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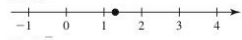
# Student Answer Appendix

## CHAPTER R

### Exercises R.1, pp. 10–12

1. proper subset; element 3. positive; negative, 7, -7; principal  
 5. Order of operations requires multiplication before addition.  
 7. a. {1, 2, 3, 4, 5} b. { } 9. True 11. True 13. True

15. 1.3



17. 2.5



19. ≈2.65



21. ≈1.73



23. a. i. {8, 7, 6} ii. {8, 7, 6} iii. (-1, 8, 7, 6)  
 iv. {-1, 8, 0, 75, 9/2, 5, 6, 7, 3/4, 6} v. { }  
 vi. {-1, 8, 0.75, 9/2, 5.6, 7, 3/4, 6} b. {-1, 3/4, 0.75, 9/2, 5.6, 6, 7, 8}



25. a. i. {√49, 2, 6, 4} ii. {√49, 2, 6, 0, 4} iii. {-5, √49, 2, -3, 6, -1, 0, 4} iv. {-5, √49, 2, -3, 6, -1, 0, 4}  
 v. {√3, π} vi. {-5, √49, 2, -3, 6, -1, √3, 0, 4, π}



27. False; not all real numbers are irrational. 29. False; not all rational numbers are integers. 31. False; √25 = 5 is not irrational. 33. c IV  
 35. a VI 37. d III 39. Let  $a$  represent Kylie's age:  $a \geq 6$  years.  
 41. Let  $n$  represent the number of incorrect words:  $n \leq 2$  incorrect.

43. 2.75 45. -4 47.  $\frac{1}{2}$  49.  $\frac{3}{4}$  51. 10 53. -8, 2 55. negative

57.  $-n$  59. undefined, since  $12 \div 0 = k$  implies  $k \cdot 0 = 12$   
 61. undefined, since  $7 \div 0 = k$  implies  $k \cdot 0 = 7$  63. a. positive

b. negative c. negative d. negative 65.  $-\frac{11}{6}$  67. -2

69.  $9^2 = 81$  is closest 71. 7 73. -2.185 75.  $4\frac{1}{3}$  77.  $-\frac{29}{12}$  or  $-2\frac{5}{12}$

79. 0 81. -5 83.  $-\frac{1}{10}$  85.  $-\frac{7}{8}$  87. -4 89.  $-\frac{11}{12}$  91. 64

93. 4489.70 95.  $D = 4.3$  cm 97. 32°F 99. 179°F  
 101. Tsu Ch'ung-chih:  $\frac{355}{113}$  103. negative

### Exercises R.2, pp. 18–21

1. constant 3. coefficient 5.  $-5 + 5 = 0$ ,  $-5 \cdot (-\frac{1}{5}) = 1$   
 7. two; 3 and -5 9. two; 2 and  $\frac{1}{4}$  11. three; -2, 1, and -5  
 13. one; -1 15.  $n - 7$  17.  $n + 4$  19.  $(n - 5)^2$  21.  $2n - 13$   
 23.  $n^2 + 2n$  25.  $\frac{3}{4}n - 5$  27.  $3(n + 5) - 7$  29. Let  $w$  represent the width. Then  $2w$  represents twice the width and  $2w - 3$  represents three meters less than twice the width. 31. Let  $b$  represent the speed of the bus. Then  $b + 15$  represents 15 mph more than the speed of the bus.  
 33.  $h = b + 150$  35.  $L = 2W + 20$  37.  $M = 2.5N$

39.  $T = 12.50g + 50$  41. 14 43. 19 45. 0 47. 16 49. -36  
 51. 51 53. 2 55. 144 57.  $-\frac{34}{3}$  59. 24

61.

x	Output
-3	14
-2	6
-1	0
0	-4
1	-6
2	-6
3	-4

-1 has an output of 0.

63.

x	Output
-3	-18
-2	-15
-1	-12
0	-9
1	-6
2	-3
3	0

3 has an output of 0.

65.

x	Output
-3	-5
-2	8
-1	9
0	4
1	-1
2	0
3	13

2 has an output of 0.

67. a.  $7 + (-5) = 2$  b.  $n + (-2)$  c.  $a + (-4.2) + 13.6 = a + 9.4$   
 d.  $x + 7 - 7 = x$  69. a. 3.2 b.  $\frac{5}{6}$  71.  $-5x + 13$

73.  $-\frac{2}{15}p + 6$  75.  $-2a$  77.  $\frac{11}{12}x$  79.  $-2a^2 + 2a$  81.  $6x^2 - 3x$

83.  $2a + 3b + 2c$  85.  $\frac{29}{8}n + \frac{38}{8}$  87.  $7a^2 - 13a - 5$  89. 10 ohms

91. a.  $t = \frac{1}{2}j$  b.  $t = 225$  mph 93. a.  $L = 2W + 3$  b. 107 ft

95.  $t = c + 22$ ; 37¢ 97.  $C = 25t + 43.50$ ; \$81

99. a. positive odd integer

### Exercises R.3, pp. 31–34

1. power 3. 20x; 0 5. a. cannot be simplified, unlike terms  
 b. can be simplified, like bases 7.  $14n^7$  9.  $-12p^5q^4$  11.  $a^{14}b^7$

13.  $216p^3q^6$  15.  $32.768h^3k^6$  17.  $\frac{p^2}{4q^2}$  19.  $49c^{14}d^4$  21.  $\frac{9}{16}x^4y^2$

23.  $\frac{9}{4}x^3y^2$  25. a.  $V = 27x^6$  b. 1728 units<sup>3</sup> 27.  $3w^3$  29.  $-3ab$

31.  $\frac{27}{8}$  33.  $2h^3$  35.  $-\frac{1}{8}$  37. -8 39.  $\frac{4p^8}{q^6}$  41.  $\frac{8x^6}{27y^9}$  43.  $\frac{25m^4n^6}{4r^8}$

45.  $\frac{25p^2q^2}{4}$  47.  $\frac{3p^2}{-4q^2}$  49.  $\frac{5}{3h^7}$  51.  $\frac{1}{a^3}$  53.  $\frac{a^{12}}{b^4c^8}$  55.  $\frac{-12}{5x^4}$

57.  $\frac{-2b^7}{27a^9c^3}$  59. 2 61.  $\frac{7}{10}$  63.  $\frac{13}{9}$  65. -4 67.  $6.6 \times 10^9$

69. 0.000 000 006 5 71. 26,571 hrs; 1,107 days 73. polynomial, none of these, degree 3 75. nonpolynomial because exponents are not whole numbers, NA, NA 77. polynomial, binomial, degree 3

79.  $-w^3 - 3w^2 + 7w + 8$ ; -1 81.  $c^3 + 2c^2 - 3c + 6$ ; 1  
 83.  $\frac{7}{3}x^2 + 12$ ;  $\frac{7}{3}$  85.  $3p^3 - 3p^2 - 12$  87.  $7.85b^2 - 0.6b - 1.9$

89.  $\frac{1}{4}x^2 - 8x + 6$  91.  $q^6 + q^5 - q^4 + 2q^3 - q^2 - 2q$   
 93.  $-3x^3 + 3x^2 + 18x$  95.  $3r^2 - 11r + 10$  97.  $x^3 - 27$

99.  $b^3 - b^2 - 34b - 56$  101.  $21v^2 - 47v + 20$  103.  $9 - m^2$   
 105.  $p^2 + 1.1p - 9$  107.  $x^2 + \frac{3}{4}x + \frac{1}{8}$  109.  $m^2 - \frac{9}{16}$

111.  $6x^2 + 11xy - 10y^2$  113.  $12c^2 + 23cd + 5d^2$   
 115.  $2x^4 - x^2 - 15$  117.  $4m + 3$ ;  $16m^2 - 9$   
 119.  $7x + 10$ ;  $49x^2 - 100$  121.  $6 - 5k$ ;  $36 - 25k^2$

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SA2 Student Answer Appendix

123.  $x - \sqrt{6}; x^2 - 6$  125.  $x^2 + 8x + 16$  127.  $16g^2 + 24g + 9$   
 129.  $16p^2 - 24pq + 9q^2$  131.  $16 - 8\sqrt{x} + x$   
 133.  $xy + 2x - 3y - 6$  135.  $k^3 + 3k^2 - 28k - 60$   
 137. a. 340 mg, 292.5 mg b. Less, amount is decreasing. c. after 5 hr  
 139.  $F = kPQd^{-2}$  141.  $5x^{-3} + 3x^{-2} + 2x^{-1} + 4$  143. \$15 145. 6

Exercises R.4, pp. 42–45

1. product 3. binomial, conjugate 5. Answers will vary.  
 7. a.  $-17(x^2 - 3)$  b.  $7b(3b^2 - 2b + 8)$  c.  $-3a^2(a^2 + 2a - 3)$   
 9. a.  $(a + 2)(2a + 3)$  b.  $(b^2 + 3)(3b + 2)$  c.  $(n + 7)(4m - 11)$   
 11. a.  $(3q + 2)(3q^2 + 5)$  b.  $(h - 12)(h^4 - 3)$  c.  $(k^2 - 7)(k^3 - 5)$   
 13. a.  $-1(p - 7)(p + 2)$  b.  $(q - 9)(q + 5)$  c.  $(n - 4)(n - 5)$   
 15. a.  $(3p + 2)(p - 5)$  b.  $(4q - 5)(q + 3)$  c.  $(5u + 3)(2u - 5)$   
 17. a.  $(2s + 5)(2s - 5)$  b.  $(3x + 7)(3x - 7)$  c.  $2(5x + 6)(5x - 6)$   
 d.  $(11h + 12)(11h - 12)$  e.  $(b + \sqrt{5})(b - \sqrt{5})$   
 19. a.  $(a - 3)^2$  b.  $(b + 5)^2$  c.  $(2m - 5)^2$  d.  $(3n - 7)^2$   
 21. a.  $(2p - 3)(4p^2 + 6p + 9)$  b.  $(m + \frac{1}{2})(m^2 - \frac{1}{2}m + \frac{1}{4})$   
 c.  $(g - 0.3)(g^2 + 0.3g + 0.09)$  d.  $-2t(t - 3)(t^2 + 3t + 9)$   
 23. a.  $(x + 3)(x - 3)(x + 1)(x - 1)$  b.  $(x^2 + 9)(x^2 + 4)$   
 c.  $(x - 2)(x^2 + 2x + 4)(x + 1)(x^2 - x + 1)$   
 25. a.  $(n + 1)(n - 1)$  b.  $(n - 1)(n^2 + n + 1)$   
 c.  $(n + 1)(n^2 - n + 1)$  d.  $7x(2x + 1)(2x - 1)$  27.  $(a + 5)(a + 2)$   
 29.  $2(x - 2)(x - 10)$  31.  $-1(3m + 8)(3m - 8)$  33.  $(r - 3)(r - 6)$   
 35.  $(2h + 3)(h + 2)$  37.  $(3k - 4)^2$  39.  $-3x(2x - 7)(x - 3)$   
 41.  $4m(m + 5)(m - 2)$  43.  $(a + 5)(a - 12)$  45.  $(2x - 5)(4x^2 + 10x + 25)$   
 47. prime 49.  $(x - 5)(x + 3)(x - 3)$  51. a. H b. E c. C d. F  
 e. B f. A g. I h. D i. G 53.  $2\pi r(r + h)$ ,  $7000\pi \text{ cm}^2$ ;  $21,991 \text{ cm}^2$   
 55.  $V = \frac{1}{3}\pi h(R + r)(R - r)$ ;  $6\pi \text{ cm}^3$ ;  $18.8 \text{ cm}^3$   
 57.  $V = x(x + 5)(x + 3)$  a. 3 in. b. 5 in.  
 c.  $V = 24(29)(27) = 18,792 \text{ in}^3$   
 59.  $L = L_{\text{av}} \left( 1 + \frac{v}{c} \left( 1 - \frac{v}{c} \right) \right)$   $L = 12\sqrt{1 + 0.75(1 - 0.75)}$   
 $= 3\sqrt{7} \text{ in.} \approx 7.94 \text{ in.}$  61. a.  $\frac{1}{4}(4x^4 + x^3 - 6x^2 + 32)$   
 b.  $\frac{1}{3}(12b^3 - 3b^3 + 8b^2 - 18)$  63.  $2x(16x - 27)(6x + 5)$   
 65.  $(x + 3)(x - 3)(x^2 + 9)$   
 67.  $(p + 1)(p^2 - p + 1)(p - 1)(p^2 + p + 1)$   
 69.  $(q + 5)(q - 5)(q + \sqrt{3})(q - \sqrt{3})$

Exercises R.5, pp. 51–54

1. 1; -1 3. common denominator 5. F; numerator should be -1  
 7. a.  $-\frac{1}{3}$  b.  $\frac{x + 3}{2x(x - 2)}$  9. a. simplified b.  $\frac{a - 4}{a - 7}$   
 11. a. -1 b. -1 13. a.  $-3ab^9$  b.  $\frac{x + 3}{9}$  c.  $-1(y + 3)$  d.  $-\frac{1}{m}$   
 15. a.  $\frac{2n + 3}{n}$  b.  $\frac{3x + 5}{2x + 3}$  c.  $x + 2$  d.  $n - 2$   
 17.  $\frac{(a - 2)(a + 1)}{(a + 3)(a + 2)}$  19. 1 21.  $\frac{(p - 4)^2}{p^2}$  23.  $-\frac{15}{4}$  25.  $\frac{3}{2}$   
 27.  $\frac{8(a - 7)}{a - 5}$  29.  $\frac{y}{x}$  31.  $\frac{m}{m - 4}$  33.  $\frac{y + 3}{3y(y + 4)}$  35.  $\frac{x + 0.3}{x - 0.2}$   
 37.  $\frac{n + \frac{1}{5}}{n + \frac{3}{2}}$  39.  $\frac{3(a^2 + 3a + 9)}{2}$  41.  $\frac{2n + 1}{n}$  43.  $\frac{3 + 20x}{8x^2}$   
 45.  $\frac{14y - x}{8x^2y^4}$  47.  $\frac{2}{p + 6}$  49.  $\frac{-3m - 16}{(m + 4)(m - 4)}$  51.  $\frac{-5m + 37}{m - 7}$   
 53.  $\frac{-y + 11}{(y + 6)(y - 5)}$  55.  $\frac{2a - 5}{(a + 4)(a - 5)}$  57.  $\frac{1}{y + 1}$   
 59.  $\frac{m^2 - 6m + 21}{(m + 3)^2(m - 3)}$  61.  $\frac{(5y + 1)(y + 3)(y - 2)}{y^2 + 26y - 1}$   
 63. a.  $\frac{1}{p^2} - \frac{5}{p} + \frac{1 - 5p}{p^2}$  b.  $\frac{1}{x^2} + \frac{2}{x^3} + \frac{x + 2}{x^3}$  65.  $-\frac{4a}{a + 20}$  67.  $p - 1$

69.  $\frac{x}{9x - 12}$  71.  $\frac{-2}{y + 31}$  73. a.  $1 + \frac{3}{m} \cdot \frac{m + 3}{m - 3}$  b.  $1 + \frac{2}{x^2} \cdot \frac{x^3 + 2}{1 - \frac{2}{x^2} \cdot x^2 - 2}$   
 75.  $\frac{f_2 + f_1}{f_1 f_2}$  77.  $\frac{-a}{x(x + h)}$  79.  $\frac{-(2x + h)}{2x^2(x + h)^2}$

81. a. \$300 million; \$2550 million 83. Price rises rapidly for first four days, then begins a gradual decrease. Yes, on the 35th day of trading.

P	450P 100 - P
40	300
60	675
80	1800
90	4050
93	5979
95	8550
98	22050
100	ERROR

Day	Price
0	10
1	16.67
2	32.76
3	47.40
4	53.51
5	52.86
6	49.25
7	44.91
8	40.75
9	37.03
10	33.81

85.  $t = 8$  weeks 87.  $b \cdot 20 \cdot n + 10 \cdot n = 2n^3$ , all others equal 2

89.  $\frac{6}{23} \frac{ac}{ad + bc}$

Exercises R.6, pp. 64–68

1. even 3.  $(16^3)^4$  5. Answers will vary. 7. 9 9. a.  $7|p|$  b.  $|x - 3|$   
 c.  $9m^2$  d.  $|x - 3|$  11. a. 4 b.  $-5x$  c.  $6e^4$  d.  $\frac{v}{-2}$   
 13. a. 2 b. not a real number c.  $3x^2$  d.  $-3x$  e.  $k - 3$  f.  $|h + 2|$   
 15. a. -5 b.  $-3|n^3|$  c. not a real number d.  $\frac{7|v^2|}{6}$  17. a. 4  
 b.  $\frac{64}{125}$  c.  $\frac{125}{8}$  d.  $\frac{9p^4}{4q^2}$  19. a. -1728 b. not a real number  
 c.  $\frac{1}{9}$  d.  $-\frac{256}{81x^4}$  21. a.  $\frac{32n^{10}}{p^2}$  b.  $\frac{1}{2y^4}$  23. a.  $3m\sqrt{2}$  b.  $10pq^2\sqrt{q}$   
 c.  $\frac{3}{2}mn\sqrt{n^2}$  d.  $4pq^3\sqrt{2p}$  e.  $-3 + \sqrt{7}$  f.  $\frac{9}{2} - \sqrt{2}$   
 25. a.  $15a^2$  b.  $-4b\sqrt{b}$  c.  $\frac{x^4\sqrt{y}}{3}$  d.  $3u^2v\sqrt[3]{v}$  27. a.  $2m^2$   
 b.  $3n$  c.  $\frac{3\sqrt{5}}{4x}$  d.  $\frac{18\sqrt[3]{3}}{z^3}$  29. a.  $2x^2y^3$  b.  $x^2\sqrt[4]{x}$  c.  $\sqrt[4]{b}$   
 d.  $\frac{1}{\sqrt[4]{6}}$  e.  $b^3$  31. a.  $9\sqrt{2}$  b.  $14\sqrt{3}$  c.  $16\sqrt{2m}$   
 d.  $-5\sqrt[3]{7p}$  33. a.  $-x\sqrt[3]{2x}$  b.  $2 - \sqrt{3x} + 3\sqrt{5}$   
 c.  $6x\sqrt{2x} + 5\sqrt{2} - \sqrt{7x} + 3\sqrt{3}$  35. a. 98 b.  $\sqrt{15} + \sqrt{21}$   
 c.  $n^2 - 5$  d.  $39 - 12\sqrt{3}$  37. a. -19  
 b.  $\sqrt{10} + \sqrt{65} - 2\sqrt{7} - \sqrt{182}$   
 c.  $12\sqrt{5} + 2\sqrt{14} + 36\sqrt{15} + 6\sqrt{42}$  39. Verified  
 41. Verified 43. a.  $\frac{\sqrt{3}}{2}$  b.  $\frac{2\sqrt{15x}}{9x^2}$  c.  $\frac{3\sqrt{6b}}{10b}$  d.  $\frac{\sqrt{2p^2}}{2p}$   
 e.  $\frac{5\sqrt{a^2}}{a}$  45. a.  $-12 + 4\sqrt{11}$ ; 1.27 b.  $\frac{6\sqrt{x} + 6\sqrt{2}}{x - 2}$   
 47. a.  $\sqrt{30} - 2\sqrt{5} - 3\sqrt{3} + 3\sqrt{2}$ ; 0.05  
 b.  $\frac{7 + 7\sqrt{2} + \sqrt{6} + 2\sqrt{3}}{-3}$ ; -7.60 49. 8.33 ft 51. a.  $8\sqrt{10}$  m;  
 b. about 25.3 m 53. a. 365.02 days b. 688.69 days c. 87.91 days  
 55. a. 36 mph b. 46.5 mph 57.  $12\pi\sqrt{34} \approx 219.82 \text{ m}^2$   
 59. a.  $(x + \sqrt{5})(x - \sqrt{5})$  b.  $(n + \sqrt{19})(n - \sqrt{19})$   
 61. a.  $13\sqrt{3x} + 39\sqrt{x}$  b. Answers will vary. 63.  $\frac{3\sqrt{2}}{2}$

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**Practice Test, pp. 70–71**


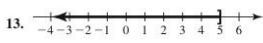
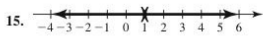
1. a. True b. True c. False;  $\sqrt{2}$  cannot be expressed as a ratio of two integers. d. True 2. a. 11 b.  $-5$  c. not a real number d. 20  
 3. a.  $\frac{9}{8}$  b.  $\frac{-7}{6}$  c. 0.5 d.  $-4.6$  4. a.  $\frac{28}{3}$  b. 0.9 c. 4 d.  $-7$   
 5. a.  $\approx 4439.28$  6. a. 0 b. undefined 7. a. 3;  $-2, 6, 5$   
 b.  $2; \frac{1}{3}$  8. a.  $-13$  b.  $\approx 7.29$  9. a.  $x^3 - (2x - 9)$   
 b.  $2n - 3\left(\frac{n}{2}\right)^2$  10. a. Let  $r$  represent Earth's radius. Then  $11r - 119$  represents Jupiter's radius. b. Let  $e$  represent this year's earnings. Then  $4e + 1.2$  million represents last year's earnings. 11. a.  $9v^2 + 3v - 7$   
 b.  $-7b + 8$  c.  $x^2 + 6x$  12. a.  $(3x + 4)(3x - 4)$  b.  $v(2v - 3)^2$   
 c.  $(x + 5)(x + 3)(x - 3)$  13. a.  $5b^3$  b.  $4a^{12}b^{12}$  c.  $\frac{m^6}{8n^3}$  d.  $\frac{25}{4}p^2q^2$   
 14. a.  $-4ab$  b.  $6.4 \times 10^{-2} = 0.064$  c.  $\frac{a^{12}}{b^4c^8}$  d.  $-6$   
 15. a.  $9x^4 - 25y^2$  b.  $4a^2 + 12ab + 9b^2$   
 16. a.  $7a^4 - 5a^3 + 8a^2 - 3a - 18$  b.  $-7x^4 + 4x^2 + 5x$  17. a.  $-1$   
 b.  $\frac{2+n}{2-n}$  c.  $x - 3$  d.  $\frac{x-5}{3x-2}$  e.  $\frac{x-5}{3x+1}$  f.  $\frac{3(m+7)}{5(m+4)(m-3)}$   
 18. a.  $|x + 11|$  b.  $\frac{-2}{3v}$  c.  $\frac{64}{125}$  d.  $\frac{-1}{2} + \frac{\sqrt{2}}{2}$  e.  $11\sqrt{10}$   
 f.  $x^2 - 5$  g.  $\frac{\sqrt{10x}}{5x}$  h.  $2(\sqrt{6} + \sqrt{2})$  19.  $-0.5x^2 + 10x + 1200$ ;  
 a. 10 decreases of 0.50 or 55.00 b. Maximum revenue is \$1250.  
 20. 58 cm

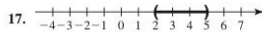
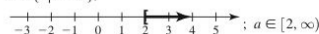
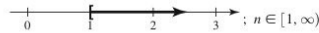
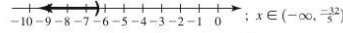
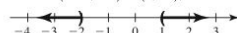
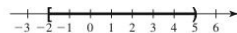
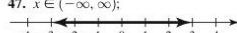

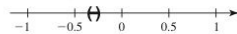
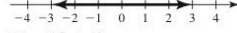
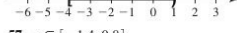
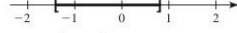
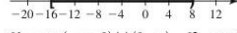
**CHAPTER 1**

**Exercises 1.1, pp. 82–85**

1. identity; unknown 3. literal; two 5. Answers will vary. 7.  $x = 3$   
 9.  $v = -11$  11.  $b = \frac{6}{5}$  13.  $b = -15$  15.  $m = -\frac{27}{4}$  17.  $x = 12$   
 19.  $x = 12$  21.  $p = -56$  23.  $a = -3.6$  25.  $v = -0.5$   
 27.  $n = \frac{20}{21}$  29.  $p = \frac{12}{5}$  31. contradiction;  $\{ \}$   
 33. conditional;  $n = -\frac{11}{10}$  35. identity;  $\{x|x \in \mathbb{R}\}$  37.  $C = \frac{P}{1+M}$   
 39.  $r = \frac{C}{2\pi}$  41.  $T_2 = \frac{T_1P_1V_2}{P_1V_1}$  43.  $h = \frac{3V}{4\pi r^2}$  45.  $n = \frac{2S_n}{a_1 + a_n}$   
 47.  $P = \frac{2(S-B)}{S}$  49.  $y = -\frac{A}{B}x + \frac{C}{B}$  51.  $y = \frac{-20}{9}x + \frac{16}{3}$   
 53.  $y = \frac{-4}{5}x - 5$  55.  $a = 3; b = 2; c = -19; x = -7$   
 57.  $a = -6; b = 1; c = 33; x = -\frac{16}{3}$   
 59.  $a = 7; b = -13; c = -27; x = -2$  61.  $h = 17$  cm 63. 510 ft  
 65. 56 in. 67. 3084 ft 69. 48; 50 71. 5; 7 73. 11; 30 A.M.  
 75. 36 min 77. 4 quarts; 50% O.J. 79. 16/lb; \$1.80/lb 81. 12 lb  
 83. 16 lb 85. Answers will vary 87. 69 89.  $-3$   
 91. a.  $(2x + 3)(2x - 3)$  b.  $(x - 3)(x^2 + 3x + 9)$

**Exercises 1.2, pp. 92–95**

1. set; interval 3. intersection; union 5. Answers will vary.  
 7.  $w \geq 45$  9.  $250 < T < 450$   
 11.   
 13.   
 15. 

17.   
 19.  $\{x|x \geq -2\}; [-2, \infty)$  21.  $\{x|-2 \leq x \leq 1\}; [-2, 1]$   
 23.  $\{a|a \geq 2\}$ ;  
;  $a \in [2, \infty)$   
 25.  $\{n|n \geq 1\}$ ;  
;  $n \in [1, \infty)$   
 27.  $\{x|x < -\frac{33}{5}\}$ ;  
;  $x \in (-\infty, -\frac{33}{5})$   
 29.  $\{ \}$  31.  $\{x|x \in \mathbb{R}\}$  33.  $\{x|x \in \mathbb{R}\}$   
 35.  $\{2\}; \{-3, -2, -1, 0, 1, 2, 3, 4, 6, 8\}$   
 37.  $\{ \}; \{-3, -2, -1, 0, 1, 2, 3, 4, 5, 6, 7\}$   
 39.  $\{4, 6\}; \{2, 4, 5, 6, 7, 8\}$   
 41.  $x \in (-\infty, -2) \cup (1, \infty)$ ;  
  
 43.  $x \in [-2, 5]$ ;  
  
 45. no solution  
 47.  $x \in (-\infty, \infty)$ ;  
  
 49.  $x \in [-5, 0]$ ;  
  
 51.  $x \in (\frac{-3}{4}, \frac{1}{4})$ ;  
  
 53.  $x \in (-\infty, \infty)$ ;  
  
 55.  $x \in [-4, 1]$ ;  
  
 57.  $x \in [-1.4, 0.8]$ ;  
  
 59.  $x \in (-16, 8)$ ;  
  
 61.  $m \in (-\infty, 0) \cup (0, \infty)$  63.  $y \in (-\infty, -7) \cup (-7, \infty)$   
 65.  $a \in (-\infty, \frac{1}{2}) \cup (\frac{1}{2}, \infty)$  67.  $x \in (-\infty, 4) \cup (4, \infty)$   
 69.  $x \in [2, \infty)$  71.  $n \in [4, \infty)$  73.  $b \in [\frac{1}{3}, \infty)$  75.  $y \in (-\infty, 2]$   
 77. a.  $W = \frac{BH^2}{704}$  b.  $W < 177.34$  lb 79.  $x \geq 81\%$  81.  $b \geq \$2000$   
 83.  $0 < w < 7.5$  m 85.  $7.2^\circ < C < 29.4^\circ$  87.  $h > 6$   
 89. Answers may vary. 91.  $<$  93.  $<$  95.  $<$  97.  $>$  99.  $2n - 8$   
 101.  $\frac{17}{8}x - 5$

**Exercises 1.3, pp. 101–103**

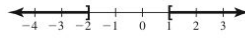
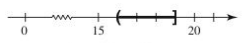
1. reverse 3.  $-7; 7$  5. no solution; answers will vary. 7.  $\{-4, 6\}$   
 9.  $\{2, -12\}$  11.  $\{-3.35, 0.85\}$  13.  $\{-\frac{8}{7}, 2\}$  15.  $\{-\frac{1}{2}, \frac{1}{2}\}$   
 17.  $\{ \}$  19.  $\{-10, -6\}$  21.  $\{3.5, 11.5\}$  23.  $\{-1.6, 1.6\}$   
 25.  $[-5, 9]$  27.  $\emptyset$  29.  $(-\frac{3}{5}, \frac{3}{5})$  31.  $(-5, -3)$  33.  $[\frac{8}{3}, \frac{14}{3}]$

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**SA4 Student Answer Appendix**

35.  $\emptyset$  37.  $[-\frac{7}{4}, 0]$  39.  $(-\infty, -10) \cup (4, \infty)$   
 41.  $(-\infty, -3] \cup [3, \infty)$  43.  $(-\infty, -\frac{7}{3}] \cup [\frac{7}{3}, \infty)$   
 45.  $(-\infty, \frac{3}{7}] \cup [1, \infty)$  47.  $(-\infty, \infty)$  49.  $(-\infty, 0) \cup (5, \infty)$   
 51.  $(-\infty, -0.75] \cup [3.25, \infty)$  53.  $(-\infty, -\frac{7}{15}) \cup (1, \infty)$   
 55.  $45 \leq d \leq 51$  in. 57. in feet: [32,500, 37,600]; yes  
 59. in feet:  $d < 210$  or  $d > 578$  61. a.  $|s - 37.58| \approx 3.35$   
 b. [34.23, 40.93] 63. a.  $|s - 125| \leq 23$  b. [102, 148]  
 65. a.  $|d - 42.7| < 0.03$  b.  $|d - 73.78| < 1.01$   
 c.  $|d - 57.150| < 0.127$  d.  $|d - 2171.05| < 12.05$   
 e. golf:  $t \approx 0.0014$  67. a.  $x = 4$  b.  $[\frac{4}{3}, 4]$  c.  $x = 0$  d.  $(-\infty, \frac{3}{5})$   
 e.  $\{ \}$  69.  $3x(2x + 5)(3x - 4)$  71.  $\frac{-3 + \sqrt{3}}{6} \approx -0.21$

**Mid-Chapter Check, pp. 103–104**

1. a.  $r = -9$  b.  $x = -6$  c. identity;  $m \in \mathbb{R}$  d.  $y = \frac{50}{13}$   
 e. contradiction:  $\{ \}$  f.  $x = 5.5$  2.  $v_0 = \frac{H + 16t^2}{t}$   
 3.  $x = \sqrt{\frac{S}{\pi(2 + y)}}$   
 4. a.  $x \geq 1$  or  $x \leq -2$   
  
 b.  $16 < x \leq 19$   


5. a.  $x \in (-\infty, \frac{5}{2}) \cup (\frac{5}{2}, \infty)$  b.  $x \in (-\infty, \frac{17}{6}]$   
 6. a.  $\{-4, 14\}$  b.  $\{ \}$  7. a.  $q \in (-8, 0)$  b.  $\{-6\}$   
 8. a.  $d \in (-\infty, 0] \cup [4, \infty)$  b.  $y \in (-\infty, \frac{19}{2}) \cup (\frac{23}{2}, \infty)$   
 c.  $k \in (-\infty, \infty)$  9. 1 hr, 20 min 10.  $w \in [8, 26]$ ; yes

**Reinforcing Basic Concepts pp. 104**

- Exercise 1:  $x = -3$  or  $x = 7$   
 Exercise 2:  $x \in [-5, 3]$   
 Exercise 3:  $x \in (-\infty, -1] \cup [4, \infty)$

**Exercises 1.4, pp. 111–114**

1.  $3 - 2i$  3.  $2 + 3\sqrt{2}$  5. (b) is correct. 7. a.  $4i$  b.  $7i$  c.  $3\sqrt{3}$   
 d.  $6\sqrt{2}$  9. a.  $-3i\sqrt{2}$  b.  $-5i\sqrt{2}$  c.  $15i$  d.  $6i$  11. a.  $i\sqrt{19}$   
 b.  $i\sqrt{31}$  c.  $\frac{2\sqrt{3}}{5}i$  d.  $\frac{3\sqrt{2}}{8}i$  13. a.  $1 + i$ ;  $a = 1, b = 1$   
 b.  $2 + \sqrt{3}i$ ;  $a = 2, b = \sqrt{3}$  15. a.  $4 + 2i$ ;  $a = 4, b = 2$   
 b.  $2 - \sqrt{2}i$ ;  $a = 2, b = -\sqrt{2}$  17. a.  $5 + 0i$ ;  $a = 5, b = 0$   
 b.  $0 + 3i$ ;  $a = 0, b = 3$  19. a.  $18i$ ;  $a = 0, b = 18$   
 b.  $\frac{\sqrt{2}}{2}i$ ;  $a = 0, b = \frac{\sqrt{2}}{2}$  21. a.  $4 + 5\sqrt{2}i$ ;  $a = 4, b = 5\sqrt{2}$   
 b.  $-5 + 3\sqrt{3}i$ ;  $a = -5, b = 3\sqrt{3}$   
 23. a.  $\frac{7}{4} + \frac{7\sqrt{2}}{8}i$ ;  $a = \frac{7}{4}, b = \frac{7\sqrt{2}}{8}$  b.  $\frac{1}{2} + \frac{\sqrt{10}}{2}i$ ;  $a = \frac{1}{2}, b = \frac{\sqrt{10}}{2}$   
 25. a.  $19 + i$  b.  $2 - 4i$  c.  $9 + 10\sqrt{3}i$  27. a.  $-3 + 2i$  b.  $8$   
 c.  $2 - 8i$  29. a.  $2.7 + 0.2i$  b.  $15 + \frac{1}{12}i$  c.  $-2 - \frac{1}{8}i$   
 31. a. 15 b. 16 33. a.  $-21 - 35i$  b.  $-42 - 18i$

35. a.  $-12 - 5i$  b.  $1 + 5i$  37. a.  $4 - 5i$ ; 41. b.  $3 + i\sqrt{2}$ ; 11  
 39. a.  $-7i$ ; 49. b.  $\frac{1}{2} + \frac{3}{4}i$ ;  $\frac{11}{36}$  41. a. 41 b. 74 43. a. 11 b.  $\frac{11}{36}$   
 45. a.  $-5 + 12i$  b.  $-7 - 24i$  47. a.  $-21 - 20i$  b.  $7 + 6\sqrt{2}i$   
 49. no 51. yes 53. yes 55. yes 57. yes 59. Answers will vary.  
 61. a. 1 b.  $-1$  c.  $-i$  d.  $i$  63. a.  $\frac{2}{7}i$  b.  $-\frac{4}{5}i$   
 65. a.  $\frac{21}{13} - \frac{14}{13}i$  b.  $-\frac{10}{13} - \frac{15}{13}i$  67. a.  $1 - \frac{3}{4}i$  b.  $-1 - \frac{2}{3}i$   
 69. a.  $\sqrt{13}$  b. 5 c.  $\sqrt{11}$  71.  $A + B = 10$   $AB = 40$   
 73.  $7 - 5i\Omega$  75.  $25 + 5i\sqrt{7}$  77.  $\frac{7}{4} + i\Omega$  79. a.  $(x + 6i)(x - 6i)$   
 b.  $(m + i\sqrt{3})(m - i\sqrt{3})$  c.  $(n + 2i\sqrt{3})(n - 2i\sqrt{3})$   
 d.  $(2x + 7i)(2x - 7i)$  81.  $-8 - 6i$  83. a.  $P = 4s$ ;  $A = s^2$   
 b.  $P = 2L + 2W$ ;  $A = LW$  85. John

**Exercises 1.5, pp. 124–128**

1. descending; 0 3. quadratic; 1 5. GCF factoring:  $x = 0, x = \frac{3}{4}$   
 7.  $a = -1; b = 2; c = -15$  9. not quadratic  
 11.  $a = \frac{1}{2}; b = -6; c = 0$  13.  $a = 2; b = 0; c = 7$  15. not quadratic  
 17.  $a = 1; b = -1; c = -5$  19.  $x = 5$  or  $x = -3$  21.  $m = 4$   
 23.  $p = 0$  or  $p = 2$  25.  $h = 0$  or  $h = -\frac{1}{2}$  27.  $a = 3$  or  $a = -3$   
 29.  $g = -9$  31.  $m = -5$  or  $m = -3$  or  $m = 3$  33.  $c = -3$  or  $c = 15$   
 35.  $r = 8$  or  $r = -3$  37.  $t = -13$  or  $t = 2$  39.  $x = 5$  or  $x = -3$   
 41.  $w = -\frac{1}{2}$  or  $w = 3$  43.  $m = \pm 4$  45.  $y = \pm 2\sqrt{7}$ ;  $y = \pm 5.29$   
 47. no real solutions 49.  $x = \pm \frac{\sqrt{21}}{4}$ ;  $x \approx \pm 1.15$  51.  $m = 9; n = -3$   
 53.  $w = -5 \pm \sqrt{3}$ ;  $w \approx -3.27$  or  $w \approx -6.73$  55. no real solutions  
 57.  $m = 2 \pm \frac{3\sqrt{5}}{2}$ ;  $m \approx 2.61$  or  $m \approx 1.39$  59.  $9; (x + 3)^2$   
 61.  $\frac{2}{3}; (n + \frac{3}{2})^2$  63.  $\frac{3}{4}; (p + \frac{1}{2})^2$  65.  $x = -1; x = -5$   
 67.  $p = 3 \pm \sqrt{6}$ ;  $p = 5.45$  or  $p = 0.55$   
 69.  $p = -3 \pm \sqrt{5}$ ;  $p \approx -0.76$  or  $p = -5.24$   
 71.  $m = \frac{-3 \pm \sqrt{13}}{2}$ ;  $m = 0.30$  or  $m = -3.30$   
 73.  $n = \frac{5}{2} \pm \frac{3\sqrt{5}}{2}$ ;  $n = 5.85$  or  $n = -0.85$   
 75.  $x = \frac{1}{2}$  or  $x = -4$  77.  $n = 3$  or  $n = -\frac{3}{2}$   
 79.  $p = \frac{3}{8} \pm \frac{\sqrt{41}}{8}$ ;  $p \approx 1.18$  or  $p \approx -0.43$   
 81.  $m = \frac{2}{3} \pm \frac{\sqrt{33}}{3}$ ;  $m = 6.37$  or  $m = 0.63$   
 83.  $x = 6$  or  $x = -3$  85.  $m = \pm \frac{5}{2}$   
 87.  $n = \frac{2 \pm \sqrt{5}}{2}$ ;  $n \approx 2.12$  or  $n \approx -0.12$  89.  $w = \frac{2}{3}$  or  $w = -\frac{1}{2}$   
 91.  $m = \frac{3}{2} \pm \frac{\sqrt{5}}{2}i$ ;  $m = 1.5 \pm 1.12i$  93.  $n = \pm \frac{3}{2}$   
 95.  $w = -\frac{1}{4}$  or  $w = 2$  97.  $a = \frac{1}{6} \pm \frac{\sqrt{23}}{6}i$ ;  $a = 0.16 \pm 0.80i$   
 99.  $p = \frac{3 \pm \sqrt{6}}{5}$ ;  $p = 1.58$  or  $p = -0.38$   
 101.  $w = \frac{1 \pm \sqrt{21}}{10}$ ;  $w = 0.56$  or  $w = -0.36$   
 103.  $a = \frac{1}{4} \pm \frac{\sqrt{31}}{4}i$ ;  $a = 0.75 \pm 1.39i$   
 105.  $p = 1 \pm \frac{3\sqrt{2}}{2}i$ ;  $p \approx 1 \pm 2.12i$   
 107.  $w = \frac{-1 \pm \sqrt{2}}{3}$ ;  $w \approx 0.14$  or  $w \approx -0.80$   
 109.  $a = \frac{-6 \pm 3\sqrt{2}}{2}$ ;  $a \approx -0.88$  or  $a \approx -5.12$   
 111.  $p = \frac{4 \pm \sqrt{694}}{10}$ ;  $p = 3.97$  or  $p = -2.64$   
 113. two rational; factorable 115. two complex 117. two rational;  
 factorable 119. two complex 121. two irrational 123. one repeated;  
 factorable 125.  $x = \frac{3}{2} \pm \frac{1}{2}i$  127.  $x = -\frac{1}{2} \pm \frac{13}{2}i$   
 129.  $x = \frac{5}{4} \pm \frac{3i\sqrt{7}}{4}$  131.  $t = \frac{v \pm \sqrt{v^2 - 64h}}{32}$   
 133.  $t = \frac{6 + \sqrt{138}}{2}$  sec;  $t \approx 8.87$  sec 135. 30,000 ovens  
 137. a.  $P = -x^2 + 120x - 2000$  b. 10,000 139.  $t = 2.5$  sec, 6.5 sec  
 141.  $x = 13.5$ , or the year 2008 143. 36 ft, 78 ft  
 145. a.  $7x^2 + 6x - 16 = 0$  b.  $6x^2 + 5x - 14 = 0$   
 c.  $5x^2 - x - 6 = 0$  147.  $x = -2i$ ;  $x = 5i$  149.  $x = \frac{-3}{4}i$ ;  $x = 2i$   
 151.  $x = -1 - i$ ;  $x = -13 - i$  153. a.  $P = 2L + 2W$ ,  $A = LW$   
 b.  $P = 2\pi r$ ,  $A = \pi r^2$  c.  $A = \frac{1}{2}h(b_1 + b_2)$ ,  $P = c + h + b_1 + b_2$   
 d.  $A = \frac{1}{2}bh$ ,  $P = a + b + c$  155. 700 \$30 tickets; 200 \$20 tickets

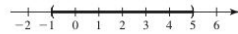
**Exercises 1.6, pp. 137–142**

1. excluded 3. extraneous 5. Answers will vary.  
 7.  $x = -2, x = 0, x = 11$  9.  $x = -3, x = 0, x = \frac{3}{2}$   
 11.  $x = -\frac{3}{2}, x = 0, x = 3$  13.  $x = 0, x = 2, x = -1 \pm i\sqrt{3}$



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15.  $x = \pm 2, x = 5$  17.  $x = 3, x = \pm 2i$  19.  $x = \pm \sqrt{5}, x = 6$   
 21.  $x = 0, x = 7, x = \pm 2i$  23.  $x = \pm 3, x = \pm 3i$   
 25.  $x = \pm 4, x = \pm 4i$  27.  $x = \pm \sqrt{2}, x = \pm 1, \pm i$   
 29.  $x = \pm 1, x = 2, x = -1 \pm i\sqrt{3}$   
 31.  $x = -\frac{1}{2} \pm \frac{i\sqrt{3}}{2}, x = \frac{1}{2} \pm \frac{i\sqrt{3}}{2}, x = \pm 1$  33.  $x = 1$  35.  $a = \frac{3}{2}$   
 37.  $y = 12$  39.  $x = 3; x = 7$  is extraneous 41.  $n = 7$   
 43.  $a = -1, a = -8$  45.  $f = \frac{f_1 f_2}{f_1 + f_2}$  47.  $r = \frac{E - IR}{I}$  or  $\frac{E}{I} - R$   
 49.  $h = \frac{3V}{\pi r^2}$  51.  $r^3 = \frac{3V}{4\pi}$  53. a.  $x = \frac{1}{3}$   
 b.  $x = 8, x = 1$  is extraneous 55. a.  $m = 3$  b.  $x = 5$  c.  $m = -64$   
 d.  $x = -16$  57. a.  $x = 25$  b.  $x = 7; x = -2$  is extraneous  
 c.  $x = 2, x = 18$  d.  $x = 6; x = 0$  is extraneous 59.  $x = -32$   
 61.  $x = 9$  63.  $x = -32, x = 22$  65.  $x = -27, 125$   
 67.  $x = \pm 5, x = \pm i$  69.  $x = \pm 1, \pm 2$  71.  $x = -1, \frac{1}{4}$   
 73.  $x = \pm \frac{1}{3}, \pm \frac{1}{2}$  75.  $x = -4, 45$   
 77.  $x = -6, x = -\frac{24}{5}$  is extraneous 79. a.  $h = \sqrt{\left(\frac{S}{\pi r}\right)^2 - r^2}$   
 b.  $S = 12\pi\sqrt{34} \text{ m}^2$  81.  $x = \pm 3, x = -2$  83.  $x = 2, 4, 6$  or  
 $x = -2, 0, 2$  85. 11 in. by 13 in. 87.  $r = 3 \text{ m}; r = 0$  and  $r = 12 \text{ m}$  do  
 not fit the context 89. either \$50 or \$30 91. a. 32 ft. ( $h = -32$ )  
 b. 11 sec c. pebble is at canyon's rim 93. 12 min 95.  $v = 6 \text{ mph}$   
 97.  $P = 52.1\%$  99. a. 36 million mi b. 67 million mi  
 c. 93 million mi d. 142 million mi e. 484 million mi  
 f. 887 million mi 101. The constant "3" was not multiplied by the LCD.  
 $3x(x + 3) - 8x = x + 3; x = -1, 1$  103.  $x \in [1, 2) \cup (2, \infty)$   
 105. a.  $x = -5, -3, 5, 7$  b.  $x = -2, -1, 6, 7$  c.  $x = -2, 1, 3$   
 d.  $x = -4, -2, 3$  e.  $x = -1, 1, 7$  f.  $x = -1, 1, 2, 7$   
 107.  $2\sqrt{11} \text{ cm}$  109.  $-1 < x < 5$



