0.4, 0.45, 0.3; A is healthy; B and C are bone; D is tumorous. **(d)** One example is to choose beams 1, 2, 3, and 6. **78.** About 20 head and face injuries, 12 concussions, 3 neck injuries, and 55 other injuries.
79. $W_1 = W_2 = 100\sqrt{3}/3 \approx 58$ lb **80.** $W_1 \approx 110$ lb and $W_2 \approx 134$ lb **81. (a)** $C = 0.011t^2 + 0.94t + 317$ **(b)** 2092
82. (a) $x = 1$ and $y = 1/2$ **(b)** $x = 1$, $y = 1$, and $z = -1$ **83.** There are y girls and $2500 - 1.5y$ boys, where y is any even integer between 0 and 1666. **84.** 179 singles, 31 doubles, 4 triples, and 11 home runs **85.** A chocolate wafer weighs 4.08 g, and a single layer of vanilla cream weighs 3.17 g.

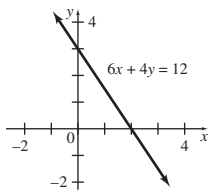
Extended Application: Contagion (page 119)

1. $PQ = \begin{bmatrix} 1 & 2 & 0 & 2 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 2 & 1 \end{bmatrix}$ **2.** None **3.** The third person **4.** The second, fourth, and fifth persons

Chapter 3 Linear Programming: The Graphical Method

Exercises 3.1 (page 127–129)

For exercises . . .	5–10	11–30	31–44	45–48	49–57
Refer to example . . .	1	2,3	4–7	4	8

W1.


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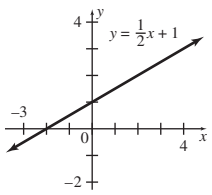

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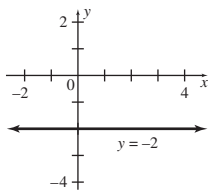

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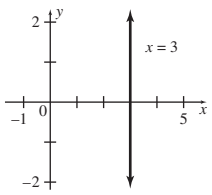
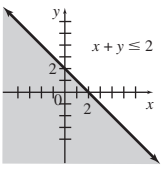


1. True **2.** False **3.** False **4.** True
5. Let x represent the number of product A produced and y represent the number of product B. Then $3x + 5y \le 60$. **6.** Let x represent the number of cows and y represent the number of sheep. Then $(1/3)x + (1/4)y \ge 120$. **7.** Let x represent the number of calcium carbonate supplements and y represent the number of calcium citrate supplements. Then $600x + 250y \ge 1500$.
8. Let x represent the number of small computers sold and y represent the number of large computers sold. Then $3x + 5y \le 45$.
9. Let x represent the number of pounds of \$8 coffee and y represent the number of pounds of \$10 coffee. Then $x + y \ge 40$.
10. Let x represent the number of gallons of light oil and y represent the number of gallons of heavy oil. Then $x + y \le 120$.

11.


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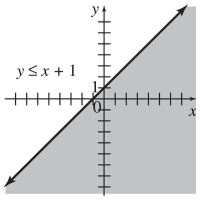

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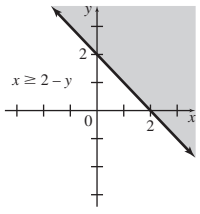

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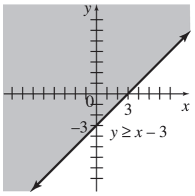

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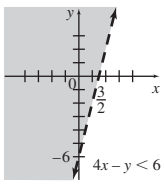

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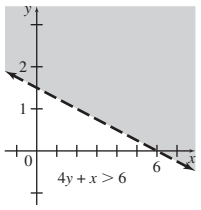

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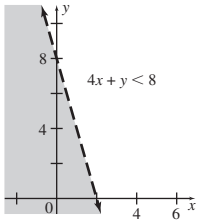

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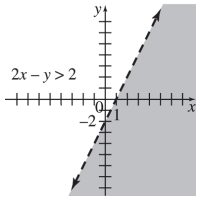

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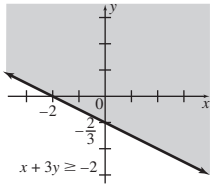

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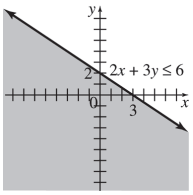

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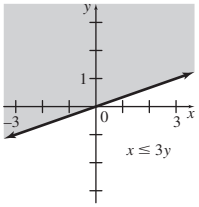

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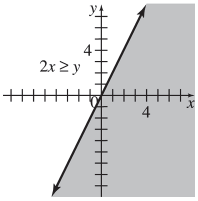

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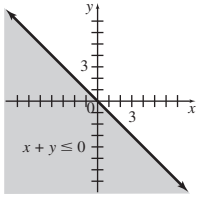

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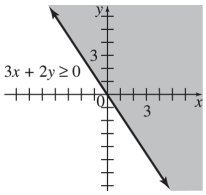

