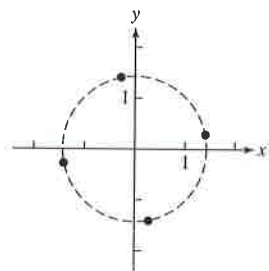


23. (a) (5, 0) or (-5, π) or (5, 2π) (b) (-5, -π) or (5, 0) or (-5, π) (c) The answers from (a), and also (-5, 3π) or (5, 4π)
 25. $y = -\frac{3}{5}x + \frac{29}{5}$; line through $(0, \frac{29}{5})$ with slope $m = -\frac{3}{5}$ 27. $x = 2(y + 1)^2 + 3$; parabola that opens to right with vertex at (3, 1)
 29. $y = \sqrt{x + 1}$; square root function starting at (-1, 0) 31. $x = 2t + 3, y = 3t + 4$ 33. $a = -3, b = 4, |z_1| = 5$
 35. $3\sqrt{3} + 3i$ 37. $-1.25 - 1.25\sqrt{3}i$ 39. $3\sqrt{2}(\cos \frac{7\pi}{4} + i \sin \frac{7\pi}{4})$; Other representations would use angles $\frac{7\pi}{4} + 2n\pi$, n an integer. 41. $\approx \sqrt{34}[\cos(5.25) + i \sin(5.25)]$ Other representations would use angles $\approx 5.25 + 2n\pi, n$ an integer.
 43. $12(\cos 90^\circ + i \sin 90^\circ); \frac{3}{4}(\cos 330^\circ + i \sin 330^\circ)$ 45. (a) $243(\cos \frac{5\pi}{4} + i \sin \frac{5\pi}{4})$ (b) $-\frac{243\sqrt{2}}{2} - \frac{243\sqrt{2}}{2}i$

47. (a) $125(\cos \pi + i \sin \pi)$ (b) -125

49. $\sqrt[8]{18}(\cos \frac{\pi}{16} + i \sin \frac{\pi}{16}), \sqrt[8]{18}(\cos \frac{9\pi}{16} + i \sin \frac{9\pi}{16}),$

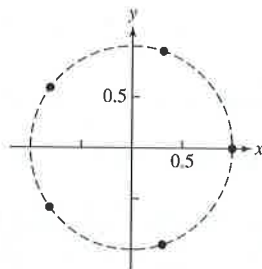
$\sqrt[8]{18}(\cos \frac{17\pi}{16} + i \sin \frac{17\pi}{16}), \sqrt[8]{18}(\cos \frac{25\pi}{16} + i \sin \frac{25\pi}{16})$



51. $1, \cos \frac{2\pi}{5} + i \sin \frac{2\pi}{5},$

$\cos \frac{4\pi}{5} + i \sin \frac{4\pi}{5}, \cos \frac{6\pi}{5} + i \sin \frac{6\pi}{5},$

$\cos \frac{8\pi}{5} + i \sin \frac{8\pi}{5}$

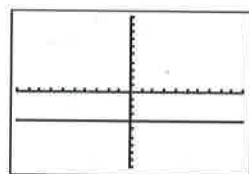


53. (b) 55. (a) 57. Not shown 59. (c) 61. $x^2 + y^2 = 4$ — a circle with center (0, 0) and radius 2

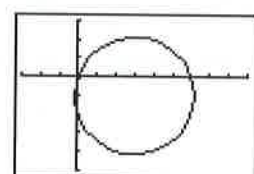
63. $(x + \frac{3}{2})^2 + (y + 1)^2 = \frac{13}{4}$ — a circle of radius $\frac{\sqrt{13}}{2}$ with center $(-\frac{3}{2}, -1)$

65. $r = -\frac{4}{\sin \theta} = -4 \csc \theta$

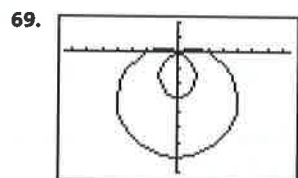
67. $r = 6 \cos \theta - 2 \sin \theta$



[-10, 10] by [-10, 10]

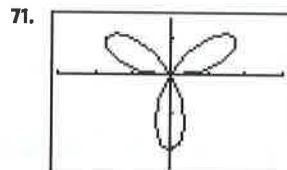


[-3, 9] by [-5, 3]



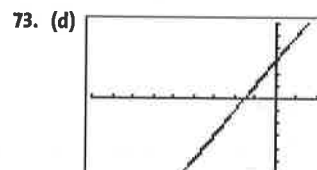
[-7.5, 7.5] by [-8, 2]