**Summary and Concept Review, pp. 142–146**

1. a. yes b. yes c. yes 2.  $b = 6$  3.  $n = 4$  4.  $m = -1$   
 5.  $x = \frac{1}{6}$  6. no solution 7.  $g = 10$  8.  $h = \frac{V}{\pi r^2}$  9.  $L = \frac{E - 2W}{2}$   
 10.  $x = \frac{c - h}{a}$  11.  $y = \frac{3}{5}x - 2$  12. 8 gal 13.  $12 + \frac{9}{8}\pi \text{ ft}^2 = 15.5 \text{ ft}^2$   
 14.  $\frac{3}{8} \text{ hr} = 40 \text{ min}$  15.  $a = 35$  16.  $a < 2$  17.  $x \leq 65$   
 18.  $c \geq 1200$  19.  $(5, \infty)$  20.  $(-10, \infty)$  21.  $(-\infty, 2]$   
 22.  $(-9, 9]$  23.  $(-6, \infty)$  24.  $(-\infty, \frac{3}{5}) \cup (\frac{3}{5}, \infty)$   
 25. a.  $(-\infty, 3) \cup (3, \infty)$  b.  $(-\infty, \frac{3}{5}) \cup (\frac{3}{5}, \infty)$  c.  $(-5, \infty)$   
 d.  $(-\infty, 6]$  26.  $x \geq 96\%$  27.  $\{-4, 10\}$  28.  $\{-7, 3\}$  29.  $\{-5, 8\}$   
 30.  $\{-4, -1\}$  31.  $(-\infty, -6) \cup (2, \infty)$  32.  $[4, 32]$  33.  $\{ \}$  34.  $\{ \}$   
 35.  $(-\infty, \infty)$  36.  $[-2, 6]$  37.  $(-\infty, -2] \cup [\frac{10}{3}, \infty)$   
 38. a.  $|r - 2.5| \leq 1.7$  b. highest: 4.2 in., lowest: 0.8 in. 39.  $6\sqrt{2}i$   
 40.  $24\sqrt{3}i$  41.  $-2 + \sqrt{2}i$  42.  $3\sqrt{2}i$  43.  $i$  44.  $21 + 20i$   
 45.  $-2 + i$  46.  $-5 + 7i$  47. 13 48.  $-20 - 12i$   
 49.  $(5i)^2 - 9 = -34$   $(-5i)^2 - 9 = -34$   
 $25i^2 - 9 = -34$   $25i^2 - 9 = -34$   
 $-25 - 9 = -34$   $-25 - 9 = -34$   
 50.  $(2 + i\sqrt{5})^2 - 4(2 + i\sqrt{5}) + 9 = 0$   
 $(2 - i\sqrt{5})^2 - 4(2 - i\sqrt{5}) + 9 = 0$   
 $4 + 4i\sqrt{5} + 5i^2 - 8 - 4i\sqrt{5} + 9 = 0$   
 $4 - 4i\sqrt{5} + 5i^2 - 8 + 4i\sqrt{5} + 9 = 0$   
 $5 + (-5) = 0$   $5 + (-5) = 0$   
 51. a.  $2x^2 + 3 = 0; a = 2, b = 0, c = 3$  b. not quadratic  
 c.  $x^2 - 8x - 99 = 0; a = 1, b = -8, c = -99$   
 d.  $x^2 + 16 = 0; a = 1, b = 0, c = 16$  52. a.  $x = 5$  or  $x = -2$   
 b.  $x = -5$  or  $x = 5$  c.  $x = -\frac{3}{4}$  or  $x = 3$  d.  $x = -2$  or  $x = 2$  or  $x = 3$   
 53. a.  $x = \pm 3$  b.  $x = 2 \pm \sqrt{5}$  c.  $x = \pm \sqrt{5}i$  d.  $x = \pm 5$   
 54. a.  $x = 3$  or  $x = -5$  b.  $x = -8$  or  $x = 2$   
 c.  $x = 1 \pm \frac{\sqrt{30}}{2}, x = 2.58$  or  $x = -0.58$  d.  $x = 2$  or  $x = \frac{1}{3}$   
 55. a.  $x = 2 \pm \sqrt{5}i; x = 2 \pm 2.24i$  b.  $x = \frac{3 \pm \sqrt{2}}{2}, x = 2.21$  or  
 $x = 0.79$  c.  $x = \frac{3}{2} \pm \frac{1}{2}i$  56. a. 1.3 sec b. 4.7 sec c. 6 sec

57. a. 0.8 sec b. 3.2 sec c. 5 sec 58. \$3.75; 3000 59. 6 hr  
 60.  $x = \pm \sqrt{3}, x = 7$  61.  $x = -2, x = 0, x = \frac{1}{3}$   
 62.  $x = 0, x = 2, x = -1 \pm \sqrt{3}i$  63.  $x = \pm \frac{1}{2}, x = \pm \frac{1}{2}i$  64.  $x = \frac{-1}{2}$   
 65.  $h = -\frac{3}{4}, h = 2$  66.  $n = 13; n = -2$  is extraneous  
 67.  $x = -3; x = 3$  68.  $x = -4; x = 5$   
 69.  $x = -1; x = 7$  is extraneous 70.  $x = \frac{5}{2}$  71.  $x = -5.8; x = 5$   
 72.  $x = -2, x = -1, x = 4, x = 5$   
 73.  $x = -3, x = 3, x = -i\sqrt{2}, x = i\sqrt{2}$  74. a. 12,000 kilocalories  
 b. 810 kg 75. width, 6 in.; length, 9 in. 76. 1 sec; 244 ft; 8 sec  
 77. \$24 per load; \$42 per load  
**Mixed Review, pp. 147–147**  
 1. a.  $x \in (8, \infty)$  b.  $x \in (-\infty, \frac{3}{4}) \cup (\frac{3}{4}, \infty)$  3. a.  $x = 2, x = \pm 5i$   
 b.  $x = 0, x = -5, x = \frac{3}{2} \pm \frac{5i\sqrt{3}}{2}$  c.  $x = -\frac{7}{3}, x = \frac{5}{3}$   
 d.  $(-\infty, 3] \cup [27, \infty)$  e.  $v = \pm 27$  f.  $x = 80$  5.  $y = \frac{-3}{4}x - 3$   
 7. a.  $x = -2$  b.  $n = 5$  9.  $x = 7, 11$  11.  $x = -\sqrt{6}, \sqrt{6}$   
 13.  $x = \frac{4}{5}$  15.  $x = \pm \sqrt{5}, \pm i\sqrt{5}$  17. a.  $v = 6, 2$  is extraneous  
 b.  $x = -5; x = 4$  c.  $x = 2; x = 18$  is extraneous 19.  $6 \cdot 10^9$

**Practice Test, pp. 147**

1. a.  $x = 27$  b.  $x = 2$  c.  $C = \frac{P}{1+k}$  d.  $x = -4, x = -1$   
 2. 30 gal 3. a.  $x > -30$  b.  $-5 \leq x < 4$  c.  $x \in \mathbb{R}$   
 d.  $x = 2, x = 4$  e.  $x < -4$  or  $x > 2$  4.  $S \geq 177$   
 5.  $z = -3, z = 10$  6.  $x = \pm 5i$  7.  $x = 1 \pm i\sqrt{3}$   
 8.  $x = \pm 1, x = \pm 4$  9.  $x = \frac{2}{3}, x = 6$  10.  $x = -2, x = \pm \frac{3}{2}$   
 11.  $x = 6, x = -2$  is extraneous 12.  $x = -\frac{3}{5}, x = 2$   
 13.  $x = 16, x = 4$  is extraneous 14.  $x = -11, x = 5$   
 15. a. \$4.50 per tin b. 90 tins 16. a.  $t = 5$  (May) b.  $t = 9$  (Sept.)  
 c. July; \$3000 more 17.  $-\frac{3}{4} \pm \frac{i\sqrt{3}}{4}$  18.  $-i$  19. a. 1 b.  $i\sqrt{3}$   
 c. 1 20.  $-\frac{3}{2} + \frac{1}{2}i$  21. 34 22.  $(2 - 3i)^2 - 4(2 - 3i) + 13 = 0$   
 $-5 - 12i - 8 + 12i + 13 = 0$   $0 = 0$  23. a.  $x = 5 \pm \frac{\sqrt{2}}{2}$   
 b.  $x = \frac{3}{2} \pm \frac{i\sqrt{2}}{2}$  24. a.  $x = \frac{3 \pm \sqrt{3}}{3}$  b.  $x = 1 \pm 3i$   
 25. a.  $P \approx 64.8 \text{ g}$  b.  $W \approx 256 \text{ g}$

**Strengthening Core Skills pp. 149–150**

- Exercise 1:**  $\frac{7}{2} + (-1) = \frac{5}{2} = \frac{-b}{a} \checkmark$   $\frac{7}{2} \cdot (-1) = \frac{-7}{2} = \frac{c}{a} \checkmark$   
**Exercise 2:**  $\frac{2 + 3\sqrt{2}}{2} + \frac{2 - 3\sqrt{2}}{2} = \frac{4}{2} = \frac{-b}{a} \checkmark$   $\frac{2 + 3\sqrt{2}}{2} \cdot \frac{2 - 3\sqrt{2}}{2} = \frac{-14}{4} = \frac{-7}{2} = \frac{c}{a} \checkmark$   
**Exercise 3:**  $(5 + 2\sqrt{3}i) + (5 - 2\sqrt{3}i) = 10 = \frac{-b}{a} \checkmark$   
 $(5 + 2\sqrt{3}i)(5 - 2\sqrt{3}i) = 25 + 12 = 37 = \frac{c}{a} \checkmark$

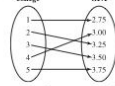
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**CHAPTER 2**

**Exercises 2.1, pp. 161–164**

1. first, second 3. radius, center 5. Answers will vary.

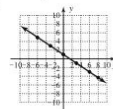
7.  $D = \{1, 2, 3, 4, 5\}$   
 $R = \{2.75, 3.00, 3.25, 3.50, 3.75\}$



9.  $D = \{1, 3, 5, 7, 9\}$ ;  $R = \{2, 4, 6, 8, 10\}$

11.  $D = \{4, -1, 2, -3\}$ ;  $R = \{0, 5, 4, 2, 3\}$

13.

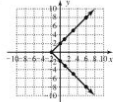


$x$	$y$
-6	5
-3	3
0	1
3	-1
6	-3
8	$-\frac{13}{3}$

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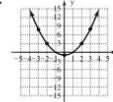
SA6 Student Answer Appendix

15.



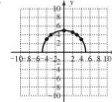
x	y
-2	0
0	2, -2
1	3, -3
3	5, -5
6	8, -8
7	9, -9

17.



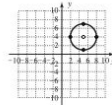
x	y
-3	8
-2	3
0	-1
2	3
3	8
4	15

19.

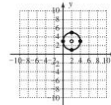


x	y
-4	3
-3	4
0	5
2	$\sqrt{21}$
3	4
4	3

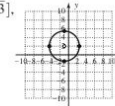
61.  $(x - 5)^2 + (y - 4)^2 = 9$



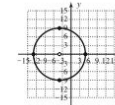
63.  $(2, 3), r = 2, x \in [0, 4], y \in [1, 5]$



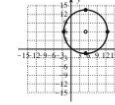
65.  $(-1, 2), r = 2\sqrt{3}, x \in [-1 - 2\sqrt{3}, -1 + 2\sqrt{3}], y \in [2 - 2\sqrt{3}, 2 + 2\sqrt{3}]$



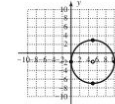
67.  $(-4, 0), r = 9, x \in [-13, 5], y \in [-9, 9]$



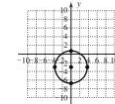
69.  $(x - 5)^2 + (y - 6)^2 = 57, (5, 6), r = \sqrt{57}$



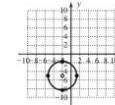
71.  $(x - 5)^2 + (y + 2)^2 = 25, (5, -2), r = 5$



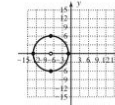
73.  $x^2 + (y + 3)^2 = 14, (0, -3), r = \sqrt{14}$



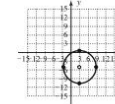
75.  $(x + 2)^2 + (y + 5)^2 = 11, (-2, -5), r = \sqrt{11}$



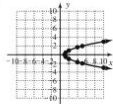
77.  $(x + 7)^2 + y^2 = 37, (-7, 0), r = \sqrt{37}$



79.  $(x - 3)^2 + (y + 5)^2 = 32, (3, -5), r = 4\sqrt{2}$

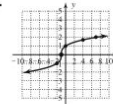


21.



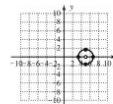
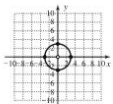
x	y
10	3, -3
5	2, -2
4	$\sqrt{3}, -\sqrt{3}$
2	1, -1
1.25	0.5, -0.5
1	0

23.

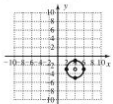


x	y
-9	-2
-2	-1
-1	0
0	1
4	$\sqrt{5}$
7	2

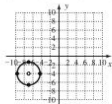
25.  $(3, 1)$  27.  $(-0.7, -0.3)$  29.  $(\frac{1}{20}, \frac{1}{24})$  31.  $(0, -1)$   
 33.  $(-1, 0)$  35.  $2\sqrt{34}$  37. 10 39. not a right triangle  
 41. not a right triangle 43. right triangle  
 45.  $x^2 + y^2 = 9$  47.  $(x - 5)^2 + y^2 = 3$



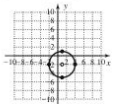
49.  $(x - 4)^2 + (y + 3)^2 = 4$



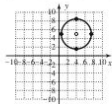
51.  $(x + 7)^2 + (y + 4)^2 = 7$



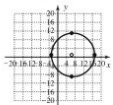
53.  $(x - 1)^2 + (y + 2)^2 = 9$



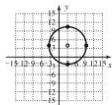
55.  $(x - 4)^2 + (y - 5)^2 = 12$



57.  $(x - 7)^2 + (y - 1)^2 = 100$

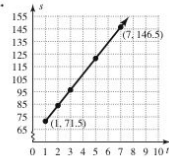


59.  $(x - 3)^2 + (y - 4)^2 = 41$



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81. a. (1, 71.5), (2, 84), (3, 96.5), (5, 121.5), (7, 146.5); yes b. \$159 c. 2011 d.



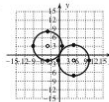
83. a.  $(x - 5)^2 + (y - 12)^2 = 625$  b. no

85. Red:  $(x - 2)^2 + (y - 2)^2 = 4$ ;

- Blue:  $(x - 2)^2 + y^2 = 16$ ;

- Area blue =  $12\pi$  units<sup>2</sup>

87. No, distance between centers is less than sum of radii. 89. Answers will vary.



91. a. center: (6, -2);  $r = 0$  (degenerate case) b. center: (1, 4);  $r = 5$

- c.  $r^2 = -1$ ; degenerate case

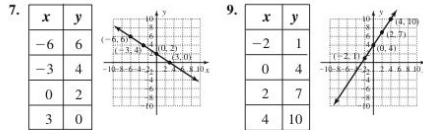
93. a. 0 b. not possible c. 0.3; many answers possible

- d. not possible e. not possible f.  $\sqrt{3}$ ; many answers possible

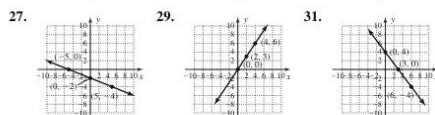
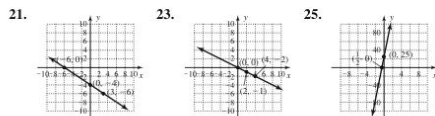
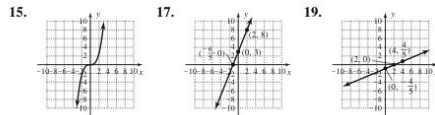
95.  $n = 1$  is a solution,  $n = -2$  is extraneous

Exercises 2.2, pp. 174–177

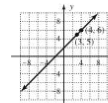
1. 0, 0 3. negative, downward 5. yes no  
 $m_1 \neq m_2$   $m_1 \cdot m_2 \neq -1$



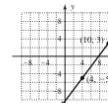
11.  $-0.5 = \frac{3}{2}(-3) + 4$   
 $-0.5 = -\frac{9}{2} + 4$   
 $-0.5 = -0.5\checkmark$   
 $\frac{19}{4} = \frac{3}{2}(\frac{1}{2}) + 4$   
 $\frac{19}{4} = \frac{3}{4} + 4$   
 $\frac{19}{4} = \frac{19}{4}\checkmark$



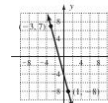
33.  $m = 1$ ;  
(2, 4) and (1, 3)



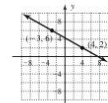
35.  $m = \frac{4}{3}$ ;  
(7, -1) and (1, -9)



37.  $m = -\frac{15}{8}$ ;  
(1, -8) and  $(-1, -\frac{1}{2})$



39.  $m = -\frac{2}{3}$ ;  
(-10, 10) and (11, -2)

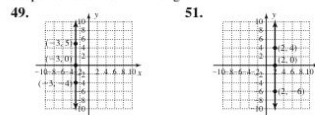


41. a.  $m = 125$ , cost increased \$125,000 per 1000 sq ft b. \$375,000

43. a.  $m = 22.5$ , distance increases 22.5 mph b. about 186 mi

45. a.  $m = \frac{23}{6}$ , a person weighs 23 lb more for each additional 6 in. in height b. 3.8

47. In inches: (0, -6) and (576, -18);  $m = -\frac{1}{48}$ . The sewer line is 1 in. deeper for each 48 in. in length.



53.  $L_1: x = 2$ ;  $L_2: y = 4$ ; point of intersection (2, 4)

55. a. For any two points chosen  $m = 0$ , indicating there has been no increase or decrease in the number of supreme court justices.

- b. For any two points chosen  $m = \frac{1}{10}$ , which indicates that over the last 5 decades, one nonwhite or nonfemale justice has been added to the court every 10 yr.

57. parallel 59. neither 61. parallel 63. not a right triangle

65. not a right triangle 67. right triangle

69. a. 76.4 yr b. 2010

71.  $v = -1250t + 8500$

- a. \$3500

- b. 5 yr

73.  $h = -3t + 300$  a. 273 in. b. 20 months

75. Yes they will meet, the two roads are not parallel;  $\frac{38}{12} \neq \frac{30}{9}$ .

77. a. \$3789 b. 2012 79. a. 23% b. 2005

81. a. -6 83. a. 142 b. -83 c. 9 d.  $\frac{27}{2}$

85. perimeter of a rectangle, volume of a rectangular prism, volume of a right circular cylinder, circumference of a circle

87. 2 hr

Exercises 2.3, pp. 186–190

1.  $-\frac{7}{4}$ ; (0, 3) 3. 2.5 5. Answers will vary

7.  $y = -\frac{4}{5}x + 2$  9.  $y = 2x + 7$  11.  $y = -\frac{5}{3}x - 5$

x	y
-5	6
-2	$\frac{18}{5}$
0	2
1	$\frac{6}{5}$
3	$-\frac{2}{5}$

x	y
-5	-3
-2	3
0	7
1	9
3	13

x	y
-5	$\frac{10}{3}$
-2	$-\frac{5}{3}$
0	-5
1	$-\frac{20}{3}$
3	-10

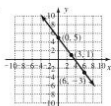
13.  $y = 2x - 3$ ; 2, -3 15.  $y = -\frac{5}{3}x - 7$ ;  $-\frac{5}{3}$ , -7

17.  $y = -\frac{6}{5}x - 4$ ;  $-\frac{25}{6}$ , -4

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SAB Student Answer Appendix

19.



25. a.  $\frac{-3}{4}$  b.  $y = \frac{-3}{4}x + 3$  c. The coeff. of  $x$  is the slope and the constant is the  $y$ -intercept.

27. a.  $\frac{2}{3}$  b.  $y = \frac{2}{3}x - 2$  c. The coeff. of  $x$  is the slope and the constant is the  $y$ -intercept.

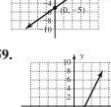
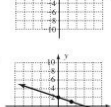
29. a.  $\frac{4}{3}$  b.  $y = \frac{4}{3}x + 3$  c. The coeff. of  $x$  is the slope and the constant is the  $y$ -intercept. 31.  $y = \frac{-2}{3}x + 2, m = \frac{-2}{3}, y$ -intercept (0, 2)

33.  $y = \frac{-5}{2}x + 5, m = \frac{-5}{2}, y$ -intercept (0, 5) 35.  $y = \frac{1}{3}x, m = \frac{1}{3}, y$ -intercept (0, 0) 37.  $y = \frac{-3}{4}x + 3, m = \frac{-3}{4}, y$ -intercept (0, 3)

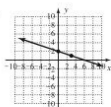
39.  $y = \frac{3}{4}x + 1$  41.  $y = 3x + 3$  43.  $y = 3x + 2$

45.  $y = 250x + 500$  47.  $y = \frac{2}{3}x + 150$  49.  $y = 2x - 13$

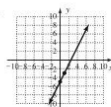
51.  $y = \frac{-3}{2}x + 4$  53.  $y = \frac{3}{2}x - 5$  55.



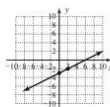
57.



59.



61.



63.  $y = \frac{2}{3}x + 4$  65.  $y = \frac{-5}{3}x + 7$  67.  $y = \frac{-12}{3}x - 29$

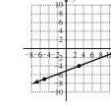
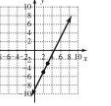
69.  $y = 5$  71. perpendicular 73. neither 75. neither

77. a.  $y = \frac{-3}{4}x - \frac{3}{4}$  b.  $y = \frac{4}{3}x - \frac{20}{3}$

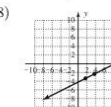
79. a.  $y = \frac{6}{5}x + \frac{11}{5}$  b.  $y = \frac{-9}{4}x + \frac{3}{4}$

81. a.  $y = \frac{-2}{3}x - 2$  b.  $y = 2x - 2$

83.  $y + 5 = 2(x - 2)$  85.  $y + 4 = \frac{3}{8}(x - 3)$



87.  $y + 3.1 = 0.5(x - 1.8)$



89.  $y - 2 = \frac{5}{3}(x - 4)$ ; For each 5000 additional sales, income rises \$6000.

91.  $y - 100 = \frac{-20}{1}(x - 0.5)$ ; For every hour of television, a student's final grade falls 20%.

93.  $y - 10 = \frac{35}{2}(x - \frac{1}{2})$ ; Every 2 in. of rainfall increases the number of cattle raised per acre by 35.

95. C 97. A

99. B 101. D 103.  $m = \frac{7}{6}, y$ -intercept =  $\frac{5}{6}$  a.  $m = \frac{-3}{4}, y$ -intercept (0, 2) b.  $m = \frac{-3}{4}, y$ -intercept (0, -3) c.  $m = \frac{8}{5}, y$ -intercept (0, 2) d.  $m = \frac{5}{3}, y$ -intercept (0, 3)

105. a. As the temperature increases  $5^\circ\text{C}$ , the velocity of sound waves increases 3 m/s. At a temperature of  $0^\circ\text{C}$ , the velocity is 331 m/s. b. 343 m/s c.  $50^\circ\text{C}$  107. a.  $V = \frac{2}{3}t + 150$  b. Every 3 yr the value of the coin increases by \$20; the initial value was \$150.

c. \$223.33 d. 15 years, in 2013 e. 3 yr 109. a.  $N = 7t + 9$

b. Every 1 yr the number of homes with Internet access increases by 7 million. c. 1993 d. 86 million e. 13 yr f. 2010

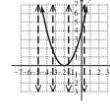
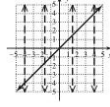
111. a.  $P = 58,000t + 740,000$  b. Each year, the prison population increases by 58,000. c. 1,726,000 113. Answers will vary.

115. (1) d (2) a (3) c (4) b (5) f (6) h

117.  $x = \frac{5 \pm \sqrt{13}}{3}, x \approx -0.74$  or  $x \approx 4.07$  119. 113, 10  $\text{yd}^2$

Exercises 2.4, pp. 200–205

1. first 3. range 5. Answers will vary. 7. function 9. Not a function. The Shaq is paired with two heights. 11. Not a function; 4 is paired with 2 and -5. 13. function 15. function 17. Not a function; -2 is paired with 3 and -4. 19. function 21. function 23. Not a function; 0 is paired with 4 and -4. 25. function 27. Not a function; 5 is paired with -1 and 1. 29. function 31. function 33. function



35. function,  $x \in [-4, 5], y \in [-2, 3]$  37. function,  $x \in [-4, \infty), y \in [-4, \infty)$  39. function,  $x \in [-4, 4], y \in [-5, -1]$  41. function,  $x \in (-\infty, \infty), y \in (-\infty, \infty)$  43. Not a function,  $x \in [-3, 5], y \in [-3, 3]$  45. Not a function,  $x \in (-\infty, 3], y \in (-\infty, \infty)$

47.  $x \in (-\infty, 5) \cup (5, \infty)$  49.  $x \in [\frac{5}{2}, \infty)$

51.  $x \in (-\infty, -5) \cup (-5, 5) \cup (5, \infty)$

53.  $y \in (-\infty, -3\sqrt{2}) \cup (-3\sqrt{2}, 3\sqrt{2}) \cup (3\sqrt{2}, \infty)$

55.  $x \in (-\infty, \infty)$  57.  $x \in (-\infty, \infty)$  59.  $x \in (-\infty, \infty)$

61.  $x \in (-\infty, -2) \cup (-2, 5) \cup (5, \infty)$  63.  $x \in [2, \frac{5}{2}) \cup (\frac{5}{2}, \infty)$

65.  $x \in (2, \infty)$  67.  $x \in (-4, \infty)$  69.  $f(-6) = 0, f(\frac{3}{2}) = \frac{15}{4}, f(2c) = c + 3,$

$f(c + 1) = \frac{1}{2}c + \frac{7}{2}$  71.  $f(-6) = 132, f(\frac{3}{2}) = \frac{3}{2}, f(2c) = 12c^2 - 8c,$

$f(c + 1) = 3c^2 + 2c - 1$  73.  $h(3) = 1, h(\frac{-2}{3}) = \frac{-2}{3}, h(3a) = \frac{1}{a}$

$h(a - 2) = \frac{3}{a - 2}$  75.  $h(3) = 5, h(\frac{-2}{3}) = -5, h(3a) = -5$  if  $a < 0$  or

$5$  if  $a > 0, h(a - 2) = 5(\frac{|a - 2|}{a - 2})$

77.  $g(4) = 8\pi, g(\frac{3}{2}) = 3\pi, g(2c) = 4\pi c, g(c + 3) = 2\pi(c + 3)$

79.  $g(4) = 16\pi, g(\frac{3}{2}) = \frac{9}{4}\pi, g(2c) = 4\pi c^2, g(c + 3) = (c^2 + 6c + 9)\pi$

81.  $p(5) = \sqrt{13}, p(\frac{3}{2}) = \sqrt{6}, p(3a) = \sqrt{6a + 3}, p(a - 1) = \sqrt{2a + 1}$

83.  $p(5) = \frac{14}{5}, p(\frac{3}{2}) = \frac{7}{9}, p(3a) = \frac{27a^2 - 5}{9a^2},$

$p(a - 1) = \frac{3a^2 - 6a - 2}{a^2 - 2a + 1}$

85. a.  $D = \{-1, 0, 1, 2, 3, 4, 5\}$  b.  $R = \{-2, -1, 0, 1, 2, 3, 4\}$  c. 1

d. -1 87. a.  $D = [-5, 5]$  b.  $y \in [-3, 4]$  c. -2 d. -4 and 0

89. a.  $D = [-3, \infty)$  b.  $y \in (-\infty, 4]$  c. 2 d. -2 and 2

91. a. 186.5 lb b. 37 lb 93.  $A = \frac{1}{2}(8) + 22 - 1 = 25$  units<sup>2</sup>

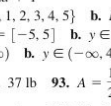
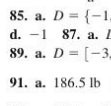
95. a.  $N(g) = 2.5g$  b.  $g \in [0, 5]; N \in [0, 12.5]$  97. a.  $[0, \infty)$

b. 750  $\pi$  c. 800 99. a.  $c(t) = 42.50t + 50$  b. \$156.25 c. 5 hr

d.  $t \in [0, 10.6]; c \in [0, 500]$  101. a. Yes. Each  $x$  is paired with exactly one  $y$ . b. 10 P.M. c. 0.9 m d. 7 P.M. and 1 A.M.

103. a.  $\frac{\Delta \text{fertility}}{\Delta \text{time}} = \frac{-1}{20}$ , negative, fertility is decreasing by one child every 20 yr b. 1940 to 1950:  $\frac{\Delta f}{\Delta t} = \frac{0.8}{10}$ , positive, fertility is increasing by less than one child every 10 yr c. 1940 to 1950:  $\frac{\Delta f}{\Delta t} = \frac{0.8}{10}$ , 1980 to 1990:  $\frac{\Delta f}{\Delta t} = \frac{0.2}{10}$ , the fertility rate was increasing four times as fast from 1940 to 1950.

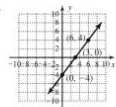
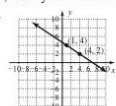
105. negative outputs become positive



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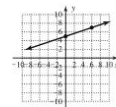
107. a.  $x \in (-\infty, -2) \cup (2, \infty)$ ;  $x = \frac{2x \pm 3}{3}$ ;  $y \in (-\infty, 1) \cup (1, \infty)$   
 b.  $x \in \mathbb{R}$ ;  $x = \pm \sqrt{y+3}$ ;  $y \in [-3, \infty)$  109. a.  $19\sqrt{6}$  b. 1  
 111. a.  $(x-3)(x-5)(x+5)$  b.  $(2x+3)(x-8)$   
 c.  $(2x-5)(4x^2+10x+25)$

Mid-Chapter Check, p. 205

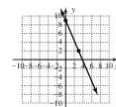
1.   
 2.  $-\frac{18}{7}$  3. positive, loss is decreasing (profit is increasing);  $m = \frac{3}{2}$ , yes;  $\frac{1.5}{1}$ , each year Data.com's loss decreases by 1.5 million.  
 4.   $y = \frac{3}{2}x + \frac{3}{2}$   
 5.  $x = -3$ ; no; input  $-3$  is paired with more than one output.  
 6.  $y = -\frac{4}{3}x + 4$ ; yes 7. a. 0 b.  $x \in [-3, 5]$  c.  $-1$   
 d.  $y \in [-4, 5]$  8. from  $x = 1$  to  $x = 2$ ; steeper line  $\rightarrow$  greater slope  
 9.  $F(p) = \frac{2}{3}p + \frac{3}{4}$ . For every 4000 pheasants, the fox population increases by 300: 1625. 10. a.  $x \in \{-3, -2, -1, 0, 1, 2, 3, 4\}$   
 $y \in \{-3, -2, -1, 0, 1, 2, 3, 4\}$  b.  $x \in [-3, 4]$   $y \in [-3, 4]$   
 c.  $x \in (-\infty, \infty)$   $y \in (-\infty, \infty)$

Reinforcing Basic Concepts, p. 206

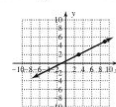
1. a.  $\frac{1}{3}$ , increasing b.  $y - 5 = \frac{1}{3}(x - 0)$  c.  $y = \frac{1}{3}x + 5$   
 d.  $x - 3y = -15$  e.  $(0, 5), (-15, 0)$



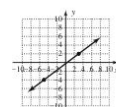
2. a.  $-\frac{7}{3}$ , decreasing b.  $y - 9 = -\frac{7}{3}(x - 0)$  c.  $y = -\frac{7}{3}x + 9$   
 d.  $7x + 3y = 27$  e.  $(0, 9), (\frac{27}{7}, 0)$



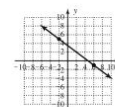
3. a.  $\frac{1}{2}$ , increasing b.  $y - 2 = \frac{1}{2}(x - 3)$  c.  $y = \frac{1}{2}x + \frac{1}{2}$   
 d.  $x - 2y = -1$  e.  $(0, \frac{1}{2}), (-1, 0)$



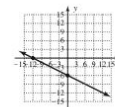
4. a.  $\frac{3}{4}$ , increasing b.  $y + 4 = \frac{3}{4}(x + 5)$  c.  $y = \frac{3}{4}x - \frac{1}{4}$   
 d.  $3x - 4y = 1$  e.  $(0, -\frac{1}{4}), (\frac{1}{3}, 0)$



5. a.  $-\frac{3}{4}$ , decreasing b.  $y - 5 = -\frac{3}{4}(x + 2)$  c.  $y = -\frac{3}{4}x + \frac{7}{2}$   
 d.  $3x + 4y = 14$  e.  $(0, \frac{7}{2}), (\frac{14}{3}, 0)$

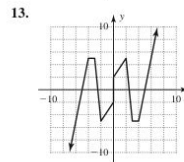
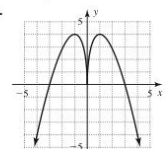


6. a.  $-\frac{1}{2}$ , decreasing b.  $y + 7 = -\frac{1}{2}(x - 2)$  c.  $y = -\frac{1}{2}x - 6$   
 d.  $x + 2y = -12$  e.  $(0, -6), (-12, 0)$



Exercises 2.5, pp. 218–224

1. linear; bounce 3. increasing 5. Answers will vary.  
 7. 9. even 11. even



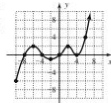
15. odd 17. not odd 19. neither 21. odd 23. neither  
 25.  $x \in [-1, 1] \cup [3, \infty)$  27.  $x \in (-\infty, -1) \cup (-1, 1) \cup (1, \infty)$   
 29.  $p(x) \geq 0$  for  $x \in [2, \infty)$  31.  $f(x) \leq 0$  for  $x \in (-\infty, 2]$   
 33.  $V(x) \uparrow$ :  $x \in (-3, 1) \cup (4, 6)$   $V(x) \downarrow$ :  $x \in (-\infty, -3) \cup (1, 4)$   
 constant: none 35.  $f(x) \uparrow$ :  $x \in (1, 4)$   $f(x) \downarrow$ :  $x \in (-2, 1) \cup (4, \infty)$   
 constant:  $x \in (-\infty, -2)$  37. a.  $p(x) \uparrow$ :  $x \in (-\infty, \infty)$   $p(x) \downarrow$ : none  
 b. down, up 39. a.  $f(x) \uparrow$ :  $x \in (-3, 0) \cup (3, \infty)$   
 $f(x) \downarrow$ :  $x \in (-\infty, -3) \cup (0, 3)$  b. up, up  
 41. a.  $x \in (-\infty, \infty)$ ,  $y \in (-\infty, 5)$  b.  $x = 1, 3$   
 c.  $H(x) \geq 0$ :  $x \in [1, 3]$   $H(x) \leq 0$ :  $x \in (-\infty, 1] \cup [3, \infty)$   
 d.  $H(x) \uparrow$ :  $x \in (-\infty, 2)$   $H(x) \downarrow$ :  $x \in (2, \infty)$  e. local max:  $y = 5$  at  $(2, 5)$   
 43. a.  $x \in (-\infty, \infty)$ ,  $y \in (-\infty, \infty)$  b.  $x = -1, 5$   
 c.  $g(x) \geq 0$ :  $x \in [-1, \infty)$   $g(x) \leq 0$ :  $x \in (-\infty, -1] \cup [0, 3.5]$   
 d.  $g(x) \uparrow$ :  $x \in (-\infty, 1) \cup (5, \infty)$   $g(x) \downarrow$ :  $x \in (1, 5)$  e. local max:  $y = 6$  at  $(1, 6)$ ; local min:  $y = 0$  at  $(5, 0)$  45. a.  $x \in [-4, \infty)$ ,  $y \in (-\infty, 3]$   
 b.  $x = -4, 2$  c.  $Y_1 \geq 0$ :  $x \in [-4, 2]$   $Y_1 \leq 0$ :  $x \in [2, \infty)$   
 d.  $Y_1 \uparrow$ :  $x \in (-4, -2)$   $Y_1 \downarrow$ :  $x \in (-2, \infty)$  e. local max:  $y = 3$  at  $(-2, 3)$   
 47. a.  $x \in \mathbb{R}$ ,  $y \in \mathbb{R}$  b.  $x = -4$  c.  $p(x) \geq 0$ :  $x \in [-4, \infty)$ ;  $p(x) \leq 0$ :  
 $x \in (-\infty, -4]$  d.  $p(x) \uparrow$ :  $x \in (-\infty, -3) \cup (-3, \infty)$ ;  $p(x) \downarrow$ : never  
 decreasing e. local max: none; local min: none  
 49. a.  $x \in (-\infty, -3] \cup [3, \infty)$ ,  $y \in [0, \infty)$  b.  $(-3, 0), (3, 0)$   
 c.  $f(x) \uparrow$ :  $x \in (3, \infty)$   $f(x) \downarrow$ :  $x \in (-\infty, -3)$  d. even  
 51. a.  $x \in [0, 260]$ ,  $y \in [0, 80]$  b. 80 ft c. 120 ft d. yes e.  $(0, 120)$   
 f.  $(120, 260)$  53. a.  $x \in (-\infty, \infty)$ ;  $y \in [-1, \infty)$  b.  $(-1, 0), (1, 0)$   
 c.  $f(x) \geq 0$ :  $x \in (-\infty, -1] \cup [1, \infty)$ ;  $f(x) < 0$ :  $x \in (-1, 1)$   
 d.  $f(x) \uparrow$ :  $x \in (0, \infty)$ ;  $f(x) \downarrow$ :  $x \in (-\infty, 0)$  e. min:  $(0, -1)$



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SA10 Student Answer Appendix

55. a.  $t \in [72, 96]$ ;  $I \in [7.25, 16]$   
 b.  $I(t) \uparrow: t \in (72, 74) \cup (77, 81) \cup (83, 84) \cup (93, 94)$   
 $I(t) \downarrow: t \in (74, 75) \cup (81, 83) \cup (84, 86) \cup (90, 93) \cup (94, 95)$   $I(t)$  constant:  $t \in (75, 77) \cup (86, 90) \cup (95, 96)$  c. max: (74, 9.25), (81, 16) (global max), (84, 13), (94, 8.5), min: (72, 7.5), (83, 12.75), (93, 7.25)  
 d. Increase: 80 to 81; Decrease: 82 to 83 or 85 to 86  
 57. zeroes: (-8, 0), (-4, 0), (0, 0), (4, 0); min: (-2, -1), (4, 0); max: (-6, 2), (2, 2)



59. a. 7 b. 7 c. They are the same.  
 d. Slopes are equal.

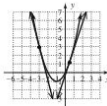


61. a. 176 ft b. 320 ft c. 144 ft/sec d. -144 ft/sec; The arrow is going down. 63. a. 17.89 ft/sec; 25.30 ft/sec b. 30.98 ft/sec; 35.78 ft/sec c. Between 5 and 10. d. 1.482 ft/sec, 0.96 ft/sec 65. 2

67.  $2x + h$  69.  $2x + 2 + h$  71.  $\frac{-2}{x(x+h)}$

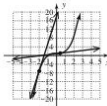
73. a.  $\frac{\Delta g}{\Delta x} = 2x + 2 + h$  b.  $\frac{\Delta g}{\Delta x} = -3.9$  c.  $\frac{\Delta g}{\Delta x} = 3.01$

d. The rates of change have opposite sign, with the secant line to the left being slightly more steep.



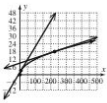
75. a.  $\frac{\Delta g}{\Delta x} = 3x^2 + 3xh + h^2$  b.  $\frac{\Delta g}{\Delta x} = 12.61$  c.  $\frac{\Delta g}{\Delta x} = 0.49$

d. Both lines have a positive slope, but the line at  $x = -2$  is much steeper.



77. a.  $\frac{\Delta d}{\Delta h} \approx 0.25$  b.  $\frac{\Delta d}{\Delta h} \approx 0.05$

c. As height increases you can see farther, the sight distance is increasing much slower.



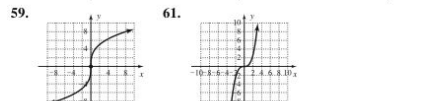
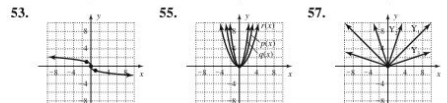
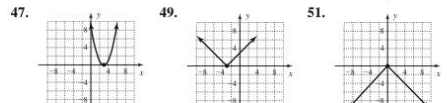
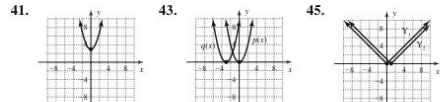
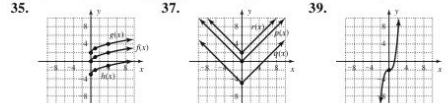
79. no; no; Answers will vary. 81. Answers will vary.

83.  $x = -2, x = 10$  85.  $y = \frac{2}{3}x - 1$

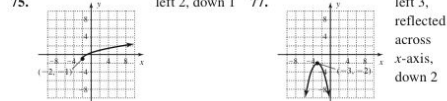
Exercises 2.6, pp. 234–239

1. stretch; compression 3. (-5, -9); upward 5. Answers will vary.  
 7. a. quadratic; b. up/up, (-2, -4),  $x = -2, (-4, 0), (0, 0), (0, 0)$ ; c.  $D: x \in \mathbb{R}, R: y \in [-4, \infty)$  9. a. quadratic; b. up/up, (1, -4),  $x = 1, (-1, 0), (3, 0), (0, -3)$ ; c.  $D: x \in \mathbb{R}, R: y \in [-4, \infty)$   
 11. a. quadratic; b. up/up, (2, -9),  $x = 2, (-1, 0), (5, 0), (0, -5)$ ; c.  $D: x \in \mathbb{R}, R: y \in [-9, \infty)$  13. a. square root; b. up to the right, (-4, -2), (-3, 0), (0, 2); c.  $D: x \in [-4, \infty), R: y \in [-2, \infty)$   
 15. a. square root; b. down to the left, (4, 3), (3, 0), (0, -3); c.  $D: x \in (-\infty, 4], R: y \in (-\infty, 3]$  17. a. square root; b. up to the left, (4, 0), (4, 0), (0, 4); c.  $D: x \in (-\infty, 4], R: y \in [0, \infty)$

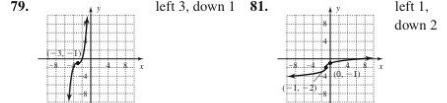
19. a. absolute value; b. up/up, (-1, -4),  $x = -1, (-3, 0), (1, 0), (0, -2)$ ; c.  $D: x \in \mathbb{R}, R: y \in [-4, \infty)$  21. a. absolute value; b. down/down, (-1, 6),  $x = -1, (-4, 0), (2, 0), (0, 4)$ ; c.  $D: x \in \mathbb{R}, R: y \in (-\infty, 6]$   
 23. a. absolute value; b. down/down, (0, 6),  $x = 0, (-2, 0), (2, 0), (0, 6)$ ; c.  $D: x \in \mathbb{R}, R: y \in (-\infty, 6]$  25. a. cubic; b. up/down, (1, 0), (1, 0), (0, 1); c.  $D: x \in \mathbb{R}, R: y \in \mathbb{R}$  27. a. cubic; b. down/up, (0, 1), (-1, 0), (0, 1); c.  $D: x \in \mathbb{R}, R: y \in \mathbb{R}$  29. a. cube root; b. down/up, (1, -1), (2, 0), (0, -2); c.  $D: x \in \mathbb{R}, R: y \in \mathbb{R}$  31. square root function; y-int (0, 2); x-int (-3, 0); initial point (-4, -2); up on right;  $D: x \in [-4, \infty), R: y \in [-2, \infty)$  33. cubic function; y-int (0, -2); x-int (-2, 0); inflection point (-1, -1); up, down;  $D: x \in \mathbb{R}, R: y \in \mathbb{R}$



63. g 65. i 67. e 69. j 71. l 73. c  
 75. left 2, down 1 77. left 3, reflected across x-axis, down 2



79. left 3, down 1 81. left 1, down 2

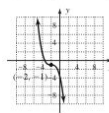


83. left 3, reflected across x-axis, down 2 85. left 1, reflected across x-axis, stretched vertically, down 3

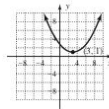


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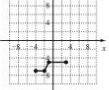
87. left 2, reflected across  $x$ -axis, compressed vertically down 1,



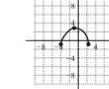
91. right 3, compressed vertically up 1



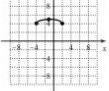
b.



95. a.



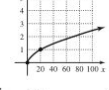
d.



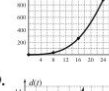
101.  $f(x) = \frac{3}{5}x + 4$



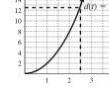
105.



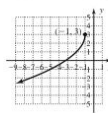
107.



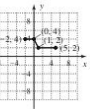
109.



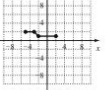
89. left 1, reflected across  $y$ -axis, reflected across  $x$ -axis, stretched vertically up 3,



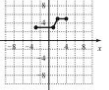
93. a.



c.

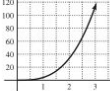


d.



97.  $f(x) = -(x - 2)^2$  99.  $p(x) = 1.5\sqrt{x + 3}$

103.  $V(t) = 4.2t^3$   
 $\approx -4.2$ , about 65 units<sup>3</sup>,  
 $65.4$  units<sup>3</sup>, yes

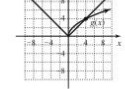


compressed vertically, 2.25 sec

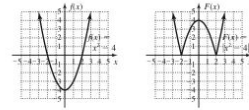
a. compressed vertically, b. 216 W,  
 c.  $\approx 15.6$ , 161.5, power increases dramatically at higher windspeeds

a. vertical stretch by a factor of 2, b. 12.5 ft,  
 c. 5, 13, distance fallen by unit time increases very fast

111.  $x \in (0, 4)$ ; yes,  $x \in (4, \infty)$ ; yes



113. Any points in Quadrants III and IV will reflect across the  $x$ -axis and move to Quadrants I and II.



115.  $p = 140$  in.  $A = 1168$  in<sup>2</sup>  
 117.  $f(x) \downarrow: x \in (-\infty, 4)$   $f(x) \uparrow: x \in (4, \infty)$

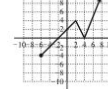
Exercises 2.7, pp. 248–253

1. continuous 3. smooth 5. Each piece must be continuous on the corresponding interval, and the function values at the endpoints of each interval must be equal. Answers will vary.