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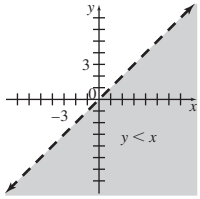

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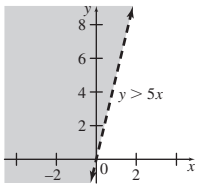

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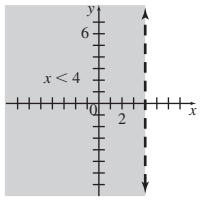

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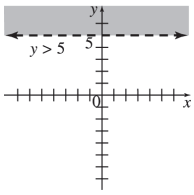

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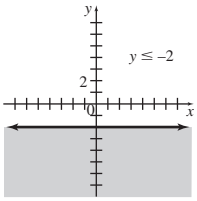

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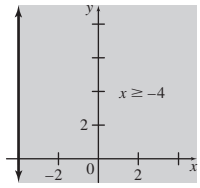

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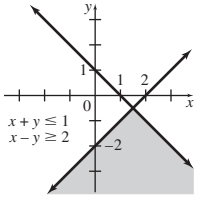

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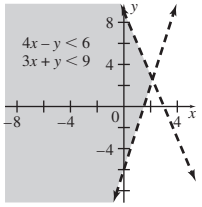

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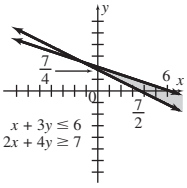

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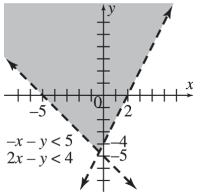

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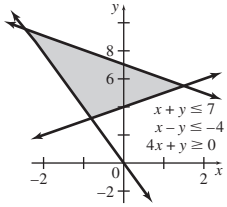

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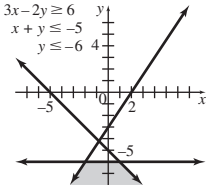

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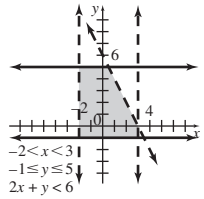

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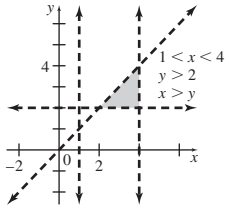

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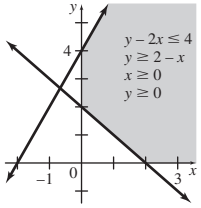

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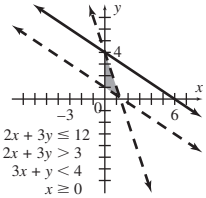

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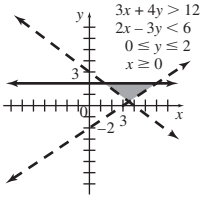

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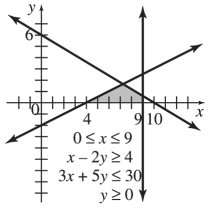
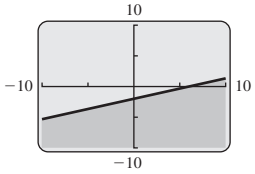


Bounded

43. No feasible region

44. No feasible region

45.



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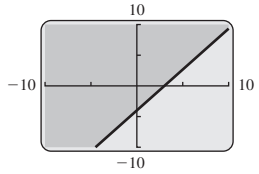

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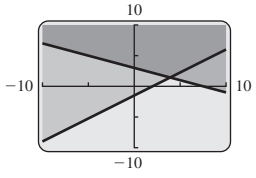

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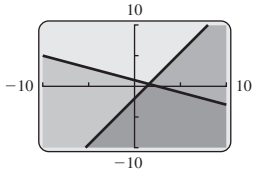
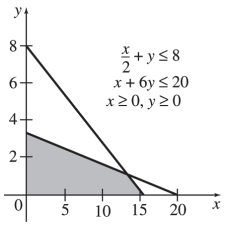


49. **B:** ≤, ≤, ≤; **C:** ≥, ≥, ≤; **D:** ≤, ≥, ≤; **E:** ≤, ≤, ≥; **F:** ≤, ≥, ≥; **G:** ≥, ≥, ≥

50. **(a)**

	Glazed	Unglazed		Total
Number Made	x	y		
Time on Wheel	1/2	1	≤	8
Time in Kiln	1	6	≤	20

(b) $(1/2)x + y \le 8$; $x + 6y \le 20$; $x \ge 0$; $y \ge 0$



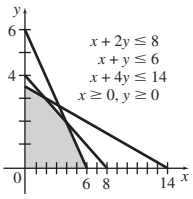
(c) Yes; no

51. (a)

	Shawls	Afghans		Total
Number Made	x	y		
Spinning Time	1	2	$\le$	8
Dyeing Time	1	1	$\le$	6
Weaving Time	1	4	$\le$	14