Domain: All reals
 Range: [-3, 7]
 Symmetric about the y-axis
 Continuous
 Bounded
 Maximum r -value: 7
 No asymptotes



[-3, 3] by [-2.5, 1.5]

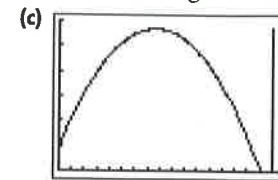
Domain: All reals
 Range: [-2, 2]
 Symmetric about the y-axis
 Continuous
 Bounded
 Maximum r -value: 2
 No asymptotes



[-9, 2] by [-6, 6]

75. (a) $\approx (-463.64, 124.23)$ (b) ≈ 508.29 mph; $\approx 283.84^\circ$ 77. (a) 826.91 pounds (b) 2883.79 pounds

79. (a) $h = -16t^2 + 245t + 200$ (b) Graph and trace: $x = 17$ and $y = -16t^2 + 245t + 200$ with $0 \leq t \leq 16.1$ (upper limit may vary) on [0, 18] by [0, 1200]. This graph will appear as a vertical line from about (17, 0) to about (17, 1138). Tracing shows how the arrow begins at a height of 200 ft, rises to over 1000 ft, then falls back to the ground.



[0, 18] by [0, 1200]

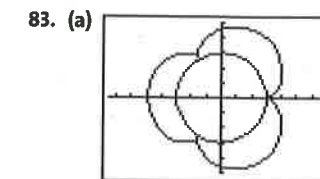
(d) 924 ft (e) $t \approx 7.66$; about 1138 ft (f) about 16.09 sec

81. $x = 40 \sin(\frac{2\pi}{15}t), y = 50 - 40 \cos(\frac{2\pi}{15}t)$

85. $t \approx 1.06$ sec, $x \approx 68.65$ ft

87. (a) about 77.59 ft (b) 4.404 sec

89. ≈ 17.65 ft

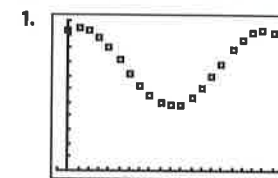


[-7.5, 7.5] by [-5, 5]

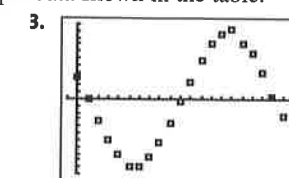
(b) All 4's should be changed to 5's.

Chapter 6 Project

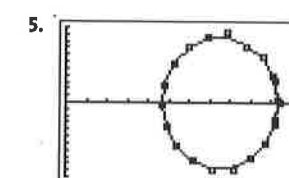
Answers are based on the sample data shown in the table.



[-0.1, 2.1] by [0, 1.1]



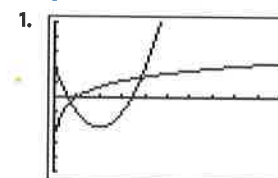
[-0.1, 2.1] by [-1.1, 1.1]



[0, 1.1] by [-1.1, 1.1]

SECTION 7.1

Exploration 1



[0, 10] by [-5, 5]

Quick Review 7.1

1. $y = \frac{5}{3} - \frac{2}{3}x$ 3. $x = -\frac{2}{3}, x = 1$ 5. 0, 2, -2 7. $y = \frac{-4x + 6}{5}$ 9. $-4x - 6y = -10$

Exercises 7.1

1. (a) No (b) Yes (c) No 3. (9, -2) 5. $(\frac{50}{7}, -\frac{10}{7})$ 7. $(-\frac{1}{2}, 2)$ 9. No solution 11. $(\pm 3, 9)$

13. $(-\frac{3}{2}, \frac{27}{2}), (\frac{1}{3}, \frac{2}{3})$ 15. (0, 0), (3, 18) 17. $(\frac{-1 + 3\sqrt{89}}{10}, \frac{3 + \sqrt{89}}{10}), (\frac{-1 - 3\sqrt{89}}{10}, \frac{3 - \sqrt{89}}{10})$

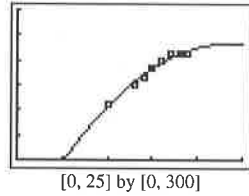
19. (8, -2) 21. (4, 2) 23. No solution 25. Any pair $(x, \frac{2x}{3} - \frac{5}{3})$ 27. (0, 1), (3, -2)

29. No solution 31. One solution 33. Infinitely many solutions 35. $\approx (0.69, -0.37)$

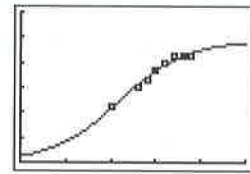
37. $\approx (-2.32, -3.16), (0.47, -1.77)$ and $(1.85, -1.08)$ 39. $(-1.2, 1.6), (2, 0)$