7. a.  $f(x) = \begin{cases} x^2 - 6x + 10 & 0 \leq x \leq 5 \\ \frac{1}{3}x - \frac{5}{2} & 5 < x \leq 9 \end{cases}$  b.  $y \in [1, 11]$

9.  $-2, 2, \frac{1}{2}, 0, 2.999, 5$  11. 5, 5, 0,  $-4, 5, 11$

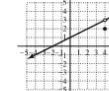
13.  $D: x \in [-6, \infty)$ ;  $R: y \in [-4, \infty)$



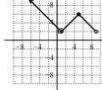
15.  $D: x \in (-2, \infty)$ ;  $R: y \in (-4, \infty)$



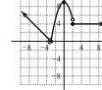
17.  $D: x \in (-\infty, \infty)$ ;  $R: y \in (-\infty, 3)$ ,  $U(3, \infty)$



19.  $x \in (-\infty, 9)$ ;  $y \in [2, \infty)$



21.  $x \in (-\infty, \infty)$ ;  $y \in [0, \infty)$



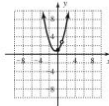
23.  $x \in (-\infty, \infty)$ ;  $y \in (-\infty, -6) \cup (-6, \infty)$ ; discontinuity at  $x = -3$ ; redefine  $f(x) = -6$  at  $x = -3$ ;  $c = -6$



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SA12 Student Answer Appendix

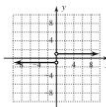
25.  $x \in (-\infty, \infty); y \in [0.75, \infty)$ ;  
discontinuity at  $x = 1$ ;  
redefine  $f(x) = 3$  at  $x = 1$ ;  $c = 3$



27.  $f(x) = \begin{cases} \frac{1}{2}x - 1 & -4 \leq x < 2 \\ 3x - 6 & x \geq 2 \end{cases}$

29.  $p(x) = \begin{cases} x^2 + 2x - 3 & x \leq 1 \\ x + 1 & x > 1 \end{cases}$

31. Graph is discontinuous at  $x = 0$ ;  $f(x) = 1$  for  $x > 0$ ;  $f(x) = -1$  for  $x < 0$ .



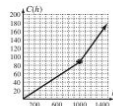
33. a.  $S(t) = \begin{cases} -t^2 + 6t & 0 \leq t \leq 5 \\ 5 & t > 5 \end{cases}$  b.  $S(t) \in [0, 9]$

35. a. 

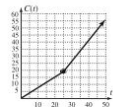
Year (0 → 1950)	Percent
5	7.33
15	14.13
25	14.93
35	22.65
45	41.55
55	60.45

 b. Each piece gives a slightly different value due to rounding of coefficients in each model. At  $t = 30$ , we use the "first" piece:  $P(30) = 13.08$ .

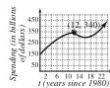
37.  $C(h) = \begin{cases} 0.09h & 0 \leq h \leq 1000 \\ 0.18h - 90 & h > 1000 \end{cases}$   
 $C(1200) = \$126$



39.  $C(t) = \begin{cases} 0.75t & 0 \leq t \leq 25 \\ 1.5t - 18.75 & t > 25 \end{cases}$   
 $C(45) = \$48.75$

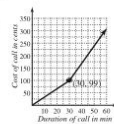


41.  $S(t) = \begin{cases} -1.35t^2 + 31.9t + 152 & 0 \leq t \leq 12 \\ 2.5t^2 - 80.6t + 950 & 12 < t \leq 22 \end{cases}$

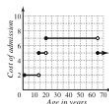


\$498 billion, \$653 billion, \$782 billion

43.  $c(m) = \begin{cases} 3.3m & 0 \leq m \leq 30 \\ 7m - 111 & m > 30 \end{cases}$ ;  
\$2.11

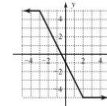


45.  $C(a) = \begin{cases} 0 & a < 2 \\ 2 & 2 \leq a < 13 \\ 5 & 13 \leq a < 20 \\ 7 & 20 \leq a < 65 \\ 5 & a \geq 65 \end{cases}$   
\$38



47. a.  $C(w-1) = 17[w-1] + 80$ , b.  $0 < w \leq 13$ ; c.  $80\epsilon$ , d.  $165\epsilon$ , e.  $165\epsilon$ , f.  $165\epsilon$ , g.  $182\epsilon$

49. yes;  $h(x) = \begin{cases} 5 & x \leq -3 \\ -2x - 1 & -3 < x < 2 \\ -5 & x \geq 2 \end{cases}$



51.  $Y_1$  has a removable discontinuity at  $x = -2$ ;  $Y_2$  has a discontinuity at  $x = -2$  53.  $x = -7, x = 4$  55. a.  $4\sqrt{5}$  cm<sup>2</sup> b.  $16\sqrt{5}$  cm<sup>2</sup> c.  $V = 320\sqrt{5}$  cm<sup>3</sup>

Exercises 2.8, pp. 264–270

1.  $(f+g)(x)$ ;  $A \cap B$  3. intersection;  $g(x)$  5. Answers will vary.

7. a.  $x \in \mathbb{R}$  b.  $f(-2) - g(-2) = 13$  9. a.  $h(x) = x^2 - 6x - 3$

b.  $h(-2) = 13$  c. they are identical 11. a.  $x \in [3, \infty)$

b.  $h(x) = \sqrt{x-3} + 2x^3 - 54$  c.  $h(4) = 75$ , 2 is not in the domain of  $h$ .

13. a.  $x \in [-5, 3]$  b.  $r(x) = \sqrt{x+5} + \sqrt{3-x}$

c.  $2(7) = \sqrt{7} + 1$ , 4 is not in the domain of  $r$ . 15. a.  $x \in [-4, \infty)$

b.  $h(x) = \sqrt{x+4}(2x+3)$  c.  $h(-4) = 0$ ,  $h(21) = 225$

17. a.  $x \in [-1, 7]$  b.  $r(x) = \sqrt{-x^2+6x+7}$  c. 15 is not in the domain of  $r$ ,  $r(3) = 4$

19. a.  $x \in (-\infty, -4) \cup (-4, \infty)$

b.  $h(x) = x - 4, x \neq -4$  21. a.  $x \in (-\infty, -4) \cup (-4, \infty)$

b.  $h(x) = x^2 - 2, x \neq -4$  23. a.  $x \in (-\infty, 1) \cup (1, \infty)$

b.  $h(x) = x^2 - 6x, x \neq 1$  25. a.  $x \in (-\infty, 5) \cup (5, \infty)$

b.  $h(x) = \frac{x+1}{x-5}, x \neq 5$  27. a.  $x \in (-\infty, -2)$  b.  $r(x) = \frac{2x-3}{\sqrt{-2-x}}$

c. 6 is not in the domain of  $r$ ,  $r(-6) = -\frac{15}{2}$  29. a.  $x \in (5, \infty)$

b.  $r(x) = \frac{x-5}{\sqrt{x-5}}$  c.  $r(6) = 1$ ; -6 is not in the domain of  $r$

31. a.  $x \in (-\frac{13}{2}, \infty)$  b.  $r(x) = \frac{x^2-36}{\sqrt{2x+13}}$  c.  $r(6) = 0$ ,  $r(-6) = 0$

33. a.  $h(x) = \frac{2x+4}{x-3}$  b.  $x \in (-\infty, 3) \cup (3, \infty)$  c.  $x \neq -2, x \neq 0$

35. sum:  $3x + 1, x \in (-\infty, \infty)$ ; difference:  $x + 5, x \in (-\infty, \infty)$ ; product:  $2x^2 - x - 6, x \in (-\infty, \infty)$ ; quotient:  $\frac{2x+3}{x-2}, x \in (-\infty, 2) \cup (2, \infty)$

37. sum:  $x^2 + 3x + 5, x \in (-\infty, \infty)$ ; difference:  $x^2 - 3x + 9, x \in (-\infty, \infty)$ ; product:  $3x^3 - 2x^2 + 21x - 14, x \in (-\infty, \infty)$ ;

quotient:  $\frac{x^2+7}{3x-2}, x \in (-\infty, \frac{2}{3}) \cup (\frac{2}{3}, \infty)$

39. sum:  $x^2 + 3x - 4, x \in (-\infty, \infty)$ ; difference:  $x^2 + x - 2, x \in (-\infty, \infty)$ ;

product:  $x^3 + x^2 - 5x + 3, x \in (-\infty, \infty)$ ;

quotient:  $x + 3, x \in (-\infty, 1) \cup (1, \infty)$

41. sum:  $3x + 1 + \sqrt{x-3}, x \in [3, \infty)$ ; difference:  $3x + 1 - \sqrt{x-3}, x \in [3, \infty)$ ;

product:  $(3x+1)\sqrt{x-3}, x \in [3, \infty)$ ;

quotient:  $\frac{3x+1}{\sqrt{x-3}}, x \in (3, \infty)$  43. sum:  $2x^2 + \sqrt{x+1}, x \in [-1, \infty)$ ;

difference:  $2x^2 - \sqrt{x+1}, x \in [-1, \infty)$ ; product:

$2x^2\sqrt{x+1}, x \in [-1, \infty)$ ; quotient:  $\frac{2x^2}{\sqrt{x+1}}, x \in (-1, \infty)$

45. sum:  $\frac{7x-11}{(x-3)(x+2)}, x \in (-\infty, -2) \cup (-2, 3) \cup (3, \infty)$ ;

difference:  $\frac{-3x+19}{(x-3)(x+2)}, x \in (-\infty, -2) \cup (-2, 3) \cup (3, \infty)$ ;

product:  $\frac{10}{(x^2-x-6)}, x \in (-\infty, -2) \cup (-2, 3) \cup (3, \infty)$ ;

quotient:  $\frac{2x+4}{(5x-15)}, x \in (-\infty, -2) \cup (-2, 3) \cup (3, \infty)$

47. 0;  $4a^2 - 10a - 14a^2 - 9a$  49. a.  $h(x) = \sqrt{2x-2}$

b.  $H(x) = 2\sqrt{x+3} - 5$  c.  $D$  of  $h(x)$ :  $x \in [1, \infty)$ ;  $D$  of  $H(x)$ :

$x \in [-3, \infty)$  51. a.  $h(x) = \sqrt{3x+1}$  b.  $H(x) = 3\sqrt{x-3} + 4$

c.  $D$  of  $h(x)$ :  $x \in [-\frac{1}{3}, \infty)$ ;  $D$  of  $H(x)$ :  $x \in [3, \infty)$

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53. a.  $h(x) = x^2 + x - 2$  b.  $H(x) = x^2 - 3x + 2$  c.  $D$  of  $h(x)$ :  $x \in (-\infty, \infty)$   $D$  of  $H(x)$ :  $x \in (-\infty, \infty)$  55. a.  $h(x) = x^2 + 7x + 8$  b.  $H(x) = x^2 + x - 1$  c.  $D$  of  $h(x)$ :  $x \in (-\infty, \infty)$   $D$  of  $H(x)$ :  $x \in (-\infty, \infty)$  57. a.  $h(x) = |-3x + 1| - 5$  b.  $H(x) = -3|x| + 16$  c.  $D$  of  $h(x)$ :  $x \in (-\infty, \infty)$   $D$  of  $H(x)$ :  $x \in (-\infty, \infty)$

59. a.  $(f \circ g)(x)$ : For  $g(x)$  to be defined,  $x \neq 0$ .

$$\text{For } f[g(x)] = \frac{2g(x)}{g(x) + 3}, g(x) \neq -3 \text{ so } x \neq -\frac{5}{3}.$$

$$\text{domain: } \left\{ x \mid x \neq 0, x \neq -\frac{5}{3} \right\}$$

b.  $(g \circ f)(x)$ : For  $f(x)$  to be defined,  $x \neq -3$ .

$$\text{For } g[f(x)] = \frac{5}{f(x)}, f(x) \neq 0 \text{ so } x \neq 0.$$

$$\text{domain: } \{x \mid x \neq 0, x \neq -3\}$$

c.  $(f \circ g)(x) = \frac{10}{5 + 3x}$ ;  $(g \circ f)(x) = \frac{5x + 15}{2x}$ ;

the domain of a composition cannot always be determined from the composed form

61. a.  $(f \circ g)(x)$ : For  $g(x)$  to be defined,  $x \neq 5$ .

$$\text{For } f[g(x)] = \frac{4}{g(x)}, g(x) \neq 0 \text{ and } g(x) \text{ is never zero}$$

$$\text{domain: } \{x \mid x \neq 5\}$$

b.  $(g \circ f)(x)$ : For  $f(x)$  to be defined,  $x \neq 0$ .

$$\text{For } g[f(x)] = \frac{1}{f(x) - 5}, f(x) \neq 5 \text{ so } x \neq \frac{4}{5}.$$

$$\text{domain: } \left\{ x \mid x \neq 0, x \neq \frac{4}{5} \right\}$$

c.  $(f \circ g)(x) = 4x - 20$ ;  $(g \circ f)(x) = \frac{x}{4 - 5x}$ ; the domain of a composition cannot always be determined from the composed form

63. a. 41 b. 41 65.  $g(x) = \sqrt{x - 2} + 1$ ,  $f(x) = x^3 - 5$

67.  $p(x) = 2(x + 4)^2 - 3$ ,  $q(x) = (2x + 7)^2 - 1$  69. a. 6000

b. 3000 c. 8000 d.  $C(9) - T(9)$ ; 4000 71. a. \$1 billion

b. \$5 billion c. 2003, 2007, 2010 d.  $t \in (2000, 2003) \cup (2007, 2010)$

e.  $t \in [2003, 2007]$  f.  $R(5) - C(5)$ ; \$4 billion 73. a. 4 b. 0 c. 2

d. 3 e.  $-\frac{1}{3}$  f. 6 g. -3 h. 1 i. 1 j. undefined k. 0.5 l. 2

75.  $h(x) = -\frac{2}{3}x + 4$  77.  $h(x) = 4x - x^2$

79.  $A = 2\pi r(20 + r)$ ;  $f(r) = 2\pi r$ ,  $g(r) = 20 + r$ ;  $A(5) = 250\pi$  units<sup>2</sup>

81. a.  $P(x) = 12,000x - 108,000$ ; b. nine boats must be sold

83. a.  $p(n) = 11.45n - 0.1n^2$  b. \$123 c. \$327

d.  $C(115) > R(115)$  85.  $h(x) = x - 2.5$ ; 10.5 87. a. 4160

b. 45,344 c.  $M(x) = 453.44x$ ; yes 89. a. 6 ft b.  $36\pi$  ft<sup>2</sup>

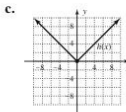
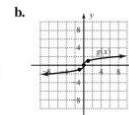
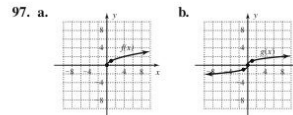
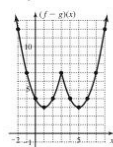
c.  $A(t) = 9\pi t^2$ ; yes 91. a. 1995 to 1996; 1999 to 2004 b. 30; 1995

c. 20 seats; 1997 d. The total number in the senate (50); the number of

additional seats held by the majority 93. Answers will vary.

95.

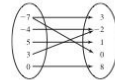
x	f(x)	g(x)	(f - g)(x)
-2	27	15	12
-1	18	11	7
0	11	7	4
1	6	3	3
2	3	-1	4
3	2	-5	7
4	3	-1	4
5	6	3	3
6	11	7	4
7	18	11	7
8	27	15	12



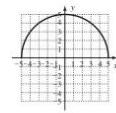
99.  $y = -\frac{3}{2}x$

Summary and Concept Review, pp. 270–277

1.  $x \in \{-7, -4, 0, 3, 5\}$   $y \in \{-2, 0, 1, 3, 8\}$

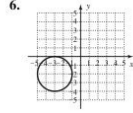
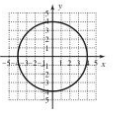


2.  $x \in [-5, 5]$   $y \in [0, 5]$

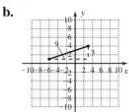
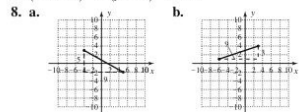


x	y
-5	0
-4	3
-2	$\sqrt{21} \approx 4.58$
0	5
2	$\sqrt{21} \approx 4.58$
4	3
5	0

3. 65 mi 4.  $(\frac{5}{2}, -3)$  5.

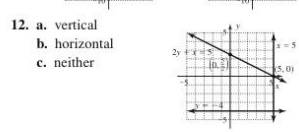
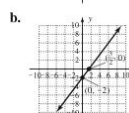
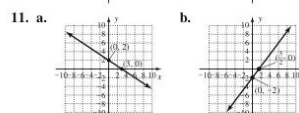
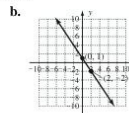
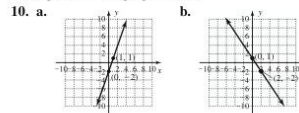


7.  $(x + 1.5)^2 + (y - 2)^2 = 6.25$



$-\frac{5}{9}, (14, -7)$   $\frac{1}{3}, (0, 3)$

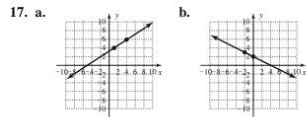
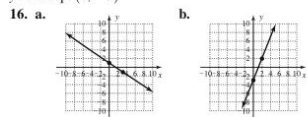
9. a. parallel b. perpendicular



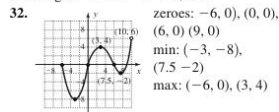
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SA14 Student Answer Appendix

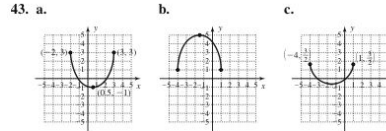
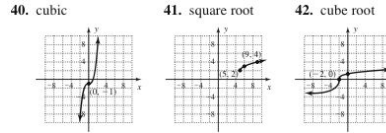
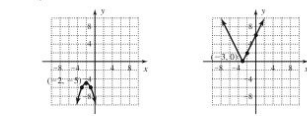
13. yes 14.  $m = \frac{2}{3}$ , y-intercept (0, 2) when the rodent population increases by 3000, the hawk population increases by 200.  
 15. a.  $y = -\frac{2}{3}x + 4$ ,  $m = -\frac{2}{3}$ , y-intercept (0, 4) b.  $y = \frac{5}{3}x - 5$ ,  $m = \frac{5}{3}$ , y-intercept (0, -5)



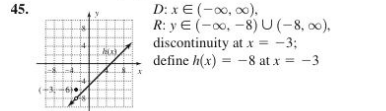
18.  $y = 5$ ,  $x = -2$ ;  $y = 5$  19.  $y = \frac{2}{3}x + \frac{11}{4}$  20.  $f(x) = \frac{4}{3}x$   
 21.  $m = \frac{2}{3}$ , y-intercept (0, 2),  $y = \frac{2}{3}x + 2$ . When the rabbit population increases by 500, the wolf population increases by 200.  
 22. a.  $y - 90 = -\frac{15}{2}(x - 2)$  b. (14, 0), (0, 105) c.  $f(x) = -\frac{15}{2}x + 105$   
 d.  $f(20) = -45$ ,  $x = 12$  23. a.  $x \in [-\frac{3}{2}, \infty)$   
 b.  $x \in (-\infty, -2) \cup (-2, 3) \cup (3, \infty)$  24.  $14\frac{20}{9}$ ;  $18a^2 - 9a$  25. It is a function. 26. I. a.  $D = \{-1, 0, 1, 2, 3, 4, 5\}$ ,  
 $R = \{-2, 1, 0, 1, 2, 3, 4\}$  b. 1 c. 2 III. a.  $x \in (-\infty, \infty)$ ,  
 $y \in (-\infty, \infty)$  b. -1 c. 3 III. a.  $x \in [-3, \infty)$ ,  $y \in [-4, \infty)$   
 b. -1 c. -3 or 3 27.  $D: x \in (-\infty, \infty)$ ,  $R: y \in [-5, \infty)$ ,  
 $f(x) \uparrow: x \in (2, \infty)$ ,  $f(x) \downarrow: x \in (-\infty, 2)$ ,  $f(x) > 0: x \in (-\infty, -1) \cup (5, \infty)$ ,  
 $f(x) < 0: x \in (-1, 5)$  28.  $D: x \in [-3, \infty)$ ,  $R: y \in (-\infty, 0)$ ,  $f(x) \uparrow$ : none,  $f(x) \downarrow: x \in (-3, \infty)$ ,  $f(x) > 0$ : none,  $f(x) < 0: x \in (-3, \infty)$   
 29.  $D: x \in (-\infty, \infty)$ ,  $R: y \in (-\infty, \infty)$ ,  $f(x) \uparrow: x \in (-\infty, -3) \cup (1, \infty)$ ,  
 $f(x) \downarrow: x \in (-3, 1)$ ,  $f(x) > 0: x \in (-5, -1) \cup (4, \infty)$ ,  
 $f(x) < 0: x \in (-\infty, -5) \cup (-1, 4)$   
 30. a. odd b. even c. neither d. odd 31. a.  $\frac{1}{4}$ , the graph is rising to the right. b.  $2x - 1 + h$ ; 3, 01



33. squaring function a. up on left/up on the right; b. x-intercepts: (-4, 0), (0, 0); y-intercept: (0, 0) c. vertex (-2, -4)  
 d.  $x \in (-\infty, \infty)$ ,  $y \in [-4, \infty)$  34. square root function a. down on the right, b. x-intercept: (0, 0); y-intercept: (0, 0) c. initial point (-1, 2);  
 d.  $x \in [-1, \infty)$ ,  $y \in (-\infty, 2]$  35. cubing function a. down on left/up on the right b. x-intercepts: (-2, 0), (1, 0), (4, 0); y-intercept: (0, 2)  
 c. inflection point: (1, 0) d.  $x \in (-\infty, \infty)$ ,  $y \in (-\infty, \infty)$   
 36. absolute value function a. down on left/down on the right  
 b. x-intercepts: (-1, 0), (3, 0); y-intercept: (0, 1) c. vertex: (1, 2);  
 d.  $x \in [-\infty, \infty)$ ,  $y \in (-\infty, 2]$  37. cube root a. up on left, down on right b. x-intercept: (1, 0); y-intercept: (0, 1) c. inflection point: (1, 0)  
 d.  $x \in (-\infty, \infty)$ ,  $y \in (-\infty, \infty)$   
 38. quadratic 39. absolute value



44. a.  $f(x) = \begin{cases} 5 & x \leq -3 \\ -x + 1 & -3 < x \leq 3 \\ 3\sqrt{x-3} - 1 & x > 3 \end{cases}$  b.  $R: y \in [-2, \infty)$



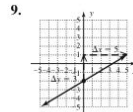
46. -4, -4, -4.5, -4.99,  $3\sqrt{3} - 9$ ,  $3\sqrt{3.5} - 9$   
 47.  $D: x \in (-\infty, \infty)$   $R: y \in [-4, \infty)$



49.  $a^2 + 7a - 2$  50. 147 51.  $x \in (-\infty, \frac{2}{3}) \cup (\frac{2}{3}, \infty)$   
 52.  $4x^2 + 8x - 3$  53. 99 54.  $x; x$   
 55.  $f(x) = \sqrt{x} + 1$ ;  $g(x) = 3x - 2$   
 56.  $f(x) = x^2 - 3x - 10$ ;  $g(x) = x^3$  57.  $A(t) = \pi(2t + 3)^2$  58. a. 4  
 b. 7 c. 6 d.  $-\frac{1}{5}$  e. 14

Mixed Review, pp. 277-278

1.  $y = -\frac{4}{3}x + 4$  3. a.  $(-\infty, 1) \cup (1, 4) \cup (4, \infty)$  b.  $(\frac{3}{2}, \infty)$   
 5.  $y = -\frac{3}{2}x - 2$  7.  $(2, 2)$ ;  $(x - 2)^2 + (y - 2)^2 = 50$

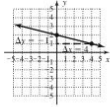
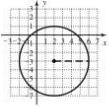


11. a. rate of change is positive in  $[-2, -1]$  since  $p$  is increasing in  $(-\infty, 2)$ ; less;  $\frac{\Delta y}{\Delta x} = \frac{14}{1}$  in  $[-2, -1]$ ;  $\frac{\Delta y}{\Delta x} = \frac{2}{1}$  in  $[1, 2]$

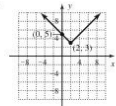
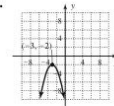
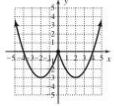
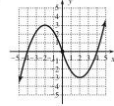
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- b. In the interval  $[15, 15.01]$ ,  $\frac{\Delta A}{\Delta t} \approx 200.1$
13.  $\frac{1}{3x^2 - 4x + 1}; (-\infty, \frac{1}{3}) \cup (\frac{1}{3}, 1) \cup (1, \infty)$
15.  $\frac{\Delta f}{\Delta x} = 2x + h$ ,  $\frac{\Delta g}{\Delta x} = 3$ ; For small  $h$ ,  $2x + h = 3$  when  $x = \frac{3-h}{2}$ .
17.  $D_x: x \in (-\infty, 6]$ ;  $R: y \in (-\infty, 3]$   $g(x) \uparrow: x \in (-\infty, -6) \cup (3, 6)$   
 $g(x) \downarrow: x \in (-3, 3)$  constant:  $x \in (-6, -3)$   $g(x) > 0: x \in (-7, -1)$   
 $g(x) < 0: x \in (-\infty, -7) \cup (-1, 6)$  max:  $y = 3$  for  $x \in (-6, -3)$ ;  
 $y = 0$  at  $(6, 0)$  min:  $y = -3$  at  $(3, -3)$  19.  $f(x) = -2x^2 + x + 3$

**Practice Test, pp. 279–280**

1. a.  $a$  and  $c$  are nonfunctions, they do not pass the vertical line test  
 2. neither 3.  4.  (2, -3);  $r = 4$

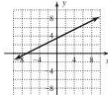
5.  $y = -\frac{6}{5}x + \frac{2}{5}$  6. a. (7.5, 1.5), b.  $\approx 61.27$  mi
7.  $L: x = -3$   $L_2: y = 4$  8. a.  $x \in \{-4, -2, 0, 2, 4, 6\}$   
 $y \in \{-2, -1, 0, 1, 2, 3\}$  b.  $x \in [-2, 6]$   $y \in [1, 4]$  9. a. 300 b. 30  
 c.  $W(h) = \frac{25}{3}h$  d. Wages are \$12.50 per hr.  
 e.  $h \in [0, 40]$ ;  $w \in [0, 500]$  10. I. a. square root  
 b.  $x \in [-4, \infty)$ ,  $y \in [-3, \infty)$  c.  $(-2, 0)$ ,  $(0, 1)$   
 d. up on right e.  $x \in (-2, \infty)$  f.  $x \in [-4, -2)$   
 II. a. cubic b.  $x \in (-\infty, \infty)$   $y \in (-\infty, \infty)$  c.  $(2, 0)$ ,  $(0, -1)$   
 d. down on left, up on right e.  $x \in (2, \infty)$  f.  $x \in (-\infty, 2)$   
 III. a. absolute value b.  $x \in (-\infty, \infty)$   $y \in (-\infty, 4]$   
 c.  $(-1, 0)$ ,  $(3, 0)$ ,  $(0, 2)$  d. down/down e.  $x \in (-1, 3)$   
 f.  $x \in (-\infty, -1) \cup (3, \infty)$  IV. a. quadratic b.  $x \in (-\infty, \infty)$ ;  
 $y \in [-5.5, \infty)$  c.  $(0, 0)$ ,  $(5, 0)$ ,  $(0, 0)$  d. up/up  
 e.  $x \in (-\infty, 0) \cup (5, \infty)$  f.  $x \in (0, 5)$   
 11. a.  $\frac{7}{2}$  b.  $\frac{-a^2 - 6a - 7}{a^2 + 6a + 9}$  c.  $-\frac{31}{25} - \frac{8}{25}i$   
 12.  $3x + 1$ ;  $x \in [\frac{1}{3}, \infty)$  13. a. No, new company and sales should be growing b. 19 for [5, 6]; 23 for [6, 7]  
 c.  $\frac{\Delta x}{\Delta t} = 4t - 3 + 2h$ . For small  $h$ , sales volume is approximately  
 $\frac{37,000 \text{ units}}{1 \text{ mo}}$  in month 10,  $\frac{69,000 \text{ units}}{1 \text{ mo}}$  in month 18, and  $\frac{93,000 \text{ units}}{1 \text{ mo}}$  in month 24

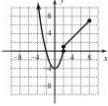
14.  15. 
16. a.  $V(t) = \frac{4}{3}\pi(\sqrt{t})^3$  b.  $36\pi \text{ in}^3$  17. a.  $D: x \in [-4, \infty)$ ;  
 $R: y \in (-3, \infty)$  b.  $f(-1) \approx 2.2$  c.  $f(x) < 0: x \in (-4, -3)$   
 $f(x) > 0: x \in (-3, \infty)$  d.  $f(x) \uparrow: x \in (-4, \infty)$   $f(x) \downarrow: \text{none}$   
 e.  $f(x) = 3\sqrt{x+4} - 3$  18. a. 4, -4, 6.25  
 19.  20. 

**Strengthening Core Skills, p. 281**

- Exercise 1:  $h(x) = x^2 - 28$ ;  $x = 4 \pm 2\sqrt{7}$   
 Exercise 2:  $h(x) = x^2 + 1$ ;  $x = -2 \pm i$   
 Exercise 3:  $h(x) = 2x^2 - \frac{3}{2}$ ;  $x = \frac{5}{2} \pm \frac{\sqrt{3}}{2}$

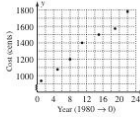
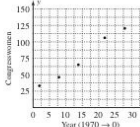
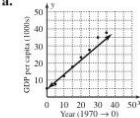
**Cumulative Review, p. 282**

1.  $x^2 + 2$  3. 29.45 cm 5.  $x = 1$  7. a.  $-\frac{1}{3}$  b.  $\frac{3}{8}$   
 9.  $y = \frac{1}{2}x + \frac{7}{2}$  11.  $(f \circ g)(x) = 3x^3 - 12x^2 + 12x$ ;  
 $(\frac{f}{g})(x) = 3x, x \neq 2$ ;  $(g \circ f) = 22$
- 
13. a.  $D: x \in (-\infty, 8]$ ,  $R: y \in [-4, \infty)$  b. 5, -3, -3, 1, 2  
 c.  $(-2, 0)$  d.  $f(x) < 0: x \in (-2, 2)$   $f(x) > 0: x \in (-\infty, -2) \cup [2, 8]$   
 e. min:  $(0, -4)$ , max:  $(8, 7)$  f.  $f(x) \uparrow: x \in (0, 8)$   $f(x) \downarrow: x \in (-\infty, 0)$

- 
15. a.  $\frac{x-7}{(x-5)(x+2)}$  b.  $\frac{b^2 - 4ac}{4a^2}$   
 17. a. False;  $\mathbb{Z} \not\subseteq \mathbb{W}$  b. False;  $\mathbb{W} \not\subseteq \mathbb{N}$  c. True d. False;  $\mathbb{R} \not\subseteq \mathbb{Z}$   
 19.  $x = -5 \pm \frac{\sqrt{2}}{2}$ ;  $x \approx -5.707$ ;  $x \approx -4.293$   
 21.  $W = 31$  cm,  $L = 47$  cm 23. a.  $x = \frac{-4}{3}, \frac{5}{2}$  b.  $x = -5, -\sqrt{3}, \sqrt{3}$   
 25.  $p = 15 + \sqrt{97}$  units  $\approx 24.8$  units. No, it is not a right triangle.  
 $5^2 + (\sqrt{97})^2 \neq 10^2$

**MODELING WITH TECHNOLOGY I**

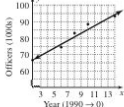
**Exercises, pp. 288–292**

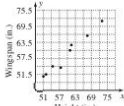
1.  positive
3.  a. linear b. positive
5. a.  b. positive c.  $m \approx 1$

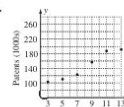


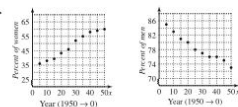
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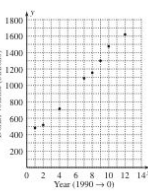
SA16 Student Answer Appendix

7. a.  b. positive c.  $y = 2.4x + 69.4$ , 74,200, 112,600

9. a.  b. linear c. positive d.  $y = 0.96x + 1.55$ , 63.95 in.

11. a.  b. linear c. positive d.  $y = 9.55x + 70.42$ ; about 271,000  
The number of applications, since the line has a greater slope.

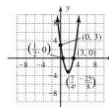
13. a.  b. women: linear c. positive b. men: linear c. negative d. yes, |slope| is greater

15.  a. linear b.  $y = 108.2x + 330.2$  c. \$1736.8 billion; about \$2602.4 billion

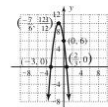
17. a.  $h(t) = -14.5t^2 + 90t$  b.  $v = 90$  ft/sec c. Venus

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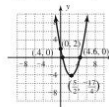
15. right  $\frac{7}{4}$ , stretched vertically, down  $\frac{23}{8}$



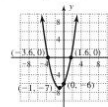
17. left  $\frac{7}{6}$ , stretched vertically, reflected across x-axis, up  $\frac{121}{12}$



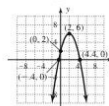
19. right  $\frac{5}{2}$ , down  $\frac{17}{4}$



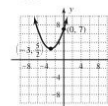
21. left 1, down 7



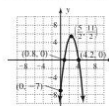
23. right 2, reflected across x-axis, up 6



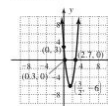
25. left 3, compressed vertically, up  $\frac{5}{2}$



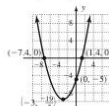
27. right  $\frac{5}{2}$ , reflected across x-axis, stretched vertically, up  $\frac{11}{2}$



29. right  $\frac{3}{2}$ , stretched vertically, down 6



31. left 3, compressed vertically, down  $\frac{19}{2}$



33.  $y = 1(x - 2)^2 - 1$  35.  $y = -1(x + 2)^2 + 4$

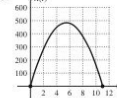
37.  $y = -\frac{3}{2}(x + 2)^2 + 3$  39. i.  $x = -3 \pm \sqrt{5}$  ii.  $x = 4 \pm \sqrt{3}$

iii.  $x = -4 \pm \frac{\sqrt{14}}{2}$  iv.  $x = 2 \pm \sqrt{2}$  v.  $t = -2.7, t = 1.3$

vi.  $t = -1.4, t = 2.6$  41. a. (0, -66,000); when no cars are produced, there is a loss of \$66,000. b. (20, 0), (330, 0); no profit will be made if less than 20 or more than 330 cars are produced. c. 175 d. \$240,250

43. a. 6 mi b. 3600 ft c. 3200 ft d. 12 mi 45. a. (0, -3300); if no appliances are sold, the loss will be \$3300. b. (20, 0), (330, 0); if less than 20 or more than 330 appliances are made and sold, there will be no profit. c.  $0 \leq x \leq 200$ ; maximum capacity is 200 d. 175, \$12,012.50

47. a. 288 ft b.  $\frac{h(t)}{t}$  c. 484 ft; 5.5 sec d. 11 sec



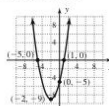
49. a.  $h(t) = -16t^2 + 32t + 5$  b. (i) 17 ft (ii) 17 ft  
c. it must occur between  $t = 0.5$  and  $t = 1.5$  d.  $t = 1$  sec  
e.  $h(1) = 21$  ft f. 2 sec 51. 155,000; \$16,625 53. a. 96 ft  $\times$  48 ft  
b. 32 ft  $\times$  48 ft 55.  $f(x) = x^2 - 4x + 13$

CHAPTER 3

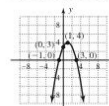
Exercises 3.1, pp. 300–304

1.  $\frac{3}{2}$  3. 0,  $f(x)$  5. Answers will vary.

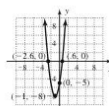
7. left 2, down 9



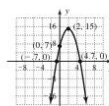
9. right 1, reflected across x-axis, up 4



11. left 1, stretched vertically, down 8



13. right 2, stretched vertically, reflected across x-axis, up 15



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**Coburn: Algebra and Trigonometry, Second Edition**

**Student Answer Appendix Chapter 3**

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Student Answer Appendix SA17

57. a. radicand will be negative—two complex zeroes. b. radicand will be positive—two real zeroes. c. radicand is zero—one real zero. d. two real, rational zeroes.

e. two real, irrational zeroes. 59.  $\frac{x-2}{x-5}$  61.  $x \in [-3, \frac{3}{2}]$

**Exercises 3.2, pp. 312–315**

- 1. synthetic; zero 3.  $P(x)$ ; remainder 5. Answers will vary.
- 7.  $x^3 - 5x^2 - 4x + 21 = (x - 2)(x^2 - 3x - 10) + 3$
- 9.  $2x^3 + 5x^2 + 4x + 17 = (x + 3)(2x^2 - x + 7) - 4$
- 11.  $x^3 - 8x^2 + 11x + 20 = (x - 5)(x^2 - 3x - 4) + 0$
- 13. a.  $\frac{2x^2 - 5x - 3}{x - 3} = (2x + 1) + \frac{0}{x - 3}$
- b.  $2x^2 - 5x - 3 = (x - 3)(2x + 1) + 0$
- 15. a.  $\frac{x^3 - 3x^2 - 14x - 8}{x - 2} = (x^2 - 5x - 4) + \frac{0}{x - 2}$
- b.  $x^3 - 3x^2 - 14x - 8 = (x + 2)(x^2 - 5x - 4) + 0$
- 17. a.  $\frac{x^3 - 5x^2 - 4x + 23}{x - 2} = (x^2 - 3x - 10) + \frac{3}{x - 2}$
- b.  $x^3 - 5x^2 - 4x + 23 = (x - 2)(x^2 - 3x - 10) + 3$
- 19. a.  $\frac{2x^3 - 5x^2 - 11x - 17}{x - 4} = (2x^2 + 3x + 1) + \frac{-13}{x - 4}$
- b.  $2x^3 - 5x^2 - 11x - 17 = (x - 4)(2x^2 + 3x + 1) - 13$
- 21.  $x^3 + 5x^2 + 7 = (x + 1)(x^2 + 4x - 4) + 11$
- 23.  $x^3 - 13x - 12 = (x - 4)(x^2 + 4x + 3) + 0$
- 25.  $3x^3 - 8x + 12 = (x - 1)(3x^2 + 3x - 5) + 7$
- 27.  $n^3 + 27 = (n + 3)(n^2 - 3n + 9) + 0$
- 29.  $x^4 + 3x^3 - 16x - 8 = (x - 2)(x^3 + 5x^2 + 10x + 4) + 0$
- 31.  $(2x + 7) + \frac{-7x + 5}{x^2 + 3}$  33.  $-(x^2 - 4) + \frac{-4x + 3}{x^2 - 1}$
- 35. a. -30 b. 12 37. a. -2 b. -22 39. a. -1 b. 3
- 41. a. 31 b. 0 43. a. -10 b. 0 45. a. yes b. yes 47. a. no b. yes 49. a. yes b. yes
- 51.  $\begin{array}{r} -3 \\ 1 \ 2 \ -5 \ -6 \\ \hline -3 \ 3 \ 6 \\ \hline 1 \ -1 \ -2 \ 0 \end{array}$  53.  $\begin{array}{r} 2 \\ 1 \ 0 \ -7 \ 6 \\ \hline 2 \ 4 \ -6 \\ \hline 1 \ 2 \ -3 \ 0 \end{array}$
- 55.  $\begin{array}{r} 3 \\ 9 \ 18 \ -4 \ -8 \\ \hline 6 \ 16 \ 8 \\ \hline 9 \ 24 \ 12 \ 0 \end{array}$
- 57.  $P(x) = (x + 2)(x - 3)(x + 5)$ ,  $P(x) = x^3 + 4x^2 - 11x - 30$
- 59.  $P(x) = (x + 2)(x - \sqrt{3})(x + \sqrt{3})$ ,  $P(x) = x^3 + 2x^2 - 3x - 6$
- 61.  $P(x) = (x + 5)(x - 2\sqrt{3})(x + 2\sqrt{3})$ ,  $P(x) = x^3 + 5x^2 - 12x - 60$
- 63.  $Q(x) = (x - 1)(x + 2)(x - \sqrt{10})(x + \sqrt{10})$ ,  $P(x) = x^4 + x^3 - 12x^2 - 10x + 20$  65.  $P(x) = (x + 2)(x - 3)(x - 4)$
- 67.  $p(x) = (x + 3)^2(x - 3)(x - 1)$  69.  $f(x) = 2(x - \frac{1}{2})(x + 2)(x + 5)$
- 71.  $p(x) = (x + 3)(x - 3)^2$  73.  $p(x) = (x - 2)^3$
- 75.  $p(x) = (x + 3)(x - 3)^3$  77.  $p(x) = (x + 3)(x - 3)^2(x + 4)^2$
- 79. 4-in. squares; 16 in.  $\times$  10 in.  $\times$  4 in. 81. a. week 10, 22.5 thousand b. one week before closing, 36 thousand c. week 9
- 83. a. 198 ft<sup>3</sup> b. 2 ft c. about 7 ft 85.  $k = 10$  87.  $k = -3$
- 89. The theorems also apply to complex zeroes of polynomials.
- 91.  $S_4 = 36$ ;  $S_5 = 225$  93. yes, John wins.
- 95.  $G(t) = 1400t + 5000$

**Exercises 3.3, pp. 325–330**

- 1. coefficients 3.  $a - bi$  5. b; 4 is not a factor of 6
- 7.  $P(x) = (x + 2)(x - 2)(x + 3i)(x - 3i)$
- $x = -2$ ,  $x = 2$ ,  $x = 3i$ ,  $x = -3i$
- 9.  $Q(x) = (x + 2)(x - 2)(x + 2i)(x - 2i)$
- $x = -2$ ,  $x = 2$ ,  $x = 2i$ ,  $x = -2i$  11.  $P(x) = (x + 1)(x + 1)(x - 1)$
- $x = -1$ ,  $x = -1$ ,  $x = 1$  13.  $P(x) = (x - 5)(x + 5)(x - 5)$
- $x = 5$ ,  $x = -5$ ,  $x = 5$
- 15.  $(x - 5)^3(x + 9)^2$ ;  $x = 5$ , multiplicity 3;  $x = -9$ , multiplicity 2

- 17.  $(x - 7)^2(x + 2)^2(x + 7)$ ;  $x = 7$ , multiplicity 2;  $x = -2$ , multiplicity 2;  $x = -7$ , multiplicity 1
- 19.  $P(x) = x^3 - 3x^2 + 4x - 12$  21.  $P(x) = x^4 - x^3 - x^2 - x - 2$
- 23.  $P(x) = x^4 - 6x^3 + 13x^2 - 24x + 36$
- 25.  $P(x) = x^4 + 2x^2 + 8x + 5$  27.  $P(x) = x^4 + 4x^3 + 27$
- 29. a. yes b. yes 31. a. yes b. yes
- 33.  $\{\pm 1, \pm 15, \pm 3, \pm 5, \pm \frac{1}{5}, \pm \frac{15}{5}, \pm \frac{3}{5}, \pm \frac{1}{3}, \pm \frac{15}{3}, \pm \frac{5}{3}, \pm \frac{1}{15}, \pm \frac{3}{15}, \pm \frac{5}{15}\}$
- 35.  $\{\pm 1, \pm 15, \pm 3, \pm 5, \pm \frac{1}{5}, \pm \frac{15}{5}, \pm \frac{3}{5}, \pm \frac{1}{3}, \pm \frac{15}{3}, \pm \frac{5}{3}, \pm \frac{1}{15}, \pm \frac{3}{15}, \pm \frac{5}{15}\}$
- 37.  $\{\pm 1, \pm 28, \pm 2, \pm 14, \pm 4, \pm 7, \pm \frac{1}{2}, \pm \frac{14}{2}, \pm \frac{4}{2}, \pm \frac{7}{2}, \pm \frac{28}{2}, \pm \frac{1}{28}, \pm \frac{2}{28}, \pm \frac{14}{28}, \pm \frac{4}{28}, \pm \frac{7}{28}, \pm \frac{28}{28}\}$
- 39.  $\{\pm 1, \pm 3, \pm \frac{1}{3}, \pm \frac{1}{16}, \pm \frac{1}{4}, \pm \frac{3}{4}, \pm \frac{3}{16}, \pm \frac{1}{3}, \pm \frac{1}{16}, \pm \frac{3}{16}, \pm \frac{1}{3}, \pm \frac{1}{16}\}$
- 41.  $(x + 4)(x - 1)(x - 3)$ ;  $x = -4, 1, 3$
- 43.  $(x + 3)(x + 2)(x - 5)$ ;  $x = -3, -2, 5$
- 45.  $(x + 3)(x - 1)(x - 4)$ ;  $x = -3, 1, 4$
- 47.  $(x + 2)(x - 3)(x - 5)$ ;  $x = -2, 3, 5$
- 49.  $(x + 4)(x + 1)(x - 2)(x - 3)$ ;  $x = -4, -1, 2, 3$
- 51.  $(x + 7)(x + 2)(x + 1)(x - 3)$ ;  $x = -7, -2, -1, 3$
- 53.  $(2x + 3)(2x - 1)(x - 1)$ ;  $x = -\frac{3}{2}, \frac{1}{2}, 1$
- 55.  $(2x + 3)^2(x - 1)$ ;  $x = -\frac{3}{2}, 1$
- 57.  $(x + 2)(x - 1)(2x - 5)$ ;  $x = -2, 1, \frac{5}{2}$
- 59.  $(x + 1)(2x + 1)(x - \sqrt{5})(x + \sqrt{5})$ ;  $x = -1, -\frac{1}{2}, \sqrt{5}, -\sqrt{5}$
- 61.  $(x - 1)(3x - 2)(x - 2i)(x + 2i)$ ;  $x = 1, \frac{2}{3}, 2i, -2i$
- 63.  $x = 1, 2, 3, \frac{-3}{2}$  65.  $x = -2, 1, \frac{-2}{3}$  67.  $x = -2, -\frac{3}{2}, 4$
- 69.  $x = 3, -1, \frac{3}{2}$  71.  $x = 1, 2, -3, \pm\sqrt{7}i$  73.  $x = -2, \frac{2}{3}, 1, \pm\sqrt{3}i$
- 75.  $x = 1, 2, 4, -2$  77.  $x = -3, 1, \pm\sqrt{2}$  79.  $x = -1, \frac{1}{2}, \pm\sqrt{3}i$
- 81.  $x = \frac{1}{2}, 1, 2, \pm\sqrt{3}i$  83. a. possible roots:  $\{\pm 1, \pm 8, \pm 2, \pm 4\}$ ; b. neither  $-1$  nor  $1$  is a root; c. 3 or 1 positive roots, 1 negative root; d. roots must lie between  $-2$  and  $2$  85. a. possible roots:  $\{\pm 1, \pm 2\}$ ; b.  $-1$  is a root; c. 2 or 0 positive roots, 3 or 1 negative roots; d. roots must lie between  $-3$  and  $2$  87. a. possible roots:  $\{\pm 1, \pm 2, \pm 2, \pm 6, \pm 3, \pm 4\}$ ; b.  $x = 1$  and  $x = -1$  are roots; c. 4, 2, or 0 positive roots, 1 negative root; d. roots must lie between  $-1$  and  $4$  89. a. possible roots:  $\pm 1, \pm 20, \pm 2, \pm 10, \pm 4, \pm 5, \pm \frac{1}{5}, \pm \frac{1}{20}$ ; b.  $x = 1$  is a root; c. 1 positive root, 1 negative root; d. roots must lie between  $-2$  and  $1$
- 91.  $(x - 4)(2x - 3)(2x + 3)$ ;  $x = 4, \frac{3}{2}, -\frac{3}{2}$
- 93.  $(2x + 1)(3x - 2)(x - 12)$ ;  $x = -\frac{1}{2}, \frac{2}{3}, 12$
- 95.  $(x - 2)(2x - 1)(2x + 1)(x + 12)$ ;  $x = 2, \frac{1}{2}, -\frac{1}{2}, -12$
- 97. a. 5 b. 13 c. 2 99. yes 101. yes
- 103. a. 4 cm  $\times$  4 cm  $\times$  4 cm b. 5 cm  $\times$  5 cm  $\times$  5 cm
- 105. length 10 in., width 5 in., height 3 in.
- 107. 1994, 1998, 2002, about 5 yr 109. a. 8.97 m, 11.29 m, 12.05 m, 12.94 m; b. 9.7 m, +3.7 111. a. yes, b. no, c. about 14.88
- 113A. a.  $(x + 5i)(x - 5i)$  b.  $(x + 3i)(x - 3i)$
- c.  $(x + i\sqrt{7})(x - i\sqrt{7})$  113B. a.  $x = -\sqrt{7}, \sqrt{7}$
- b.  $x = -2\sqrt{3}, 2\sqrt{3}$  c.  $x = -3\sqrt{2}, 3\sqrt{2}$
- 115. a.  $C(z) = (z - 4i)(z + 3)(z - 2)$
- b.  $C(z) = (z - 9i)(z + 4)(z + 1)$
- c.  $C(z) = (z - 3i)(z - 1 - 2i)(z - 1 + 2i)$
- d.  $C(z) = (z - i)(z - 2 - 5i)(z - 2 + 5i)$
- e.  $C(z) = (z - 6i)(z - 1 - \sqrt{3}i)(z - 1 + \sqrt{3}i)$
- f.  $C(z) = (z + 4i)(z - 3 - \sqrt{2}i)(z - 3 + \sqrt{2}i)$
- g.  $C(z) = (z - 2 + i)(z - 3i)(z + i)$
- h.  $C(z) = (z - 2 + 3i)(z - 5i)(z + 2i)$  117. a.  $w = 150$  ft,  $l = 300$ ; b.  $A = 15,000$  ft<sup>2</sup> 119.  $r(x) = 2\sqrt{x} + 4 - 2$