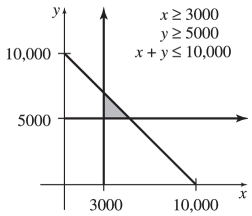
(c) Yes; no

(b)



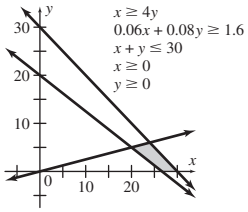
52. (a) $x \ge 3000$; $y \ge 5000$; $x + y \le 10{,}000$

(b)



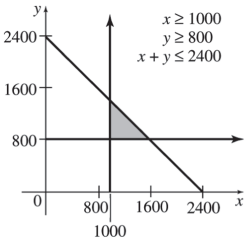
53. (a) $x \ge 4y$; $0.06x + 0.08y \ge 1.6$; $x + y \le 30$; $x \ge 0$; $y \ge 0$

(b)



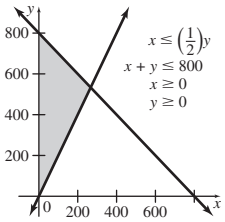
54. (a) $x \ge 1000$; $y \ge 800$; $x + y \le 2400$

(b)



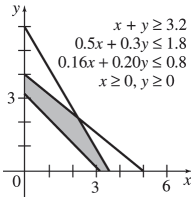
55. (a) $x \le (1/2)y$; $x + y \le 800$; $x \ge 0$; $y \ge 0$

(b)



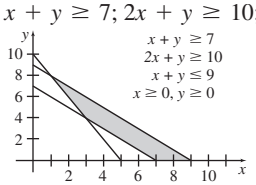
56. (a) $x + y \ge 3.2$; $0.16x + 0.20y \le 0.8$; $0.5x + 0.3y \le 1.8$; $x \ge 0$; $y \ge 0$

(b)



57. (a) $x + y \ge 7$; $2x + y \ge 10$; $x + y \le 9$; $x \ge 0$; $y \ge 0$

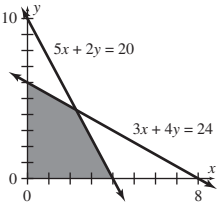
(b)



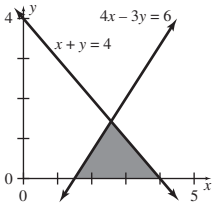
Exercises 3.2 (page 134–136)

For exercises . . .	5–20
Refer to example . . .	3

W1. $(2, 3)$ **W2.** $(4, 10)$ **W3.**



W4.



1. True **2.** True **3.** False **4.** True **5. (a)** Maximum of 29 at $(7, 4)$; minimum of 10 at $(0, 5)$ **(b)** Maximum of 35 at $(3, 8)$; minimum of 8 at $(4, 1)$ **6. (a)** Maximum of 34 at $(2, 8)$; minimum of 8 at $(4, 1)$ **(b)** Maximum of 32 at $(4, 6)$; minimum of 13 at $(1, 4)$ **7. (a)** Maximum of 44 at $(4, 8)$ and $(7, 3)$, and all points on the line segment between; minimum of 0 at $(0, 0)$ **(b)** Maximum of 12 at $(8, 0)$; minimum of 0 at $(0, 0)$ **8. (a)** Maximum of 24.6 at $(6, 18)$; minimum of 0 at $(0, 0)$ **(b)** Maximum of 126 at $(6, 18)$ and $(10, 9)$, and all points on the line segment between; minimum of 0 at $(0, 0)$ **9. (a)** No maximum; minimum of 16 at $(0, 8)$ **(b)** No maximum; minimum of 40 at $(3, 4)$ and $(13/2, 2)$, and all points on the line segment between **(c)** No maximum; minimum of 21 at $(13/2, 2)$ **(d)** No maximum; minimum of 12 at $(12, 0)$ **(e)** No maximum or minimum **10. (a)** No maximum; minimum of 10 at $(0, 10)$ **(b)** No maximum; minimum of 34 at $(2, 4)$ **(c)** No maximum; minimum of 16 at $(2, 4)$ and $(5, 2)$, and all points on the line segment between **(d)** No maximum; minimum of 15 at $(15, 0)$ **(e)** No maximum or minimum **11.** Minimum of 24 when $x = 6$ and $y = 0$ **12.** Minimum of 25/3 when $x = 10/3$ and $y = 5/3$ **13.** Maximum of 46 when $x = 6$ and $y = 8$ **14.** Minimum of 400 when $x = 200/7$ and $y = 100/7$, as well as when $x = 40$ and $y = 0$ and all points on the line segment between **15.** Maximum of 1500 when $x = 150$ and $y = 0$, as well as when $x = 50$ and $y = 100$ and all points on the line segment between **16.** No solution **17.** No solution **18.** Maximum of 47 when $x = 13/2$ and $y = 7/2$ **19. (a)** Maximum of 204 when $x = 18$ and $y = 2$ **(b)** Maximum of 588/5 when $x = 12/5$ and $y = 39/5$ **(c)** Maximum of 102 when $x = 0$ and $y = 17/2$ **20. (a)** Maximum of 7 when $x = 0$ and $y = 7/2$ **(b)** Minimum of 10 when $x = 0$ and $y = 5$ **(c)** Minimum of 58/3 when $x = 14/3$ and $y = 8/3$ **21.** (b)