41. $\approx (2.05, 2.19)$ and $(-2.05, 2.19)$ 43. $(3.75, 143.75)$

45. (a) $y \approx -0.710x^2 + 33.095x - 153.467$ (b) $y \approx \frac{243.956}{1 + 19.259e^{(-0.271x)}}$



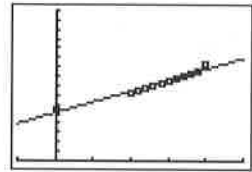
[0, 25] by [0, 300]



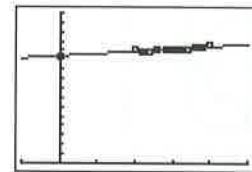
[0, 25] by [0, 300]

- (c) Quadratic: never; logistic: in 2006
 (d) The quadratic regression predicts that the expenditures will eventually be 0.
 (e) The logistic regression predicts that the expenditures will eventually level off at about 244 billion dollars.

47. (a) $y \approx 116.841x + 2561.768$ (b) $y \approx 25.060x + 5715.174$ (c) Sometime in 2014



[-5, 25] by [0, 8000]



[-5, 25] by [0, 8000]

49. $\approx 5.28 \text{ m} \times \approx 94.72 \text{ m}$
 51. current speed $\approx 1.06 \text{ mph}$; rowing speed $\approx 3.56 \text{ mph}$
 53. Medium: \$0.79; large: \$0.95
 55. $a = \frac{2}{3}, b = \frac{14}{3}$ 57. (a) 300

59. False. A system of two linear equations in two variables has either 0, 1, or infinitely many solutions. 61. (c) 63. (d)

65. (a) $y = \frac{3}{2}\sqrt{4-x^2}, y = -\frac{3}{2}\sqrt{4-x^2}$ (b) $\approx (-1.29, 2.29)$ or $(1.91, -0.91)$ 67. $(\pm\sqrt{\frac{2}{3}}, \frac{10}{3})$ 69. 12.5 units

SECTION 7.2

Exploration 1

1. $A = \begin{bmatrix} 2 & 1 \\ 5 & 4 \end{bmatrix}; B = \begin{bmatrix} -1 & 2 \\ 2 & 5 \end{bmatrix}$ 3. $\begin{bmatrix} 8 & -1 \\ 11 & 2 \end{bmatrix}$

Exploration 2

1. $\det A = -a_{12}a_{21}a_{33} + a_{13}a_{21}a_{32} + a_{11}a_{22}a_{33} - a_{13}a_{22}a_{31} - a_{11}a_{23}a_{32} + a_{12}a_{23}a_{31}$

3. Since each term in the expansion contains an element from each row and each column, at least one factor in each term is a zero. Therefore, the expansion will be the sum of $2n$ zero terms, or zero.

Quick Review 7.2

1. (a) $(3, 2)$ (b) $(x, -y)$ 3. (a) $(-2, 3)$ (b) (y, x) 5. $(3 \cos \theta, 3 \sin \theta)$ 7. $\sin \alpha \cos \beta + \cos \alpha \sin \beta$
 9. $\cos \alpha \cos \beta - \sin \alpha \sin \beta$

Exercises 7.2

1. 2×3 ; not square 3. 3×2 ; not square 5. 3×1 ; not square 7. 3 9. 4

11. (a) $\begin{bmatrix} 3 & 0 \\ -3 & 1 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & 6 \\ 1 & 9 \end{bmatrix}$ (c) $\begin{bmatrix} 6 & 9 \\ -3 & 15 \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 15 \\ 4 & 22 \end{bmatrix}$

13. (a) $\begin{bmatrix} 1 & 1 \\ -2 & 0 \\ -1 & 0 \end{bmatrix}$ (b) $\begin{bmatrix} -7 & 1 \\ 2 & -2 \\ 5 & 2 \end{bmatrix}$ (c) $\begin{bmatrix} -9 & 3 \\ 0 & -3 \\ 6 & 3 \end{bmatrix}$ (d) $\begin{bmatrix} -18 & 2 \\ 6 & -5 \\ 13 & 5 \end{bmatrix}$

15. (a) $\begin{bmatrix} -3 \\ 1 \\ 4 \end{bmatrix}$ (b) $\begin{bmatrix} -1 \\ 1 \\ -4 \end{bmatrix}$ (c) $\begin{bmatrix} -6 \\ 3 \\ 0 \end{bmatrix}$ (d) $\begin{bmatrix} -1 \\ 2 \\ -12 \end{bmatrix}$ 17. (a) $\begin{bmatrix} -4 & -18 \\ -11 & -17 \end{bmatrix}$ (b) $\begin{bmatrix} 5 & -12 \\ 0 & -26 \end{bmatrix}$