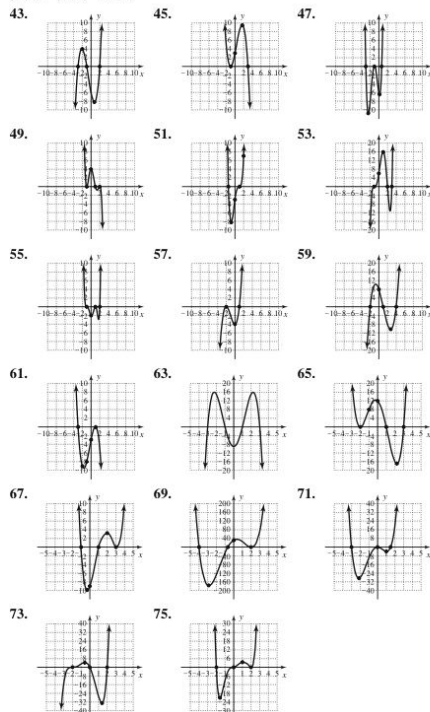
**Exercises 3.4, pp. 340–343**

- 1. zero;  $m$  3. bounce; flatter 5. Answers will vary.
- 7. polynomial, degree 3 9. not a polynomial, sharp turns
- 11. polynomial, degree 2 13. up/down 15. down/down
- 17. down/up; (0, -2) 19. down/down; (0, -6) 21. up/down; (0, -6)
- 23. a. even b. -3 odd, -1 even, 3 odd c.  $f(x) = (x + 3)(x + 1)^2(x - 3)$ , deg 4 d.  $x \in \mathbb{R}$ ,  $y \in [-9, \infty)$  25. a. even b. -3 odd, -1 odd, 2 odd, 4 odd
- c.  $f(x) = -(x + 3)(x + 1)(x - 2)(x - 4)$ , deg 4

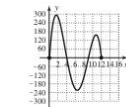
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SA18 Student Answer Appendix

- d.  $x \in \mathbb{R}, y \in (-\infty, 25]$  27. a. odd b.  $-1$  even, 3 odd  
 c.  $f(x) = -(x + 1)^2(x - 3)$ , deg 3 d.  $x \in \mathbb{R}, y \in \mathbb{R}$   
 29. degree 6; up/up; (0, -12) 31. degree 5; up/down; (0, -24)  
 33. degree 6; up/up; (0, -192) 35. degree 5; up/down; (0, 2)  
 37. b 39. e 41. c



43. 45. 47.   
 49. 51. 53.   
 55. 57. 59.   
 61. 63. 65.   
 67. 69. 71.   
 73. 75.
77.  $h(x) = (x + 4)(x - \sqrt{3})(x + \sqrt{3})(x - \sqrt{3})(x + \sqrt{3})$   
 79.  $f(x) = 2(x + \frac{3}{2})(x - \sqrt{2})(x + \sqrt{2})(x - \sqrt{3})(x + \sqrt{3})$   
 81.  $P(x) = \frac{1}{4}(x + 4)(x - 1)(x - 3)$ ,  $P(x) = \frac{1}{4}(x^3 - 13x + 12)$   
 83.  $P(x) = x^4 - 2x^3 - 13x^2 + 14x + 24$   
 85. a. 280 vehicles above average, 216 vehicles below average, 154 vehicles below average b. 6:00 A.M. ( $t = 0$ ), 10:00 A.M. ( $T = 4$ ), 3:00 P.M. ( $t = 9$ ), 6:00 P.M. ( $t = 12$ )  
 c. max: about 300 vehicles above average at 7:30 A.M.; min: about 220 vehicles below average at 12 noon



87. c.  $B(x) = \frac{1}{3}x(x - 4)(x - 9)$ ,  $-\$80,000$   
 89. a.  $f(x) \rightarrow \infty, f(x) \rightarrow -\infty$  b.  $g(x) \rightarrow \infty, g(x) \rightarrow \infty; x^4 \geq 0$  for all  $x$   
 91. verified 93.  $h(x) = \frac{1 - 2x}{x^2}$ ,  $D: x \in \{x | x \neq 0\}$ ;  $H(x) = \frac{1}{x^2 - 2x}$   
 $D: x \in \{x | x \neq 0, x \neq 2\}$  95. a.  $x = 2$  b.  $x = 8$  c.  $x = 4, x = -6$

Mid Chapter, p. 344

1. a.  $x^3 + 8x^2 + 7x - 14 = (x^2 + 6x - 5)(x + 2) - 4$   
 b.  $\frac{x^3 + 8x^2 + 7x - 14}{x + 2} = x^2 + 6x - 5 - \frac{4}{x + 2}$   
 2.  $f(x) = (2x + 3)(x + 1)(x - 1)(x - 2)$  3.  $f(-2) = 7$   
 4.  $f(x) = x^3 - 2x + 4$  5.  $g(2) = -8$  and  $g(3) = 5$  have opposite signs  
 6.  $f(x) = (x - 2)(x + 1)(x + 2)(x + 4)$   
 7.  $x = -2, x = 1, x = -1 \pm 3i$   
 8. 9.

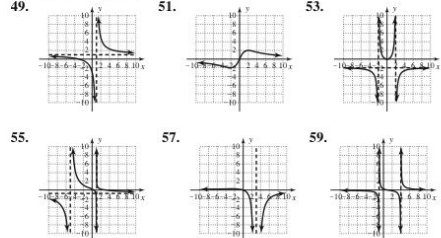
10. a. degree 4; three turning points b. 2 sec  
 c.  $A(t) = (t - 1)^2(t - 3)(t - 5)$   $A(t) = t^4 - 10t^3 + 32t^2 - 38t + 15$   
 $A(2) = 3$ ; altitude is 300 ft above hard-deck  $A(4) = -9$ ; altitude is 900 ft below hard-deck

Reinforcing Basic Concepts, pp. 344-345

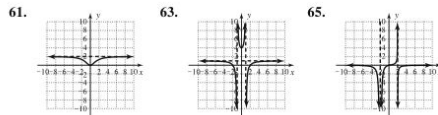
- Exercise 1: 1.532  
 Exercise 2:  $-2.152, 1.765$

Exercises 3.5, pp. 356-362

1. as  $x \rightarrow -\infty, y \rightarrow 2$  3. denominator; numerator 5. about  $x = 98$   
 7. a. as  $x \rightarrow -\infty, y \rightarrow 2$  as  $x \rightarrow \infty, y \rightarrow 2$  9. a. as  $x \rightarrow -\infty, y \rightarrow 1$  as  $x \rightarrow \infty, y \rightarrow 1$   
 b. as  $x \rightarrow 1^-, y \rightarrow -\infty$  as  $x \rightarrow 2^-, y \rightarrow \infty$  as  $x \rightarrow 1^+, y \rightarrow \infty$  as  $x \rightarrow 2^+, y \rightarrow -\infty$   
 11. reciprocal quadratic,  $S(x) = \frac{1}{(x + 1)^2} - 2$   
 13. reciprocal function,  $Q(x) = \frac{1}{x + 1} - 2$   
 15. reciprocal quadratic,  $v(x) = \frac{1}{(x + 2)^2} - 5$   
 17.  $\rightarrow -2$  19.  $\rightarrow -\infty$  21.  $-1; \pm \infty$   
 23.  $x = 3, x \in (-\infty, 3) \cup (3, \infty)$   
 25.  $x = 3, x = -3, x \in (-\infty, -3) \cup (-3, 3) \cup (3, \infty)$   
 27.  $x = \frac{-3}{2}, x = 1, x \in (-\infty, -\frac{3}{2}) \cup (-\frac{3}{2}, 1) \cup (1, \infty)$   
 29. No V.A.,  $x \in (-\infty, \infty)$  31.  $x = 3$ , yes;  $x = -2$ , yes  
 33.  $x = 3$ , no 35.  $x = 2$ , yes;  $x = -2$ , no 37.  $y = 0$ , crosses at  $(\frac{3}{2}, 0)$   
 39.  $y = 4$ , crosses at  $(-\frac{2}{3}, 4)$  41.  $y = 3$ , does not cross  
 43. (0, 0) cross, (3, 0) cross 45.  $(-4, 0)$  cross, (0, 4)  
 47. (0, 0) cross, (3, 0) bounce



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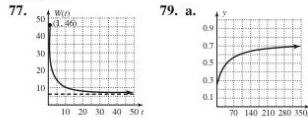
61.  $f(x) = \frac{(x-4)(x+1)}{(x+2)(x-3)}$  63.  $f(x) = \frac{x^2-4}{9-x^2}$  65.  $f(x) = \frac{x^2-4}{9-x^2}$

71. a. Population density approaches zero far from town. c. 4.5 mi, 704 people per square mi

73. a. \$20,000, \$80,000, \$320,000; cost increases dramatically

b.  c. as  $p \rightarrow 100^-$ ,  $C \rightarrow \infty$

75. a. 5 hr; about 0.28 b.  $-0.019, -0.005$ ; As the number of hours increases, the rate of change decreases. c.  $h \rightarrow \infty, C \rightarrow 0^+$ ; horizontal asymptote



b. 35%; 62.5%; 160 gal; c. 160 gal; 200 gal; d. 70%; 75%  
81. a. \$225; \$175 b. 2000 heaters c. 4000 d. The horizontal asymptote at  $y = 125$  means the average cost approaches \$125 as monthly production gets very large. Due to limitations on production (maximum of 5000 heaters) the average cost will never fall below  $A(5000) = 135$ .

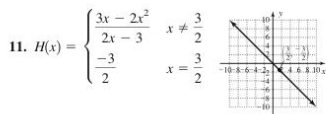
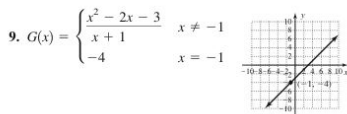
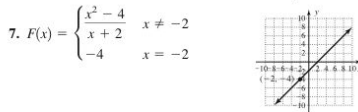
83. a. 5 b. 18 c. The horizontal asymptote at  $y = 95$  means her average grade will approach 95 as the number of tests taken increases; no d. 6  
85. a. 16.0 28.7 65.8 277.8 b. 12.7, 37.1, 212.0 c. a. 22.4, 40.2, 92.1, 388.9 b. 17.8, 51.9, 296.8; answers will vary.

87. a.  $q(x) = 3$ , horizontal asymptote at  $y = 3$ ;  $r(x) = -7x + 10$ , graph crosses HA at  $x = \frac{10}{7}$  b.  $q(x) = -2$ , horizontal asymptote at  $y = -2$ ;  $r(x) = 7$ , no zeroes—graph will not cross

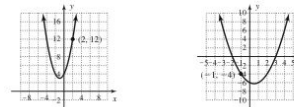
89.  $y = \frac{-4}{3}x - \frac{1}{3}$  91.  $39, \frac{3}{2}, 1$

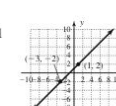
**Exercises 3.6, pp. 371–375**

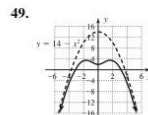
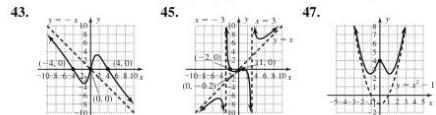
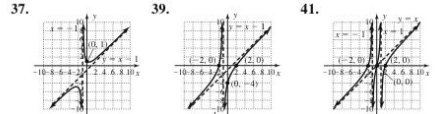
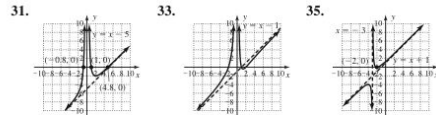
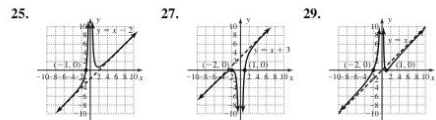
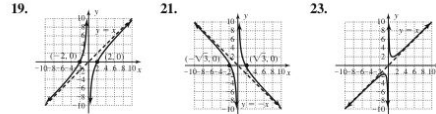
1. nonremovable 3. two 5. Answers will vary.



13.  $P(x) = \begin{cases} \frac{x^3 - 8}{x - 2} & x \neq 2 \\ 12 & x = 2 \end{cases}$  15.  $q(x) = \begin{cases} \frac{x^3 - 7x - 6}{x + 1} & x \neq -1 \\ -4 & x = -1 \end{cases}$



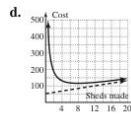
17.  $R(x) = \begin{cases} \frac{x^3 + 3x^2 - x - 3}{x^2 + 2x - 3} & x \neq -3, x \neq 1 \\ -2 & x = -3 \\ 2 & x = 1 \end{cases}$  



53. a.  $a = 5, y = 3a + 15$  b. 60.5 c. 10  
55. a.  $A(x) = \frac{4x^2 + 53x + 250}{x}$ ;  $x = 0, g(x) = 4x + 53$   
b. cost: \$307, \$372, \$445, Avg. cost: \$307, \$186, \$148.33 c. 8, \$116.25

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SA20 Student Answer Appendix

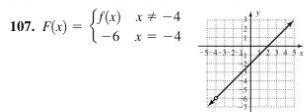


- d.  $S(x, y) = 2x^2 + 4xy$ ;  $V(x, y) = x^2y$  b.  $S(x) = \frac{2x^3 + 48}{x}$   
 c.  $S(x)$  is asymptotic to  $y = 2x^2$ . d.  $x = 2$  ft 3.5 in.;  $y = 2$  ft 3.5 in.  
 59. a.  $A(x, y) = xy$ ;  $R(x, y) = (x - 2.5)(y - 2)$  b.  $y = \frac{2x + 55}{x - 2.5}$   
 $A(x) = \frac{2x^2 + 55x}{x - 2.5}$  c.  $A(x)$  is asymptotic to  $y = 2x + 60$   
 d.  $x \approx 11.16$  in.;  $y = 8.93$  in. 61. a.  $h = \frac{V}{\pi r^2}$  b.  $S = 2\pi r^2 + \frac{2V}{r}$   
 c.  $S = \frac{2\pi r^3 + 2V}{r}$  d.  $r \approx 5.76$  cm,  $h \approx 11.51$  cm;  $S \approx 625.13$  cm<sup>2</sup>  
 63. Answers will vary. 65.  $S = \frac{\pi r^3 + 2V}{r}$ ;  $r = 3.1$  in.,  $h = 3$  in.  
 67.  $y = \frac{1}{3}x - 4$ ,  $m = \frac{1}{3}$ ,  $(0, -4)$  69. a.  $P = 30$  cm,  $b.CD = \frac{60}{13}$  cm,  $c. 30$  cm<sup>2</sup>, d.  $A = \frac{750}{169}$  cm<sup>2</sup>, and  $A = \frac{4320}{169}$  cm<sup>2</sup>

Exercises 3.7, pp. 384–388

1. vertical; multiplicity 3. empty 5. Answers will vary.  
 7.  $x \in (0, 4)$  9.  $x \in (-\infty, -5] \cup [1, \infty)$  11.  $x \in (-1, \frac{3}{2})$   
 13.  $x \in [-\sqrt{7}, \sqrt{7}]$  15.  $x \in [-\frac{3}{2} - \frac{\sqrt{33}}{2}, -\frac{3}{2} + \frac{\sqrt{33}}{2}]$   
 17.  $x \in (-\infty, -\frac{3}{2}] \cup [1, \infty)$  19.  $x \in (-\infty, \infty)$  21.  $\{ \}$   
 23.  $x \in (-\infty, 5) \cup (5, \infty)$  25.  $\{ \}$  27.  $x \in (-\infty, \infty)$   
 29.  $x \in (-\infty, \infty)$  31.  $x \in (-\infty, -5] \cup [5, \infty)$   
 33.  $x \in (-\infty, 0] \cup [5, \infty)$  35.  $\{ \}$  37.  $x \in (-3, 5)$   
 39.  $x \in [4, \infty) \cup \{-1\}$  41.  $x \in (-\infty, -2] \cup \{2\} \cup [4, \infty)$   
 43.  $x \in (-2 - \sqrt{3}, -2 + \sqrt{3})$  45.  $x \in [-\infty, -3] \cup \{-1\}$   
 47.  $x \in (-3, 1) \cup (2, \infty)$  49.  $x \in (-\infty, -3) \cup (-1, 1) \cup (3, \infty)$   
 51.  $x \in (-\infty, -2) \cup (-2, 1) \cup (3, \infty)$  53.  $x \in [-1, 1] \cup \{3\}$   
 55.  $x \in [-3, 2)$  57.  $x \in (-\infty, -2) \cup (-2, -1)$   
 59.  $x \in (-\infty, -2) \cup [2, 3)$  61.  $x \in (-\infty, -5) \cup (0, 1) \cup (2, \infty)$   
 63.  $x \in (-4, -2] \cup (1, 2) \cup (3, \infty)$  65.  $x \in (-7, -3) \cup (2, \infty)$   
 67.  $x \in (-\infty, -2] \cup (0, 2)$  69.  $x \in (-\infty, -17) \cup (-2, 1) \cup (7, \infty)$   
 71.  $x \in (-3, \frac{7}{4}] \cup (2, \infty)$  73.  $x \in (-2, \infty)$  75.  $x \in (-1, \infty)$   
 77.  $(-\infty, -3) \cup (3, \infty)$  79.  $x \in (-\infty, -3] \cup [5, \infty)$   
 81.  $x \in [-3, 0] \cup [3, \infty)$  83.  $x \in (-\infty, -2) \cup (2, 3)$   
 85.  $x \in (-\infty, -2] \cup (-1, 1) \cup [3, \infty)$  87. b 89. b 91. a. verified  
 b.  $D = -4(p + \frac{1}{3})(p + 3)^2$ ,  $p = -3$ ,  $q = -2$ ;  $p = \frac{3}{4}$ ,  $q = \frac{1}{4}$   
 c.  $(-\infty, -3) \cup (-3, \frac{3}{4})$  d. verified  
 93.  $d(x) = k(x^3 - 192x + 1024)$  a.  $x \in [5, 8]$  b. 320 units  
 c.  $x \in [0, 3)$  d. 2 ft 95. a. verified b. horizontal:  $r_2 = 20$ , as  $r_1$  increases,  $r_2$  decreases to maintain  $R = 40$  vertical:  $r_1 = 20$ , as  $r_1$  decreases,  $r_2$  increases to maintain  $R = 40$  97.  $R(t) = 0.01t^2 + 0.1t + 30$   
 a.  $[0^\circ, 30^\circ)$  b.  $(20^\circ, \infty)$  c.  $(50^\circ, \infty)$  99. a.  $n \geq 4$  b.  $n \leq 9$   
 c. 13 101. a. yes,  $x^2 \geq 0$  b. yes,  $\frac{x^2}{x^2 + 1} \geq 0$

103.  $x(x + 2)(x - 1)^2 > 0$ ;  $\frac{x(x + 2)}{(x - 1)^2} > 0$   
 105.  $R(x) < 0$  for  $x \in (2, 8) \cup (8, 14)$



109.  $\frac{x^2}{x^2 + 1} \geq 0$

Exercises 3.8, pp. 394–399

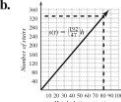
1. constant 3.  $y = \frac{k}{x}$  5. Answers will vary. 7.  $d = kr$  9.  $F = ka$

11.  $y = 0.025x$

x	y
500	12.5
650	16.25
750	18.75

13.  $w = 9.18h$ ; \$321.30; the hourly wage;  $k = \$9.18/\text{hr}$

15. a.  $k = \frac{1952}{47^2}$ ,  $S = \frac{1952}{47^2} h$  c. 330 stairs d.  $S = 331$ ; yes

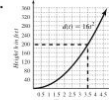


17.  $A = kS^2$  19.  $P = kc^2$   
 21.  $k = 0.112$ ;  $p = 0.112 q^2$

q	P
45	226.8
55	338.8
70	548.8

23.  $k = 6$ ,  $A = 6s^2$ ; 55,303,776 m<sup>2</sup>

25. a.  $k = 16$  d.  $16r^2$  b.



- c. about 3.5 sec d. 3.5 sec; yes e. 2.75 sec 27.  $F = \frac{k}{d^2}$  29.  $S = \frac{k}{t}$

31.  $Y = \frac{12,321}{Z^2}$

Z	Y
37	9
74	2.25
111	1

33.  $w = \frac{3,072,000,000}{r^2}$ ; 48 kg 35.  $l = krt$

37.  $A = kh(B + b)$  39.  $V = ktr^3$

41.  $C = \frac{6.75R}{S^2}$

R	S	C
120	6	22.5
200	12.5	8.64
350	15	10.5

43.  $E = 0.5mv^2$ ; 612.50 J

45. cube root family; answers will vary: 0.054 or 5.4%

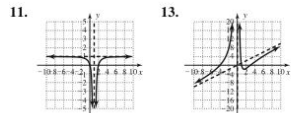
Amount A	Rate R
1.0	0.000
1.05	0.016
1.10	0.032
1.15	0.048
1.20	0.063
1.25	0.077





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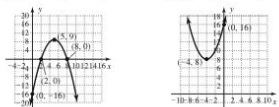
SA22 Student Answer Appendix



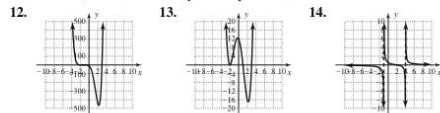
15.  $x \in (-\infty, 3) \cup (-2, 2)$   
 17. a.  $V(x) = (24 - 2x)(16 - 2x)(x) = 4x^3 - 80x^2 + 384x$   
 b.  $512 = 4x^3 - 80x^2 + 384x \Rightarrow 0 = x^3 - 20x^2 + 96x - 128$   
 c. for  $0 < x < 8$ , possible rational zeroes are 1, 2, and 4  
 d.  $x = 4$  e.  $x = 8 - 4\sqrt{2} \approx 2.34$  in. 19.  $R = kL\left(\frac{L}{4}\right)$

Practice Test, pp. 405–406

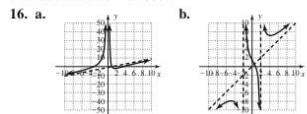
1. a.  $f(x) = -(x - 5)^2 + 9$  b.  $g(x) = \frac{1}{2}(x + 4)^2 + 8$



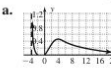
2.  $(-2, 0)$ ,  $y = 2x^2 + 4x$  3. a. 40 ft, 48 ft b. 49 ft c. 14 sec  
 4.  $x - 5 + \frac{14x + 3}{x^2 + 2x + 1}$  5.  $x^2 + 2x - 9 + \frac{-2}{x + 2}$   
 6.  $\frac{-3}{1} \frac{1}{-3} \frac{0}{-6} \frac{-15}{8} \frac{-10}{0} \frac{24}{0} \frac{-24}{0} R = 0 \checkmark$   
 7. -1 8.  $P(x) = x^3 - 2x^2 + 9x - 18$   
 9.  $Q(x) = (x - 2)^2(x - 1)^2(x + 1)$ , 2 mult 2, 1 mult 2, -1 mult 1  
 10. a.  $\pm 1, \pm 18, \pm 2, \pm 9, \pm 3, \pm 6$  b. 1 positive zero, 3 or 1 negative zeros; 2 or 0 complex zeroes c.  $C(x) = (x + 2)(x - 1)(x - 3i)(x + 3i)$   
 11. a. 1992, 1994, 1998 b. 4 yr c. surplus of \$2.5 million



15. a. removal of 100% of the contaminants b. \$500,000; \$3,000,000; dramatic increase c. 88%



17. 800 18. a.  $x \in (-\infty, -3] \cup [-1, 4]$  b.  $x \in (-\infty, -4) \cup (0, 2)$

19. a. 
- b.  $h = -\sqrt{55}$ ; no c. 28.6% 29.6%  
 d.  $\approx 11.7$  hr e. 4 hr 43.7%  
 f. The amount of the chemical in the bloodstream becomes negligible.

20. 520 lb

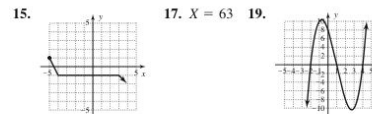
Strengthening Core Skills, pp. 407–408

- Exercise 1:  $x \in (-\infty, 3]$   
 Exercise 2:  $x \in (-2, -1) \cup (2, \infty)$   
 Exercise 3:  $x \in (-\infty, -4) \cup (1, 3)$   
 Exercise 4:  $x \in [-2, \infty)$   
 Exercise 5:  $x \in (-\infty, -2) \cup (2, \infty)$   
 Exercise 6:  $x \in [-3, 1] \cup [3, \infty)$

Cumulative Review chapter R–3, pp. 408–409

1.  $R = \frac{R_1 R_2}{R_1 + R_2}$  3. a.  $(x - 1)(x^2 + x + 1)$   
 b.  $(x - 3)(x + 2)(x - 2)$  5. all reals 7. verified  
 9.  $y = \frac{11}{60}x + \frac{1009}{60}$ ; 39 min, driving time increases 11 min every 60 days

11. Month 9 13.  $f^{-1}(x) = \frac{x^3 + 3}{2}$



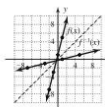
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**CHAPTER 4**

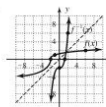
**Exercises 4.1, pp. 420–424**

1. second; one 3.  $(-11, -2), (-5, 0), (1, 2), (19, 4)$  5. False, answers will vary. 7. one-to-one 9. one-to-one 11. not a function 13. one-to-one 15. not one-to-one, fails horizontal line test:  $x = -3$  and  $x = 3$  are paired with  $y = 1$  17. not one-to-one,  $y = 7$  is paired with  $x = -2$  and  $x = 2$  19. one-to-one 21. one-to-one 23. not one-to-one;  $p(t) > 5$ , corresponds to two  $x$ -values 25. one-to-one 27. one-to-one  
 29.  $f^{-1}(x) = \{(1, -2), (4, -1), (5, 0), (9, 2), (15, 5)\}$   
 31.  $v^{-1}(x) = \{(3, -4), (2, -3), (1, 0), (0, 5), (-1, 12), (-2, 21), (-3, 32)\}$   
 33.  $f^{-1}(x) = x - 5$  35.  $p^{-1}(x) = \frac{-5}{4}x$  37.  $f^{-1}(x) = \frac{x - 3}{4}$   
 39.  $Y_1^{-1} = x^3 + 4$  41.  $f^{-1}(x) = x^3 + 2$  43.  $f^{-1}(x) = \sqrt[3]{x - 1}$   
 45.  $f^{-1}(x) = \frac{8}{x} - 2$  47.  $f^{-1}(x) = \frac{x}{1 - x}$  49. a.  $x \geq -5, y \geq 0$   
 b.  $f^{-1}(x) = \sqrt{x} - 5, x \geq 0, y \geq -5$  51. a.  $x > 3, y > 0$   
 b.  $v^{-1}(x) = \sqrt{\frac{8}{x}} + 3, x > 0, y > 3$  53. a.  $x \geq -4, y \geq -2$   
 b.  $p^{-1}(x) = \sqrt{x + 2} - 4, x \geq -2, y \geq -4$   
 55.  $(f \circ g)(x) = x, (g \circ f)(x) = x$  57.  $(f \circ g)(x) = x, (g \circ f)(x) = x$   
 59.  $(f \circ g)(x) = x, (g \circ f)(x) = x$  61.  $(f \circ g)(x) = x, (g \circ f)(x) = x$   
 63.  $f^{-1}(x) = \frac{x + 5}{3}$  65.  $f^{-1}(x) = 2x + 5$  67.  $f^{-1}(x) = 2x + 6$   
 69.  $f^{-1}(x) = \sqrt{x - 3}$  71.  $f^{-1}(x) = \frac{x^3 - 1}{2}$  73.  $f^{-1}(x) = 2\sqrt{x} + 1$   
 75.  $f^{-1}(x) = \frac{x^2 - 2}{3}, x \geq 0; y \in \left[-\frac{2}{3}, \infty\right)$   
 77.  $p^{-1}(x) = \frac{x^2}{4} + 3, x \geq 0; y \in [3, \infty)$   
 79.  $v^{-1}(x) = \sqrt{x - 3}, x \geq 3; y \in [0, \infty)$

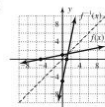
81.



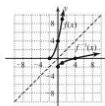
83.



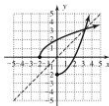
85.

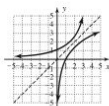


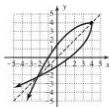
87.



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89.   $D: x \in [0, \infty), R: y \in [-2, \infty);$   
 $D: x \in [-2, \infty), R: y \in [0, \infty)$

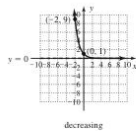
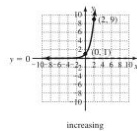
91.   $D: x \in (0, \infty), R: y \in (-\infty, \infty);$   
 $D: x \in (-\infty, \infty), R: y \in (0, \infty)$

93.   $D: x \in (-\infty, 4], R: y \in (-\infty, 4];$   
 $D: x \in (-\infty, 4], R: y \in (-\infty, 4]$

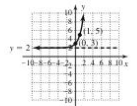
95. a. 31.5 cm b. The result is 80 cm. It gives the distance of the projector from the screen. 97. a.  $-63.5^\circ\text{F}$  b.  $f^{-1}(x) = \frac{-2}{3}(x - 59)$ ; independent: temperature, dependent: altitude c. 22,000 ft 99. a. 144 ft  
 b.  $f^{-1}(x) = \frac{\sqrt{x}}{4}$ , independent: distance fallen, dependent: time fallen  
 c. 7 sec 101. a. 28,260 ft<sup>3</sup> b.  $f^{-1}(x) = \sqrt{\frac{3x}{\pi}}$ , independent: volume, dependent: height c. 9 ft 103. Answers will vary. 105. d  
 107.  $x \in [-1, 2]$  109. a.  $P = 2l + 2w$  b.  $A = \pi r^2$  c.  $V = \pi r^2 h$   
 d.  $V = \frac{1}{3}\pi r^2 h$  e.  $C = 2\pi r$  f.  $A = \frac{1}{2}bh$  g.  $A = \frac{1}{2}(b_1 + b_2)h$   
 h.  $V = \frac{4}{3}\pi r^3$  i.  $a^2 + b^2 = c^2$

Exercises 4.2, pp. 432–436

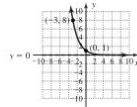
1.  $b^2$ ;  $b$ ;  $x$  3. a; 1 5. False; for  $|b| < 1$  and  $x_2 > x_1$ ,  $b^{x_2} < b^{x_1}$ , so function is decreasing 7. 40,000; 5000; 20,000; 27,589.162 9. 500; 1.581; 2.321; 221.168 11. 10,000; 1975.309; 1487.206; 1316.872  
 13. increasing 15. decreasing



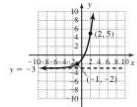
17. up 2



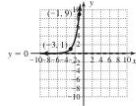
21. reflect across y-axis



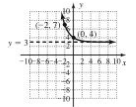
25. left 1, down 3



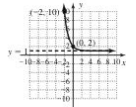
19. left 3



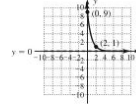
23. reflect across y-axis, up 3



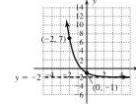
27. up 1



29. right 2



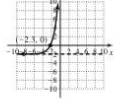
31. down 2



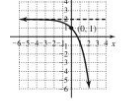
33. e 35. a 37. b 39. 2.718282 41. 7.389056 43. 4.481689

45. 4.113250

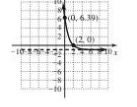
- 47.



- 49.



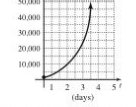
- 51.



53. 3 55.  $\frac{3}{2}$  57.  $-\frac{1}{3}$  59. 4 61.  $-3$  63. 3 65. 2 67.  $-2$

69. 2 71. 3

73. a. 1732, 3000, 5196, 9000 b. yes c. as  $t \rightarrow \infty, P \rightarrow \infty$



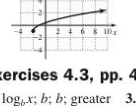
75. no, they will have to wait about 10 min 77. a. \$100,000 b. 3 yr

79. a.  $\approx \$86,806$  b. 3 yr 81. a. \$40 million b. 7 yr 83. 32% transparent 85. 17% transparent 87.  $\approx \$32,578$  89. a. 8 g

- b. 48 min 91.  $9.5 \times 10^{-7}$ ; answers will vary 93. 9 95.  $\frac{3}{2}$

97. a.  $\frac{\Delta y}{\Delta x} = 0.3842, 0.056, 0.011, 0.003$ ; the rate of growth seems to be approaching zero b. 16,608 c. yes, the secant lines are becoming virtually horizontal

99. 101. a. volume of a sphere b. area of a triangle c. volume of a rectangular prism d. Pythagorean theorem



Exercises 4.3, pp. 445–449

1.  $\log_2 x$ ;  $b$ ; greater 3. (1, 0); 0 5. 5; answers will vary 7.  $2^3 = 8$

9.  $7^{-1} = \frac{1}{7}$  11.  $9^0 = 1$  13.  $8^{\frac{1}{3}} = 2$  15.  $2^1 = 2$  17.  $7^2 = 49$

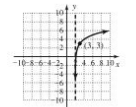
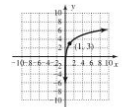
19.  $10^2 = 100$  21.  $e^4 \approx 54.598$  23.  $\log_2 64 = 3$  25.  $\log_3 \frac{1}{3} = -2$

27.  $0 = \log_2 1$  29.  $\log_2 27 = -3$  31.  $\log 1000 = 3$  33.  $\log_{100} \frac{1}{100} = -2$

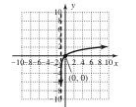
35.  $\log_8 8 = \frac{3}{2}$  37.  $\log_{\frac{1}{8}} \frac{1}{8} = -\frac{3}{2}$  39. 1 41. 2 43. 1 45.  $\frac{1}{2}$

47.  $-2$  49.  $-2$  51. 1.6990 53. 0.4700 55. 5.4161 57. 0.7841

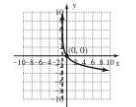
59. shift up 3 61. shift right 2, up 3



63. shift left 1



65. reflect across x-axis, shift left 1



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1246

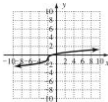
Coburn: Algebra and Trigonometry, Second Edition

Student Answer Appendix Chapter 4

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SA24 Student Answer Appendix

67. II 69. VI 71. V 73.  $x \in (-\infty, -1) \cup (3, \infty)$  75.  $x \in (\frac{2}{3}, \infty)$   
 77.  $x \in (-3, 3)$  79. pH  $\approx$  4.1; acid 81. a.  $\approx$  4.7 b.  $\approx$  4.9  
 83. about 3.2 times 85. a.  $\approx$  2.4 b.  $\approx$  1.2 87. a. 20 dB b. 120 dB  
 89. about 3162 times 91. 6,194 m 93. a. about 5434 m  
 b. 4000 m 95. a. 2225 items b. 2732 items c. \$117,000  
 d. verified 97. a. about 58.6 cfm b. about 1605 ft<sup>2</sup> 99. a. 95%  
 b. 67% c. 39% 101.  $\approx$  4.3; acid 103. Answers will vary. a. 0 dB  
 b. 90 dB c. 15 dB d. 120 dB e. 100 dB f. 140 dB 105. a.  $-\frac{2}{3}$   
 b.  $-\frac{3}{2}$  c.  $-\frac{5}{2}$  107. D:  $x \in \mathbb{R}$ ; R:  $y \in \mathbb{R}$



109.  $x \in (-\infty, -5)$ ;  $f(x) = (x + 5)(x - 4)^2 = x^3 - 3x^2 - 24x + 80$

Mid-Chapter Check, pp. 449–450

1. a.  $\frac{2}{3} = \log_3 9$  b.  $\frac{2}{3} = \log_3 243$  2. a.  $8^3 = 32$  b.  $1296^{0.25} = 6$   
 3. a.  $x = 5$  b.  $b = \frac{2}{3}$  4. a.  $x = 3$  b.  $b = 5$  5. a. \$71,191.41  
 b. 6 yr 6.  $F(x) = 4 \cdot 5^{x-3} + 2$  7.  $f^{-1}(x) = (x - 1)^2 + 3$ , D:  
 $x \in [1, \infty)$ ; R:  $y \in [3, \infty)$ ; verified 8. a. 4 =  $\log_3 81$ , verified  
 b. 4 =  $\ln 54.598$ , verified 9. a.  $27^3 = 9$ , verified b.  $e^{1.4} \approx 4.0552$ ,  
 verified 10.  $\approx$  7.9 times more intense

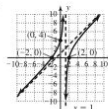
Reinforcing Basic Concepts p. 450

- Exercise 1: about 158 times  
 Exercise 2: about 501 times  
 Exercise 3: about 12,589 times  
 Exercise 4: about 398 times  
 Exercise 5: about 39,811 times

Exercises 4.4, pp. 462–466

1. e 3. extraneous 5. 2.316566275 7.  $x \approx$  29.964 9.  $x \approx$  1.778  
 11.  $x \approx$  2.200 13.  $x \approx$  1.260 15.  $x \approx$  4.7881 17.  $x \approx$  -3.1079  
 19.  $x = -\frac{\ln 2.32}{0.75}$ ;  $x \approx$  -1.1221 21.  $x = e^3 - 4$ ;  $x \approx$  10.3919  
 23.  $x = 5 - 10^{1.25}$ ;  $x \approx$  -12.7828 25.  $x = \frac{e^{0.4} - 5}{2}$ ,  
 $x \approx$  -1.7541 27.  $\ln(2x^2 - 14x)$  29.  $\log(x^2 - 1)$  31.  $\log_3 4$   
 33.  $\log\left(\frac{x}{x+1}\right)$  35.  $\ln\left(\frac{x-5}{x}\right)$  37.  $\ln(x-2)$  39.  $\log_2 42$   
 41.  $\log_5(x-2)$  43.  $(x+2) \log 8$  45.  $(2x-1) \ln 5$  47.  $\frac{1}{2} \log 22$   
 49.  $4 \log_3 3$  51.  $3 \log a + \log b$  53.  $\ln x + \frac{1}{4} \ln y$  55.  $2 \ln x - \ln y$   
 57.  $\frac{3}{2} [\log(x-2) - \log x]$   
 59.  $\ln 7 + \ln x + \frac{1}{2} \ln(3-4x) - \ln 2 - 3 \ln(x-1)$   
 61.  $\frac{\ln 60}{\ln 7}$ ; 2.104076884 63.  $\frac{\ln 152}{\ln 5}$ ; 3.121512475  
 65.  $\frac{\log 1.73205}{\log 3}$ ; 0.499999576 67.  $\frac{\log 0.125}{\log 0.5}$ ; 3  
 69.  $f(x) = \frac{\log(x)}{\log(3)}$ ;  $f(5) \approx$  1.4650;  $f(15) \approx$  2.4650;  $f(45) \approx$  3.4650;  
 outputs increase by 1;  $f(3^3 \cdot 5) = 4.465$   
 71.  $h(x) = \frac{\log(x)}{\log(9)}$ ;  $h(2) \approx$  0.3155;  $h(4) \approx$  0.6309;  $h(8) \approx$  0.9464;  
 outputs are multiples of 0.3155;  $h(2^2) = 4(0.3155) \approx$  1.2619  
 73.  $x = 32$  75.  $x = 6.4$  77.  $x = 20$ , -5 is extraneous  
 79.  $x = 2$ ,  $-\frac{2}{3}$  is extraneous 81.  $x = 0$  83.  $x = \frac{2}{3}$  85.  $x = \frac{2}{3}$   
 87.  $x = \frac{3}{2}$  89.  $x = -\frac{19}{9}$  91.  $x = \frac{e^2 - 63}{9}$   
 93.  $x = 2$ ; -9 is extraneous 95.  $x = 3e^3 - \frac{1}{2}$ ;  $x \approx$  59.75661077  
 97. no solution 99.  $t = -\frac{1}{2}$ ; -4 is extraneous

101.  $x = 2 + \sqrt{3}$ ,  $x = 2 - \sqrt{3}$  is extraneous  
 103.  $x = \frac{\ln 231}{\ln 7} - 2$ ;  $x \approx$  0.7968 105.  $x = \frac{\ln 128,965}{3 \ln 5} + \frac{2}{3}$ ;  $x \approx$  3.1038  
 107.  $x = \frac{\ln 2}{\ln 3 - \ln 2}$ ;  $x \approx$  1.7095 109.  $x = \frac{\ln 9 - \ln 5}{2 \ln 5 - \ln 9}$ ;  $x \approx$  0.5753  
 111.  $x \approx$  46.2 113.  $t = -\frac{\ln\left(\frac{c-1}{a}\right)}{-k}$ ;  $t \approx$  55.45  
 115. a. 30 fish b. about 37 months 117. about 3.2 cmHg  
 119. about 50.2 min 121. \$15,641 123. 6 hr, 18.0%  
 125.  $M_f =$  52.76 tons 127. a. 26 planes b. 9 days  
 129. a.  $\log_4 4 + \log_5 5 = 2.7268$  b.  $\log_4 4 - \log_5 5 = -0.203$   
 c.  $2 \log_3 5 = 2.9298$  131. a. d b. e c. b d. f e. a f. c  
 133.  $x = 0.69314718$  135. a.  $(f \circ g)(x) = 3^{(3^{\log_3(x+2)}) - 2} = 3^{\log_3(x+2)} = x$ ;  
 $(g \circ f)(x) = \log_3(3^{x-2}) + 2 = x - 2 + 2 = x$   
 b.  $(f \circ g)(x) = e^{(\ln(x+1)) - 1} = e^{\ln x} = x$ ;  
 $(g \circ f)(x) = \ln e^{x-1} + 1 = x - 1 + 1 = x$   
 137. a.  $y = e^{x \ln 2} = e^{\ln 2^x} = 2^x$ ;  
 $y = 2^x \Rightarrow \ln y = x \ln 2$ ,  $e^{\ln y} = e^{x \ln 2} \Rightarrow y = e^{x \ln 2}$   
 b.  $y = b^x$ ,  $\ln y = x \ln b$ ,  $e^{\ln y} = e^{x \ln b}$ ,  $y = e^{x \ln b}$  for  $r = \ln b$   
 139. Answers will vary. 141. b 143.