Exercises 3.3 (page 142–144)

For exercises . . .	1–6	1–4,7,13,17–21	5,6,8–12,14–16,22	23
Refer to example . . .	1–3	3	1,2	2

W1. Maximum of 21.25 at $x = 3.5$ and $y = 1.25$ **W2.** Minimum of 16 at $x = 0$ and $y = 8$

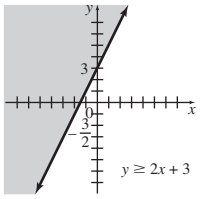
1. Sell 20 5 oz and 20 10 oz containers, for a maximum revenue of \$320. **2.** Make 10 Very Berry Smoothies and 15 Tropical Smoothies, for a maximum revenue of \$105. **3.** 51 to plant I and 32 to plant II, for a minimum cost of \$2810 **4.** 50 refrigerators to warehouse A and 50 to warehouse B, for a minimum cost of \$1100. **5.** \$10 million in bonds and \$20 million in mutual funds, or \$5 million in bonds and \$22.5 million in mutual funds (or any solution on the line segment between those two points), for a maximum annual interest of \$2 million. **6.** Grow 250,000 hectares of each crop or grow 200,000 hectares of coffee and 270,000 hectares of cocoa (or any point on the line segment between these two points), for a maximum profit of \$192,500,000. **7. (a)** 6 units of policy A and 16 units of policy B, for a minimum premium cost of \$940. **(b)** 30 units of policy A and 0 units of policy B, for a minimum premium cost of \$750. **8. (a)** 120 kg of the half-and-half mix and 120 kg of the other mix, for a maximum revenue of \$1980. **(b)** 0 kg of the half-and-half mix and 200 kg of the other mix, for a maximum revenue of \$2200. **9. (a)** 40 gal from dairy I and 60 gal from dairy II, for a maximum butterfat of 3.4 gal. **(b)** 10 gal from dairy I and 20 gal from dairy 2. No. **10. (a)** 300 Flexscan sets and 300 Panoramic 1 sets, for a maximum profit of \$255,000. **(b)** 475 Flexscan sets and 175 Panoramic 1 sets, for a maximum profit of \$301,250. **(c)** The solution to part (a) leaves 200 hours in the testing and packing department. The solution to part (b) leaves 75 hours in the cabinet shop. No. **11. (a)** 500 type I and 1000 type II. **(b)** Maximum revenue is \$275. **(c)** If the price of the type I bolt exceeds 20¢, then it is more profitable to produce 1050 type I bolts and 450 type II bolts. **12. (a)** 6.4 million gal of gasoline and 3.05 million gal of fuel oil **(b)** \$22.10 million (or \$22,100,000) **(c)** 10 **13.** 60 boxes are shipped from warehouse I to San Jose, 300 boxes are shipped from warehouse I to Memphis, and 290 boxes are shipped from warehouse II to San Jose for a minimum cost of \$1477. **14.** (b) **15.** (a) **16.** (c) **17. (a)** Three of pill 1 and two of pill 2, for a minimum cost of \$1.05 per day. **(b)** 360 surplus IU of vitamin A. No. **18.** 8/7 units of species I and 10/7 units of species II, for a minimum of 46/7 units of energy; a predator probably can catch and digest only whole numbers of prey. **19.** 4 ounces of fruit and 2 ounces of nuts, for a minimum of 140 calories. **20. (a)** 1 Brand X pill and 3 Brand Y pills, for a minimum daily cost of 17¢. **(b)** 75 surplus units of vitamin D. No. **21.** 0 plants and 18 animals, for a minimum of 270 hours **22.** 181.82 sq ft is used for windows and 509.09 sq ft is used for walls, for a maximum total area of 690.91 sq ft.

Chapter 3 Review Exercises (page 146–148)

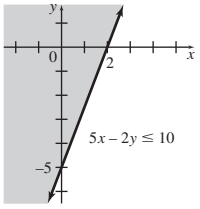
For exercises . . .	1,6,8,10,12–14,21–36	2,7,9,15–20	3,4,5,37–46	11
Refer to section . . .	2	1	3	2,3

1. False **2.** True **3.** False **4.** False **5.** False **6.** False **7.** True **8.** False **9.** False **10.** True **11.** True **12.** True **13.** True **14.** No limit

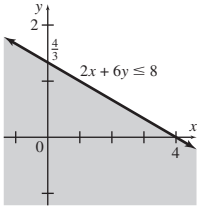
15.