19. (a) $\begin{bmatrix} 2 & 2 \\ -11 & 12 \end{bmatrix}$ (b) $\begin{bmatrix} 4 & 8 & -5 \\ -5 & 4 & -6 \\ -2 & -8 & 6 \end{bmatrix}$ 21. (a) $\begin{bmatrix} 6 & -7 & -2 \\ 3 & 7 & 3 \\ 8 & -1 & -1 \end{bmatrix}$ (b) $\begin{bmatrix} 2 & 1 & 3 \\ 5 & 0 & 0 \\ -18 & -3 & 10 \end{bmatrix}$

23. (a) $[-8]$ (b) $\begin{bmatrix} -10 & -5 & -15 \\ 8 & -4 & 12 \\ 4 & -2 & 6 \end{bmatrix}$ 25. (a) not possible (b) $[18 \quad 14]$ 27. (a) $\begin{bmatrix} -1 & 3 & 4 \\ 2 & 0 & 1 \\ 1 & 2 & 1 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & 2 & 1 \\ 1 & 0 & 2 \\ 4 & 3 & -1 \end{bmatrix}$

29. $a = 5, b = 2$ 31. $a = -2, b = 0$ 33. $AB = BA = I_2$ 35. $\begin{bmatrix} -1 & 1.5 \\ 1 & -1 \end{bmatrix}$ 37. no inverse 39. no inverse

41. -14 43. $\begin{bmatrix} -1 \\ -\frac{1}{3} \end{bmatrix}$ 45. (a) The distance from city X to city Y is the same as the distance from city Y to city X.

(b) Each entry represents the distance from city X to city X. 47. (a) $[382 \quad 227.50]$ 49. (a) AB^T or BA^T (b) $(A - C)B^T$

51. (a) $\approx (1.37, 0.37)$ (b) $\approx (0.37, 1.37)$ 55. $A \cdot A^{-1} = I_2$ 57. $\begin{bmatrix} x & y \\ -1 & 0 \\ 0 & 1 \end{bmatrix}$ 59. $\begin{bmatrix} x & y \\ 0 & -1 \\ -1 & 0 \end{bmatrix}$

61. $\begin{bmatrix} x & y \\ c & 0 \\ 0 & 1 \end{bmatrix}$ 63. False. It can be negative. For example, the determinant of $A = \begin{bmatrix} 1 & 0 \\ 2 & -1 \end{bmatrix}$ is -1 .

65. (b) 67. (d) 71. (a) $A \cdot A^{-1} = A^{-1} \cdot A = I_2$ (c) It is the inverse of A.

73. (b) The constant term equals $-\det A$. (c) The coefficient of x^2 is the opposite of the sum of the elements of the main diagonal in A.

SECTION 7.3

Exploration 1

1. $x + y + z$ must equal 60 L. 3. The number of liters of 35% solution must equal twice the number of liters of 55% solution.

5. $\begin{bmatrix} 3.75 \\ 37.5 \\ 18.75 \end{bmatrix}$

Quick Review 7.3

1. 12.8 liters 3. 38 liters 5. $(-1, 6)$ 7. $y = w - z + 1$ 9. $\begin{bmatrix} -0.5 & -0.75 \\ 0.5 & 0.25 \end{bmatrix}$

Exercises 7.3

1. $(\frac{25}{2}, \frac{7}{2}, -2)$ 3. $(1, 2, 1)$ 5. No solution 7. $(\frac{9}{2}, \frac{7}{2}, 4, -\frac{15}{2})$ 9. $\begin{bmatrix} 2 & -6 & 4 \\ 1 & 2 & -3 \\ 0 & -8 & 4 \end{bmatrix}$ 11. $\begin{bmatrix} 0 & -10 & 10 \\ 1 & 2 & -3 \\ -3 & 1 & -2 \end{bmatrix}$

13. R_{12} 15. $(-3)R_2 + R_3$

For Exercises 17 and 19, possible answers are given.