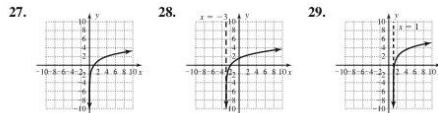
Exercises 4.5, pp. 475–480

1. Compound 3.  $Q_0 e^{-rt}$  5. Answers will vary. 7. \$4896 9. 250%  
 11. \$2152.47 13. 5.25 yr 15. 80% 17. 4 yr 19. 16 yr  
 21. \$7561.33 23. about 5 yr 25. 7.5 yr 27. no 29. a. no  
 b. 9.12% 31. 7.9 yr 33. 7.5 yr 35. a. no b. 9.4% 37. a. no  
 b. approx 13,609 euros 39. No; \$234,612.01 41. about 7 yr  
 43. 23 yr 45. a. no b. \$302.25 47. a.  $t = \frac{A - P}{pr}$  b.  $p = \frac{A}{1 + rt}$   
 49. a.  $r = n \left( \sqrt[n]{\frac{A}{P}} - 1 \right)$  b.  $t = \frac{\ln\left(\frac{A}{P}\right)}{n \ln\left(1 + \frac{r}{n}\right)}$  51. a.  $Q_0 = \frac{Q(t)}{e^{rt}}$   
 b.  $t = -\frac{\ln\left(\frac{Q(t)}{Q_0}\right)}{r}$  53. \$709.74 55. a. 5.78% b. 91.67 hr 57. 0.65 g  
 59. 816 yr 61. about 12.4% 63. \$17,027,502.21 65. 7.93%  
 67. 2548.8 m 69.  $P(x) = x^4 - 4x^3 + 6x^2 - 4x - 15$

Summary and Concept Review, pp. 480–484

1. no 2. no 3. yes 4.  $f^{-1}(x) = \frac{x-2}{-3}$  5.  $f^{-1}(x) = \sqrt{x+2}$   
 6.  $f^{-1}(x) = x^2 + 1$ ;  $x \geq 0$   
 7.  $f(x)$ : D:  $x \in [-4, \infty)$ ; R:  $y \in [0, \infty)$ ;  $f^{-1}(x)$ : D:  $x \in [0, \infty)$ ,  
 R:  $y \in [-4, \infty)$  8.  $f(x)$ : D:  $x \in (-\infty, \infty)$ ; R:  $y \in (-\infty, \infty)$ ;  
 $f^{-1}(x)$ : D:  $(-\infty, \infty)$ ; R:  $y \in (-\infty, \infty)$  9.  $f(x)$ : D:  $x \in (-\infty, \infty)$ ,  
 R:  $y \in (0, \infty)$ ;  $f^{-1}(x)$ : D:  $x \in (0, \infty)$ ; R:  $y \in (-\infty, \infty)$  10. a. \$3.05  
 b.  $f^{-1}(t) = \frac{t-2}{0.15}$ ;  $f^{-1}(3.05) = 7$  c. 12 days  
 11.   
 12.   
 13.   
 14. 2 15. -2 16.  $\frac{2}{3}$  17. 12.1 yr 18.  $3^2 = 9$  19.  $5^{-3} = \frac{1}{125}$   
 20.  $e^{3.7612} \approx 43$  21.  $\log_3 25 = 2$  22.  $\ln 0.7788 \approx -0.25$   
 23.  $\log_8 81 = 4$  24. 5 25. -1 26.  $\frac{2}{3}$

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27.  $x \in (-\infty, 0) \cup (6, \infty)$  28.  $x \in (-\frac{2}{3}, \infty)$  29.  $a. 4.79$   $b. 10^{7.3} I_0$   
 30.  $x \in (-\infty, 0) \cup (6, \infty)$  31.  $x \in (-\frac{2}{3}, \infty)$  32.  $a. 4.79$   $b. 10^{7.3} I_0$   
 33. a.  $x = e^{32}$  b.  $x = 10^{2.38}$  c.  $x = \ln 9.8$  d.  $x = \frac{1}{2} \log 7$   
 34. a.  $x = \frac{\ln 4}{0.5}$ ,  $x \approx 2.7726$  b.  $x = \frac{\ln 19}{0.2}$ ,  $x \approx 6.3938$   
 c.  $x = \frac{10^3}{3}$ ,  $x \approx 33.3333$  d.  $x = e^{-2.75}$ ,  $x \approx 0.0639$  35. a.  $\ln 42$   
 b.  $\log_0 30$  c.  $\ln(\frac{x-3}{1})$  d.  $\log(x^2 + x)$  36. a.  $2 \log_9 9$  b.  $2 \log_7 4$   
 c.  $(2x - 1) \ln 5$  d.  $(3x + 2) \ln 10$  37. a.  $\ln x + \frac{1}{4} \ln y$   
 b.  $\frac{1}{3} \ln p + \ln q$  c.  $\frac{1}{3} \log x + \frac{1}{3} \log y - \frac{2}{3} \log x - \frac{2}{3} \log y$   
 d.  $\log 4 + \frac{2}{3} \log p + \frac{1}{3} \log q - \frac{2}{3} \log p - \log q$  38. a.  $\frac{\log 45}{\log 6} \approx 2.215$   
 b.  $\frac{\log 128}{\log 3} \approx 4.417$  c.  $\frac{\ln 124}{\ln 2} \approx 6.954$  d.  $\frac{\ln 0.42}{\ln 5} \approx -0.539$   
 39.  $x = \frac{\ln 7}{\ln 2}$  40.  $x = \frac{\ln 5}{\ln 3} - 1$  41.  $x = \frac{2}{1 - \ln 3}$  42.  $x \approx 6.389$   
 43.  $x = 5$ ;  $-2$  is extraneous 44.  $x = 4.25$  45. a. 17.77%  
 b. 23.98 days 46. 38.6 cmHg 47. 18.5% 48. Almost, she needs \$42.15 more. 49. a. no b. \$268.93 50. 55.0%

**Mixed Review, pp. 484–485**

1. a.  $\frac{\log 30}{\log 2} \approx 4.9069$  b.  $-1.5$  c.  $\frac{1}{3}$  3. a.  $2 \log_{10} 20$  b.  $0.05x$   
 c.  $(x - 3) \ln 2$   
 5. 7. 9. a.  $5^4 = 625$   
 b.  $e^{0.45} \approx 0.15x$  c.  $10^7 = 0.1 \times 10^8$  11. a.  $x \in [1, \infty)$ ,  $y \in [2, \infty)$   
 b.  $g^{-1}(x) = (x - 2)^2 + 1$ ,  $x \in [2, \infty)$ ,  $y \in [1, \infty)$  c. Answers will vary. 13.  $6 + \log 2$  15.  $\frac{9}{4} + \frac{\sqrt{129}}{4}$  17.  $I \approx 6.3 \times 10^{17}$   
 19. 1.6 m, 1.28 m, 1.02 m, 0.82 m, 0.66 m, 0.52 m

**Practice Test, pp. 485–486**

1.  $3^4 = 81$  2.  $\log_{25} 5 = \frac{1}{2}$  3.  $\frac{2}{3} \log_6 x + 3 \log_6 y - \log_6 z$   
 4.  $\log_b \frac{m\sqrt{n^3}}{\sqrt{p}}$  5.  $x = 10$  6.  $x = \frac{-5}{3}$  7. 2.68 8.  $-1.24$   
 9. 10. 11. a. 4.19 b.  $-0.81$   
 12.  $f$  is a parabola (hence not one-to-one),  $x \in \mathbb{R}$ ,  $y \in [-3, \infty)$ ; vertex is at  $(2, -3)$ , so restricted domain could be  $x \in [2, \infty)$  to create a one-to-one function;  $f^{-1}(x) = \sqrt{x + 3} + 2$ ,  $x \in [-3, \infty)$ ,  $y \in [2, \infty)$ .  
 13.  $x = 1 + \frac{\ln 89}{\ln 3}$  14.  $x = 1$ ,  $x = -5$  is extraneous 15.  $\approx 5$  yr  
 16.  $\approx 8.7$  yr 17. 19.1 months 18. 7% compounded semi-annually  
 19. a. no b. \$54.09 20. a. 10.2 lb b. 19 weeks

**Strengthening Core Skills, p. 488**

- Exercise 1: Answers will vary.  
 Exercise 2: a.  $\log(x^2 + 3x)$  b.  $\ln(x^2 - 4)$  c.  $\log_{\frac{x}{x+3}}$   
 Exercise 3: Answers will vary.  
 Exercise 4: a.  $x \log 3$  b.  $5 \ln x$  c.  $(3x - 1) \ln 2$

**Cumulative Review chapters 1–4, pp. 488–489**

1.  $x = 2 \pm 7i$  3.  $(4 + 5i)^2 - 8(4 + 5i) + 41 = 0$  5.  $f(g(x)) = x$   
 $g(f(x)) = x$  Since  $(f \circ g)(x) = (g \circ f)(x)$ , they are inverse functions.  
 7. a.  $T(t) = 455t + 2645$  (1991  $\rightarrow$  year 1) b.  $\frac{\Delta T}{\Delta t} = \frac{455}{1}$ , triple births increase by 455 each year c.  $T(6) = 5375$  sets of triplets,  
 $T(17) = 10,380$  sets of triplets  
 9.  $D: x \in [-10, \infty)$ ,  $R: y \in [-9, \infty)$   
 $h(x) \uparrow: x \in (-2, 0) \cup (3, \infty)$   $h(x) \downarrow: x \in (0, 3)$

11.  $x = 3$ ,  $x = 2$  (multiplicity 2);  $x = -4$  13.  $\sqrt{\frac{2V}{\pi}} = b$

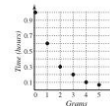
15. a.  $f^{-1}(x) = \frac{5x - 3}{2}$  b. c.  $f^{-1}(f(x)) = x$

17.  $x = 5$ ,  $x = -6$  is an extraneous root 19. a.  $\approx 88$  hp for sport wagon,  $\approx 81$  hp for minivan b.  $\approx 3294$  rpm  
 c. minivan, 208 hp at 5800 rpm

**MODELING WITH TECHNOLOGY II**

**Modeling with Technology Exercises, pp. 495–502**

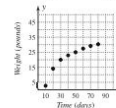
1. e 3. a 5. d 7. linear 9. exponential 11. logistic  
 13. exponential  
 15. As time increases, the amount of radioactive material decreases but will never truly reach 0 or become negative. Exponential with  $b < 1$  and  $k > 0$  is the best choice.  
 $y = (1.042)^{0.5626^x}$



17. Sales will increase rapidly, then level off as the market is saturated with ads and advertising becomes less effective, possibly modeled by a logarithmic function.  
 $y = 120.4938 + 217.2705 \ln(x)$

19. a. b. about 1750 c.  $y \approx \frac{1719}{1 + 10.2e^{-0.11x}}$

21. 4.95 23. 6.25 25. 5.75 27. 6.84  
 29. logarithmic,  $y \approx -27.4 + 13.5 \ln x$   
 a. 9.2 lb b. 29 days c. 34.8 lb



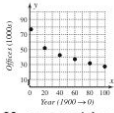


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SA26 Student Answer Appendix

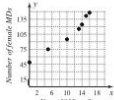
31. logarithmic,  $y = 78.8 - 10.3 \ln x$

a. 51,000 b. 1977 c. 30,400



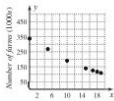
33. exponential,  $y = 50.21(1.07)^x$

a. 86,270 b. 272,511 c. 1990



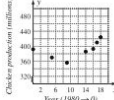
35. exponential,  $y = 346.79(0.94)^x$

a. 155,142 b. 78,548 c. 1993



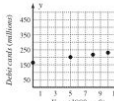
37. quadratic  $y \approx 0.576x^2 - 8.879x + 394$

a. 360 million b. about 513 million c. from 1984 to 1990

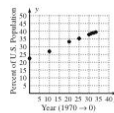


39. linear,  $y = 6.555x + 165.308$

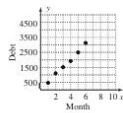
a. 224 million b. 264 million c. 2010



41. linear,  $P(t) = 0.51t + 22.51$ , 2005: 40.4%, 2010: 43%

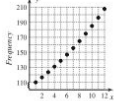


43. linear,  $y \approx 509.18x - 7.96$ ; about \$6100; the next July ( $x \approx 19.7$ )

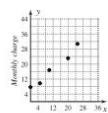


45. exponential,  $y = 103.83(1.0595)^x$

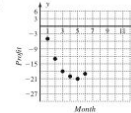
a. 220 b. The 22nd note, or F sharp c. frequency doubles, yes



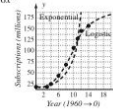
47. exponential,  $y \approx 8.02(1.0564)^x$   
\$41.59/mo, \$54.72/mo



49. quadratic,  $y \approx 1.18x^2 - 10.99x + 4.60$ ; month 8

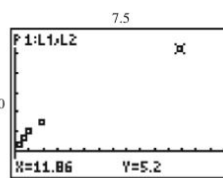


51. logistic,  $y \approx \frac{222.133}{1 + 32.280e^{-0.336x}}$



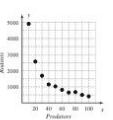
about 55 million, about 184 million, about 214 million; 2014

53.



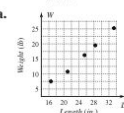
power regression, a.  $y = x^{0.665}$ , 9.5 AU; b. 84.8 yr

55.



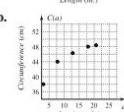
a. power regression,  $y \approx 58555.89(x^{-1.056})$ ; b. about 295 rodents c. about 17 predators

57. a.



linear,  $W = 1.24L - 15.83$ , 32.5 lb, 35.3 in.

57. b.



logarithmic,  $C(a) \approx 37.9694 + 3.4229 \ln(a)$ , about 49.3 cm, about 34 mo

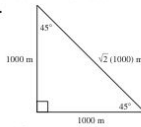
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**CHAPTER 5****Exercises 5.1, pp. 513–518**

1. Complementary;  $180^\circ$ ; less; greater1. 3.  $r\theta$ ,  $\frac{1}{2}r^2\theta$ , radians  
 5. Answers will vary. 7. a.  $77.5^\circ$  b.  $30.8^\circ$  9.  $53^\circ$  11.  $42.5^\circ$   
 13.  $67.555^\circ$  15. 285.0025° 17. 45.7625° 19.  $20^\circ 15' 00''$   
 21.  $67^\circ 18' 25.2''$  23.  $275^\circ 19' 48''$  25.  $5^\circ 27' 9''$  27. No,  
 $19 + 16 < 40$  29.  $69^\circ$  31.  $25^\circ$  33. 62.5 m  
 35.  $41\sqrt{2}$  ft  $\approx 58$  ft + 10 ft = 68 ft 37.  $-645^\circ$ ,  $-285^\circ$ ,  $435^\circ$ ,  $795^\circ$   
 39.  $-765^\circ$ ,  $-405^\circ$ ,  $315^\circ$ ,  $675^\circ$  41.  $s = 980$  m 43.  $\theta = 0.75$  rad  
 45.  $r \approx 1760$  yd 47.  $s = \frac{8\pi}{3}$  mi 49.  $\theta = 0.2575$  rad  
 51.  $r \approx 9.4$  km 53.  $A = 115.6$  km<sup>2</sup> 55.  $\theta = 0.6$  rad  
 57.  $r \approx 3$  m 59.  $\theta = 1.5$  rad;  $s = 7.5$  cm;  $r = 5$  cm;  $A = 18.75$  cm<sup>2</sup>  
 61.  $\theta = 4.3$  rad  $s = 43$  m;  $r = 10$  m;  $A = 215$  m<sup>2</sup>  
 63.  $\theta = 3$  rad;  $A = 864$  mm<sup>2</sup>;  $s = 72$  mm;  $r = 24$  mm  
 65.  $2\pi$  rad 67.  $\frac{\pi}{4}$  rad 69.  $\frac{7\pi}{6}$  rad 71.  $-\frac{2\pi}{3}$  rad 73. 0.4712 rad  
 75. 3.9776 rad 77.  $60^\circ$  79.  $30^\circ$  81.  $120^\circ$  83.  $720^\circ$  85.  $165^\circ$

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87.  $186.4^\circ$  89.  $171.9^\circ$  91.  $-143.2^\circ$   
 93.  $h \approx 7.06$  cm;  $m \approx 3.76$  cm;  $n \approx 13.24$  cm  
 95. 960.7 mi apart 97. a.  $\approx 50.3$  m<sup>2</sup> b.  $\approx 80^\circ$  c.  $\approx 17$  m  
 99. a.  $1.5\pi$  rad/sec b. about 15 mi/hr  
 101. a.  $40\pi$  rad/min b.  $\frac{\pi}{6}$  ft/sec  $\approx 0.52$  ft/sec c. about 11.5 sec  
 103. a. 1000 m b. 1000 m  
 c.  $1000\sqrt{2}$  m  $\approx 1414.2$  m



105.  $50\sqrt{2}$  or about 70.7 mi apart  
 107. a.  $\approx 50.3^\circ$ /day;  $\approx 0.8788$  rad/day b.  $\approx 0.0366$  rad/hr c.  $\approx 6.67$  mi/sec  
 109. Answers will vary. 111. a.  $\approx 192$  yd b.  $\approx 86.7$  rpm  
 113.  $\approx 8.14\%$  115.  $y = \frac{1}{4}(x-2)^2 - 4$

**Exercises 5.2, pp. 525–531**

1.  $\theta = \tan^{-1}x$  3. opposite; hypotenuse  
 5. To find the measure of all three angles and all three sides  
 7.  $\sin \theta = \frac{12}{13}$ ,  $\csc \theta = \frac{13}{12}$ ,  $\sec \theta = \frac{13}{5}$ ,  $\tan \theta = \frac{12}{5}$ ,  $\cot \theta = \frac{5}{12}$   
 9.  $\cos \theta = \frac{13}{85}$ ,  $\sec \theta = \frac{85}{13}$ ,  $\cot \theta = \frac{13}{84}$ ,  $\sin \theta = \frac{84}{85}$ ,  $\csc \theta = \frac{85}{84}$   
 11.  $\sin \theta = \frac{11}{5\sqrt{5}}$ ,  $\tan \theta = \frac{11}{2}$ ,  $\csc \theta = \frac{5\sqrt{5}}{11}$ ,  $\cos \theta = \frac{2}{5\sqrt{5}}$ ,  $\sec \theta = \frac{5\sqrt{5}}{2}$

13.

Angles	Sides
$A = 30^\circ$	$a = 98$ cm
$B = 60^\circ$	$b = 98\sqrt{3}$ cm
$C = 90^\circ$	$c = 196$ cm

15.

Angles	Sides
$A = 45^\circ$	$a = 9.9$ mm
$B = 45^\circ$	$b = 9.9$ mm
$C = 90^\circ$	$c = 9.9\sqrt{2}$ mm

17.

Angles	Sides
$A = 22^\circ$	$a = 14$ m
$B = 68^\circ$	$b \approx 34.65$ m
$C = 90^\circ$	$c \approx 37.37$ m

19.

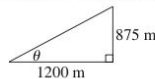
Angles	Sides
$A = 32^\circ$	$a = 5.6$ mi
$B = 58^\circ$	$b \approx 8.96$ mi
$C = 90^\circ$	$c \approx 10.57$ mi

verified

21.

Angles	Sides
$A = 65^\circ$	$a = 625$ mm
$B = 25^\circ$	$b \approx 291.44$ mm
$C = 90^\circ$	$c \approx 689.61$ mm

23. 0.4540 25. 0.8391 27. 1.3230 29. 0.9063 31.  $27^\circ$  33.  $40^\circ$   
 35.  $40.9^\circ$  37.  $65^\circ$  39.  $44.7^\circ$  41.  $20.2^\circ$  43.  $18.4^\circ$  45.  $46.2^\circ$   
 47.  $61.6^\circ$  49. 21.98 mm 51. 3.04 mi 53. 177.48 furlongs  
 55. They have like values. 57. They have like values.  
 59.  $43^\circ$  61.  $21^\circ$  63.  $\frac{1}{2}, \frac{\sqrt{3}}{2}, \frac{\sqrt{3}}{3}, \frac{1}{3}, \sqrt{3}, 2, \frac{2\sqrt{3}}{3}, \sqrt{3}$   
 65.  $6 + 2\sqrt{3}$  67.  $7 + 4\sqrt{3}$  69.  $\theta \approx 11.0^\circ, \beta \approx 23.9^\circ, \gamma \approx 145.1^\circ$   
 71. approx. 300.6 m 73. approx. 1483.8 ft 75. approx. 118.1 mph  
 77. a. approx. 250.0 yd b. approx. 351.0 yd c. approx. 23.1 yd  
 79. approx. 1815.2 ft; approx. 665.3 ft 81. approx. 386.0  $\Omega$   
 83. a. 875 m b. 1200 m  
 c. 1485 m;  $36.1^\circ$



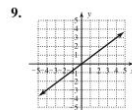
85. approx. 450 ft 87. a. approx. 20.2 cm for each side b. approx.  $35.3^\circ$   
 89.  $\cot u = \frac{x}{h}$   
 $x = h \cot u$   
 $\cot v = \frac{x-d}{h}$   
 $\cot v = \frac{h \cot u - d}{h}$

$h \cot v = h \cot u - d$   
 $d = h \cot u - h \cot v$   
 $h = \frac{d}{\cot u - \cot v}$

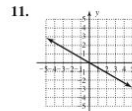
91. a. approx. 3055.6 mi b. approx. 9012.8 mi c. approx. 7 hr, 13 min  
 93. a. local max:  $(-5, 2), (2, 3)$ ; local min:  $(-2, -1), (-7, -2), (6, -3)$   
 b. zeroes:  $x = -6, -3, -1, 4$   
 c.  $T(x) \downarrow$ :  $x \in (-5, -2) \cup (2, 6)$ ;  $T(x) \uparrow$ :  $x \in (-7, -5) \cup (-2, 2)$   
 d.  $T(x) > 0$ :  $x \in (-6, -3) \cup (-1, 4)$ ;  $T(x) < 0$ :  $x \in [-7, -6) \cup (-3, -1) \cup (4, 6)$   
 95.  $d \approx 53.74$  in.  
 $D \approx 65.82$  in.

**Exercises 5.3, pp. 538–541**

1. origin; x-axis 3. positive; clockwise 5. Answers will vary.  
 7. slope =  $\sqrt{3}$ , equation:  $y = \sqrt{3}x$ ,  
 $\sin 60^\circ = \frac{\sqrt{3}}{2}$ ,  $\cos 60^\circ = \frac{1}{2}$ ,  $\tan 60^\circ = \sqrt{3}$



- QI/III;  
 $(4, 3)$ :  $\sin \theta = \frac{3}{5}$ ;  $(-4, -3)$ :  $\sin \theta = -\frac{3}{5}$   
 $\cos \theta = \frac{4}{5}$   $\cos \theta = -\frac{4}{5}$   
 $\tan \theta = \frac{3}{4}$   $\tan \theta = -\frac{3}{4}$



- QII/QIV;  
 $(-3, \sqrt{3})$ :  $\sin \theta = \frac{\sqrt{3}}{2}$ ;  $(3, -\sqrt{3})$ :  $\sin \theta = -\frac{\sqrt{3}}{2}$   
 $\cos \theta = -\frac{3}{2}$   $\cos \theta = \frac{\sqrt{3}}{2}$   
 $\tan \theta = -\frac{1}{\sqrt{3}}$   $\tan \theta = -\frac{1}{\sqrt{3}}$

13.  $\sin \theta = \frac{15}{17}$ ,  $\csc \theta = \frac{17}{15}$ ,  $\cos \theta = \frac{8}{17}$ ,  $\sec \theta = \frac{17}{8}$ ,  $\tan \theta = \frac{15}{8}$ ,  
 $\cot \theta = \frac{8}{15}$   
 15.  $\sin \theta = \frac{21}{29}$ ,  $\csc \theta = \frac{29}{21}$ ,  $\cos \theta = -\frac{20}{29}$ ,  
 $\sec \theta = -\frac{29}{20}$ ,  $\tan \theta = -\frac{21}{20}$ ,  $\cot \theta = -\frac{20}{21}$   
 17.  $\sin \theta = \frac{-\sqrt{2}}{2}$ ,  $\csc \theta = \frac{-2}{\sqrt{2}}$ ,  $\cos \theta = \frac{\sqrt{2}}{2}$ ,  
 $\sec \theta = \frac{2}{\sqrt{2}}$ ,  $\tan \theta = -1$ ,  $\cot \theta = -1$   
 19.  $\sin \theta = \frac{1}{2}$ ,  $\csc \theta = 2$ ,  $\cos \theta = \frac{\sqrt{3}}{2}$ ,  
 $\sec \theta = \frac{2}{\sqrt{3}}$ ,  $\tan \theta = \frac{1}{\sqrt{3}}$ ,  $\cot \theta = \sqrt{3}$   
 21.  $\sin \theta = \frac{4}{\sqrt{17}}$ ,  $\csc \theta = \frac{\sqrt{17}}{4}$ ,  $\cos \theta = \frac{1}{\sqrt{17}}$ ,  
 $\sec \theta = \sqrt{17}$ ,  $\tan \theta = 4$ ,  $\cot \theta = \frac{1}{4}$

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SA28 Student Answer Appendix

23.  $\sin \theta = \frac{-2}{\sqrt{13}}$ ,  $\csc \theta = \frac{-\sqrt{13}}{2}$ ,  $\cos \theta = \frac{-3}{\sqrt{13}}$ ,  
 $\sec \theta = \frac{-\sqrt{13}}{3}$ ,  $\tan \theta = \frac{2}{3}$ ,  $\cot \theta = \frac{3}{2}$
25.  $\sin \theta = \frac{6}{\sqrt{61}}$ ,  $\csc \theta = \frac{\sqrt{61}}{6}$ ,  $\cos \theta = \frac{-5}{\sqrt{61}}$ ,  
 $\sec \theta = \frac{-\sqrt{61}}{5}$ ,  $\tan \theta = \frac{-6}{5}$ ,  $\cot \theta = \frac{-5}{6}$
27.  $\sin \theta = \frac{-2\sqrt{5}}{\sqrt{21}}$ ,  $\csc \theta = \frac{-\sqrt{21}}{2\sqrt{5}}$ ,  $\cos \theta = \frac{1}{\sqrt{21}}$ ,  
 $\sec \theta = \sqrt{21}$ ,  $\tan \theta = -2\sqrt{5}$ ,  $\cot \theta = \frac{-1}{2\sqrt{5}}$
29.  $x = 0$ ,  $y = k$ ;  $k > 0$ ;  $r = |k|$ ;  
 $\sin 90^\circ = \frac{k}{k}$ ,  $\cos 90^\circ = \frac{0}{k}$ ,  $\tan 90^\circ = \frac{k}{0}$ ;  
 $\sin 90^\circ = 1$ ,  $\cos 90^\circ = 0$ ,  $\tan 90^\circ$  is undefined  
 $\csc 90^\circ = 1$ ,  $\sec 90^\circ$  is undefined  
 $\cot 90^\circ = 0$
31.  $60^\circ$  33.  $45^\circ$  35.  $45^\circ$  37.  $68^\circ$  39.  $40^\circ$  41.  $11.6^\circ$
43. QII 45. QII
47.  $\sin \theta = -\frac{1}{2}$ ,  $\cos \theta = \frac{\sqrt{3}}{2}$ ,  $\tan \theta = -\frac{1}{\sqrt{3}}$
49.  $\sin \theta = \frac{-\sqrt{2}}{2}$ ,  $\cos \theta = \frac{\sqrt{2}}{2}$ ,  $\tan \theta = -1$
51.  $\sin \theta = \frac{-\sqrt{3}}{2}$ ,  $\cos \theta = \frac{-1}{2}$ ,  $\tan \theta = \sqrt{3}$
53.  $\sin \theta = -\frac{1}{2}$ ,  $\cos \theta = \frac{-\sqrt{3}}{2}$ ,  $\tan \theta = \frac{1}{\sqrt{3}}$
55.  $x = 4$ ,  $y = -3$ ,  $r = 5$ ; QIV;  $\sin \theta = \frac{-3}{5}$ ,  $\csc \theta = \frac{-5}{3}$ ,  $\cos \theta = \frac{4}{5}$ ,  
 $\sec \theta = \frac{5}{4}$ ,  $\tan \theta = \frac{-3}{4}$ ,  $\cot \theta = \frac{-4}{3}$
57.  $x = -12$ ,  $y = -35$ ,  $r = 37$ ; QIII;  $\sin \theta = \frac{-35}{37}$ ,  $\csc \theta = \frac{-37}{35}$ ,  
 $\cos \theta = \frac{-12}{37}$ ,  $\sec \theta = \frac{-37}{12}$ ,  $\tan \theta = \frac{35}{12}$ ,  $\cot \theta = \frac{12}{35}$
59.  $x = 2\sqrt{2}$ ,  $y = 1$ ,  $r = 3$ ; QI;  $\sin \theta = \frac{1}{3}$ ,  $\csc \theta = 3$ ,  $\cos \theta = \frac{2\sqrt{2}}{3}$ ,  
 $\sec \theta = \frac{3}{2\sqrt{2}}$ ,  $\tan \theta = \frac{1}{2\sqrt{2}}$ ,  $\cot \theta = 2\sqrt{2}$
61.  $x = -\sqrt{15}$ ,  $y = -7$ ,  $r = 8$ ; QIII;  $\sin \theta = \frac{-7}{8}$ ,  $\csc \theta = \frac{-8}{7}$ ,  
 $\cos \theta = \frac{-\sqrt{15}}{8}$ ,  $\sec \theta = \frac{-8}{\sqrt{15}}$ ,  $\tan \theta = \frac{7}{\sqrt{15}}$ ,  $\cot \theta = \frac{\sqrt{15}}{7}$
63.  $52^\circ + 360^\circ k$  65.  $87.5^\circ + 360^\circ k$  67.  $225^\circ + 360^\circ k$
69.  $-107^\circ + 360^\circ k$  71.  $\frac{\sqrt{3}}{2}, \frac{-1}{2}, -\sqrt{3}$  73.  $\frac{1}{2}, \frac{\sqrt{3}}{2}, \frac{1}{\sqrt{3}}$
75.  $\sin \theta = \frac{-\sqrt{3}}{2}$ ,  $\cos \theta = \frac{-1}{2}$ ,  $\tan \theta = \sqrt{3}$
77.  $\sin \theta = \frac{-\sqrt{3}}{2}$ ,  $\cos \theta = \frac{1}{2}$ ,  $\tan \theta = \sqrt{3}$
79.  $\sin \theta = \frac{-1}{2}$ ,  $\cos \theta = \frac{-\sqrt{3}}{2}$ ,  $\tan \theta = \frac{1}{\sqrt{3}}$
81.  $\sin \theta = \frac{-1}{2}$ ,  $\cos \theta = \frac{-\sqrt{3}}{2}$ ,  $\tan \theta = \frac{1}{\sqrt{3}}$
83. QIV, neg., -0.0175 85. QIV, neg., -1.6643
87. QIV, neg., -1.5890 89. QI, pos., 0.0872
91. a. approx. 144.78 units<sup>2</sup> b.  $53^\circ$  c. The parallelogram is a rectangle whose area is  $A = ab$ . d.  $A = \frac{ab}{2} \sin \theta$
93.  $\theta = 60^\circ + 360^\circ k$  and  $\theta = 300^\circ + 360^\circ k$
95.  $\theta = 240^\circ + 360^\circ k$  and  $\theta = 300^\circ + 360^\circ k$

97.  $\theta = 61.1^\circ + 360^\circ k$  and  $\theta = 118.9^\circ + 360^\circ k$
99.  $\theta = 113.0^\circ + 360^\circ k$  and  $\theta = 293.0^\circ + 360^\circ k$
101.  $1890^\circ$ ;  $90^\circ + 360^\circ k$  103. head first;  $900^\circ$
105. approx. 701.6° 107. 343.12 in<sup>2</sup> 109. Answers will vary.
111. a. 12,960° b. 125.66 in. c. 15,080 in. d. 85.68 mph
113. about 555.4 ft 115.  $y = -\frac{3}{4}x + 2$

Exercises 5.4, pp. 550–555

1.  $x$ ;  $y$ ; origin 3.  $x$ ;  $y$ ;  $\frac{y}{x}$ ; sec  $t$ ; csc  $t$ ; cot  $t$  5. Answers will vary.
7.  $(-0.6, -0.8)$  9.  $(\frac{5}{13}, \frac{-12}{13})$  11.  $(\frac{\sqrt{11}}{6}, \frac{5}{6})$  13.  $(\frac{-\sqrt{11}}{4}, \frac{\sqrt{5}}{4})$
15.  $(-0.9769, -0.2137)$  17.  $(-0.9928, 0.1198)$
19.  $(\frac{-\sqrt{3}}{2}, \frac{-1}{2})$ ,  $(\frac{\sqrt{3}}{2}, \frac{1}{2})$ ,  $(\frac{\sqrt{3}}{2}, \frac{-1}{2})$
21.  $(\frac{-\sqrt{11}}{6}, \frac{-5}{6})$ ,  $(\frac{-\sqrt{11}}{6}, \frac{5}{6})$ ,  $(\frac{\sqrt{11}}{6}, \frac{5}{6})$
23.  $(-0.3325, 0.9431)$ ,  $(-0.3325, -0.9431)$ ,  $(0.3325, -0.9431)$
25.  $(0.9937, 0.1121)$ ,  $(-0.9937, 0.1121)$ ,  $(-0.9937, -0.1121)$
27.  $(\frac{1}{2}, \frac{\sqrt{3}}{2})$  is on unit circle 29.  $\frac{\pi}{4}$ ;  $(\frac{-\sqrt{2}}{2}, \frac{-\sqrt{2}}{2})$
31.  $\frac{\pi}{6}$ ;  $(\frac{-\sqrt{3}}{2}, \frac{-1}{2})$  33.  $\frac{\pi}{4}$ ;  $(\frac{-\sqrt{2}}{2}, \frac{\sqrt{2}}{2})$  35.  $\frac{\pi}{6}$ ;  $(\frac{\sqrt{3}}{2}, \frac{1}{2})$
37. a.  $\frac{\sqrt{2}}{2}$  b.  $\frac{\sqrt{2}}{2}$  c.  $\frac{-\sqrt{2}}{2}$  d.  $\frac{-\sqrt{2}}{2}$  e.  $\frac{\sqrt{2}}{2}$  f.  $\frac{-\sqrt{2}}{2}$
- g.  $\frac{\sqrt{2}}{2}$  h.  $\frac{-\sqrt{2}}{2}$  39. a. -1 b. 1 c. 0 d. 0
41. a.  $\frac{\sqrt{3}}{2}$  b.  $\frac{-\sqrt{3}}{2}$  c.  $\frac{-\sqrt{3}}{2}$  d.  $\frac{\sqrt{3}}{2}$  e.  $\frac{\sqrt{3}}{2}$  f.  $\frac{\sqrt{3}}{2}$  g.  $\frac{-\sqrt{3}}{2}$
- h.  $\frac{\sqrt{3}}{2}$  43. a. 0 b. 0 c. undefined d. undefined
45.  $\sin t = 0.6$ ,  $\cos t = -0.8$ ,  $\tan t = -0.75$ ,  $\csc t = 1.6$ ,  $\sec t = -1.25$ ,  
 $\cot t = -1.3$
47.  $\sin t = -\frac{5}{13}$ ,  $\cos t = \frac{12}{13}$ ,  $\tan t = \frac{12}{5}$ ,  $\csc t = -\frac{13}{5}$ ,  $\sec t = \frac{13}{12}$ ,  
 $\cot t = \frac{5}{12}$
49.  $\sin t = \frac{\sqrt{11}}{6}$ ,  $\cos t = \frac{5}{6}$ ,  $\tan t = \frac{\sqrt{11}}{5}$ ,  $\csc t = \frac{6\sqrt{11}}{11}$ ,  $\sec t = \frac{6}{5}$ ,  
 $\cot t = \frac{5\sqrt{11}}{11}$
51.  $\sin t = \frac{\sqrt{21}}{5}$ ,  $\cos t = \frac{-2}{5}$ ,  $\tan t = \frac{-\sqrt{21}}{2}$ ,  $\csc t = \frac{5\sqrt{21}}{21}$ ,  
 $\sec t = \frac{-5}{2}$ ,  $\cot t = \frac{-2\sqrt{21}}{21}$
53.  $\sin t = \frac{-2\sqrt{2}}{3}$ ,  $\cos t = \frac{-1}{3}$ ,  $\tan t = 2\sqrt{2}$ ,  $\csc t = \frac{-3\sqrt{2}}{4}$ ,  
 $\sec t = -3$ ,  $\cot t = \frac{\sqrt{2}}{4}$
55.  $\sin t = \frac{\sqrt{3}}{2}$ ,  $\cos t = \frac{1}{2}$ ,  $\tan t = \sqrt{3}$ ,  $\csc t = \frac{2\sqrt{3}}{3}$ ,  $\sec t = 2$ ,  
 $\cot t = \frac{\sqrt{3}}{3}$
57.  $\sin t = \frac{\sqrt{2}}{2}$ ,  $\cos t = \frac{-\sqrt{2}}{2}$ ,  $\tan t = -1$ ,  $\csc t = \sqrt{2}$ ,  $\sec t = -\sqrt{2}$ ,  
 $\cot t = -1$
59. QI, 0.7 61. QIV, 0.7 63. QI, 1 65. QII, 1.1
67. QII, -0.4 69. QIV, -3.1 71.  $\frac{2\pi}{3}$  73.  $\frac{7\pi}{6}$  75.  $\frac{2\pi}{3}$  77.  $\frac{\pi}{2}$
79.  $\frac{3\pi}{4}, \frac{5\pi}{4}$  81.  $\frac{\pi}{2}, \frac{3\pi}{2}$  83.  $\frac{3\pi}{4}, \frac{5\pi}{4}$  85. 0,  $\pi$  87. a.  $(\frac{3}{4}, \frac{3}{4})$  b.  $(\frac{-3}{4}, \frac{3}{4})$
89. 2.3416 91. 1.7832 93. 3.5416
95. a.  $(\frac{5}{13}, \frac{12}{13})$ ,  $(\frac{5}{13})^2 + (\frac{12}{13})^2 = \frac{25}{169} + \frac{144}{169} = \frac{169}{169} = 1$ ;  $\sin t = \frac{12}{13}$ ,  
 $\cos t = \frac{5}{13}$ ,  $\tan t = \frac{12}{5}$ ,  $\csc t = \frac{13}{12}$ ,  $\sec t = \frac{13}{5}$ ,  $\cot t = \frac{5}{12}$

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b.  $(\frac{7}{25}, \frac{24}{25}, 1), (\frac{7}{25})^2 + (\frac{24}{25})^2 = \frac{49}{625} + \frac{576}{625} = 1; \sin t = \frac{24}{25}, \cos t = \frac{7}{25}, \tan t = \frac{24}{7}, \csc t = \frac{25}{24}, \sec t = \frac{25}{7}, \cot t = \frac{7}{24}$   
 c.  $(\frac{12}{37}, \frac{35}{37}, 1), (\frac{12}{37})^2 + (\frac{35}{37})^2 = \frac{144}{1369} + \frac{1225}{1369} = 1; \sin t = \frac{35}{37}, \cos t = \frac{12}{37}, \tan t = \frac{35}{12}, \csc t = \frac{37}{35}, \sec t = \frac{37}{12}, \cot t = \frac{12}{35}$   
 d.  $(\frac{9}{41}, \frac{40}{41}, 1), (\frac{9}{41})^2 + (\frac{40}{41})^2 = \frac{81}{1681} + \frac{1600}{1681} = 1; \sin t = \frac{40}{41}, \cos t = \frac{9}{41}, \tan t = \frac{40}{9}, \csc t = \frac{41}{40}, \sec t = \frac{41}{9}, \cot t = \frac{9}{40}$

97. a. 5 rad b. 30 rad 99. a. 5 dm b. ≈6.28 dm  
 101. a. 2.5 AU b. ≈6.28 AU 103. yes  
 105. range of sin t and cos t is [-1, 1]  
 107. a. 2t = 2.2 b. QI c. cos t ≈ 0.5 d. No  
 109. a. d = 10 b. midpoint: (1, -1) c. m =  $\frac{3}{4}$   
 111. a. x = -6, 4 b. x = 24

**Mid-Chapter Check, p. 555**

1. a. 36.11°N, 115.08°W b. 2495.7 mi  
 2.  $\theta = 4.3; A = 860 \text{ cm}^2$  3. a.  $\frac{1}{\sqrt{3}}$  b.  $-\frac{\sqrt{2}}{2}$   
 4. a. ≈1.0353 b. ≈8.9152  
 5.  $y = \frac{-2}{3}, \sin \theta = \frac{-2}{3}, \csc \theta = \frac{-3}{2}, \cos \theta = \frac{-\sqrt{5}}{3}, \sec \theta = \frac{-3}{\sqrt{5}}$   
 $\tan \theta = \frac{2}{\sqrt{5}}, \cot \theta = \frac{\sqrt{5}}{2}$   
 6. 221.8°, 3.8711 7. b = 7√3 cm, c = 14 cm  
 8. approximately 367 ft 9. a. QIV b. 2π - 5.94 ≈ 0.343 c. sin t, tan t  
 10. approximately 3 ft 5.6 in.

**Reinforcing Basic Concepts, p. 556**

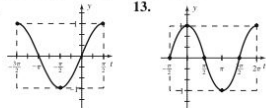
1.  $(-\frac{1}{2}, \frac{\sqrt{3}}{2}), \cos t = -\frac{1}{2}, \sin t = \frac{\sqrt{3}}{2}$  2.  $t = \frac{5\pi}{6}$ , negative since x < 0  
 3. QIV, negative since y < 0 4. QI, cos t =  $\frac{1}{2}, \sin t = \frac{\sqrt{3}}{2}, t = \frac{\pi}{3}$

**Exercises 5.5, pp. 568–573**

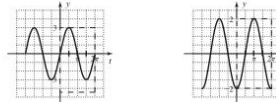
1. increasing 3.  $(-\infty, \infty), [-1, 1]$  5. Answers will vary.

t	y = cos t
π	-1
$\frac{7\pi}{6}$	$-\frac{\sqrt{3}}{2}$
$\frac{5\pi}{4}$	$-\frac{\sqrt{2}}{2}$
$\frac{4\pi}{3}$	$-\frac{1}{2}$
$\frac{3\pi}{2}$	0
$\frac{5\pi}{3}$	$\frac{1}{2}$
$\frac{7\pi}{4}$	$\frac{\sqrt{2}}{2}$
$\frac{11\pi}{6}$	$\frac{\sqrt{3}}{2}$
2π	1

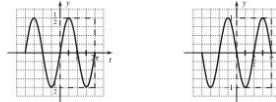
9. a. II b. V c. IV d. I e. III  
 11. 13.



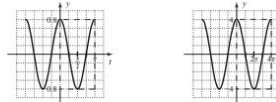
15.  $|A| = 3, P = 2\pi$  17.  $|A| = 2, P = 2\pi$



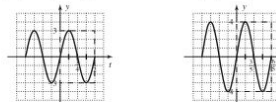
19.  $|A| = \frac{1}{2}, P = 2\pi$  21.  $|A| = 1, P = \pi$



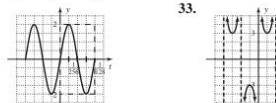
23.  $|A| = 0.8, P = \pi$  25.  $|A| = 4, P = 4\pi$



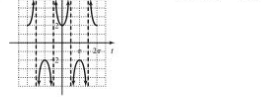
27.  $|A| = 3, P = \frac{1}{2}$  29.  $|A| = 4, P = \frac{\pi}{2}$



31.  $|A| = 2, P = \frac{5\pi}{128}$  33.



35. 37.  $|A| = 2, P = \frac{\pi}{2}, k$



39.  $|A| = 3, P = \pi, t$  41.  $P = 4\pi, h$  43.  $|A| = \frac{3}{4}, P = 5\pi, b$

45.  $P = \frac{1}{4}, j$  47.  $|A| = 4, P = \frac{1}{2}, d$  49.  $y = -\frac{3}{4} \cos(8t)$

51.  $y = -0.2 \csc(\frac{1}{2}t)$  53.  $y = 6 \cos(\frac{2\pi}{3}t)$

55. red:  $y = -\cos x$ ; blue:  $y = \sin x; x = \frac{3\pi}{4}, \frac{7\pi}{4}$

57. red:  $y = -2 \cos x$ ; blue:  $y = 2 \sin(3x);$

- $x = \frac{3\pi}{8}, \frac{3\pi}{4}, \frac{7\pi}{8}, \frac{11\pi}{8}, \frac{7\pi}{4}, \frac{15\pi}{8}$

59.  $\cos t = \frac{11}{13}, (15, 112, 113)$

61. a. 3 ft b. 80 mi c.  $h = 1.5 \cos(\frac{\pi}{40}x)$

63. a.  $D = -4 \cos(\frac{\pi}{12}t)$  b.  $D = 3.86$  c.  $72^\circ$

65. a.  $D = 15 \cos(\pi t)$  b. at center c. Swimming leisurely.

- One complete cycle in 2 sec 67. a. Graph a b. 76 days c. 96 days

69. a. 480 nm → blue b. 620 nm → orange

71.  $I = 30 \sin(50\pi t), I = 21.2$  amps

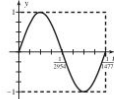
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SA30 Student Answer Appendix

73. Since  $m = -M, 0$ ;  
 avg. value = 3; shifted up 3 units;  
 avg. value = 1; amplitude is  
 "centered" on average value.

$t$	$y$
0	3
$\frac{\pi}{2}$	5
$\pi$	3
$\frac{3\pi}{2}$	1
$2\pi$	3

75.  $g(t)$  has the shortest period;

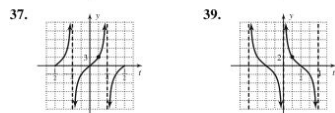
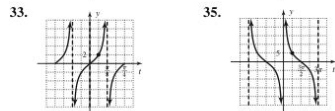
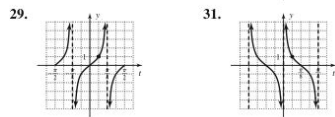
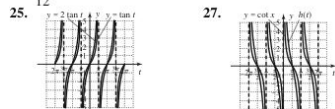


77. distance =  $\frac{200}{\sqrt{3}}$  yd  $\approx 115.5$  yd

79. a.  $3 - 4i$  b.  $-1 + 6i$  c.  $7 - 3i$  d.  $\frac{-3 - 7i}{2}$

Exercises 5.6, pp. 582–587

1.  $\pi; P = \frac{\pi}{|B|}$  3. odd,  $-f(t)$ ;  $-0.268$  5. a. use  $\frac{\cos t}{\sin t}$   
 b. use reciprocals of  $\tan t$  7. 0,  $\frac{1}{\sqrt{3}}$ , 1,  $\sqrt{3}$ , und.  
 9. 1.6, 0.8, 0.5, 1.4, 0.7, 1.2 11. a.  $-1$  b.  $\sqrt{3}$  c.  $-1$  d.  $\sqrt{3}$   
 13. a.  $\frac{7\pi}{4}$  b.  $\frac{7\pi}{6}$  c.  $\frac{5\pi}{3}$  d.  $\frac{3\pi}{4}$  15. und.,  $\sqrt{3}$ , 1,  $\frac{1}{\sqrt{3}}$ , 0  
 17.  $\frac{-13\pi}{24}$ ,  $\frac{35\pi}{24}$ ,  $\frac{59\pi}{24}$  19.  $-1.6, 4.6, 7.8$  21.  $\frac{\pi}{10} + \pi k, k \in \mathbb{Z}$   
 23.  $\frac{\pi}{12} + \pi k, k \in \mathbb{Z}$



41.  $y = 3 \tan\left(\frac{1}{2}t\right)$  43.  $y = 2 \cot\left(\frac{2\pi}{3}t\right)$  45.  $\frac{\pi}{8}, \frac{3\pi}{8}$

47. about 137.8 ft

49.  $y = 5.2 \tan\left(\frac{\pi}{12}t\right); P = 12$ ; asymptotes at  $x = 6 + 12k, k \in \mathbb{Z}$ ; using (3, 5.2),  $|A| = 5.2$ ; at  $x = 2$ , model gives  $y \approx 3.002$ ; at  $x = -2$ , model gives  $y \approx -3.002$ ; answers will vary.

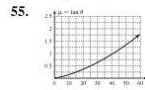
51. Answers will vary;  $y = 11.95 \tan \theta; P = 180^\circ$ ; asymptotes at  $\theta = 90^\circ + 180^\circ k; |A| = 11.95$  from  $(30^\circ, 6.9 \text{ cm})$ ; pen is  $\approx 12 \text{ cm}$  long

53. a.  $20\pi \text{ cm} \approx 62.8 \text{ cm}$  b. 80 cm; it is a square

c.