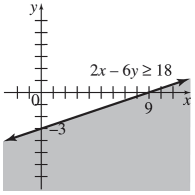
16.



17.



18.



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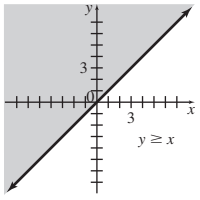

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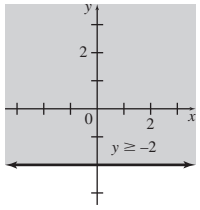
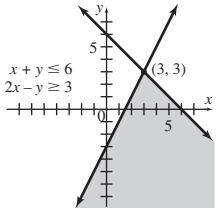
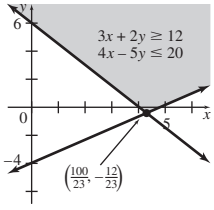


21.



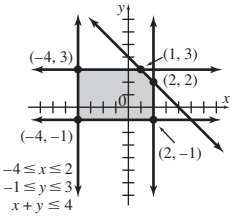
Unbounded

22.



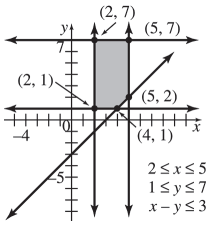
Unbounded

23.



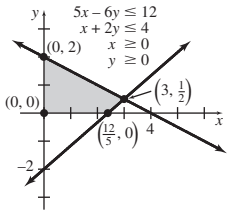
Bounded

24.



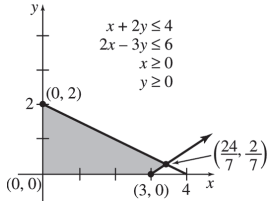
Bounded

25.



Bounded

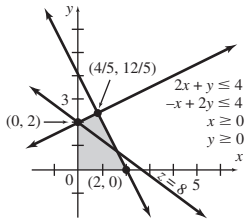
26.



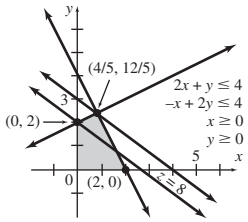
Bounded

27. Maximum of 22 at $(3,4)$; minimum of 0 at $(0,0)$ **28.** Maximum of 48 at $(8, 8)$; minimum of 4 at $(2, 0)$ **29.** Maximum of 24 at $(0,6)$ **30.** Minimum of 24 at $(0, 8)$ **31.** Minimum of 40 at $(0, 20)$ and $(10/3, 40/3)$, and all points on the line segment between **32.** Maximum of 32 at $(4, 0)$

35. (a)

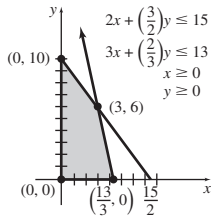


(b)

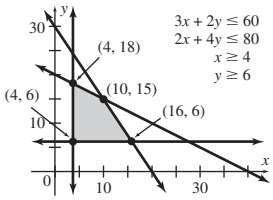


36. The maximum value of z is 32 when $x = 4$ and $y = 0$.

37. Let $x =$ number of batches of cakes and $y =$ number of batches of cookies. Then $x \geq 0$, $y \geq 0$, $2x + (3/2)y \leq 15$, and $3x + (2/3)y \leq 13$.



38. Let $x =$ the number of Mighty Meaty pizzas and $y =$ the number of Very Veggie pizzas. Then $x \geq 4$, $y \geq 6$, $3x + 2y \leq 60$, and $2x + 4y \leq 80$.



39. (a) 3 batches of cakes and 6 batches of cookies, for a maximum profit of \$210. **(b)** If the profit per batch of cookies increases by more than \$2.50 (to above \$22.50), then it will be more profitable to make 10 batches of cookies and no batches of cake.
40. 10 Mighty Meaty pizzas and 15 Very Veggie pizzas, for a maximum revenue of \$330. **41.** 7 packages of gardening mixture and 2 packages of potting mixture, for a maximum income of \$31. **42.** 3 of each model, for a minimum cost of \$210,000. **43.** Produce no runs of type I and 7 runs of type II, for a minimum cost of \$42,000. **44.** 10 ounces of Health Trough and 6 ounces of Power Gunk should be used for a minimum cholesterol intake of 104 mg. **45.** 0 acres for millet and 2 acres for wheat, for a maximum harvest of 1600 lb **46.** 7 hours with the math tutor and 2 hours with the accounting tutor to gain a maximum of 31 points.