17. $\begin{bmatrix} 1 & 3 & -1 \\ 0 & 1 & -1.2 \\ 0 & 0 & 1 \end{bmatrix}$ 19. $\begin{bmatrix} 1 & 2 & 3 & -4 \\ 0 & 1 & 0 & -0.6 \\ 0 & 0 & 1 & -9.2 \end{bmatrix}$ 23. $\begin{bmatrix} 1 & 0 & -1 & 3 \\ 0 & 1 & 2 & -1 \end{bmatrix}$ 25. $\begin{bmatrix} 2 & -3 & 1 & 1 \\ -1 & 1 & -4 & -3 \\ 3 & 0 & -1 & 2 \end{bmatrix}$

27. $\begin{bmatrix} 2 & -5 & 1 & -1 & -3 \\ 1 & 0 & -2 & 1 & 4 \\ 0 & 2 & -3 & -1 & 5 \end{bmatrix}$

In Exercises 29 and 31, the variable names are arbitrary.

29. $3x + 2y = -1$
 $-4x + 5y = 2$

31. $2x + z = 3$
 $-x + y = 2$
 $2y - 3z = -1$

33. $(2, -1, 4); \begin{bmatrix} 1 & -2 & 1 & 8 \\ 0 & 1 & -1 & -5 \\ 0 & 0 & 1 & 4 \end{bmatrix}$

35. $(-2, 3, 1)$ 37. No solution

39. $(2 - z, 1 + z, z)$ 41. no solution 43. $(z + w + 2, 2z - w - 1, z, w)$ 45. $\begin{bmatrix} 2 & 5 \\ 1 & -2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} -3 \\ 1 \end{bmatrix}$

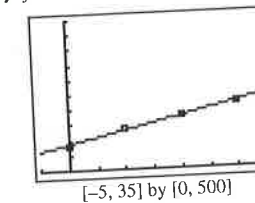
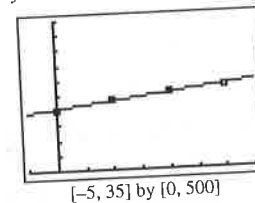
47. $3x - y = -1$
 $2x + 4y = 3$

49. $(-2, 3)$ 51. $(-2, -5, -7)$ 53. $(-1, 2, -2, 3)$ 55. $(0, -10, 1)$ 57. $(3, 3, -2, 0)$

59. $(2 - \frac{3}{2}z, -\frac{1}{2}z - 4, z)$ 61. $(-1 - 2w, w + 1, -w, w)$ 63. $(-w - 2, 0.5 - z, z, w)$ 65. No solution

67. $f(x) = 2x^2 - 3x - 2$ 69. $f(x) = (-c - 3)x^2 + x + c$, for any c

71. (a) $y = 2.42x + 206.7$ (b) $y = 4.47x + 87.2$ (c) Sometime in 2028



73. 825 children, 410 adults, 165 senior citizens 75. \$14,500 CDs, \$5500 bonds, \$60,000 growth funds

77. \$0 CDs, \$38,983.05 bonds, \$11,016.95 growth fund 79. 22 nickels, 35 dimes, and 17 quarters 81. $(\frac{16}{3}, \frac{220}{3})$

85. False. The determinant of the matrix must be not equal to zero. 87. (d) 89. (d)

93. (a) $C(x) = x^2 - 8x + 13$ (b)

(c) $4 \pm \sqrt{3}$
 (d) $\det A = C(0) = 13$
 (e) $a_{11} + a_{22} = (4 - \sqrt{3}) + (4 + \sqrt{3}) = 8$

SECTION 7.4

Exploration 1

1. (a) $3 = A_2$ (b) $2 = A_1$

Quick Review 7.4

1. $\frac{3x-5}{x^2-4x+3}$ 3. $\frac{4x^2+6x+1}{x^3+2x^2+x}$ 5. $3x^2 - 2 + \frac{3}{x-2}$ 7. $(x+1)(x-3)(x^2+4)$ 9. $A = 3, B = -1, C = 1$

Exercises 7.4

1. $\frac{A_1}{x} + \frac{A_2}{x-2} + \frac{A_3}{x+2}$ 3. $\frac{A_1}{x} + \frac{A_2}{x^2} + \frac{A_3}{x^3} + \frac{A_4}{x-1} + \frac{A_5}{(x-1)^2} + \frac{B_1x+C_1}{x^2+9}$ 5. $\frac{-3}{x+4} + \frac{4}{x-2}$ 7. $\frac{3}{x^2+1} + \frac{2x-1}{(x^2+1)^2}$

9. $\frac{1}{x-2} + \frac{2}{(x-2)^2} + \frac{1}{(x-2)^3}$ 11. $\frac{2}{x+3} + \frac{-1}{(x+3)^2} + \frac{3x-1}{x^2+2} + \frac{x+2}{(x^2+2)^2}$ 13. $\frac{1}{x-5} + \frac{-1}{x-3}$ 15. $\frac{2}{x-1} + \frac{-2}{x+1}$