$n$	$P$
10	64.984
20	63.354
30	63.063
100	62.853

getting close to  $20\pi$



- a. no;  $\approx 35^\circ$  b. 1.05

- c. Angles will be greater than  $68.2^\circ$ ; soft rubber on sandstone

57. a. 5.67 units b.  $86.5^\circ$  c. Yes. Range of  $\tan \theta$  is  $(-\infty, \infty)$ .

- d. The closer  $\theta$  gets to  $90^\circ$ , the longer the line segment gets.

59.  $[2, 3] \rightarrow \approx 7.1 \text{ m/sec}$ ;  $[3, 3.5] \rightarrow \approx 26.1 \text{ m/sec}$ ;  $[3.5, 3.8] \rightarrow \approx 128 \text{ m/sec}$ . The velocity of the beam is increasing dramatically,  $[3.9, 3.99] \rightarrow \approx 12,733 \text{ m/sec}$

61. a. x-intercepts: (0, 0), (3, 0); y-intercept: (0, 0); vertical

asymptotes:  $x = -2, x = 2$ ; horizontal asymptote:  $y = \frac{3}{2}$

- b. x-intercept:  $(-1, 0)$ ; y-intercept: none; vertical asymptotes:  $x = 0, x = 4$ ; horizontal asymptote:  $y = 0$

- c. x-intercepts:  $(-1, 0), (1, 0)$ ; y-intercept:  $\left(0, -\frac{1}{2}\right)$ ; vertical asymptote:  $x = -2$ ; slant asymptote:  $y = x - 2$

63.  $\approx 7.37 \text{ hr}$

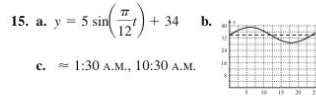
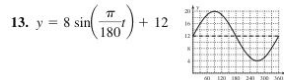
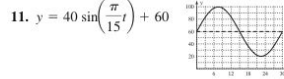
Exercises 5.7, pp. 596–600

1.  $y = A \sin(Bt + C) + D; y = A \cos(Bt + C) + D$

3.  $0 \leq Bt + C < 2\pi$  5. Answers will vary.

7. a.  $|A| = 50, P = 24$  b.  $\approx -25$  c.  $[1.6, 10.4]$

9. a.  $|A| = 200, P = 3$  b.  $-175$  c.  $[1.75, 2.75]$



- c.  $\approx 1:30 \text{ A.M.}, 10:30 \text{ A.M.}$

17. a.  $y = -6.4 \cos\left(\frac{\pi}{6}t\right) + 12.4$

- b.

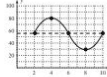
- c.  $\approx 134 \text{ days}$

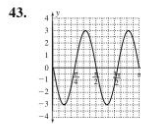
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19. a.  $P = 11$  yr  
 b.   
 c. max = 1200, min = 700  
 d. about 2 yr.

21.  $P(t) = 250 \cos\left[\frac{2\pi}{11}(t - 2.75)\right] + 950$ ;  $P(t) = 250 \sin\left(\frac{2\pi}{11}t\right) + 950$   
 23.  $|A| = 120$ ;  $P = 24$ ; HS: 6 units right; VS: (none); PI:  $6 \leq t < 30$   
 25.  $|A| = 1$ ;  $P = 12$ ; HS: 2 units right; VS: (none); PI:  $2 \leq t < 14$   
 27.  $|A| = 1$ ;  $P = 8$ ; HS:  $\frac{2}{3}$  unit right; VS: (none); PI:  $\frac{2}{3} \leq t < \frac{26}{3}$   
 29.  $|A| = 24.5$ ;  $P = 20$ ; HS: 2.5 units right; VS: 15.5 units up; PI:  $2.5 \leq t < 22.5$   
 31.  $|A| = 28$ ;  $P = 12$ ; HS:  $\frac{5}{2}$  units right; VS: 92 units up; PI:  $\frac{5}{2} \leq t < \frac{29}{2}$   
 33.  $|A| = 2500$ ;  $P = 8$ ; HS:  $\frac{1}{3}$  unit left; VS: 3150 units up; PI:  $-\frac{1}{3} \leq t < \frac{23}{3}$

35.  $y = 250 \sin\left(\frac{\pi}{12}t\right) + 350$     37.  $y = 5 \sin\left(\frac{\pi}{50}t + \frac{\pi}{2}\right) + 13$

39.  $y = 4 \sin\left(\frac{\pi}{180}t + \frac{\pi}{4}\right) + 7$     41. 



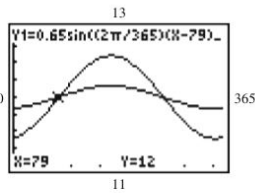
45.  $P = \frac{2\pi}{B}$ ,  $B = \frac{2\pi}{P}$ ,  $f = \frac{1}{P}$ ,  $P = \frac{1}{f}$ ,  $B = \frac{2\pi}{1/f} = 2\pi f$ .  
 $A \sin(Bt) = A \sin[(2\pi f)t]$

47. a.  $P = 4$  sec,  $f = \frac{1}{4}$  cycle/sec    b. -4.24 cm, moving away  
 c. -4.24 cm, moving toward    d. about 1.76 cm. avg. vel. = 3.52 cm/sec, greater, still gaining speed

49.  $d(t) = 15 \cos\left(\frac{5\pi}{4}t\right)$     51. red  $\rightarrow D_3$ ; blue  $\rightarrow A_3$

53.  $D_3: y = \sin[146.84(2\pi t)]$ ;  $P \approx 0.0068$  sec;  
 $G_4: y = \sin[392(2\pi t)]$ ;  $P \approx 0.00255$  sec

55. a. Caracas:  $\approx 11.4$  hr, Tokyo:  $\approx 9.9$  hr  
 b. (i) Same # of hours on 79th day & 261st day  
 (ii) Caracas:  $\approx 81$  days, Tokyo:  $\approx 158$  days



57. a. Adds 12 hr. The sinusoidal behavior is actually based on hours more/less than an average of 12 hr of light.  
 b. Means 12 hr of light and dark on March 20, day 79 (Solstice!).  
 c. Additional hours of deviation from average. In the north, the planet is tilted closer toward the Sun or farther from Sun, depending on date. Variations will be greater!

59. QIII:  $3.7 - \pi \approx 0.5584$

61. sum: -2, difference:  $2i\sqrt{5}$ , product: 6, quotient:  $-\frac{2}{3} - \frac{i\sqrt{5}}{3}$

Summary and Concept Review, pp. 601–608

1. 147.613    2.  $32^\circ 52' 12''$     3.  $10.125 \times 13.5 \times 16.875$   
 4. approx. 692.82 yd    5.  $120^\circ$     6.  $\frac{7\pi}{6}$     7. approx. 4.97 units    8.  $-\frac{1}{2}$   
 9.  $s = 25.5$  cm,  $A = 191.25$  cm<sup>2</sup>    10.  $r \approx 41.74$  in.,  $A \approx 2003.48$  in<sup>2</sup>  
 11.  $\theta = 4.75$  rad,  $s = 38$  m    12. a. approx. 9.4248 rad/sec  
 b. approx. 3.9 ft/sec    c. about 15.4 sec    13. a.  $A \approx 0.80$     b.  $A \approx 64.3^\circ$   
 14. a. cot  $32.6^\circ$     b.  $\cos(70^\circ 29' 45'')$

15.

Angles	Sides
$A = 49^\circ$	$a = 89$ in.
$B = 41^\circ$	$b \approx 77.37$ in.
$C = 90^\circ$	$c \approx 117.93$ in.

16.

Angles	Sides
$A \approx 43.6^\circ$	$a = 20$ m
$B \approx 46.4^\circ$	$b \approx 21$ m
$C = 90^\circ$	$c = 29$ m

17. approx. 5.18 m    18. a. approx. 239.32 m    b. approx. 240.68 m apart  
 19. approx.  $54.5^\circ$  and  $35.5^\circ$     20.  $207^\circ + 360^\circ k$ ; answers will vary.  
 21.  $28^\circ, 19^\circ, 30^\circ$

22. a.  $\sin \theta = \frac{35}{37}$ ,  $\csc \theta = \frac{37}{35}$ ,  $\cos \theta = \frac{-12}{37}$ ,  
 $\sec \theta = \frac{-37}{12}$ ,  $\tan \theta = \frac{-35}{12}$ ,  $\cot \theta = \frac{-12}{35}$

b.  $\sin \theta = \frac{-3}{\sqrt{13}}$ ,  $\csc \theta = \frac{-\sqrt{13}}{3}$ ,  $\cos \theta = \frac{2}{\sqrt{13}}$ ,  
 $\sec \theta = \frac{\sqrt{13}}{2}$ ,  $\tan \theta = \frac{-3}{2}$ ,  $\cot \theta = \frac{-2}{3}$

23. a.  $x = 4$ ,  $y = -3$ ,  $r = 5$ ; QIV;  $\sin \theta = -\frac{3}{5}$ ,  $\csc \theta = -\frac{5}{3}$ ,  
 $\cos \theta = \frac{4}{5}$ ,  $\sec \theta = \frac{5}{4}$ ,  $\tan \theta = \frac{-3}{4}$ ,  $\cot \theta = \frac{-4}{3}$

b.  $x = 5$ ,  $y = -12$ ,  $r = 13$ ; QIV;  $\sin \theta = \frac{-12}{13}$ ,  $\csc \theta = \frac{-13}{12}$ ,  
 $\cos \theta = \frac{5}{13}$ ,  $\sec \theta = \frac{13}{5}$ ,  $\tan \theta = \frac{-12}{5}$ ,  $\cot \theta = \frac{-5}{12}$

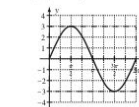
24. a.  $\theta = 135^\circ + 180^\circ k$     b.  $\theta = 30^\circ + 360^\circ k$  or  $\theta = 330^\circ + 360^\circ k$   
 c.  $\theta = 76.0^\circ + 180^\circ k$     d.  $\theta = -27.0^\circ + 360^\circ k$  or  $\theta = 207.0^\circ + 360^\circ k$

25.  $y = -\frac{6}{7} \left(-\frac{\sqrt{13}}{7}, \frac{6}{7}\right), \left(-\frac{\sqrt{13}}{7}, -\frac{6}{7}\right), \text{ and } \left(\frac{\sqrt{13}}{7}, \frac{6}{7}\right)$

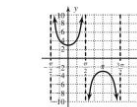
26.  $\sin t = -\frac{\sqrt{7}}{4}$ ,  $\csc t = -\frac{4}{\sqrt{7}}$ ,  $\cos t = \frac{3}{4}$ ,  
 $\sec t = \frac{4}{3}$ ,  $\tan t = -\frac{\sqrt{7}}{3}$ ,  $\cot t = -\frac{3}{\sqrt{7}}$

27.  $\frac{\pi}{3}$  and  $\frac{2\pi}{3}$     28.  $t \approx 2.44$     29. a. approx. 19.67 rad    b. 25 rad

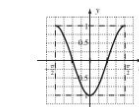
30.  $|A| = 3$ ,  $P = 2\pi$



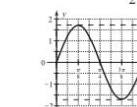
31.  $P = 2\pi$



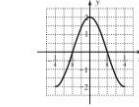
32.  $|A| = 1$ ,  $P = \pi$



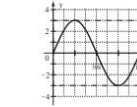
33.  $|A| = 1.7$ ,  $P = \frac{\pi}{2}$



34.  $|A| = 2$ ,  $P = \frac{1}{2}$



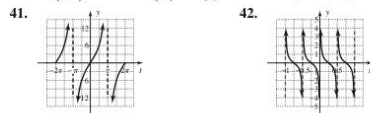
35.  $|A| = 3$ ,  $P = \frac{1}{199}$



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SA32 Student Answer Appendix

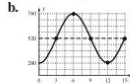
36.  $y = 0.75 \sin(6t)$  37.  $y = 4 \csc(3\pi t)$  38. green, red  
 39.  $\tan\left(\frac{7\pi}{4}\right) = -1$ ;  $\cot\left(\frac{\pi}{3}\right) = \frac{1}{\sqrt{3}}$  40.  $\theta = \frac{2\pi}{3}$ ;  $\theta = \frac{2\pi}{3}$



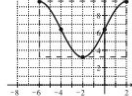
41.  $1.55 + k\pi$  radians;  $k \in \mathbb{Z}$  44. 3.5860 45.  $\approx 151.14$  m

46.  $y = 5.2 \tan\left(\frac{\pi}{12}x\right)$ ; period = 12;  $A = 5.2$ ; asymptotes  $x = -6$ ,  $x = 6$

47. a.  $|A| = 240$ ,  $P = 12$ , HS: 3 units right, VS: 520 units up



48. a.  $|A| = 3.2$ ,  $P = 8$ , HS: 6 units left, VS: 6.4 units up



49.  $|A| = 125$ ,  $P = 24$ , HS: 3 units right, VS: 175 units up,

$y = 125 \cos\left[\frac{\pi}{12}(t - 3)\right] + 175$

50.  $A = 75$ ,  $P = \frac{3\pi}{8}$ , HS: (none), VS: 105 units up,

$y = 75 \sin\left(\frac{16}{3}t\right) + 105$  51. a.  $P(t) = 0.91 \sin\left(\frac{\pi}{6}t\right) + 1.35$

- b. August: 1.81 in., Dec: 0.44 in.

Mixed Review, pp. 607–609

1. a.  $A = 10$  b.  $D = 15$  c.  $P = 6$  d.  $f(4) = 20$

3.  $t = \frac{2\pi}{3}$  and  $t = \frac{4\pi}{3}$  5.  $220^\circ 48' 50''$

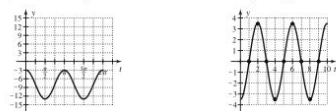
7.  $12\sqrt{2}$  in.;  $60\sqrt{2} \approx 84.9$  in.

9. arc length:  $\frac{28}{3}\pi \approx 29.3$  units; area:  $\frac{112\pi}{3} \approx 117.3$  units<sup>2</sup> 11.  $86.915^\circ$

13.  $\sin \theta = \frac{-8}{17}$ ,  $\sec \theta = \frac{17}{15}$ ,  $\cos \theta = \frac{15}{17}$   
 $\csc \theta = \frac{-17}{8}$ ,  $\tan \theta = \frac{-8}{15}$ ,  $\cot \theta = \frac{-15}{8}$  15.  $60^\circ$

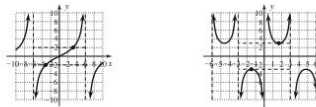
17. a.  $|A| = 5$ ;  $P = \pi$ ; HS: (none); b.  $|A| = \frac{7}{2}$ ;  $P = 4$ ; HS: 1 unit right;

VS: 8 units down; PI:  $0 \leq t < \pi$  VS: (none); PI:  $1 \leq t < 5$



19. a.  $6\pi$  rad/sec b.  $20(6\pi)$  cm/sec  $\approx 377$  cm/sec

- c.  $|A|$ : NA;  $P = 4\pi$ ; HS: none; d.  $|A|$ : NA;  $P = 2\pi$ ; HS:  $\frac{\pi}{2}$  to the  
 VS: none; PI:  $(-2\pi, 2\pi)$  right; VS: none; PI:  $(-\pi, \pi)$



Practice Test, pp. 609–610

1. complement:  $55^\circ$ ; supplement:  $145^\circ$  2. a.  $45^\circ$  b.  $30^\circ$  c.  $\frac{\pi}{6}$  d.  $\frac{\pi}{3}$   
 3.  $30^\circ + 360^\circ k$ ;  $k \in \mathbb{Z}$  4. a.  $100.755^\circ$  b.  $48^\circ 12' 45''$   
 5. a. 430 mi b.  $215\sqrt{3} \approx 372$  mi

$t$	$\sin t$	$\cos t$	$\tan t$	$\csc t$	$\sec t$	$\cot t$
0	0	1	0	undefined	1	undefined
$\frac{2\pi}{3}$	$\frac{\sqrt{3}}{2}$	$-\frac{1}{2}$	$-\sqrt{3}$	$\frac{2\sqrt{3}}{3}$	-2	$-\frac{\sqrt{3}}{3}$
$\frac{7\pi}{6}$	$-\frac{1}{2}$	$-\frac{\sqrt{3}}{2}$	$\frac{\sqrt{3}}{3}$	-2	$-\frac{2\sqrt{3}}{3}$	$\sqrt{3}$
$\frac{5\pi}{4}$	$-\frac{\sqrt{2}}{2}$	$-\frac{\sqrt{2}}{2}$	1	$-\sqrt{2}$	$-\sqrt{2}$	1
$\frac{5\pi}{3}$	$-\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$-\sqrt{3}$	$-\frac{2\sqrt{3}}{3}$	2	$-\frac{\sqrt{3}}{3}$
$\frac{13\pi}{6}$	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{3}}{3}$	2	$\frac{2\sqrt{3}}{3}$	$\sqrt{3}$

7.  $\sec \theta = \frac{5}{2}$ ;  $\sin \theta = \frac{-\sqrt{21}}{5}$ ,  $\tan \theta = \frac{-\sqrt{21}}{2}$ ,  $\csc \theta = \frac{-5}{\sqrt{21}}$   
 $\cot \theta = \frac{-2}{\sqrt{21}}$

8.  $\left(\frac{1}{3}\right)^2 + \left(\frac{-2\sqrt{2}}{3}\right)^2 = \frac{1}{9} + \frac{8}{9} = 1$ ;  $\cos t = \frac{1}{3}$ ;  $\sin t = \frac{2\sqrt{2}}{3}$ ,  $\tan t = 2\sqrt{2}$ ,  
 $\sec t = 3$ ,  $\csc t = \frac{3\sqrt{2}}{4}$ ,  $\cot t = \frac{\sqrt{2}}{4}$

9. a.  $\approx 225.8$  ft or 225 ft 9.6 in. b.  $\frac{23\pi}{480} \approx 0.1505$  rad/sec

- c. 11.29 ft/sec  $\approx 7.7$  mph

10.

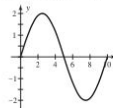
Angles	Sides
$A = 33^\circ$	$a \approx 8.2$ cm
$B = 57^\circ$	$b \approx 12.6$ cm
$C = 90^\circ$	$c = 15.0$ cm

11. about 67 cm,  $49.6^\circ$  12. 57.9 m 13. a.  $\frac{7\pi}{6}$  b.  $\frac{11\pi}{6}$  c.  $\frac{3\pi}{4}$

14. a.  $W(t) = 18.4 \sin\left(\frac{\pi}{12}t\right) + 34.1$

- b. 433,000 gal; 249,000 gal

15. a.  $D: t \in \mathbb{R}, R: y \in [-2, 2]$ ,  
 $P = 10$ ,  $|A| = 2$ ;



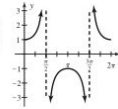
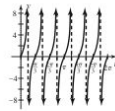


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b.  $D: t \neq \frac{\pi}{2}(2k + 1)$  for  $k \in \mathbb{Z}$ ,

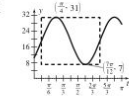
$R: y \in (-\infty, -1] \cup [1, +\infty), P = 2\pi$

c.  $D: t \neq \frac{\pi}{6}(2k + 1)$  for  $k \in \mathbb{Z}, R: y \in \mathbb{R}, P = \frac{\pi}{3}$



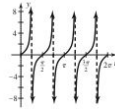
16.  $|A| = 12, P = \frac{2\pi}{3}$ ; HS:  $\frac{\pi}{12}$  units right, VS: 19 units up

PI:  $\frac{\pi}{12} \leq t < \frac{3\pi}{4}$

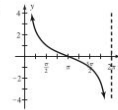


17. 1260°

18. a.  $D: t \neq \frac{\pi}{4}(2k + 1), k \in \mathbb{Z}, R: y \in \mathbb{R}, P = \frac{\pi}{2}$ ;



b.  $D: t \neq 2\pi k, k \in \mathbb{Z}, R: y \in \mathbb{R}, P = 2\pi$ ,



19.  $y = 7.5 \sin\left(\frac{\pi}{6}t - \frac{\pi}{2}\right) + 12.5$  20. a.  $t \approx 4$  b.  $t \approx 2.3$

**Strengthening Core Skills, pp. 612–613**

**Exercise 1:**

$t$	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$
$\sin t = y$	0	$\frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	1
$\cos t = x$	1	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{1}{2}$	0
$\tan t = \frac{y}{x}$	0	$\frac{\sqrt{3}}{3}$	1	$\sqrt{3}$	—
$\frac{2\pi}{3}$	$\frac{3\pi}{4}$	$\frac{5\pi}{6}$	$\pi$	$\frac{7\pi}{6}$	$\frac{5\pi}{4}$
$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{1}{2}$	0	$-\frac{1}{2}$	$-\frac{\sqrt{2}}{2}$
$-\frac{1}{2}$	$-\frac{\sqrt{2}}{2}$	$-\frac{\sqrt{3}}{2}$	-1	$-\frac{\sqrt{3}}{2}$	$-\frac{\sqrt{2}}{2}$
$-\sqrt{3}$	-1	$-\frac{\sqrt{3}}{3}$	0	$\frac{\sqrt{3}}{3}$	1

**Exercise 2:**

a.  $t = \frac{4\pi}{3}, \frac{5\pi}{3}$  b.  $t = \frac{\pi}{4}, \frac{7\pi}{4}$  c.  $t = \frac{\pi}{6}, \frac{7\pi}{6}$  d.  $t = \frac{\pi}{4}, \frac{7\pi}{4}$

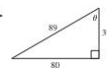
**Exercise 3:**

a. no solution b.  $t \approx 1.2310, t \approx 5.0522$  c.  $t \approx 6.0382, t \approx 2.8966$   
d.  $t \approx 1.9823, t \approx 4.3009$

**Cumulative Review Chapters 1–5, pp. 613–614**

1.  $-5 < x < 3$

3.



hyp = 89;  $\theta \approx 64^\circ; 90 - \theta = 26^\circ$

5.  $\cos t = \frac{3}{4}, \sin t = \frac{-\sqrt{7}}{4}, \tan t = \frac{-\sqrt{7}}{3}, \sec t = \frac{4}{3}$

$\csc t = \frac{-4}{\sqrt{7}} = \frac{-4\sqrt{7}}{7}, \cot t = \frac{-3}{\sqrt{7}} = \frac{-3\sqrt{7}}{7}$

7. a.  $D: x \in \left[\frac{3}{2}, \infty\right), R: y \in [0, \infty)$

b.  $D: x \in (-\infty, -7) \cup (-7, 7) \cup (7, \infty), R: y \in (-\infty, \infty)$

9. a. max:  $(-2, 4)$ , endpoint max:  $(4, 0)$

min:  $(2, -4)$ , endpoint min:  $(-4, 0)$

b.  $f(x) \geq 0: x \in [-4, 0] \cup \{4\}$

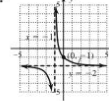
$f(x) < 0: x \in (0, 4)$

c.  $f(x) \uparrow: x \in (-4, -2) \cup (2, 4)$

$f(x) \downarrow: x \in (-2, 2)$

d. function is odd:  $f(-x) = -f(x)$

11.  $\approx 114.3$  ft 13.



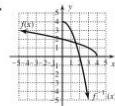
15.  $x = -9, y = 40, r = 41$ , QII;

$\cos \theta = \frac{-9}{41}, \sin \theta = \frac{40}{41}, \tan \theta = \frac{-40}{9}, \sec \theta = \frac{-41}{9}, \csc \theta = \frac{41}{40}$

$\cot \theta = \frac{-9}{40}, \theta \approx 102.7^\circ$

17.  $S = 18$  m;  $A = 135$  m<sup>2</sup> 19.  $y = \frac{3}{2} \sin\left(4t - \frac{\pi}{2}\right) + \frac{1}{2}$

21.



23.  $y = \frac{3}{4}x - 2, m = \frac{3}{4}$ , y-intercept  $(0, -2)$

25. about 6.85%

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SA34 Student Answer Appendix

CHAPTER 6

Exercises 6.1, pp. 620–623

1.  $\sin \theta$ ;  $\sec \theta$ ;  $\cos \theta$ . 3. one, false 5.  $\frac{1 - \sin^2 x}{\sin x \sec x}$ ; Answers will vary.  
7. Answers may vary;

$$\tan x = \frac{\sec x}{\csc x} = \frac{\sin x}{\cos x} = \frac{\sec x}{\csc x} \cdot \frac{1}{\cot x} = \frac{\sec x}{\csc x} \cdot \frac{1}{\cot x} = \frac{\sin x}{\cos x}$$

$$9. 1 = \sec^2 x - \tan^2 x; \tan^2 x = \sec^2 x - 1; 1 = (\sec x + \tan x)(\sec x - \tan x); \tan x = \pm \sqrt{\sec^2 x - 1}$$

$$11. \sin x \cot x = \frac{\sin x}{\sin x} \cdot \frac{\cos x}{\sin x} = \cos x$$

$$13. \sec^2 x \cot^2 x = \frac{1}{\cos^2 x} \cdot \frac{\cos^2 x}{\sin^2 x} = \frac{1}{\sin^2 x} = \csc^2 x$$

$$15. \cos x (\sec x - \cos x) = \cos x \sec x - \cos^2 x = \frac{1}{\cos x} - \cos^2 x = 1 - \cos^2 x = \sin^2 x$$

$$17. \sin x (\csc x - \sin x) = 1 - \sin^2 x = \cos^2 x$$

$$19. \tan x (\csc x + \cot x) = \tan x \csc x + \tan x \cot x = \frac{\sin x}{\cos x} \cdot \frac{1}{\sin x} + \frac{\sin x}{\cos x} \cdot \frac{\cos x}{\sin x} = \frac{1}{\cos x} + 1 = \sec x + 1$$

$$21. \tan^2 x \csc^2 x - \tan^2 x = \tan^2 x (\csc^2 x - 1) = 1; \tan^2 x (\cot^2 x) = 1$$

$$23. \frac{\sin x \cos x + \sin x}{1 + \sin x} = \frac{\cos x (1 + \sin x)}{(1)(1 + \sin x)} = \frac{\cos x}{1} = \cos x$$

$$25. \frac{\cos x + \cos x \sin x}{\sin x \tan x + \sin x} = \frac{(\cos x)(1 + \sin x)}{\sin x (\tan x + 1)} = \frac{\cos x}{\sin x} = \csc x$$

$$27. \frac{\sin x}{\tan x + \tan^2 x} = \frac{\sin x}{\tan x (1 + \tan x)} = \frac{\sin x}{\tan x} = \cos x$$

$$\frac{\sin x}{\sin x / \cos x} = \frac{\sin x \cos x}{\sin x} = \cos x$$

$$29. \frac{\sin^2 x + \cos^2 x + 2 \sin x \cos x}{\cos x} = \frac{\sin^2 x + 2 \sin x \cos x + \cos^2 x}{\cos x} = \frac{(1 + 2 \sin x \cos x)}{\cos x}$$

$$\frac{1}{\cos x} + \frac{2 \sin x \cos x}{\cos x} = \sec x + 2 \sin x$$

$$31. (1 + \sin x)[1 + \sin(-x)] = (1 + \sin x)(1 - \sin x) = 1 - \sin^2 x = \cos^2 x$$

$$33. \frac{(\csc x - \cot x)(\csc x + \cot x)}{\tan x} = \frac{\csc^2 x - \cot^2 x}{\tan x} = \frac{1}{\tan x} = \cot x$$

$$35. \frac{\cos^2 x}{\sin x} + \frac{\sin x}{1} = \frac{\cos^2 x + \sin^2 x}{\sin x} = \frac{1}{\sin x} = \csc x$$

$$37. \frac{\tan x}{\csc x} - \frac{\sin x}{\cos x} = \frac{\tan x \cos x - \sin x \csc x}{\csc x \cos x} = \frac{\frac{\sin x}{\cos x} \cos x - \sin x \frac{1}{\sin x}}{\frac{1}{\sin x} \cos x} = \frac{\sin x - 1}{\cot x}$$

$$39. \frac{\sec x}{\sin x} - \frac{\csc x}{\sec x} = \frac{\sec^2 x - \sin x \csc x}{\sin x \sec x} = \frac{\sec^2 x - 1}{\sin x \frac{1}{\cos x}} = \frac{\tan^2 x}{\tan x} = \tan x$$

$$41. \frac{\sin x}{\pm \sqrt{1 - \sin^2 x}} = \frac{\sin x}{\pm \sqrt{\cos^2 x}} = \frac{\sin x}{\pm \cos x} = \pm \frac{\sin x}{\cos x} = \pm \tan x$$

$$43. \pm \sqrt{\frac{1}{\cot^2 x} + 1} = \pm \sqrt{\frac{1 + \cot^2 x}{\cot^2 x}} = \pm \frac{\sqrt{1 + \cot^2 x}}{\cot x} = \pm \frac{\csc x}{\cot x} = \pm \frac{1}{\sin x} = \pm \csc x$$

$$45. \frac{\pm \sqrt{1 - \sin^2 x}}{\sin x} = \frac{\pm \sqrt{\cos^2 x}}{\sin x} = \frac{\pm \cos x}{\sin x} = \pm \cot x$$

$$47. \sin \theta = \frac{21}{29}, \tan \theta = \frac{21}{20}, \sec \theta = \frac{29}{20}, \csc \theta = \frac{29}{21}, \cot \theta = \frac{20}{21}$$

$$49. \cos \theta = -\frac{8}{17}, \sin \theta = -\frac{15}{17}, \sec \theta = -\frac{17}{8}, \csc \theta = -\frac{17}{15}, \cot \theta = \frac{8}{15}$$

$$51. \cos \theta = \frac{x}{\sqrt{x^2 + 25}}, \sin \theta = \frac{5}{\sqrt{x^2 + 25}}, \tan \theta = \frac{5}{x}$$

$$\sec \theta = \frac{\sqrt{x^2 + 25}}{x}, \csc \theta = \frac{\sqrt{x^2 + 25}}{5}$$

$$53. \cos \theta = -\frac{\sqrt{120}}{13} = -\frac{2\sqrt{30}}{13}, \tan \theta = \frac{7}{2\sqrt{30}}, \sec \theta = -\frac{13}{2\sqrt{30}}$$

$$\csc \theta = -\frac{13}{7}, \cot \theta = \frac{2\sqrt{30}}{7}$$

$$55. \sin \theta = \frac{4\sqrt{2}}{9}, \cos \theta = -\frac{7}{9}, \tan \theta = -\frac{4\sqrt{2}}{7}$$

$$\csc \theta = \frac{9}{4\sqrt{2}}, \cot \theta = -\frac{7}{4\sqrt{2}} \quad 57. \text{Answers will vary.}$$

59. Answers will vary. 61. Answers will vary.

$$63. \text{a. } A = \frac{m^2}{4} \cot\left(\frac{\pi}{n}\right) \quad \text{b. } A = \frac{4(8\text{ m})^2}{4} \cot\left(\frac{\pi}{4}\right) = 64 \text{ m}^2 \cdot 1 = 64 \text{ m}^2$$

$$\text{c. } A \approx 119.62 \text{ m}^2$$

$$65. \cos^3 x = (\cos x)(\cos^2 x) = (\cos x)(1 - \sin^2 x)$$

$$67. \tan x + \tan^3 x = (\tan x)(1 + \tan^2 x) = (\tan x)(\sec^2 x)$$

$$69. \tan^2 x \sec x - 4 \tan^2 x = (\tan^2 x)(\sec x - 4) = (\sec x - 4)(\tan^2 x) = (\sec x - 4)(\sec^2 x - 1) = (\sec x - 4)(\sec x - 1)(\sec x + 1)$$

$$71. \cos^2 x \sin x - \cos^2 x = (\cos^2 x)(\sin x - 1) = (1 - \sin^2 x)(\sin x - 1) = (1 + \sin x)(1 - \sin x)(\sin x - 1) = (1 + \sin x)(1 - \sin x)(-1)(1 - \sin x) = (-1)(1 + \sin x)(1 - \sin x)^2$$

$$73. \text{a. } A = m^2 \tan\left(\frac{\pi}{n}\right) \quad \text{b. } A = 4 \cdot 4^2 \tan\left(\frac{\pi}{4}\right) = 64 \text{ m}^2$$

$$\text{c. } A \approx 51.45 \text{ m}^2 \quad 75. \tan \theta = \frac{1 + m_1 m_2}{m_2 - m_1} \quad 77. \theta = 45^\circ$$

$$79. 0, \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2} \quad 81. \text{about } 1148 \text{ ft}$$

$$83. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$85. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$87. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$89. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$91. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$93. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$95. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$97. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$99. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$101. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$103. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$105. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$107. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$109. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$111. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$113. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$115. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$117. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$119. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$121. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$123. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$125. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$127. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$129. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$131. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

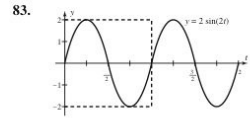
$$133. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$135. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$137. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$139. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$

$$141. \frac{\pi}{3}, \frac{2\pi}{3}, \pi, \frac{3\pi}{2}$$



Exercises 6.2, pp. 627–630

1. substituted 3. complicated; simplify; build  
5. Because we don't know if the equation is true. 7.  $\frac{1 + \sin x}{\cos x}$

$$9. \cos x \quad 11. \frac{1 - \cos x}{\sin x}$$

$$13. \cos^2 x \tan^2 x = \cos^2 x \cdot \frac{\sin^2 x}{\cos^2 x} = \sin^2 x$$

$$15. \tan x + \cot x = \frac{\sin x}{\cos x} + \frac{\cos x}{\sin x} = \frac{\sin^2 x + \cos^2 x}{\cos x \sin x} = \frac{1}{\cos x \sin x}$$

$$17. \csc x - \sin x = \frac{1}{\sin x} - \sin x = \frac{1 - \sin^2 x}{\sin x} = \frac{\cos^2 x}{\sin x} = \frac{\cos x}{\sin x} \cdot \frac{\cos x}{1} = \cot x \cos x$$

$$19. \sec x \csc x = \frac{1}{\cos x} \cdot \frac{1}{\sin x} = \frac{1}{\cos x \sin x}$$

$$21. \tan x \cot x = \frac{\sin x}{\cos x} \cdot \frac{\cos x}{\sin x} = 1$$

$$23. \sin x \csc x = \sin x \cdot \frac{1}{\sin x} = 1$$

$$25. \cos x \sec x = \cos x \cdot \frac{1}{\cos x} = 1$$

$$27. \tan x \cot x = \frac{\sin x}{\cos x} \cdot \frac{\cos x}{\sin x} = 1$$

$$29. \sin x \csc x = \sin x \cdot \frac{1}{\sin x} = 1$$

$$31. \cos x \sec x = \cos x \cdot \frac{1}{\cos x} = 1$$

$$33. \tan x \cot x = \frac{\sin x}{\cos x} \cdot \frac{\cos x}{\sin x} = 1$$

$$35. \sin x \csc x = \sin x \cdot \frac{1}{\sin x} = 1$$

$$37. \cos x \sec x = \cos x \cdot \frac{1}{\cos x} = 1$$

$$39. \tan x \cot x = \frac{\sin x}{\cos x} \cdot \frac{\cos x}{\sin x} = 1$$

$$41. \sin x \csc x = \sin x \cdot \frac{1}{\sin x} = 1$$

$$43. \cos x \sec x = \cos x \cdot \frac{1}{\cos x} = 1$$

$$45. \tan x \cot x = \frac{\sin x}{\cos x} \cdot \frac{\cos x}{\sin x} = 1$$

$$47. \sin x \csc x = \sin x \cdot \frac{1}{\sin x} = 1$$

$$49. \cos x \sec x = \cos x \cdot \frac{1}{\cos x} = 1$$

$$51. \tan x \cot x = \frac{\sin x}{\cos x} \cdot \frac{\cos x}{\sin x} = 1$$

$$53. \sin x \csc x = \sin x \cdot \frac{1}{\sin x} = 1$$

$$55. \cos x \sec x = \cos x \cdot \frac{1}{\cos x} = 1$$

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$$\begin{aligned} 19. \sec \theta + \tan \theta &= \frac{1}{\cos \theta} + \frac{\sin \theta}{\cos \theta} \\ &= \frac{1 + \sin \theta}{\cos \theta} \\ &= \frac{(1 + \sin \theta)(1 - \sin \theta)}{\cos \theta(1 - \sin \theta)} \\ &= \frac{1 - \sin^2 \theta}{\cos \theta(1 - \sin \theta)} \\ &= \frac{\cos^2 \theta}{\cos \theta(1 - \sin \theta)} \\ &= \frac{\cos \theta}{1 - \sin \theta} \end{aligned}$$

$$\begin{aligned} 21. \frac{1 - \sin x}{\cos x} &= \frac{(1 - \sin x)(1 + \sin x)}{\cos x(1 + \sin x)} \\ &= \frac{1 - \sin^2 x}{\cos x(1 + \sin x)} \\ &= \frac{\cos^2 x}{\cos x(1 + \sin x)} \\ &= \frac{\cos x}{1 + \sin x} \end{aligned}$$

$$\begin{aligned} 23. \frac{\csc x}{\cos x} - \frac{\cos x}{\csc x} &= \frac{\csc^2 x - \cos^2 x}{\cos x \csc x} \\ &= \frac{\csc^2 x - (1 - \sin^2 x)}{\cos x \csc x} \\ &= \frac{\csc^2 x - 1 + \sin^2 x}{\cot x} \\ &= \frac{\cot^2 x + \sin^2 x}{\cot x} \end{aligned}$$

$$\begin{aligned} 25. \frac{\sin x}{1 + \sin x} - \frac{\sin x}{1 - \sin x} &= \frac{\sin x(1 - \sin x) - \sin x(1 + \sin x)}{(1 + \sin x)(1 - \sin x)} \\ &= \frac{\sin x - \sin^2 x - \sin x - \sin^2 x}{1 - \sin^2 x} \\ &= \frac{-2 \sin^2 x}{\cos^2 x} \\ &= -2 \tan^2 x \end{aligned}$$

$$\begin{aligned} 27. \frac{\cot x}{1 + \csc x} - \frac{\cot x}{1 - \csc x} &= \frac{\cot x(1 - \csc x) - \cot x(1 + \csc x)}{(1 + \csc x)(1 - \csc x)} \\ &= \frac{\cot x - \cot x \csc x - \cot x - \cot x \csc x}{1 - \csc^2 x} \\ &= \frac{2 \cot x \csc x}{\cot^2 x} \\ &= \frac{2 \csc x}{\cot x} \\ &= \frac{2}{\sin x} \\ &= \frac{\cos x}{\sin x} \\ &= \frac{2}{\cos x} \\ &= 2 \sec x \end{aligned}$$

$$\begin{aligned} 29. \frac{\sec^2 x}{1 + \cot^2 x} &= \frac{\sec^2 x}{\csc^2 x} \\ &= \frac{1}{\cos^2 x} \\ &= \frac{1}{\sin^2 x} \\ &= \frac{\sin^2 x}{\cos^2 x} \\ &= \tan^2 x \end{aligned}$$

$$\begin{aligned} 31. \sin^2 x(\cot^2 x - \csc^2 x) &= \sin^2 x \cot^2 x - \sin^2 x \csc^2 x \\ &= \sin^2 x \frac{\cos^2 x}{\sin^2 x} - \sin^2 x \frac{1}{\sin^2 x} \\ &= \cos^2 x - 1 \\ &= -\sin^2 x \end{aligned}$$

$$\begin{aligned} 33. \cos x \cot x + \sin x &= \cos x \frac{\cos x}{\sin x} + \sin x \\ &= \frac{\cos^2 x}{\sin x} + \sin x \\ &= \frac{\cos^2 x + \sin^2 x}{\sin x} \\ &= \frac{1}{\sin x} \\ &= \csc x \end{aligned}$$

$$\begin{aligned} 35. \frac{\sec x}{\cot x + \tan x} &= \frac{\frac{1}{\cos x}(\sin x)(\cos x)}{\left(\frac{\cos x}{\sin x} + \frac{\sin x}{\cos x}\right)(\sin x)(\cos x)} \\ &= \frac{\sin x}{\cos^2 x + \sin^2 x} \\ &= \frac{\sin x}{1} \\ &= \sin x \end{aligned}$$

$$\begin{aligned} 37. \frac{\sin x - \csc x}{\csc x} &= \frac{\sin x}{\csc x} - \frac{\csc x}{\csc x} \\ &= \sin^2 x - 1 \\ &= -\cos^2 x \end{aligned}$$

$$\begin{aligned} 39. \frac{1}{\csc x - \sin x} &= \frac{1}{(\csc x - \sin x) \sin x} \\ &= \frac{1}{\sin x} \\ &= \frac{1 - \sin^2 x}{\sin x} \\ &= \frac{\cos^2 x}{\sin x} \\ &= \frac{\sin x}{\cos x} \frac{1}{\cos x} \\ &= \tan x \sec x \end{aligned}$$

$$\begin{aligned} 41. \frac{1 + \sin x}{1 - \sin x} &= \frac{(1 + \sin x)(1 + \sin x)}{(1 - \sin x)(1 + \sin x)} \\ &= \frac{1 + 2 \sin x + \sin^2 x}{1 - \sin^2 x} \\ &= \frac{1 + 2 \sin x + \sin^2 x}{\cos^2 x} \\ &= \frac{1}{\cos^2 x} + 2 \frac{\sin x}{\cos x} \frac{1}{\cos x} + \frac{\sin^2 x}{\cos^2 x} \\ &= \sec^2 x + 2 \tan x \sec x + \tan^2 x \\ &= (\sec x + \tan x)^2 \\ &= (\tan x + \sec x)^2 \end{aligned}$$

$$\begin{aligned} 43. \frac{\cos x - \sin x}{1 - \tan x} &= \frac{(\cos x - \sin x)(\cos x + \sin x)}{(1 - \tan x)(\cos x + \sin x)} \\ &= \frac{(\cos x - \sin x)(\cos x + \sin x)}{\cos x + \sin x - \sin x - \frac{\sin^2 x}{\cos x}} \\ &= \frac{(\cos x - \sin x)(\cos x + \sin x)}{\cos x \left(1 - \frac{\sin^2 x}{\cos^2 x}\right)} \\ &= \frac{(\cos x - \sin x)(\cos x + \sin x)}{\cos x(1 - \tan^2 x)} \\ &= \frac{(\cos x - \sin x)(\cos x + \sin x)}{\cos x(1 - \tan x)(1 + \tan x)} \\ &= \frac{(\cos x - \sin x)(\cos x + \sin x)}{(\cos x - \sin x)(1 + \tan x)} \\ &= \frac{\cos x + \sin x}{1 + \tan x} \end{aligned}$$

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SA36 Student Answer Appendix

45.  $\frac{\tan^2 x - \cot^2 x}{\tan x - \cot x} = \frac{(\tan x + \cot x)(\tan x - \cot x)}{(\tan x - \cot x)}$   
 $= \tan x + \cot x$   
 $= \frac{\sin x}{\cos x} + \frac{\cos x}{\sin x}$   
 $= \frac{\sin^2 x + \cos^2 x}{\cos x \sin x}$   
 $= \frac{1}{\cos x \sin x}$   
 $= \frac{1}{\cos x} \cdot \frac{1}{\sin x}$   
 $= \sec x \csc x$   
 $= \csc x \sec x$

47.  $\frac{\cot x}{\cot x + \tan x} = \frac{\sin x}{\cos x + \sin x} \cdot \frac{(\cos x)(\sin x)}{(\cos x)(\sin x)}$   
 $= \frac{\sin^2 x}{\cos^2 x + \sin^2 x}$   
 $= \frac{\cos^2 x}{\cos^2 x + \sin^2 x}$   
 $= \frac{\cos^2 x}{1}$   
 $= \cos^2 x$

49.  $\frac{\sec^4 x - \tan^4 x}{\sec^2 x + \tan^2 x} = \frac{(\sec^2 x - \tan^2 x)(\sec^2 x + \tan^2 x)}{(\sec^2 x + \tan^2 x)}$   
 $= \sec^2 x - \tan^2 x$   
 $= 1$

51.  $\frac{\cos^4 x - \sin^4 x}{\cos^2 x} = \frac{(\cos^2 x - \sin^2 x)(\cos^2 x + \sin^2 x)}{\cos^2 x}$   
 $= \frac{(\cos^2 x - \sin^2 x)(1)}{\cos^2 x}$   
 $= \frac{\cos^2 x}{\cos^2 x} - \frac{\sin^2 x}{\cos^2 x}$   
 $= 1 - \tan^2 x$   
 $= 1 - (\sec^2 x - 1)$   
 $= 1 - \sec^2 x + 1$   
 $= 2 - \sec^2 x$

53.  $(\sec x + \tan x)^2 = \sec^2 x + 2 \sec x \tan x + \tan^2 x$   
 $= \frac{1}{\cos^2 x} + \frac{2 \sin x}{\cos^2 x} + \frac{\sin^2 x}{\cos^2 x}$   
 $= \frac{1 + 2 \sin x + \sin^2 x}{\cos^2 x}$   
 $= \frac{(1 + \sin x)^2}{\cos^2 x}$   
 $= \frac{(\sin x + 1)^2}{\cos^2 x}$

55.  $\frac{\cos x}{\sin x} + \frac{\sin x}{\cos x} + \frac{\csc x}{\sec x} = \frac{\cos^2 x \sec x + \sin^2 x \sec x + \csc x \sin x \cos x}{\sin x \cos x \sec x}$   
 $= \frac{\sec x(\cos^2 x + \sin^2 x) + (1)\cos x}{\sin x(1)}$   
 $= \frac{\sec x + \cos x}{\sin x}$

57.  $\frac{\sin^4 x - \cos^4 x}{\sin^3 x + \cos^3 x} = \frac{(\sin^2 x + \cos^2 x)(\sin^2 x - \cos^2 x)}{(\sin x + \cos x)(\sin^2 x - \sin x \cos x + \cos^2 x)}$   
 $= \frac{(1)(\sin x + \cos x)(\sin x - \cos x)}{(\sin x + \cos x)(\sin^2 x + \cos^2 x - \sin x \cos x)}$   
 $= \frac{\sin x - \cos x}{1 - \sin x \cos x}$

59. a.  $d^2 = (20 + x \cos \theta)^2 + (20 - x \sin \theta)^2$   
 $= 400 + 40x \cos \theta + x^2 \cos^2 \theta + 400 - 40x \sin \theta + x^2 \sin^2 \theta$   
 $= 800 + 40x(\cos \theta - \sin \theta) + x^2(\cos^2 \theta + \sin^2 \theta)$   
 $= 800 + 40x(\cos \theta - \sin \theta) + x^2$

b.  $\approx 42.2$  ft

61. a.  $h = \sqrt{\cot^2 x + \tan x}$   
 $h \approx 3.76$

b.  $\cot x + \tan x = \frac{\cos x}{\sin x} + \frac{\sin x}{\cos x}$   
 $= \frac{\cos^2 x + \sin^2 x}{\sin x \cos x}$   
 $= \frac{1}{\sin x \cos x}$   
 $= \csc x \sec x$   
 $h = \sqrt{\csc x \sec x}$   
 $h \approx 3.76$ ; yes

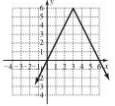
63.  $D^2 = 400 + 40x \cos \theta + x^2$   
 $D = 40.5$  ft

65.  $\sin \alpha = \cos \theta$  67. Answers will vary.