Extended Application: Sensitivity Analysis (page 151)

1. Raise 6 goats and 10 pigs for maximum profit of \$550. **2.** Raise 6 goats and 10 pigs for maximum profit of \$422.
3. \$0.87 **4. (b)** Katie's maximum profit is \$200 with 0 weeding jobs and 8 mowing jobs. **(c)** Katie's maximum profit is \$225 with 0 weeding jobs and 9 mowing jobs. **(d)** \$2.78 **(e)** \$0.34 **(f)** \$0.28

Chapter 4 Linear Programming: The Simplex Method

Exercises 4.1 (page 158–160)

For exercises . . .	5–12	13–17,31–35	19–22	23–28
Refer to example . . .	1	2	3	4

1. True **2.** True **3.** True **4.** True **5.** $x_1 + 2x_2 + s_1 = 6$
6. $x_1 + 2x_2 + s_1 = 50$ **7.** $2.3x_1 + 5.7x_2 + 1.8x_3 + s_1 = 17$ **8.** $8x_1 + 6x_2 + 5x_3 + s_1 = 250$
9. (a) 3 **(b)** s_1, s_2, s_3 **(c)** $2x_1 + 3x_2 + s_1 = 15$; $4x_1 + 5x_2 + s_2 = 35$; $x_1 + 6x_2 + s_3 = 20$
10. (a) 2 **(b)** s_1, s_2 **(c)** $2.4x_1 + 1.5x_2 + s_1 = 10$; $1.7x_1 + 1.9x_2 + s_2 = 15$
11. (a) 2 **(b)** s_1, s_2 **(c)** $7x_1 + 6x_2 + 8x_3 + s_1 = 118$; $4x_1 + 5x_2 + 10x_3 + s_2 = 220$
12. (a) 2 **(b)** s_1, s_2 **(c)** $2x_1 + 2x_2 + x_3 + s_1 = 8$; $x_1 + 4x_2 + 3x_3 + s_2 = 12$

13.
$$\begin{array}{cccccc|c} x_1 & x_2 & s_1 & s_2 & z & \\ \hline 4 & 2 & 1 & 0 & 0 & 5 \\ 1 & 2 & 0 & 1 & 0 & 4 \\ \hline -7 & -1 & 0 & 0 & 1 & 0 \end{array}$$

14.
$$\begin{array}{ccccccc} x_1 & x_2 & s_1 & s_2 & z & \\ \hline 2 & 3 & 1 & 0 & 0 & 100 \\ 5 & 4 & 0 & 1 & 0 & 200 \\ \hline -1 & -3 & 0 & 0 & 1 & 0 \end{array}$$

15.
$$\begin{array}{cccccccc} x_1 & x_2 & s_1 & s_2 & s_3 & z & \\ \hline 1 & 1 & 1 & 0 & 0 & 0 & 10 \\ 5 & 2 & 0 & 1 & 0 & 0 & 20 \\ 1 & 2 & 0 & 0 & 1 & 0 & 36 \\ \hline -1 & -3 & 0 & 0 & 0 & 1 & 0 \end{array}$$

16.
$$\begin{array}{cccccc|c} x_1 & x_2 & s_1 & s_2 & z & \\ \hline 1 & 1 & 1 & 0 & 0 & 25 \\ 4 & 3 & 0 & 1 & 0 & 48 \\ \hline -5 & -3 & 0 & 0 & 1 & 0 \end{array}$$

17.
$$\begin{array}{ccccccc} x_1 & x_2 & s_1 & s_2 & z & \\ \hline 3 & 1 & 1 & 0 & 0 & 12 \\ 1 & 1 & 0 & 1 & 0 & 15 \\ \hline -2 & -1 & 0 & 0 & 1 & 0 \end{array}$$

18.
$$\begin{array}{ccccccc} x_1 & x_2 & s_1 & s_2 & z & \\ \hline 10 & 4 & 1 & 0 & 0 & 100 \\ 20 & 10 & 0 & 1 & 0 & 150 \\ \hline -4 & -5 & 0 & 0 & 1 & 0 \end{array}$$

19. $x_1 = 0, x_2 = 4, x_3 = 0, s_1 = 0, s_2 = 8, z = 28$ **20.** $x_1 = 6, x_2 = 0, x_3 = 15, s_1 = 0, s_2 = 0, z = 64$
21. $x_1 = 0, x_2 = 0, x_3 = 8, s_1 = 0, s_2 = 6, s_3 = 7, z = 12$ **22.** $x_1 = 5, x_2 = 0, x_3 = 2, s_1 = 3, s_2 = 0, s_3 = 0, z = 20$
23. $x_1 = 0, x_2 = 20, x_3 = 0, s_1 = 16, s_2 = 0, z = 60$ **24.** $x_1 = 0, x_2 = 5, x_3 = 0, s_1 = 3, s_2 = 0, z = 30$
25. $x_1 = 0, x_2 = 0, x_3 = 12, s_1 = 0, s_2 = 9, s_3 = 8, z = 36$ **26.** $x_1 = 0, x_2 = 0, x_3 = 28/5, s_1 = 26/5, s_2 = 0,$ $s_3 = 169/5, z = 112/5$ **27.** $x_1 = 0, x_2 = 250, x_3 = 0, s_1 = 0, s_2 = 50, s_3 = 200, z = 1000$

28. $x_1 = 0, x_2 = 250, x_3 = 0, x_4 = 0, s_1 = 65, s_2 = 100, s_3 = 0, z = 100$

31. If x_1 is the number of simple figures, x_2 is the number of figures with additions, and x_3 is the number of computer-drawn sketches, maximize $z = 95x_1 + 200x_2 + 325x_3$ subject to $20x_1 + 35x_2 + 60x_3 \le 2200$, $x_1 + x_2 + x_3 \le 400$, $x_3 \le x_1 + x_2$, $x_1 \ge 2x_2$, with $x_1 \ge 0$, $x_2 \ge 0$, and $x_3 \ge 0$; $20x_1 + 35x_2 + 60x_3 + s_1 = 2200$, $x_1 + x_2 + x_3 + s_2 = 400$, $-x_1 - x_2 + x_3 + s_3 = 0$, $-x_1 + 2x_2 + s_4 = 0$.

x_1	x_2	x_3	s_1	s_2	s_3	s_4	z	
20	35	60	1	0	0	0	0	2200
1	1	1	0	1	0	0	0	400
−1	−1	1	0	0	1	0	0	0
−1	2	0	0	0	0	1	0	0
−95	−200	−325	0	0	0	0	1	0

32. If x_1 represents the number of racing bicycles, x_2 the number of touring bicycles, and x_3 the number of mountain bicycles, maximize $z = 8x_1 + 12x_2 + 22x_3$ subject to $17x_1 + 27x_2 + 34x_3 \le 91{,}800$, $12x_1 + 21x_2 + 15x_3 \le 42{,}000$, with $x_1 \ge 0$, $x_2 \ge 0$, and $x_3 \ge 0$; $17x_1 + 27x_2 + 34x_3 + s_1 = 91{,}800$, $12x_1 + 21x_2 + 15x_3 + s_2 = 42{,}000$.

x_1	x_2	x_3	s_1	s_2	z	
17	27	34	1	0	0	91,800
12	21	15	0	1	0	42,000
−8	−12	−22	0	0	1	0

33. If x_1, x_2, and x_3 are the number of each style of jacket, maximize $z = x_1 + x_2 + x_3$ subject to $6x_1 + 4x_2 + 3x_3 \le 300$, $2x_1 + 3x_2 + 5x_3 \le 150$, $20x_1 + 18x_2 + 17x_3 \le 600$, with $x_1 \ge 0$, $x_2 \ge 0$, and $x_3 \ge 0$; $6x_1 + 4x_2 + 3x_3 + s_1 = 300$, $2x_1 + 3x_2 + 5x_3 + s_2 = 150$, $20x_1 + 18x_2 + 17x_3 + s_3 = 600$.

x_1	x_2	x_3	s_1	s_2	s_3	z	
6	4	3	1	0	0	0	300
2	3	5	0	1	0	0	150
20	18	17	0	0	1	0	600
−1	−1	−1	0	0	0	1	0

34. If x_1 represents the number of Basic sets, x_2 the number of Regular sets, and x_3 the number of Deluxe sets, maximize $z = 30x_1 + 40x_2 + 60x_3$ subject to $2x_1 + 2x_2 + 3x_3 \le 800$, $x_1 + x_2 + x_3 \le 400$, $x_2 + x_3 \le 200$, with $x_1 \ge 0$, $x_2 \ge 0$, and $x_3 \ge 0$; $2x_1 + 2x_2 + 3x_3 + s_1 = 800$, $x_1 + x_2 + x_3 + s_2 = 400$, $x_2 + x_3 + s_3 = 200$.

x_1	x_2	x_3	s_1	s_2	s_3	z	
2	2	3	1	0	0	0	800
1	1	1	0	1	0	0	400
0	1	1	0	0	1	0	200
−30	−40	−60	0	0	0	1	0

35. If x_1 is the number of newspaper ads run, x_2 is the number of Internet banner ads run, and x_3 is the number of TV ads run, maximize $z = 4000x_1 + 3000x_2 + 10{,}000x_3$ subject to $400x_1 + 20x_2 + 2000x_3 \le 8000$, $x_1 \le 30$, $x_2 \le 60$, $x_3 \le 10$, with $x_1 \ge 0$, $x_2 \ge 0$, and $x_3 \ge 0$; $400x_1 + 20x_2 + 2000x_3 + s_1 = 8000$, $x_1 + s_2 = 30$, $x_2 + s_3 = 60$, $x_3 + s_4 = 10$.

x_1	x_2	x_3	s_1	s_2	s_3	s_4	z	
400	20	2000	1	0	0	0	0	8000
1	0	0	0	1	0	0	0	30
0	1	0	0	0	1	0	0	60
0	0	1	0	0	0	1	0	10
−4000	−3000	−10,000	0	0	0	0	1	0

Exercises 4.2 (page 169–173)

For exercises . . .	5–20,25–48	19,20	21,22
Refer to example . . .	1	2	3

W1.