69.  $(\sin^2 x + \cos^2 x)^2 = (1)^2 = 1$

71.  $\sin t = \frac{3}{4}$ ,  $\cos t = \frac{\sqrt{7}}{4}$ ,  $\tan t = \frac{3}{\sqrt{7}}$

73.



Exercises 6.3, pp. 635–639

1. false; QII 3. repeat; opposite 5. Answers will vary.

7.  $\frac{\sqrt{2} - \sqrt{6}}{4}$  9.  $\frac{\sqrt{2} - \sqrt{6}}{4}$

11. a.  $\cos(45^\circ + 30^\circ) = \cos 45^\circ \cos 30^\circ - \sin 45^\circ \sin 30^\circ = \frac{\sqrt{6} - \sqrt{2}}{4}$

b.  $\cos(120^\circ - 45^\circ) = \cos 120^\circ \cos 45^\circ + \sin 120^\circ \sin 45^\circ = \frac{-\sqrt{2} + \sqrt{6}}{4} = \frac{\sqrt{6} - \sqrt{2}}{4}$

13.  $\cos(5\theta)$  15.  $\frac{\sqrt{3}}{2}$  17.  $-\frac{16}{65}$  19.  $\sin 33^\circ$  21.  $\cot\left(\frac{\pi}{12}\right)$

23.  $\cos\left(\frac{\pi}{3} + \theta\right)$  25.  $\sin(8x)$  27.  $\tan(3\theta)$  29. 1 31.  $\sqrt{3}$

33. a.  $-\frac{304}{425}$  b.  $-\frac{304}{297}$  35.  $\frac{\sqrt{6} + \sqrt{2}}{4}$  37.  $\frac{\sqrt{6} + \sqrt{2}}{4}$

39.  $-\frac{1}{\sqrt{3}} = -\frac{\sqrt{3}}{3}$  41.  $-\sqrt{3}$

43. a.  $\sin(45^\circ - 30^\circ) = \sin 45^\circ \cos 30^\circ - \cos 45^\circ \sin 30^\circ = \frac{\sqrt{6} - \sqrt{2}}{4}$

b.  $\sin(135^\circ - 120^\circ) = \sin 135^\circ \cos 120^\circ - \cos 135^\circ \sin 120^\circ$   
 $= \left(\frac{\sqrt{2}}{2}\right)\left(-\frac{1}{2}\right) - \left(-\frac{\sqrt{2}}{2}\right)\left(\frac{\sqrt{3}}{2}\right)$   
 $= \frac{-\sqrt{2}}{4} + \frac{\sqrt{6}}{4}$   
 $= \frac{\sqrt{6} - \sqrt{2}}{4}$

45.  $-\frac{\sqrt{2} - \sqrt{6}}{4}$  47. a.  $\frac{319}{481}$  b.  $\frac{480}{481}$  c.  $\frac{319}{360}$

49. a.  $\frac{3416}{4505}$  b.  $-\frac{1767}{4505}$  c.  $\frac{3416}{2937}$

51. a.  $\frac{12 + 5\sqrt{3}}{26}$  b.  $\frac{12\sqrt{3} - 5}{26}$  c.  $\frac{12 + 5\sqrt{3}}{12\sqrt{3} - 5}$

53.  $(90^\circ - \alpha) + \theta + (90^\circ - \beta) = 180^\circ$  a.  $\frac{247}{265}$  b.  $\frac{96}{265}$  c.  $\frac{247}{96}$

55.  $\sin(\pi - \alpha) = \sin \pi \cos \alpha - \cos \pi \sin \alpha$   
 $= 0 - (-1)\sin \alpha$   
 $= \sin \alpha$

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$$57. \cos\left(x + \frac{\pi}{4}\right) = \cos x \cos\left(\frac{\pi}{4}\right) - \sin x \sin\left(\frac{\pi}{4}\right) = \cos x \left(\frac{\sqrt{2}}{2}\right) - \sin x \left(\frac{\sqrt{2}}{2}\right) = \frac{\sqrt{2}}{2}(\cos x - \sin x)$$

$$59. \tan\left(x + \frac{\pi}{4}\right) = \frac{\tan x + \tan\left(\frac{\pi}{4}\right)}{1 - \tan x \tan\left(\frac{\pi}{4}\right)} = \frac{\tan x + 1}{1 - \tan x} = \frac{1 + \tan x}{1 - \tan x}$$

$$61. \cos(\alpha + \beta) + \cos(\alpha - \beta) = \cos \alpha \cos \beta - \sin \alpha \sin \beta + \cos \alpha \cos \beta + \sin \alpha \sin \beta = 2 \cos \alpha \cos \beta$$

$$63. \cos(2t) = \cos(t + t) = \cos t \cos t - \sin t \sin t = \cos^2 t - \sin^2 t$$

$$65. \sin(3t) = \sin(2t + t) = \sin(2t) \cos t + \cos(2t) \sin t = 2 \sin t \cos t \cos t + (\cos^2 t - \sin^2 t) \sin t = 2 \sin t \cos^2 t + \sin t \cos^2 t - \sin^3 t = 3 \sin t \cos^2 t - \sin^3 t = 3 \sin t (1 - \sin^2 t) - \sin^3 t = 3 \sin t - 3 \sin^3 t - \sin^3 t = -4 \sin^3 t + 3 \sin t$$

$$67. \cos\left(x - \frac{\pi}{4}\right) = \cos x \cos\left(\frac{\pi}{4}\right) + \sin x \sin\left(\frac{\pi}{4}\right) = \cos x \left(\frac{\sqrt{2}}{2}\right) + \sin x \left(\frac{\sqrt{2}}{2}\right) = \frac{\sqrt{2}}{2}(\cos x + \sin x)$$

$$69. F = \frac{Wk}{c} \frac{1 - \sqrt{3}}{1 + \sqrt{3}}$$

$$71. R = \frac{\cos s \cos t}{\omega C \sin(s + t)} = \frac{\cos s \cos t}{\omega C(\sin s \cos t + \cos s \sin t)} = \frac{\cos s \cos t}{\cos s \cos t \frac{1}{\omega C \sin s \cos t + \cos s \sin t}} = \frac{1}{\omega C \left( \frac{\sin s \cos t}{\cos s \cos t} + \frac{\cos s \sin t}{\cos s \cos t} \right)} = \frac{1}{\omega C(\tan s + \tan t)}$$

$$73. \frac{A}{B} = \frac{\sin \theta \cos(90^\circ - \theta)}{\cos \theta \sin(90^\circ - \theta)} = \frac{\sin \theta (\cos 90^\circ \cos \theta + \sin 90^\circ \sin \theta)}{\cos \theta (\sin 90^\circ \cos \theta - \cos 90^\circ \sin \theta)} = \frac{\sin \theta (0 + \sin \theta)}{\cos \theta (\cos \theta - 0)} = \frac{\sin^2 \theta}{\cos^2 \theta} = \tan^2 \theta$$

$$75. \text{verified using sum identity for sine}$$

$$77. \frac{f(x+h) - f(x)}{h} = \frac{\sin(x+h) - \sin x}{h} = \frac{\sin x \cos h + \cos x \sin h - \sin x}{h} = \frac{\sin x \cos h - \sin x + \cos x \sin h}{h} = \frac{\sin x(\cos h - 1) + \cos x \sin h}{h} = \sin x \frac{\cos h - 1}{h} + \cos x \frac{\sin h}{h}$$

$$79. \frac{-\sqrt{2}}{2} \quad 81. \frac{1}{2}$$

$$83. D = d, \text{ so } D^2 = d^2, \text{ and}$$

$$D^2 = (\cos \alpha - \cos \beta)^2 + (\sin \alpha - \sin \beta)^2 = \cos^2 \alpha - 2 \cos \alpha \cos \beta + \cos^2 \beta + \sin^2 \alpha - 2 \sin \alpha \sin \beta + \sin^2 \beta = 2 - 2 \cos \alpha \cos \beta - 2 \sin \alpha \sin \beta = 2 - 2 \cos(\alpha + \beta) = 2 - 2 \cos \alpha \cos \beta - 2 \sin \alpha \sin \beta = \frac{-2 \cos(\alpha + \beta)}{-2} = \cos \alpha \cos \beta + \sin \alpha \sin \beta = \cos(\alpha - \beta)$$

$$85. P = 16 \quad 87. \text{about } 19.3 \text{ ft}$$

Exercises 6.4, pp. 648–652

1. sum;  $\alpha = \beta$    3.  $2x$ ;  $x$    5. Answers will vary
7.  $\sin(2\theta) = \frac{-120}{169}$ ,  $\cos(2\theta) = \frac{119}{169}$ ,  $\tan(2\theta) = \frac{-120}{119}$
9.  $\sin(2\theta) = \frac{-720}{1681}$ ,  $\cos(2\theta) = \frac{-1519}{1681}$ ,  $\tan(2\theta) = \frac{720}{1519}$
11.  $\sin(2\theta) = \frac{2184}{7225}$ ,  $\cos(2\theta) = \frac{6887}{7225}$ ,  $\tan(2\theta) = \frac{2184}{6887}$
13.  $\sin(2\theta) = \frac{-5280}{5329}$ ,  $\cos(2\theta) = \frac{721}{5329}$ ,  $\tan(2\theta) = \frac{-5280}{721}$
15.  $\sin(2\theta) = \frac{-24}{25}$ ,  $\cos(2\theta) = \frac{7}{25}$ ,  $\tan(2\theta) = \frac{-24}{7}$
17.  $\sin \theta = \frac{4}{5}$ ,  $\cos \theta = \frac{3}{5}$ ,  $\tan \theta = \frac{4}{3}$
19.  $\sin \theta = \frac{21}{29}$ ,  $\cos \theta = \frac{20}{29}$ ,  $\tan \theta = \frac{21}{20}$
21.  $\sin(3\theta) = \sin(2\theta + \theta) = \sin(2\theta)\cos \theta + \cos(2\theta)\sin \theta = (2 \sin \theta \cos \theta)\cos \theta + (1 - 2 \sin^2 \theta)\sin \theta = 2 \sin \theta \cos^2 \theta + \sin \theta - 2 \sin^3 \theta = 2 \sin \theta (1 - \sin^2 \theta) + \sin \theta - 2 \sin^3 \theta = 2 \sin \theta - 2 \sin^3 \theta + \sin \theta - 2 \sin^3 \theta = 3 \sin \theta - 4 \sin^3 \theta$
23.  $\frac{1}{4}$    25.  $\frac{\sqrt{2}}{2}$    27. 1   29.  $4.5 \sin(6x)$    31.  $\frac{1}{8} - \frac{1}{8} \cos(4x)$
33.  $\frac{9}{8} + \frac{3}{2} \cos(2x) + \frac{3}{8} \cos(4x)$
35.  $\frac{5}{8} - \frac{7}{8} \cos(2x) + \frac{3}{8} \cos(4x) - \frac{1}{8} \cos(2x)\cos(4x)$
37.  $\sin \theta = \frac{\sqrt{2} - \sqrt{2}}{2}$ ,  $\cos \theta = \frac{\sqrt{2} + \sqrt{2}}{2}$ ,  $\tan \theta = \sqrt{2} - 1$
39.  $\sin \theta = \frac{\sqrt{2} - \sqrt{3}}{2}$ ,  $\cos \theta = \frac{\sqrt{2} + \sqrt{3}}{2}$ ,  $\tan \theta = 2 - \sqrt{3}$
41.  $\sin \theta = \frac{\sqrt{2} + \sqrt{2}}{2}$ ,  $\cos \theta = \frac{\sqrt{2} - \sqrt{2}}{2}$ ,  $\tan \theta = \sqrt{2} + 1$
43.  $\sin \theta = \frac{\sqrt{2} + \sqrt{2}}{2}$ ,  $\cos \theta = \frac{\sqrt{2} - \sqrt{2}}{2}$ ,  $\tan \theta = \sqrt{2} + 1$
45.  $\frac{\sqrt{2} - \sqrt{2} + \sqrt{2}}{2}$    47.  $\frac{\sqrt{2} - \sqrt{2} + \sqrt{3}}{2}$    49.  $\cos 15^\circ$
51.  $\tan 2\theta$    53.  $\tan x$
55.  $\sin\left(\frac{\theta}{2}\right) = \frac{3}{\sqrt{13}}$ ,  $\cos\left(\frac{\theta}{2}\right) = \frac{2}{\sqrt{13}}$ ,  $\tan\left(\frac{\theta}{2}\right) = \frac{3}{2}$
57.  $\sin\left(\frac{\theta}{2}\right) = \frac{3}{\sqrt{10}}$ ,  $\cos\left(\frac{\theta}{2}\right) = \frac{1}{\sqrt{10}}$ ,  $\tan\left(\frac{\theta}{2}\right) = 3$
59.  $\sin\left(\frac{\theta}{2}\right) = \frac{7}{\sqrt{74}}$ ,  $\cos\left(\frac{\theta}{2}\right) = \frac{5}{\sqrt{74}}$ ,  $\tan\left(\frac{\theta}{2}\right) = \frac{7}{5}$
61.  $\sin\left(\frac{\theta}{2}\right) = \frac{1}{\sqrt{226}}$ ,  $\cos\left(\frac{\theta}{2}\right) = \frac{15}{\sqrt{226}}$ ,  $\tan\left(\frac{\theta}{2}\right) = \frac{1}{15}$

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## SA38 Student Answer Appendix

$$63. \sin\left(\frac{\theta}{2}\right) = \frac{5}{\sqrt{29}}, \cos\left(\frac{\theta}{2}\right) = \frac{-2}{\sqrt{29}}, \tan\left(\frac{\theta}{2}\right) = -\frac{5}{2}$$

$$65. \frac{1}{2}[\cos(12\theta) - \cos(4\theta)] \quad 67. \cos(2t) + \cos(5t)$$

$$69. \cos(1540\pi t) + \cos(2418\pi t) \quad 71. \frac{1 + \sqrt{3}}{2} \quad 73. \frac{-1}{4}$$

$$75. 2 \sin\left(\frac{55\pi}{2}\right) \cos\left(\frac{27\pi}{2}\right) \quad 77. -2 \sin x \sin\left(\frac{x}{6}\right)$$

$$79. 2 \cos\left(\frac{2061\pi}{2}\right) \cos\left(\frac{357\pi}{2}\right) \quad 81. \frac{-\sqrt{2}}{2}$$

$$83. \frac{2 \sin x \cos x}{\cos^2 x - \sin^2 x} = \frac{\sin(2x)}{\cos(2x)} = \tan(2x)$$

$$85. (\sin x + \cos x)^2 = \sin^2 x + 2 \sin x \cos x + \cos^2 x \\ = \sin^2 x + \cos^2 x + 2 \sin x \cos x \\ = 1 + 2 \sin x \cos x \\ = 1 + \sin(2x)$$

$$87. \cos(8\theta) = \cos(2 \cdot 4\theta) \\ = \cos^2(4\theta) - \sin^2(4\theta)$$

$$89. \frac{\cos(2\theta)}{\sin^2\theta} = \frac{\cos^2\theta - \sin^2\theta}{\sin^2\theta} \\ = \frac{\cos^2\theta}{\sin^2\theta} - \frac{\sin^2\theta}{\sin^2\theta} \\ = \cot^2\theta - 1$$

$$91. \tan(2\theta) = \frac{2 \tan \theta}{1 - \tan^2\theta} \\ = \frac{(2 \tan \theta) \frac{1}{\tan \theta}}{1 - \tan^2\theta} \\ = \frac{(1 - \tan^2\theta) \frac{1}{\tan \theta}}{2} \\ = \frac{1}{2 \tan \theta - \tan \theta} \\ = \frac{2}{\cot \theta - \tan \theta}$$

$$93. 2 \csc(2x) = \frac{2}{\sin(2x)} \\ = \frac{2}{2 \sin x \cos x} \\ = \frac{1}{\sin x \cos x} \\ = \frac{\sin^2 x + \cos^2 x}{\sin x \cos x} \\ = \frac{\sin^2 x}{\sin x \cos x} + \frac{\cos^2 x}{\sin x \cos x} \\ = \frac{\sin x}{\cos x} + \frac{\cos x}{\sin x} \\ = \tan x + \cot x$$

$$95. \cos^2\left(\frac{x}{2}\right) - \sin^2\left(\frac{x}{2}\right) = \cos\left(2 \cdot \frac{x}{2}\right) \\ = \cos x$$

$$97. 1 - 4 \sin^2\theta + 4 \sin^4\theta = (1 - 2 \sin^2\theta)^2 \\ = [\cos(2\theta)]^2 \\ = \cos^2(2\theta) \\ = 1 - \sin^2(2\theta)$$

$$99. \frac{\sin(120\pi) + \sin(80\pi)}{\cos(120\pi) - \cos(80\pi)} = \frac{2 \sin(100\pi) \cos(20\pi)}{-2 \sin(100\pi) \sin(20\pi)} \\ = \frac{\cos(20\pi)}{\sin(20\pi)} \\ = -\cot(20\pi)$$

$$101. \sin^2\alpha + (1 - \cos\alpha)^2 = \sin^2\alpha + 1 - 2 \cos\alpha + \cos^2\alpha \\ = \sin^2\alpha + \cos^2\alpha + 1 - 2 \cos\alpha = 1 + 1 - 2 \cos\alpha = 2 - 2 \cos\alpha \\ = 2(1 - \cos\alpha) = 4 \left(\frac{1 - \cos\alpha}{2}\right) = 4 \sin^2\left(\frac{\alpha}{2}\right) = \left[2 \sin\left(\frac{\alpha}{2}\right)\right]^2$$

$$103. \sin(2\alpha) = \sin(\alpha + \alpha) \\ = \sin\alpha \cos\alpha + \cos\alpha \sin\alpha \\ = \sin\alpha \cos\alpha + \sin\alpha \cos\alpha \\ = 2 \sin\alpha \cos\alpha \\ \tan(\alpha + \beta) = \frac{\tan\alpha + \tan\beta}{1 - \tan\alpha \tan\beta} \\ = \frac{\tan\alpha + \tan\alpha}{1 - \tan^2\alpha} \\ = \tan(2\alpha) = \frac{2 \tan\alpha}{1 - \tan^2\alpha}$$

$$105. \frac{1}{2}[\cos(\alpha - \beta) - \cos(\alpha + \beta)] = \sin\alpha \sin\beta$$

$$107. \text{a. } \mathcal{M} = \frac{2}{\sqrt{2} - \sqrt{3}}, \mathcal{M} \approx 3.9$$

$$\text{b. } \mathcal{M} = \frac{2}{\sqrt{2} - \sqrt{2}}, \mathcal{M} \approx 2.6 \quad \text{c. } \theta = 60^\circ$$

$$109. \text{a. } 288 - 144\sqrt{2} \text{ ft} \approx 84.3 \text{ ft} \quad \text{b. } 288 - 144\sqrt{2} \text{ ft} \approx 84.3 \text{ ft}$$

$$111. \cos[2\pi(1209)t] + \cos[2\pi(941)t]; \text{ the } \square \text{ key}$$

$$113. d(t) = \left| 6 \sin\left(\frac{\pi t}{60}\right) \right| \\ = \left| 6 \sin\left(\frac{1}{2} \cdot \frac{\pi t}{30}\right) \right| \\ = \left| 6 \left( \pm \sqrt{\frac{1 - \cos\left(\frac{\pi t}{30}\right)}{2}} \right) \right| \\ = 6 \sqrt{\frac{1 - \cos\left(\frac{\pi t}{30}\right)}{2}} \\ = \sqrt{36 \frac{1 - \cos\left(\frac{\pi t}{30}\right)}{2}} \\ = \sqrt{18 \left[ 1 - \cos\left(\frac{\pi t}{30}\right) \right]}$$

$$115. \text{a. } \sin(2\theta - 90^\circ) + 1 \\ = \sin(2\theta)\cos 90^\circ - \cos(2\theta)\sin 90^\circ + 1 \\ = 0 - \cos(2\theta) + 1 \\ = 1 - \cos(2\theta)$$

$$\text{b. } 2 \sin^2\theta = \sin^2\theta + \sin^2\theta \\ = 1 - \cos^2\theta + \sin^2\theta \\ = 1 - (\cos^2\theta - \sin^2\theta) \\ = 1 - \cos(2\theta)$$

$$\text{c. } 1 + \sin^2\theta - \cos^2\theta = 1 - (\cos^2\theta - \sin^2\theta) \\ = 1 - \cos(2\theta)$$

$$\text{d. } 1 - \cos(2\theta) = 1 - \cos(2\theta)$$

$$117. \text{a. } \approx 0.9659; \approx 0.9659$$

$$\text{b. } \left(\frac{\sqrt{2} + \sqrt{3}}{2}\right)^2 \pm \left(\frac{\sqrt{6} + \sqrt{2}}{4}\right)^2 \\ = \frac{2 + \sqrt{3}}{4} \pm \frac{6 + 2\sqrt{12} + 2}{4} \\ = \frac{2 + \sqrt{3}}{4} \pm \frac{8 + 4\sqrt{3}}{4} \\ = \frac{2 + \sqrt{3}}{4} \pm \frac{2 + \sqrt{3}}{4}$$

$$119. \text{ Must be a unit circle with } \theta \text{ in radians. Must use a right triangle definition of tangent: } \tan\left(\frac{\theta}{2}\right) = \frac{\text{opposite side}}{\text{adjacent side}} = \frac{\sin \theta}{1 + \cos \theta}$$

$$121. x = 1; x = -2; x = -\sqrt{6}; x = \sqrt{6}$$

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$$123. \left(\frac{16}{65}\right)^2 + \left(\frac{63}{65}\right)^2 = \frac{256}{4224} + \frac{3969}{4225} = \frac{4225}{4225} = 1.$$

$$\tan \theta = \frac{63}{16}, \sec \theta = \frac{65}{16}$$

$$1 + \left(\frac{63}{16}\right)^2 = \left(\frac{65}{16}\right)^2$$

$$1 + \frac{3969}{256} = \frac{4225}{256}$$

$$\frac{256}{256} + \frac{3969}{256} = \frac{4225}{256}$$

**Mid-Chapter Check, pp. 652–653**

$$1. \sin x[\csc x - \sin x] = \sin x \csc x - \sin^2 x$$

$$= \sin x \frac{1}{\sin x} - \sin^2 x$$

$$= 1 - \sin^2 x$$

$$= \cos^2 x$$

$$2. \cos^2 x - \cot^2 x = \cos^2 x - \frac{\cos^2 x}{\sin^2 x}$$

$$= \cos^2 x \left(1 - \frac{1}{\sin^2 x}\right)$$

$$= \cos^2 x (1 - \csc^2 x)$$

$$= \cos^2 x (-\cot^2 x)$$

$$= -\cos^2 x \cot^2 x$$

$$3. \frac{2 \sin x}{\sec x} - \frac{\cos x}{\csc x} = \frac{2 \sin x \csc x - \cos x \sec x}{\sec x \csc x}$$

$$= \frac{2(1) - 1}{\sec x \csc x}$$

$$= \frac{1}{\sec x \csc x}$$

$$= \cos x \sin x$$

$$4. 1 + \sec^2 x = \tan^2 x$$

$$1 + \sec^2 0 = \tan^2 0$$

$$1 + 1^2 = 0^2$$

$$1 + 1 = 0$$

$$2 = 0 \text{ False}$$

$$5. \text{ a. } \frac{\sin^3 x + \cos^3 x}{\sin x + \cos x} = \frac{(\sin x + \cos x)(\sin^2 x - \sin x \cos x + \cos^2 x)}{(\sin x + \cos x)}$$

$$= (\sin^2 x + \cos^2 x - \sin x \cos x)$$

$$= 1 - \sin x \cos x$$

$$\text{ b. } \frac{1 + \sec x}{\csc x} - \frac{1 + \cos x}{\cot x} = \frac{1 + \frac{1}{\cos x}}{\frac{1}{\sin x}} - \frac{1 + \cos x}{\frac{\cos x}{\sin x}}$$

$$= \left(\sin x + \frac{\sin x}{\cos x}\right) - \left(\frac{\sin x}{\cos x} + \sin x\right)$$

$$= \sin x + \frac{\sin x}{\cos x} - \frac{\sin x}{\cos x} - \sin x$$

$$= 0$$

$$6. \text{ a. } \frac{\sec^2 x - \tan^2 x}{\sec^2 x} = \frac{\sec^2 x}{\sec^2 x} - \frac{\tan^2 x}{\sec^2 x}$$

$$= 1 - \frac{\sin^2 x}{\cos^2 x}$$

$$= 1 - \frac{\cos^2 x}{\cos^2 x}$$

$$= 1 - \sin^2 x$$

$$= \cos^2 x$$

$$\text{ b. } \frac{\cot x - \tan x}{\csc x \sec x} = \frac{\cot x}{\csc x \sec x} - \frac{\tan x}{\csc x \sec x}$$

$$= \frac{\cos x}{\sin x} \cdot \frac{\sin x}{\cos x} - \frac{\sin x}{\cos x} \cdot \frac{\cos x}{\sin x}$$

$$= \frac{1}{\sin x} \cdot \frac{1}{\cos x} - \frac{1}{\sin x} \cdot \frac{1}{\cos x}$$

$$= \frac{\cos^2 x \sin x - \sin^2 x \cos x}{\sin x \cos x}$$

$$= \frac{\cos^2 x - \sin^2 x}{\cos x}$$

$$7. \text{ a. } \frac{456}{5785} \quad \text{ b. } \frac{-3193}{5785} \quad \text{ c. } \frac{456}{5767}$$

$$8. \sin A = \frac{7 + 24\sqrt{3}}{50}, \cos A = \frac{24 - 7\sqrt{3}}{50}, \tan A = \frac{7 + 24\sqrt{3}}{24 - 7\sqrt{3}}$$

$$9. \sin\left(\frac{\theta}{2}\right) = \frac{4}{\sqrt{17}}, \cos\left(\frac{\theta}{2}\right) = \frac{1}{\sqrt{17}}$$

$$10. \sin(2\alpha) = \frac{336}{625}, \cos(2\alpha) = \frac{527}{625}, \tan(2\alpha) = \frac{336}{527}$$

**Reinforcing Basic Concepts, pp. 653–654**

$$1. \sin^2 x + \cos^2 x = 1$$

$$\frac{\sin^2 x}{\sin^2 x} + \frac{\cos^2 x}{\cos^2 x} = \frac{1}{\sin^2 x}$$

$$\frac{1}{\sin^2 x} + \cot^2 x = \csc^2 x \checkmark$$

$$\frac{\sin^2 x}{\sin^2 x} + \cos^2 x = 1$$

$$\frac{\sin^2 x}{\cos^2 x} + \frac{\cos^2 x}{\cos^2 x} = \frac{1}{\cos^2 x}$$

$$\tan^2 x + 1 = \sec^2 x \checkmark$$

$$2. \cos(\alpha + \beta) = \cos(\alpha + \alpha) = \cos \alpha \cos \alpha - \sin \alpha \sin \alpha$$

$$= \cos^2 \alpha - \sin^2 \alpha$$

$$= \cos^2 \alpha - (1 - \cos^2 \alpha)$$

$$= 2 \cos^2 \alpha - 1$$

$$= \cos^2 \alpha - \sin^2 \alpha$$

$$= (1 - \sin^2 \alpha) - \sin^2 \alpha$$

$$= 1 - 2 \sin^2 \alpha$$

**Exercises 6.5, pp. 665–670**

$$1. \text{ horizontal; line; one; one} \quad 3. [-1, 1]; \left[-\frac{\pi}{2}, \frac{\pi}{2}\right] \quad 5. \cos^{-1}\left(\frac{1}{3}\right)$$

$$7. 0; \frac{1}{2}; \frac{\pi}{6}; \frac{\pi}{2} \quad 9. \frac{\pi}{4} \quad 11. \frac{\pi}{2} \quad 13. 1.0956, 62.8^\circ$$

$$15. 0.3876, 22.2^\circ \quad 17. \frac{\sqrt{2}}{2} \quad 19. \frac{\pi}{3} \quad 21. 45^\circ \quad 23. 0.8205$$

$$25. 0; \frac{\sqrt{3}}{2}; 120^\circ; \pi \quad 27. \frac{\pi}{3} \quad 29. \pi \quad 31. 1.4352; 82.2^\circ$$

$$33. 0.7297; 41.8^\circ \quad 35. \frac{\pi}{4} \quad 37. 0.5560 \quad 39. \frac{\sqrt{2}}{2} \quad 41. \frac{3\pi}{4}$$

$$43. 0; -\sqrt{3}; 30^\circ; \sqrt{3}; \frac{\pi}{3} \quad 45. \frac{\pi}{6} \quad 47. \frac{\pi}{3} \quad 49. -1.1170, -64.0^\circ$$

$$51. 0.9441, 54.1^\circ \quad 53. \frac{\pi}{6} \quad 55. \frac{\sqrt{3}}{3} \quad 57. \sqrt{2} \quad 59. -30^\circ$$

$$61. \text{ cannot evaluate } \tan\left(\frac{\pi}{2}\right)$$

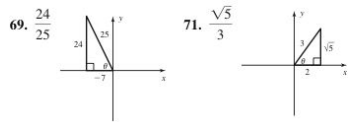
$$63. \csc \frac{\pi}{4} = \sqrt{2} > 1, \text{ not in domain of } \sin^{-1} x.$$

$$65. \sin \theta = \frac{3}{5}, \cos \theta = \frac{4}{5}, \tan \theta = \frac{3}{4}$$

$$67. \sin \theta = \frac{\sqrt{x^2 - 36}}{x}, \cos \theta = \frac{6}{x}, \tan \theta = \frac{\sqrt{x^2 - 36}}{6}$$

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SA40 Student Answer Appendix



70.  $\frac{24}{25}$   $\frac{\sqrt{25-9x^2}}{3x}$   $\frac{\sqrt{5}}{3}$   $\frac{\sqrt{12}}{\sqrt{12+x^2}}$

77.  $0; 2; 30^\circ; -1; \pi$  **79.**  $\frac{\pi}{6}$  **81.**  $\frac{\pi}{6}$  **83.**  $80.1^\circ$  **85.**  $67.8^\circ$

**87.** a.  $F_N \approx 2.13$  N;  $F_N \approx 1.56$  N **b.**  $\theta \approx 63^\circ$  for  $F_N = 1$  N,  $\theta \approx 24.9^\circ$  for  $F_N = 2$  N **89.**  $\approx 30^\circ$  **91.**  $\theta \approx 72.3^\circ$ ; straight line distance;  $\approx 157.5$  yd

**93.** a.  $\theta = \tan^{-1}\left(\frac{75}{d}\right) - \tan^{-1}\left(\frac{50}{d}\right)$  **b.**  $d \in (39.2, 95.7)$

**c.**  $\theta \approx 11.5^\circ$  at  $d \approx 61.2$  ft

**95.** a.  $\theta = \tan^{-1}\left(\frac{94}{x}\right) - \tan^{-1}\left(\frac{70}{x}\right)$  **b.**  $\theta \approx 8.4^\circ$  at  $d \approx 81.1$  ft

**97.** a.  $\theta \approx 15.5^\circ$ ;  $\theta \approx 0.2705$  rad **b.**  $\approx 29$  mi **99.** a. 413.6 ft away

**b.**  $-503$  ft **c.**  $\approx 651.2$  ft **101.**  $\sin(2\theta) = \frac{84}{85}$

**103.**  $x \in (-\infty, -3] \cup [0, 3]$

Exercises 6.6, pp. 678–682

1. principal;  $[0, 2\pi)$ ; real **3.**  $\frac{\pi}{4}; \frac{3\pi}{4}; \frac{\pi}{4} + 2\pi k; \frac{3\pi}{4} + 2\pi k$   
 5. Answers will vary. **7.** a. QIV **b.** 2 roots **9.** a. QIV **b.** 2 roots

$\theta$	$\sin \theta$	$\cos \theta$	$\tan \theta$
0	0	1	0
$\frac{\pi}{6}$	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{3}}{3}$
$\frac{\pi}{3}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$
$\frac{\pi}{2}$	1	0	und.
$\frac{2\pi}{3}$	$\frac{\sqrt{3}}{2}$	$-\frac{1}{2}$	$-\sqrt{3}$
$\frac{5\pi}{6}$	$\frac{1}{2}$	$-\frac{\sqrt{3}}{2}$	$-\frac{\sqrt{3}}{3}$
$\pi$	0	-1	0
$\frac{7\pi}{6}$	$-\frac{1}{2}$	$-\frac{\sqrt{3}}{2}$	$\frac{\sqrt{3}}{3}$
$\frac{4\pi}{3}$	$-\frac{\sqrt{3}}{2}$	$-\frac{1}{2}$	$\sqrt{3}$

- 13.**  $\frac{\pi}{4}$  **15.**  $-\frac{\pi}{4}$  **17.**  $\frac{\pi}{6}$  **19.**  $-\frac{\pi}{3}$  **21.**  $\pi$  **23.**  $\frac{\pi}{3}$  **25.**  $\frac{\pi}{6}$  **27.**  $\frac{5\pi}{6}$   
**29.**  $\frac{\pi}{6}; \frac{5\pi}{6}$  **31.**  $\frac{2\pi}{3}; \frac{5\pi}{3}$  **33.**  $\frac{3\pi}{4}; \frac{7\pi}{4}$  **35.**  $\frac{\pi}{6}; \frac{5\pi}{6}; \frac{7\pi}{6}; \frac{11\pi}{6}$   
**37.**  $\frac{\pi}{3}; \frac{2\pi}{3}; \frac{4\pi}{3}; \frac{5\pi}{3}$  **39.**  $\frac{\pi}{4}; \frac{3\pi}{4}; \frac{5\pi}{4}; \frac{7\pi}{4}$  **41.**  $\frac{\pi}{2}; \frac{3\pi}{2}$   
**43.**  $\theta = 1.2310 + 2\pi k$  or  $5.0522 + 2\pi k$   
**45.**  $x = \frac{\pi}{2} + \pi k$  or  $\frac{\pi}{6} + 2\pi k$  or  $\frac{5\pi}{6} + 2\pi k$   
**47.**  $x = \frac{2\pi}{3} + 2\pi k$  or  $\frac{4\pi}{3} + 2\pi k$  or  $1.4455 + 2\pi k$  or  $4.8377 + 2\pi k$

- 49.**  $x = \frac{\pi}{6} + \pi k$  or  $\frac{5\pi}{6} + \pi k$  **51.**  $x = \frac{5\pi}{4} + 2\pi k$  or  $\frac{7\pi}{4} + 2\pi k$   
**53.**  $x = \frac{3\pi}{4} + 2\pi k$  or  $\frac{5\pi}{4} + 2\pi k$  **55.**  $x = \frac{3\pi}{4} + \pi k$   
**57.**  $x = \frac{\pi}{3} + \pi k$  or  $\frac{2\pi}{3} + \pi k$  **59.**  $x = \frac{3\pi}{8} + \frac{\pi}{2} k$  **61.**  $x = 3\pi + 6\pi k$   
**63.**  $x = \frac{\pi}{2} + \pi k$  **65.**  $x = \frac{\pi}{6} + \frac{\pi}{3} k$  or  $\frac{\pi}{12} + \pi k$  or  $\frac{5\pi}{12} + \pi k$   
**67.** a.  $x \approx 1.2310$  **b.**  $x \approx 1.2310 + 2\pi k, 5.0522 + 2\pi k$   
**69.** a.  $x \approx 1.2094$  **b.**  $x \approx 1.2094 + 2\pi k, 5.0738 + 2\pi k$   
**71.** a.  $\theta \approx 0.3649$  **b.**  $\theta \approx 0.3649 + \pi k, 1.2059 + \pi k$   
**73.** a.  $\theta \approx 0.8861$  **b.**  $\theta \approx 0.8861 + \pi k, 2.2555 + \pi k$   
**75.**  $x = \frac{\pi}{6} + \pi k$  or  $\frac{5\pi}{6} + \pi k$  **77.**  $x = \frac{2\pi}{9} + \frac{4\pi}{3} k$  or  $\frac{10\pi}{9} + \frac{4\pi}{3} k$   
**79.**  $\theta = \frac{\pi}{2}$  **81.**  $\theta \approx 0.3398 + 2\pi k$  or  $2.8018 + 2\pi k$  **83.**  $x \approx 0.7290$   
**85.**  $x \approx 2.6649$  **87.**  $x \approx 0.4566$  **89.**  $22.1^\circ$  and  $67.9^\circ$   
**91.**  $0^\circ$ ; the ramp is horizontal. **93.**  $30.7^\circ$ ; smaller  
**95.**  $\alpha = 35^\circ, \beta = 25.5^\circ$  **97.**  $k \approx 1.36, \alpha \approx 20.6^\circ$  **99.** a. 7 in.  
**b.**  $\approx 1.05$  in. and  $\approx 5.24$  in. **101.** 1.1547 **103.**  $\frac{\pi}{2} + \pi k$ , explanations will vary.  
**105.**  $f(2+i) = (2+i)^2 - 4(2+i) + 5$  **107.** a.  $-\frac{1}{\sqrt{3}}$  **b.**  $-\frac{\sqrt{2}}{2}$   
 $= 4 + 4i + i^2 - 8 - 4i + 5$   
 $= 4 + 4i - 1 - 8 - 4i + 5 = 0$

Exercises 6.7, pp. 687–690

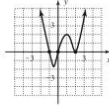
1.  $\sin^2 x + \cos^2 x = 1$ ;  $1 + \tan^2 x = \sec^2 x$ ;  $1 + \cot^2 x = \csc^2 x$   
 3. factor; grouping **5.** Answers will vary. **7.**  $\frac{\pi}{12}; \frac{5\pi}{12}$  **9.** 0  
**11.** 0.4456, 1.1252 **13.**  $\frac{\pi}{4}; \frac{5\pi}{4}; \frac{\pi}{6}; \frac{5\pi}{6}$  **15.**  $\frac{\pi}{4}; \frac{3\pi}{4}; \frac{5\pi}{4}; \frac{7\pi}{4}$ , 0.8411, 5.4421  
**17.**  $\frac{\pi}{4}; \frac{3\pi}{4}; \frac{5\pi}{4}; \frac{7\pi}{4}$  **19.**  $\frac{\pi}{6}; \frac{5\pi}{6}; 0.7297, 2.4119$  **21.**  $\frac{2\pi}{3}$   
**23.**  $\frac{\pi}{9} + \frac{2\pi}{3} k, \frac{5\pi}{9} + \frac{2\pi}{3} k; k = 0, 1, 2$  **25.**  $\frac{\pi}{4}; \frac{3\pi}{4}; \frac{5\pi}{4}; \frac{7\pi}{4}$   
**27.**  $P = 12; x = 3; x = 11$  **29.**  $P = 24; x \approx 0.4909, x \approx 5.5091$   
**31.**  $\frac{\pi}{12}; \frac{17\pi}{12}$  **33.** 0.3747, 5.9085, 2.7669, 3.5163  
**35.**  $\frac{\pi}{2}$  ( $\frac{3\pi}{2}$  is extraneous) **37.**  $\frac{3\pi}{4}; \frac{7\pi}{4}$  **39.**  $\frac{\pi}{12}; \frac{5\pi}{12}; \frac{13\pi}{12}; \frac{17\pi}{12}$   
**41.** I. a.  $\left(\frac{5}{2}, \frac{5}{2}\right)$  **b.**  $D = \sqrt{12.5}, \theta = \frac{\pi}{4}, y = \frac{\sqrt{12.5} - x \cos\left(\frac{\pi}{4}\right)}{\sin\left(\frac{\pi}{4}\right)}$   
**c.** verified  
**II.** a. (2, 4) **b.**  $D = 2\sqrt{5}, \theta \approx 1.1071, y = \frac{2\sqrt{5} - x \cos 1.1071}{\sin 1.1071}$   
**c.** verified  
**III.** a. (1,  $\sqrt{3}$ ) **b.**  $D = 2, \theta = \frac{\pi}{3}, y = \frac{2 - x \cos\left(\frac{\pi}{3}\right)}{\sin\left(\frac{\pi}{3}\right)}$  **c.** verified  
**43.** a.  $2500\pi \text{ ft}^3 \approx 7853.98 \text{ ft}^3$  **b.**  $\approx 7824.09 \text{ ft}^3$  **c.**  $\theta \approx 78.5^\circ$   
**45.** a.  $\approx 78.53 \text{ m}^3/\text{sec}$  **b.** during the months of August, September, October, and November **47.** a.  $\approx \$3554.52$  **b.** during the months of May, June, July, and August **49.** a.  $\approx 12.67$  in. **b.** during the months of April, May, June, July, and August **51.** a.  $\approx 8.39$  gal **b.** approx. day 214 to day 333 **53.** a. 68 bpm **b.**  $\approx 176.2$  bpm  
**c.** from about 4.6 min to 7.4 min  
**55.** a.  $y = 19 \cos\left(\pi - \frac{\pi}{6} x\right) + 53$  **b.**  $y = -21 \sin\left(\frac{2\pi}{365} x\right) + 29$



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57. a.  $L \approx 25.5$  cm. b.  $\theta \approx 38.9^\circ$  or  $33.4^\circ$ , depending on what side you consider the base.