x_1	x_2	s_1	s_2	z	
3	4	1	0	0	12
2	5	0	1	0	10
−3	−2	0	0	1	0

W2.

x_1	x_2	x_3	s_1	s_2	z	
3	8	2	1	0	0	24
5	6	3	0	1	0	30
−14	−16	−12	0	0	1	0

W3. $x_1 = 4, x_2 = 0, s_1 = 0, s_2 = 2, z = 12$ **W4.** $x_1 = 0, x_2 = 3, x_3 = 0, s_1 = 0, s_2 = 12, z = 48$

1. True **2.** True **3.** False **4.** True **5.** Maximum is 30 when $x_1 = 10, x_2 = 0, x_3 = 0, s_1 = 6$, and $s_2 = 0$. **6.** Maximum is 36 when $x_1 = 0, x_2 = 6, x_3 = 0, s_1 = 0$, and $s_2 = 4$. **7.** Maximum is 8 when $x_1 = 4, x_2 = 0, s_1 = 8, s_2 = 2$, and $s_3 = 0$. **8.** Maximum is 45 when $x_1 = 15/2, x_2 = 0, x_3 = 5, s_1 = 0, s_2 = 0$, and $s_3 = 15/2$. **9.** Maximum is 264 when $x_1 = 16$, $x_2 = 4, x_3 = 0, s_1 = 0, s_2 = 16$, and $s_3 = 0$. **10.** Maximum is 32 when $x_1 = 0, x_2 = 8, x_3 = 0, s_1 = 2$, and $s_2 = 0$. **11.** Maximum is 25 when $x_1 = 0, x_2 = 5, s_1 = 20$, and $s_2 = 0$. **12.** Maximum is 17.5 when $x_1 = 2.5, x_2 = 2.5, s_1 = 0$, and $s_2 = 0$. **13.** Maximum is 120 when $x_1 = 0, x_2 = 10, s_1 = 0, s_2 = 40$, and $s_3 = 4$. **14.** Maximum is 21 when $x_1 = 0, x_2 = 5, s_1 = 4$, and $s_2 = 0$. **15.** Maximum is 944 when $x_1 = 118, x_2 = 0, x_3 = 0, s_1 = 0$, and $s_2 = 102$. **16.** Maximum is 64 when $x_1 = 8, x_2 = 0, x_3 = 0, s_1 = 2$, and $s_2 = 0$. **17.** Maximum is 3300 when $x_1 = 240, x_2 = 60, x_3 = 0$, $x_4 = 0, s_1 = 0$, and $s_2 = 0$. **18.** Maximum is 200 when $x_1 = 0, x_2 = 0, x_3 = 0, x_4 = 40, s_1 = 75, s_2 = 0$, and $s_3 = 50$. **19.** No maximum **20.** No maximum **21.** Maximum is 120 when $x_1 = 0, x_2 = 15, s_1 = 5$, and $s_2 = 0$, and when $x_1 = 10, x_2 = 10, s_1 = 0$, and $s_2 = 0$, and at all points on the line segment between. **22.** Maximum is 200 when $x_1 = 100$, $x_2 = 0, x_3 = 0, s_1 = 0$, and $s_2 = 140$, and when $x_1 = 0, x_2 = 100, x_3 = 0, s_1 = 0$, and $s_2 = 40$, and at all points on the line segment between. **23.** One possible answer is $a = 0, b = 3, c = -2, d = 6$, and $e = 3$. **24. (a)** One possible answer is $a = 0, b = -4, c = -6, d = -5$, and $e = -2$. **(b)** One possible answer is $a = 0, b = 3, c = -2, d = 1$, and $e = 0$. **25.** Maximum is 70,818.18 when $x_1 = 181.82, x_2 = 0, x_3 = 454.55, x_4 = 0, x_5 = 1363.64, s_1 = 0, s_2 = 0, s_3 = 0$, and $s_4 = 0$. **26.** Maximum is 795.68 when $x_1 = 0, x_2 = 0, x_3 = 46.97, x_4 = 176.72, x_5 = 124.05, s_1 = 0, s_2 = 0, s_3 = 0$, and $s_4 = 32.31$. **31.** 6 churches and 2 labor unions, for a maximum of \$1000 per month **32. (a)** 300 Flexscan sets and 300 Panoramic I sets, for a maximum profit of \$255,000 **(b)** $s_3 = 200$; there are 200 leftover hours in the testing and packing department. **33. (a)** Assemble 1000 Royal Flush poker sets, 3000 Deluxe Diamond poker sets, and 0 Full House poker sets, for a maximum profit of \$104,000. **(b)** $s_4 = 1000$; there are 1000 unused dealer buttons. **34. (a)** 50 loaves of raisin bread and 20 raisin cakes **(b)** \$167.50 **(c)** No; there are 30 units of raisins left; $s_3 = 30$. **35. (a)** No racing or touring bicycles and