59.  $(-1, 0), (0, 0), (2, 0)$  (multiplicity 2): up/up;



61.  $\theta \approx 4.56^\circ$

**Summary and Concept Review, pp. 691–695**

$$1. \sin x(\csc x - \sin x) = \sin x \csc x - \sin x \sin x$$

$$= \sin x \frac{1}{\sin x} - \sin^2 x$$

$$= 1 - \sin^2 x$$

$$= \cos^2 x$$

$$2. \frac{\tan^2 x \csc x + \csc x}{\sec^2 x} = \frac{\csc x(\tan^2 x + 1)}{\sec^2 x}$$

$$= \frac{\csc x \sec^2 x}{\sec^2 x}$$

$$= \csc x$$

$$3. \frac{(\sec x - \tan x)(\sec x + \tan x)}{\csc x} = \frac{\sec^2 x + \sec x \tan x - \sec x \tan x - \tan^2 x}{\csc x}$$

$$= \frac{\sec^2 x - \tan^2 x}{\csc x}$$

$$= \frac{\csc x}{1 + \tan^2 x - \tan^2 x}$$

$$= \frac{1}{\csc x}$$

$$= \sin x$$

$$4. \frac{\sec^2 x}{\csc x} - \sin x = \frac{\sec^2 x - \sin x \csc x}{\csc x}$$

$$= \frac{\sec^2 x - 1}{\csc x}$$

$$= \frac{\tan^2 x}{\csc x}$$

$$= \frac{\tan^2 x \sin x}{\sin x}$$

$$5. \sin \theta = \frac{-35}{37}, \csc \theta = \frac{-37}{35}, \cot \theta = \frac{12}{35}, \tan \theta = \frac{35}{12}, \sec \theta = \frac{-37}{12}$$

$$6. \sin \theta = \frac{-4\sqrt{6}}{25}, \csc \theta = \frac{-25}{4\sqrt{6}}, \cot \theta = \frac{-23}{4\sqrt{6}}, \tan \theta = \frac{4\sqrt{6}}{23},$$

$$\cos \theta = \frac{23}{25}$$

$$7. \frac{1 + \cos x}{\sin x};$$
 answers will vary. 8.  $\sec x - \tan x$ ; answers will vary.
 
$$9. \frac{\csc^2 x(1 - \cos^2 x)}{\tan^2 x} = \frac{\csc^2 x \sin^2 x}{\tan^2 x}$$

$$= \frac{1}{\tan^2 x}$$

$$= \cot^2 x$$

$$10. \frac{\cot x}{\sec x} - \frac{\csc x}{\tan x} = \frac{\cot x}{\sec x} - \cot x \csc x$$

$$= \cot x \cos x - \cot x \csc x$$

$$= \cot x(\cos x - \csc x)$$

$$11. \frac{\sin^4 x - \cos^4 x}{\sin x \cos x} = \frac{(\sin^2 x - \cos^2 x)(\sin^2 x + \cos^2 x)}{\sin x \cos x}$$

$$= \frac{(\sin^2 x - \cos^2 x)(1)}{\sin x \cos x}$$

$$= \frac{\sin x \sin x - \cos x \cos x}{\sin x \cos x}$$

$$= \frac{\sin x}{\cos x} - \frac{\cos x}{\sin x}$$

$$= \tan x - \cot x$$

$$12. \frac{(\sin x + \cos x)^2}{\sin x \cos x} = \frac{\sin^2 x + 2 \sin x \cos x + \cos^2 x}{\sin x \cos x}$$

$$= \frac{\sin^2 x + \cos^2 x}{\sin x \cos x} + \frac{2 \sin x \cos x}{\sin x \cos x}$$

$$= \frac{1}{\sin x \cos x} + 2$$

$$= \csc x \sec x + 2$$

13. a.  $\cos 75^\circ = \frac{\sqrt{6} - \sqrt{2}}{4}$

b.  $\tan\left(\frac{\pi}{12}\right) = \frac{\sqrt{3} - 1}{1 + \sqrt{3}} = \frac{(\sqrt{3} - 1)^2}{2} = 2 - \sqrt{3}$

14. a.  $\tan 15^\circ = \frac{\sqrt{3} - 1}{1 + \sqrt{3}} = \frac{(\sqrt{3} - 1)^2}{2} = 2 - \sqrt{3}$

b.  $\sin\left(\frac{-\pi}{12}\right) = \frac{\sqrt{2} - \sqrt{6}}{4}$

15. a.  $\cos 180^\circ = -1$  b.  $\sin 120^\circ = \frac{\sqrt{3}}{2}$

16. a.  $\cos x$  b.  $\sin\left(\frac{5x}{8}\right)$  17. a.  $\cos 1170^\circ = \cos 90^\circ = 0$

b.  $\sin\left(\frac{57\pi}{4}\right) = \sin\left(\frac{\pi}{4}\right) = \frac{\sqrt{2}}{2}$  18. a.  $\cos\left(\frac{x}{8}\right) = \sin\left(\frac{\pi}{2} - \frac{x}{8}\right)$

b.  $\sin\left(x - \frac{\pi}{12}\right) = \cos\left(\frac{7\pi}{12} - x\right)$

19.  $\tan(45^\circ - 30^\circ) = \frac{\tan 45^\circ - \tan 30^\circ}{1 + \tan 45^\circ \tan 30^\circ}$

$$= \frac{1 - \frac{\sqrt{3}}{3}}{1 + 1 \cdot \frac{\sqrt{3}}{3}} = \frac{\frac{3 - \sqrt{3}}{3}}{\frac{3 + \sqrt{3}}{3}} = \frac{3 - \sqrt{3}}{3 + \sqrt{3}}$$

$$= \frac{3 - \sqrt{3}}{3 + \sqrt{3}} \cdot \frac{3 - \sqrt{3}}{3 - \sqrt{3}} = \frac{(3 - \sqrt{3})^2}{3^2 - (\sqrt{3})^2} = \frac{3 - \sqrt{3}}{\sqrt{3} + 1}$$

$\tan(135^\circ - 120^\circ) = \frac{\tan 135^\circ - \tan 120^\circ}{1 + \tan 135^\circ \tan 120^\circ}$

$$= \frac{-1 + \sqrt{3}}{1 + (-1)(-\sqrt{3})} = \frac{\sqrt{3} - 1}{1 + \sqrt{3}} = \frac{\sqrt{3} - 1}{\sqrt{3} + 1}$$

20.  $\cos\left(x + \frac{\pi}{6}\right) + \cos\left(x - \frac{\pi}{6}\right) = \sqrt{3} \cos x$

$$= \cos x \cos\left(\frac{\pi}{6}\right) - \sin x \sin\left(\frac{\pi}{6}\right) + \cos x \cos\left(\frac{\pi}{6}\right) + \sin x \sin\left(\frac{\pi}{6}\right)$$

$$= 2 \cos x \cos\left(\frac{\pi}{6}\right) + 0 = 2 \cos x \left(\frac{\sqrt{3}}{2}\right) = \sqrt{3} \cos x$$

21. a.  $\sin(2\theta) = 2 \left(\frac{-84}{85}\right) \left(\frac{13}{85}\right) = \frac{-2184}{7225}$

$$\cos(2\theta) = \left(\frac{13}{85}\right)^2 - \left(\frac{84}{85}\right)^2 = \frac{-6887}{7225}$$

$$\tan(2\theta) = \frac{2184}{-7225} \cdot \frac{7225}{-6887} = \frac{2184}{6887}$$

b.  $\sin(2\theta) = 2 \left(\frac{-20}{29}\right) \left(\frac{-21}{29}\right) = \frac{840}{841}$

$$\cos(2\theta) = \left(\frac{-21}{29}\right)^2 - \left(\frac{-20}{29}\right)^2 = \frac{441 - 400}{841} = \frac{41}{841}$$

$$\tan(2\theta) = \frac{2 \left(\frac{20}{21}\right)}{1 - \left(\frac{20}{21}\right)^2} = \frac{840}{41}$$

22. a.  $\sin \theta = \frac{21}{29}, \cos \theta = \frac{-20}{29}, \tan \theta = \frac{-21}{20}$

b.  $\sin \theta = \frac{7}{25}$  or  $\sin \theta = \frac{24}{25}, \cos \theta = \frac{-24}{25}$  or  $\cos \theta = \frac{-7}{25}, \tan \theta = \frac{-7}{24}$

or  $\tan \theta = \frac{-24}{7}$

23. a.  $\cos 45^\circ = \frac{\sqrt{2}}{2}$  b.  $\cos\left(\frac{\pi}{6}\right) = \frac{\sqrt{3}}{2}$

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SA42 Student Answer Appendix

24. a.  $\sin 67.5 = \sqrt{\frac{1 - \cos 135^\circ}{2}} = \sqrt{\frac{1 + \frac{\sqrt{2}}{2}}{2}} = \sqrt{\frac{2 + \sqrt{2}}{4}}$   
 $= \frac{\sqrt{2 + \sqrt{2}}}{2}$   
 $\cos 67.5 = \sqrt{\frac{1 + \cos 135^\circ}{2}} = \sqrt{\frac{1 - \frac{\sqrt{2}}{2}}{2}} = \sqrt{\frac{2 - \sqrt{2}}{4}}$   
 $= \frac{\sqrt{2 - \sqrt{2}}}{2}$   
 b.  $\sin\left(\frac{5\pi}{8}\right) = \sqrt{\frac{1 - \cos\left(\frac{5\pi}{4}\right)}{2}} = \sqrt{\frac{1 + \frac{\sqrt{2}}{2}}{2}} = \sqrt{\frac{2 + \sqrt{2}}{4}}$   
 $= \frac{\sqrt{2 + \sqrt{2}}}{2}$   
 $\cos\left(\frac{5\pi}{8}\right) = -\sqrt{\frac{1 + \cos\left(\frac{5\pi}{4}\right)}{2}} = -\sqrt{\frac{1 - \frac{\sqrt{2}}{2}}{2}} = -\frac{\sqrt{2 - \sqrt{2}}}{2}$

25. a.  $\sin\left(\frac{\theta}{2}\right) = \sqrt{\frac{1 - 24/25}{2}} = \sqrt{\frac{25 - 24}{50}} = \frac{1}{5\sqrt{2}} \cdot \frac{\theta}{2}$  in QII  
 $\cos\left(\frac{\theta}{2}\right) = -\sqrt{\frac{1 + 24/25}{2}} = -\sqrt{\frac{49}{50}}$   
 $= -\sqrt{\frac{49}{50}} = \frac{-7}{5\sqrt{2}}$  in QII  
 b.  $\sin\left(\frac{\theta}{2}\right) = -\sqrt{\frac{1 - 56/65}{2}} = -\sqrt{\frac{65 - 56}{130}}$   
 $= -\sqrt{\frac{9}{130}} = \frac{-3}{\sqrt{130}}$  in QIV  
 $\cos\left(\frac{\theta}{2}\right) = \sqrt{\frac{1 + 56/65}{2}} = \sqrt{\frac{121}{130}} = \frac{11}{\sqrt{130}}$  in QIV

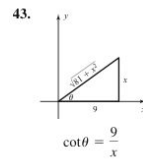
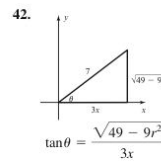
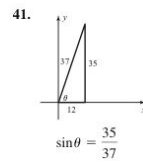
26.  $\frac{\cos(3\alpha) - \cos \alpha}{\cos(3\alpha) + \cos \alpha} = \frac{-2 \sin(2\alpha) \sin \alpha}{2 \cos(2\alpha) \cos \alpha}$   
 $= \frac{-2 \sin^2 \alpha}{\cos^2 \alpha - \sin^2 \alpha} = \frac{2 \sin^2 \alpha}{\sin^2 \alpha - \cos^2 \alpha}$   
 $= \frac{2 \sin^2 \alpha}{2 \tan^2 \alpha} = \frac{1 - 2 \cos^2 \alpha}{\sec^2 \alpha - 2}$

27.  $\cos(3x) + \cos x = 0 \rightarrow 2 \cos(2x) \cos x = 0$   
 $\cos(2x) = 0: x = \frac{\pi}{4} + \frac{\pi}{2}k; k \in \mathbb{Z}$   
 $\cos x = 0: x = \frac{\pi}{2} + \pi k; k \in \mathbb{Z}$

28. a.  $A = 12^2 \sin\left(\frac{30^\circ}{2}\right) \cos\left(\frac{30^\circ}{2}\right) = 144 \sqrt{\frac{1 - \cos 30^\circ}{2}} \sqrt{\frac{1 + \cos 30^\circ}{2}}$   
 $= 144 \sqrt{\frac{1 - \frac{\sqrt{3}}{2}}{2}} \sqrt{\frac{1 + \frac{\sqrt{3}}{2}}{2}} = 144 \sqrt{\frac{2 - \sqrt{3}}{4}} \sqrt{\frac{2 + \sqrt{3}}{4}}$   
 $= 144 \sqrt{4 - 3} = 36 \text{ cm}^2; \text{ yes}$   
 b.  $x^2 \sin\left(\frac{\theta}{2}\right) \cos\left(\frac{\theta}{2}\right)$   
 Let  $u = \frac{\theta}{2}$ , then  $x^2 \sin u \cos u = \frac{1}{2} x^2 (2 \sin u \cos u) = \frac{1}{2} x^2 \sin(2u)$   
 $= \frac{1}{2} x^2 \sin \theta; A = \frac{1}{2} (12)^2 \sin(30^\circ) = 72 \left(\frac{1}{2}\right) = 36 \text{ cm}^2; \text{ yes}$

29.  $\frac{\pi}{4}$  or  $45^\circ$  30.  $\frac{\pi}{6}$  or  $30^\circ$  31.  $\frac{5\pi}{6}$  or  $150^\circ$  32. 1.3431 or  $77.0^\circ$   
 33. 1.0956 or  $62.8^\circ$  34. 0.5054 or  $29.0^\circ$  35.  $\frac{1}{2}$  36.  $\frac{\pi}{4}$

37. undefined 38. 1.0245 39.  $60^\circ$  40.  $\frac{3\pi}{4}$



44.  $\theta = \cos^{-1}\left(\frac{x}{5}\right)$  45.  $\theta = \sec^{-1}\left(\frac{x}{7\sqrt{3}}\right)$

46.  $\theta = \sin^{-1}\left(\frac{x}{4}\right) + \frac{\pi}{6}$

47. a.  $\frac{\pi}{4}$  b.  $\frac{\pi}{4}, \frac{3\pi}{4}$  c.  $x = \frac{\pi}{4} + 2\pi k$  or  $\frac{3\pi}{4} + 2\pi k, k \in \mathbb{Z}$

48. a.  $\frac{2\pi}{3}$  b.  $\frac{2\pi}{3}, \frac{4\pi}{3}$  c.  $\frac{2\pi}{3} + 2\pi k$  or  $\frac{4\pi}{3} + 2\pi k, k \in \mathbb{Z}$

49. a.  $\frac{\pi}{3}$  b.  $\frac{2\pi}{3}, \frac{5\pi}{3}$  c.  $\frac{2\pi}{3} + \pi k, k \in \mathbb{Z}$

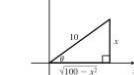
50. a.  $\approx 1.1102$  b.  $\approx 1.1102, 5.1729$  c.  $\approx 1.1102 + 2\pi k$  or  $5.1729 + 2\pi k, k \in \mathbb{Z}$  51. a.  $\approx 0.3376$  b.  $\approx 0.3376, 1.2332, 3.4792, 4.3748$  c.  $\approx 0.3376 + \pi k$  or  $1.2332 + \pi k, k \in \mathbb{Z}$  52. a.  $\approx 0.3614$  b.  $\approx 0.3614, 2.7802$  c.  $\approx 0.3614 + 2\pi k$  or  $2.7802 + 2\pi k, k \in \mathbb{Z}$

Mixed Review, pp. 695–696

1.  $\sin \theta = \frac{6}{\sqrt{117}}, \sec \theta = \frac{-\sqrt{117}}{9}, \tan \theta = \frac{-6}{9} = \frac{-2}{3}, \cos \theta = \frac{-9}{\sqrt{117}}$

csc  $\theta = \frac{\sqrt{117}}{6}, \cot \theta = \frac{-3}{2}$  3.  $\sqrt{3} + 2$

5.  $\tan \theta = \frac{x}{\sqrt{100 - x^2}}$



7.  $x = 0.4103; x = 4.9230$

9. a.  $y = 5000 \sin\left(\frac{\pi}{3}x + \pi\right) + 9000$  b.  $\approx \$4670$  c. mid-October

11.  $\frac{1 - (\cos^2 \theta - \sin^2 \theta)}{\tan^2 \theta} = \frac{1 - \cos(2\theta)}{1 - \cos(2\theta)} = \frac{1 + \cos(2\theta)}{1 + \cos(2\theta)} = 1 + \cos(2\theta)$

13.  $\frac{3\pi}{4}$  or  $135^\circ$

15. a.  $\sin(2x) = \sin(x + x) = \sin x \cos x + \sin x \cos x = 2 \sin x \cos x$

b.  $\cos(2x) = \cos(x + x) = \cos x \cos x - \sin x \sin x = \cos^2 x - \sin^2 x$

17.  $\theta = \csc^{-1}\left(\frac{x}{2\sqrt{2}}\right) + \frac{\pi}{4}$  19. a.  $t \approx 0.7754$  b.  $t \approx 0.7754, 2.3662$  c.  $t \approx 0.7754 + 2\pi k$  or  $2.3662 + 2\pi k$

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**Practice Test, pp. 697–698**

$$1. \frac{(\csc x - \cot x)(\csc x + \cot x)}{\sec x} = \frac{\csc^2 x + \csc x \cot x - \csc x \cot x - \cot^2 x}{\sec x}$$

$$= \frac{\csc^2 x - \cot^2 x}{\sec x} = \frac{(1 + \cot^2 x) - \cot^2 x}{\sec x} = \frac{1}{\sec x} = \frac{\sec x}{\cos x}$$

$$2. \frac{\sin^3 x - \cos^3 x}{1 + \cos x \sin x} = \frac{(\sin x - \cos x)(\sin^2 x + \sin x \cos x + \cos^2 x)}{1 + \cos x \sin x} = \frac{(\sin x - \cos x)(1 + \sin x \cos x)}{1 + \cos x \sin x} = \sin x - \cos x$$

$$3. \sin \theta = \frac{-55}{73}, \sec \theta = \frac{73}{48}, \cot \theta = \frac{-48}{55}, \tan \theta = \frac{-55}{48}, \csc \theta = \frac{-73}{55}$$

$$4. \frac{\sqrt{3}-1}{\sqrt{3}+1} \quad 5. \frac{\sqrt{2}}{2} \quad 6. \frac{-\sqrt{2}}{2}$$

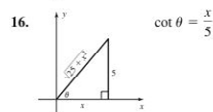
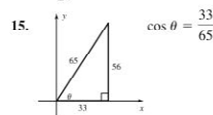
$$7. \sin\left(x + \frac{\pi}{4}\right) - \sin\left(x - \frac{\pi}{4}\right) = \sin x \cos\left(\frac{\pi}{4}\right) + \cos x \sin\left(\frac{\pi}{4}\right) - \sin x \cos\left(\frac{\pi}{4}\right) + \cos x \sin\left(\frac{\pi}{4}\right) = 2 \sin\left(\frac{\pi}{4}\right) \cos x = 2 \cdot \frac{\sqrt{2}}{2} \cos x = \sqrt{2} \cos x$$

$$8. \sin \theta = \frac{15}{17}, \cos \theta = \frac{8}{17}, \tan \theta = \frac{15}{8} \quad 9. \frac{-\sqrt{3}}{2} \quad 10. \frac{1}{\sqrt{37}}, \frac{6}{\sqrt{37}}$$

$$11. 20\sqrt{2} - \sqrt{2} \quad 12. \frac{\sqrt{6} - \sqrt{2}}{4} \approx 0.2588; \frac{\sqrt{6} + \sqrt{2}}{4} \approx 0.9659$$

$$13. \text{a. } y = 30^\circ \quad \text{b. } f(x) = \frac{1}{2} \quad \text{c. } y = 30^\circ$$

$$14. \text{a. } y = 0.8523 \text{ rad or } y = 48.8^\circ \quad \text{b. } y = 78.5^\circ \text{ or } \frac{157\pi}{360} \text{ rad} \quad \text{c. } y = \frac{7\pi}{24} \text{ rad or } 52.5^\circ$$



$$17. \text{I. a. } \cos^{-1}\left(\frac{-\sqrt{2}}{2}\right) = \frac{3\pi}{4} \quad \text{b. } x = \frac{3\pi}{4}, \frac{5\pi}{4} \quad \text{c. } x = \frac{3\pi}{4} + 2\pi k \text{ or } \frac{5\pi}{4} + 2\pi k, k \in \mathbb{Z} \quad \text{II. a. } \frac{\pi}{6} \quad \text{b. } x = \frac{\pi}{6}, \frac{11\pi}{6}$$

$$\text{c. } x = \frac{\pi}{6} + 2\pi k \text{ or } \frac{11\pi}{6} + 2\pi k, k \in \mathbb{Z} \quad 18. \text{I. a. } x \approx 0.1922 \quad \text{b. } x \approx 0.1922, 1.3786, 3.3338, 4.5202 \quad \text{c. } x \approx 0.1922 + \pi k \text{ or } 1.3786 + \pi k, k \in \mathbb{Z} \quad \text{II. a. } x \approx 0.9204 \quad \text{b. } x \approx 0.9204, 2.2212, 4.0620, 5.3628 \quad \text{c. } x \approx 0.9204 + \pi k \text{ or } 2.2212 + \pi k, k \in \mathbb{Z}$$

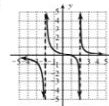
$$19. \text{a. } x \approx -1.6875, -0.3413, 1.1321, 2.8967 \quad \text{b. } x \approx 0.9671, 2.6110, 3.4538 \quad 20. \text{a. } x = 0, \pi, \frac{7\pi}{6}, \frac{11\pi}{6} \quad \text{b. } x = \frac{7\pi}{12}, \frac{11\pi}{12}, \frac{19\pi}{12}, \frac{23\pi}{12}$$

**Strengthening Core Skills p. 699**

- Exercise 1:  $x \in (0.6025, 2.5391)$   
 Exercise 2:  $x \in [0, 0.7945] \cup [4.4415, 2\pi]$   
 Exercise 3:  $x \in [0, 2.6154] \cup [9.3847, 12]$   
 Exercise 4:  $x \in (67.3927, 202.6073)$

**Cumulative Review Chapters 1–6, p. 700**

1.  $\sin \theta = \frac{84}{85}, \csc \theta = \frac{85}{84}, \cos \theta = \frac{-13}{85}, \sec \theta = \frac{-85}{13}, \tan \theta = \frac{-84}{13}, \cot \theta = \frac{-13}{84}$   
 3.  $g(2 + \sqrt{3}) = (2 + \sqrt{3})^2 - 4(2 + \sqrt{3}) + 1 = 4 + 4\sqrt{3} + 3 - 8 - 4\sqrt{3} + 1 = 0$   
 5. about 474 ft 7.



9. 50.89 km/hr 11.  $x \in \left[-\frac{9}{2}, \frac{11}{2}\right]$  13. a.  $y = -\frac{1}{2}x + 31$  b. every 2 years, the amount of emissions decreases by 1 million tons.  
 c. 23.5 million tons; 11 million tons 15.  $x \in (1, 5)$  17. \$7

$$19. \frac{\cos x}{\sec x - 1} = \frac{\cos x(\sec x + 1)}{(\sec x - 1)(\sec x + 1)} = \frac{1 + \cos x}{\sec^2 x - 1} = \frac{1 + \cos x}{1 + \cos x} = \tan^2 x$$

23. a.  $y = 5.4 \sin\left(\frac{\pi}{6}x - \frac{2\pi}{3}\right) + 27.1$  b. from early May until late August

**MODELING WITH TECHNOLOGY III**

**Modeling with Technology III Exercises, pp. 707–710**

1.  $y = 25 \sin\left(\frac{\pi}{6}x\right) + 50$  3.  $y = 2.25 \sin\left(\frac{\pi}{12}x + \frac{\pi}{4}\right) + 5.25$   
 5.  $y = 503 \sin\left(\frac{\pi}{6}x + \frac{2\pi}{3}\right) + 782$   
 7. a.  $T(x) = 19.6 \sin\left(\frac{\pi}{6}x + \frac{4\pi}{3}\right) + 84.6$  b. about 94.4°F  
 c. beginning of May ( $x \approx 5.1$ ) to end of August ( $x \approx 8.9$ )

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**SA44** Student Answer Appendix

9. a.  $T(x) = 0.4 \sin\left(\frac{\pi}{12}x + \frac{13\pi}{12}\right) + 98.6$  b. at 11 A.M. and 11 P.M.  
 c. from  $x = 1$  to  $x = 9$ , about 8 hr

11.  $P = 12$ ,  $B = \frac{\pi}{12}$ ,  $C = \frac{\pi}{2}$ ; using (4, 3) gives  $A = -3\sqrt{3}$ , so

$f(x) = -3\sqrt{3} \tan\left(\frac{\pi}{12}x + \frac{\pi}{2}\right)$  a.  $f(2.5) \approx 6.77$  b.  $f(x) = 16$  for

$x \approx 1.20$  13. a. using (18, 10) gives  $A \approx 4.14$ ;  $H(d) = 4.14 \tan\left(\frac{\pi}{48}d\right)$

b.  $\approx 12.2$  cm c.  $\approx 21.9$  mi

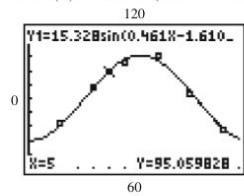
15. a.  $y \approx 49.26 \sin(0.213x - 1.104) + 51.43$

b.  $y \approx 49 \sin(0.203x - 0.963) + 51$  c. at day 31  $\approx 5.6$

17. a.  $y \approx 5.88 \sin(0.523x - 0.521) + 16.00$

b.  $y \approx 6 \sin(0.524x - 0.524) + 16$  c. at month 9  $\approx 0.12$

19. a.  $T(m) \approx 15.328 \sin(0.461m - 1.610) + 85.244$



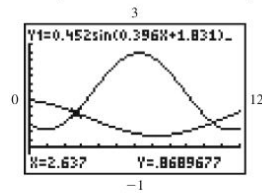
b.

Month	Temp. (°F)
1	71
3	82
5	95
7	101
9	94
11	80

c. max difference is about 1°F in months 6 and 8

21. a. Reno:  $R(t) \approx 0.452 \sin(0.396t + 1.831) + 0.750$

b. The graphs intersect at  $t \approx 2.6$  and  $t \approx 10.5$ . Reno gets more rainfall than Cheyenne for about 4 months of the year:  $2.6 + (12 - 10.5) = 4.1$



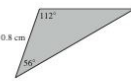
23. a.  $f(x) \approx 49.659 \sin(0.214x - 0.689) + 48.328$  b. about 26.8%

c.  $g(x) = 49.5 \sin\left(\frac{2\pi}{31}x - \frac{7\pi}{62}\right) + 49.5$ ; values for  $A$ ,  $B$ , and  $D$  are very close; some variation in  $C$ .

25. a.  $D(t) = 2000 \cos\left(\frac{\pi}{60}t\right)$  b. 30 min c. north, 1258.6 mi.

$$27. \frac{m-D}{A} = \frac{m - \left(\frac{M+m}{2}\right)}{\frac{M-m}{2}} = \frac{2m - M - m}{M - m} = \frac{m - M}{M - m} = -1$$

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23.  25. a. 10 cm b. 0 c. 2 d. 1

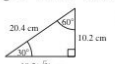
27. not possible 29.  $B = 60^\circ, C = 90^\circ, b = 12.9\sqrt{3}$  mi  
 31.  $A \approx 39^\circ, B \approx 82^\circ, a \approx 42.6$  mi or  $A \approx 23^\circ, B \approx 98^\circ, a \approx 26.4$  mi  
 33.  $A \approx 39^\circ, B \approx 82^\circ, a \approx 42.6$  ft or  $A \approx 23^\circ, B \approx 98^\circ, a \approx 26.4$  ft  
 35. not possible 37.  $A \approx 80.0^\circ, B \approx 38.0^\circ, b \approx 1.8 \times 10^{25}$  mi  
 39.  $A_1 \approx 19.3^\circ, A_2 \approx 160.7^\circ, 48^\circ + 160.7^\circ > 180^\circ$ ; no second solution possible  
 41.  $C_1 \approx 71.3^\circ, C_2 \approx 108.7^\circ, 57^\circ + 108.7^\circ < 180^\circ$ ; two solutions possible  
 43. not possible,  $\sin A > 1$  45.  $\frac{\sqrt{2}}{2}$   
 47. 34.6 million miles or 119.7 million miles 49. a. No b.  $\approx 3.9$  mi  
 51.  $V \leftrightarrow S = 41.7$  km,  $V \leftrightarrow P = 80.8$  km  
 53. a. No b. about 201.5 ft c.  $\approx 15$  sec  
 55. Two triangles

Angles	Sides	Angles	Sides
$A_1 \approx 41.1^\circ$	$a = 12$ cm	$A_2 \approx 138.9^\circ$	$a = 12$ cm
$B = 26^\circ$	$b = 8$ cm	$B = 26^\circ$	$b = 8$ cm
$C_1 \approx 112.9^\circ$	$c_1 \approx 16.8$ cm	$C_2 \approx 15.1^\circ$	$c_2 \approx 4.8$ cm

57.

Angles	Sides	Angles	Sides
$A_1 \approx 47.0^\circ$	$a = 9$ cm	$A_2 \approx 133.0^\circ$	$a = 9$ cm
$B_1 \approx 109.0^\circ$	$b_1 \approx 11.6$ cm	$B_2 = 23.0^\circ$	$b_2 = 4.8$ cm
$C \approx 24^\circ$	$c = 5$ cm	$C \approx 24^\circ$	$c = 5$ cm

59.  $a \approx 33.7$  ft,  $c \approx 22.3$  ft 61. Rhymes to Tarryson: 61.7 km, Sexton to Tarryson: 52.6 km 63.  $\approx 3.2$  mi 65.  $h \approx 161.9$  yd  
 67. angle =  $90^\circ$ ; sides  $\approx 9.8$  cm, 11 cm; diameter  $\approx 11$  cm; it is a right triangle. 69. a. about 3187 m b. about 2613 m c. about 2368 m

71.   $\sqrt{3} = \frac{\sin 60^\circ}{\sin 30^\circ}; \sqrt{2} = \frac{\sin 90^\circ}{\sin 45^\circ}$

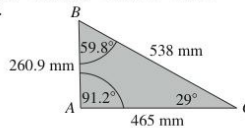
73.  $A = 19^\circ, B = 31^\circ, C = 130^\circ, a = 45$  cm,  $b \approx 71.2$  cm,  $c \approx 105.8$  cm  
 75.  $\approx 12,564$  mph

$$\begin{aligned} 77. \tan^2 x - \sin^2 x &= \frac{\sin^2 x}{\cos^2 x} - \sin^2 x \\ &= \frac{\sin^2 x}{\cos^2 x} - \frac{\sin^2 x \cos^2 x}{\cos^2 x} \\ &= \frac{\sin^2 x - \sin^2 x \cos^2 x}{\cos^2 x} \\ &= \frac{\sin^2 x(1 - \cos^2 x)}{\cos^2 x} \\ &= \frac{\sin^2 x \sin^2 x}{\cos^2 x} \\ &= \sin^2 x \frac{\sin^2 x}{\cos^2 x} \\ &= \sin^2 x \tan^2 x \end{aligned}$$

79. a.  $y = \frac{5}{9}x - \frac{2}{9}$  b.  $\sqrt{106}$  units

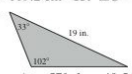
**Exercises 7.2, pp. 731–736**

1. cosines 3. Pythagorean 5.  $B \approx 33.1^\circ, C \approx 129.9^\circ, a \approx 19.8$  m; law of sines 7. yes 9. no 11. yes 13. verified 15.  $B \approx 41.4^\circ$   
 17.  $a \approx 7.24$  19.  $A \approx 41.6^\circ$  21.  $A \approx 120.4^\circ, B \approx 21.6^\circ, c \approx 53.5$  cm  
 23.  $A \approx 23.8^\circ, C \approx 126.2^\circ, b \approx 16$  mi  
 25.



**CHAPTER 7**

**Exercises 7.1, pp. 719–724**

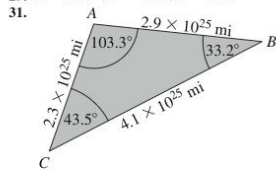
1. ambiguous 3. I; II 5. Answers will vary. 7.  $a \approx 8.98$   
 9.  $C \approx 49.2^\circ$  11.  $C \approx 21.4^\circ$  13.  $\angle C = 78^\circ, b \approx 109.5$  cm,  
 $c \approx 119.2$  cm 15.  $\angle C = 90^\circ, a = 10$  in.,  $c = 20$  in.  
 17.  19.  $\angle C = 90^\circ, a = 15$  mi,  $b = 15$  mi

21.  $\angle A = 57^\circ, b \approx 49.5$  km,  $c \approx 17.1$  km

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27.  $A \approx 137.9^\circ, B \approx 15.6^\circ, C \approx 26.5^\circ$

29.  $A \approx 119.3^\circ, B \approx 41.5^\circ, C \approx 19.2^\circ$



33.  $A \approx 139.7^\circ, B \approx 23.7^\circ, C \approx 16.6^\circ$

35.  $C \approx 86.3^\circ$  37. about 1688 mi 39.  $P \approx 27.7^\circ$ ; heading  $297.7^\circ$

41. It cannot be constructed (available length  $\approx 10,703.6$  ft)

43. 1678.2 mi 45.  $P \approx 22.4$  cm,  $A = 135^\circ, B \approx 23.2^\circ, C \approx 21.8^\circ$

47.  $A \approx 20.6^\circ, B \approx 15.3^\circ, C \approx 144.1^\circ$  49. 58.78 cm

51.  $a = 13$   $A = 133.2^\circ$  53.  $33.7^\circ, 150$  ft<sup>2</sup>

$b = 5$   $B = 16.3^\circ$

$c = \sqrt{82}$   $C = 30.5^\circ$

55. a.  $0.65 = 65\%$  b. \$1,950,000 57. about 483,529 km<sup>2</sup>

59.  $387 + 502 = 889 < 902$  61. (1)  $a^2 = b^2 + c^2 - 2bc \cos A$

(2)  $b^2 = a^2 + c^2 - 2ac \cos B$ , use substitution for  $a^2$  and (2) becomes

$b^2 = (b^2 + c^2 - 2bc \cos A) + c^2 - 2ac \cos B$ . Then

$0 = 2c^2 - 2bc \cos A - 2ac \cos B, 2bc \cos A +$

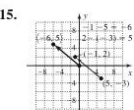
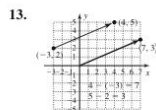
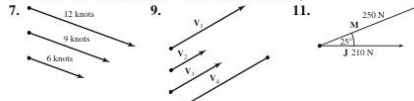
$2ac \cos B = 2c^2, b \cos A + a \cos B = c$  63. 2

65.  $\sin x = \frac{-5}{13}$ ,  $\csc x = \frac{-13}{5}$ ,  $\cos x = \frac{12}{13}$ ,  $\sec x = \frac{13}{12}$

$\tan x = \frac{-5}{12}$ ,  $\cot x = \frac{-12}{5}$

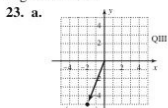
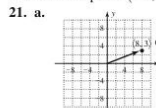
Exercises 7.3, pp. 747–751

1. scalar 3. directed; line 5. Answers will vary.



17. Terminal point: (5, -1), magnitude:  $\sqrt{53}$

19. Terminal point: (-1, 1), magnitude:  $\sqrt{34}$



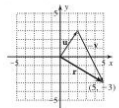
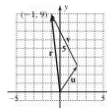
b.  $\sqrt{3}$  c.  $20.6^\circ$

b.  $\sqrt{29}$  c.  $68.2^\circ$

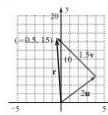
25.  $(-10.9, 5.1)$  27.  $(106, -92.2)$  29.  $(-9.7, -2.6)$

31. a.  $(-1, 9)$

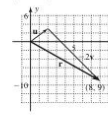
b.  $(5, -3)$



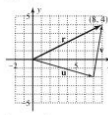
c.  $(-0.5, 15)$



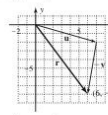
d.  $(8, -9)$



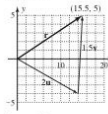
33. a.  $(8, 4)$



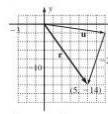
b.  $(6, -8)$



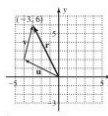
c.  $(15.5, 5)$



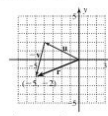
d.  $(5, -14)$



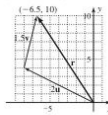
35. a.  $(-3, 6)$



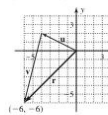
b.  $(-5, -2)$



c.  $(-6.5, 10)$



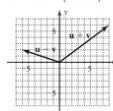
d.  $(-6, -6)$



37. True 39. False 41. True

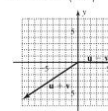
43.  $\mathbf{u} + \mathbf{v} = \langle 8, 6 \rangle$

$\mathbf{u} - \mathbf{v} = \langle -6, 2 \rangle$



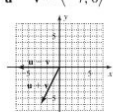
45.  $\mathbf{u} + \mathbf{v} = \langle -9, -6 \rangle$

$\mathbf{u} - \mathbf{v} = \langle 7, 0 \rangle$



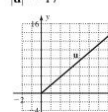
47.  $\mathbf{u} + \mathbf{v} = \langle -3, -6 \rangle$

$\mathbf{u} - \mathbf{v} = \langle -7, 0 \rangle$



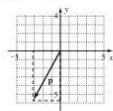
49.  $\mathbf{u} = 8\mathbf{i} + 15\mathbf{j}$

$|\mathbf{u}| = 17$



51.  $\mathbf{p} = -3.2\mathbf{i} - 5.7\mathbf{j}$

$|\mathbf{p}| \approx 6.54$



53. a.



b.  $\mathbf{v} = \langle -11.5, -3.3 \rangle$

c.  $\mathbf{v} = -11.5\mathbf{i} - 3.3\mathbf{j}$

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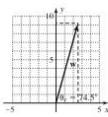
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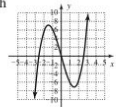
Student Answer Appendix Chapter 7

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SA46 Student Answer Appendix

55. a.  b.  $w = \langle 2.5, 9.2 \rangle$  c.  $w = 2.5i + 9.2j$

57. a.  $p = -2i + 2j$ ;  $|p| = 2\sqrt{2}$ ,  $\theta = 135^\circ$   
 b.  $q = 6i - 8j$ ;  $|q| = 10$ ,  $\theta = 306.9^\circ$   
 c.  $r = -2i + 1.5j$ ;  $|r| = 2.5$ ,  $\theta = 143.1^\circ$   
 d.  $s = 10i - 13j$ ;  $|s| = 16.4$ ,  $\theta = 307.6^\circ$   
 59. a.  $p = 2\sqrt{2}i + 2j$ ;  $|p| = 3.5$ ,  $\theta = 35.3^\circ$   
 b.  $q = 8\sqrt{2}i + 12j$ ;  $|q| = 16.5$ ,  $\theta = 46.7^\circ$   
 c.  $r = 5.5\sqrt{2}i + 6.5j$ ;  $|r| = 10.1$ ,  $\theta = 39.9^\circ$   
 d.  $s = 11\sqrt{2}i + 17j$ ;  $|s| = 23.0$ ,  $\theta = 47.5^\circ$   
 61. a.  $p = 8i + 4j$ ;  $|p| = 8.9$ ,  $\theta = 26.6^\circ$   
 b.  $q = 16i + 4j$ ;  $|q| = 16.5$ ,  $\theta = 14.0^\circ$   
 c.  $r = 18i + 8j$ ;  $|r| = 19.7$ ,  $\theta = 24.0^\circ$   
 d.  $s = 20i + 4j$ ;  $|s| = 20.4$ ,  $\theta = 11.3^\circ$   
 63.  $\langle \frac{7}{25}, \frac{24}{25} \rangle$ , verified 65.  $\langle \frac{-20}{29}, \frac{21}{29} \rangle$ , verified  
 67.  $\frac{20}{29}i - \frac{21}{29}j$ , verified 69.  $\frac{7}{25}i + \frac{24}{25}j$ , verified  
 71.  $\langle \frac{-13}{\sqrt{178}}, \frac{3}{\sqrt{178}} \rangle$ , verified 73.  $\frac{6}{\sqrt{157}}i + \frac{11}{\sqrt{157}}j$ , verified  
 75.  $\approx 4.48 \langle \frac{5}{\sqrt{29}}, \frac{2}{\sqrt{29}} \rangle \approx \langle 4.16, 1.66 \rangle$   
 77.  $\approx 5.83 \langle \frac{8}{\sqrt{73}}, \frac{-3}{\sqrt{73}} \rangle \approx \langle 5.46, -2.05 \rangle$  79.  $\approx 14.4$  81.  $\approx 24.3^\circ$   
 83. hor. comp.  $\approx 79.9$  ft/sec; vert. comp.  $\approx 60.2$  ft/sec  
 85. heading  $68.2^\circ$  at 266.7 mph 87.  $\approx \langle 82.10 \text{ cm}, 22.00 \text{ cm} \rangle$   
 89.  $l(a, b) = \langle la, lb \rangle = \langle a, b \rangle$   
 91.  $\langle a, b \rangle - \langle c, d \rangle = \langle a - c, b - d \rangle = \langle a + (-c), b + (-d) \rangle = \langle a, b \rangle + \langle -c, -d \rangle = \langle a, b \rangle + -1\langle c, d \rangle = \mathbf{u} + (-1\mathbf{v})$   
 93.  $\langle ck \rangle \mathbf{u} = \langle cka, ckb \rangle = \langle kca, kcb \rangle = k\langle ca, cb \rangle = k\langle c\mathbf{u} \rangle$   
 95.  $\mathbf{u} + (-\mathbf{u}) = \langle a, b \rangle + \langle -a, -b \rangle = \langle a - a, b - b \rangle = \langle 0, 0 \rangle$   
 97.  $\langle c + k \rangle \mathbf{u} = \langle (c + k)a, (c + k)b \rangle = \langle ca + ka, cb + kb \rangle = \langle ca, cb \rangle + \langle ka, kb \rangle = \mathbf{cu} + \mathbf{ku}$   
 99.  $\langle 1, 3 \rangle + \langle 3, 3 \rangle + \langle 4, -1 \rangle + \langle 2, -4 \rangle + \langle -4, -3 \rangle + \langle -6, 2 \rangle = \langle 0, 0 \rangle$   
 101. Answers will vary, one possibility:  $0^\circ, 81.4^\circ, -34^\circ$   
 103. a. not a real number b. not possible c. not a real number  
 105.  $x = 0, \pm \sqrt{7}$ ; see graph



Mid-Chapter Check, p. 751

1.  $\sin B = \frac{b \sin A}{a}$  2.  $\cos B = \frac{a^2 + c^2 - b^2}{2ac}$   
 3.  $a = 129 \text{ m}$ ,  $B = 86.5^\circ$ ,  $C = 62.5^\circ$   
 4.  $A = 42.3^\circ$ ,  $B = 81.5^\circ$ ,  $C = 56.2^\circ$   
 5.  $A = 44^\circ$   $a = 2.1 \text{ km}$  6.  $A = 18.5^\circ$   $a = 70 \text{ yd}$   
 $B = 68.1^\circ$   $b = 2.8 \text{ km}$   $B = 134.5^\circ$   $b = 157.1 \text{ yd}$   
 $C = 67.9^\circ$   $c = 2.8 \text{ km}$   $C = 27^\circ$   $c = 100 \text{ yd}$   
 or  
 $A = 44^\circ$   $a = 2.1 \text{ km}$   
 $B = 23.9^\circ$   $b = 1.2 \text{ km}$   
 $C = 112.1^\circ$   $c = 2.8 \text{ km}$   
 7. about 60.7 ft 8. 169 m 9.  $\alpha = 49.6^\circ$ ;  $\beta = 92.2^\circ$ ;  $\gamma = 38.2^\circ$   
 10. 9.4 mi

Reinforcing Basic Concepts, p. 751

1. 

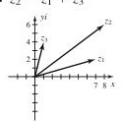
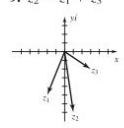
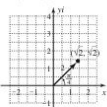
Angles	Sides
$A = 35^\circ$	$a = 11.6 \text{ cm}$
$B = 81.5^\circ$	$a = 20 \text{ cm}$
$C = 63.5^\circ$	$c = 18 \text{ cm}$

  
 2. For  $\angle A = 35^\circ$ ,  $a = 10.3$   
 For  $\angle A = 50^\circ$ ,  $a = 14.2$   
 For  $\angle A = 70^\circ$ ,  $a = 19.1$ ;  
 yes, very close  
 Very close.

Exercises 7.4, pp. 761–765

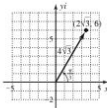
1. equilibrium; zero 3. orthogonal 5. Answers will vary.  
 7.  $\langle 6, 8 \rangle$  9.  $\langle -5, 10 \rangle$  11.  $-6i - 8j$  13.  $-2.2i + 0.4j$   
 15.  $\langle -11.48, -9.16 \rangle$  17.  $\langle -24, -27 \rangle$  19.  $F_3 \approx 3336.8$ ;  $\theta \approx 268.5^\circ$   
 21. 37.16 kg 23. 644.49 lb 25. 2606.74 kg 27. approx. 286.79 lb  
 29. approx. 43.8° 31. 1125 N-m 33. approx. 957.0 ft 35. approx. 64,951.90 ft-lb 37. approx. 451.72 lb 39. approx. 2819.08 N-m  
 41. 800 ft-lb 43. 118 ft-lb 45. verified 47. verified 49. a. 29 b.  $45^\circ$   
 51. a. 0 b.  $90^\circ$  53. a. 1 b.  $89.4^\circ$  55. yes 57. no 59. yes  
 61. 3.68 63. -4 65. 3.17  
 67. a.  $\langle 3.73, 1.40 \rangle$  b.  $\mathbf{u}_1 = \langle 3.73, 1.40 \rangle$ ,  $\mathbf{u}_2 = \langle -1.73, 4.60 \rangle$   
 69. a.  $\langle -0.65, 0.11 \rangle$  b.  $\mathbf{u}_1 = \langle -0.65, 0.11 \rangle$ ,  $\mathbf{u}_2 = \langle -1.35, -8.11 \rangle$   
 71. a.  $10.54i + 1.76j$  b.  $\mathbf{u}_1 = 10.54i + 1.76j$ ,  $\mathbf{u}_2 = -0.54i + 3.24j$   
 73. a. projectile is about 375 ft away, and 505.52 ft high b. approx. 1.27 sec and 12.26 sec 75. a. projectile is about 424.26 ft away, and 280.26 ft high b. approx. 2.44 sec and 6.40 sec  
 77. about 74.84 ft;  $t = 3.9 - 1.2 = 2.7$  sec  
 79.  $\mathbf{w} \cdot (\mathbf{u} + \mathbf{v}) = \langle e, f \rangle \cdot \langle a + c, b + d \rangle$   
 $= e(a + c) + f(b + d) = ea + ec + fb + fd$   
 $= (ea + fb) + (ec + fd)$   
 $= \langle e, f \rangle \cdot \langle a, b \rangle + \langle e, f \rangle \cdot \langle c, d \rangle$   
 $= \mathbf{w} \cdot \mathbf{u} + \mathbf{w} \cdot \mathbf{v}$   
 81.  $\mathbf{0} \cdot \mathbf{u} = \langle 0, 0 \rangle \cdot \langle a, b \rangle = 0(a) + 0(b) = 0$   
 $\mathbf{u} \cdot \mathbf{0} = \langle a, b \rangle \cdot \langle 0, 0 \rangle = a(0) + b(0) = 0$   
 83.  $\theta = 56.9^\circ$ ; answers will vary. 85.  $x = -20$   
 87.  $a = 138.4$ ,  
 $B = 106.8^\circ$   
 $C = 41.2^\circ$ ,  
 $P = 560.4 \text{ m}$ ,  
 $A = 11,394.3 \text{ m}^2$

Exercises 7.5, pp. 773–776

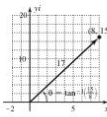
1. modulus; argument 3. multiply; add  
 5.  $2(\cos 240^\circ + i \sin 240^\circ)$ ,  $z$  is in QIII  
 7.  $z_2 = z_1 + z_3$  9.  $z_2 = z_1 + z_3$   
  
  
 11.  $2\sqrt{2}(\cos 225^\circ + i \sin 225^\circ)$  13.  $10(\cos 210^\circ + i \sin 210^\circ)$   
 15.  $6 \left[ \cos\left(\frac{3\pi}{4}\right) + i \sin\left(\frac{3\pi}{4}\right) \right]$  17.  $8 \left[ \cos\left(\frac{11\pi}{6}\right) + i \sin\left(\frac{11\pi}{6}\right) \right]$   
 19.  $10 \text{ cis} \left[ \tan^{-1}\left(\frac{6}{8}\right) \right]$ ;  $10 \text{ cis } 36.9^\circ$   
 21.  $13 \text{ cis} \left[ 180^\circ + \tan^{-1}\left(\frac{12}{5}\right) \right]$ ;  $13 \text{ cis } 247.4^\circ$   
 23.  $18.5 \text{ cis} \left[ \tan^{-1}\left(\frac{17.5}{6}\right) \right]$ ;  $18.5 \text{ cis } 1.2405$   
 25.  $2\sqrt{34} \text{ cis} \left[ \pi + \tan^{-1}\left(-\frac{5}{3}\right) \right]$ ;  $2\sqrt{34} \text{ cis } 2.1112$   
 27.  $r = 2$ ,  $\theta = \frac{\pi}{4}$   
 $z = 2 \text{ cis} \left( \frac{\pi}{4} \right)$   
 $= \sqrt{2} + \sqrt{2}i$   


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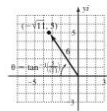
29.  $r = 4\sqrt{3}$ ,  $\theta = \frac{\pi}{3}$   
 $z = 4\sqrt{3} \operatorname{cis}\left(\frac{\pi}{3}\right)$   
 $= 2\sqrt{3} + 6i$



31.  $r = 17$ ,  $\theta = \tan^{-1}\left(\frac{15}{8}\right)$   
 $z = 17 \operatorname{cis}\left[\tan^{-1}\left(\frac{15}{8}\right)\right]$   
 $= 17\left(\frac{8}{17} + \frac{15}{17}i\right) = 8 + 15i$



33.  $r = 6$ ,  $\theta = \pi - \tan^{-1}\left(\frac{5}{\sqrt{11}}\right)$   
 $z = 6 \operatorname{cis}\left[\pi - \tan^{-1}\left(\frac{5}{\sqrt{11}}\right)\right]$   
 $= 6\left(-\frac{\sqrt{11}}{6} + \frac{5}{6}i\right) = -\sqrt{11} + 5i$



35.  $r_1 = 2\sqrt{2}$ ,  $r_2 = 3\sqrt{2}$ ,  $\theta_1 = 135^\circ$ ,  $\theta_2 = 45^\circ$ ;  
 $z = z_1 z_2 = -12 + 0i \Rightarrow r = 12$ ,  $\theta = 180^\circ$ ;  
 $r_1 r_2 = 2\sqrt{2}(3\sqrt{2}) = 12\sqrt{2}$   
 $\theta_1 + \theta_2 = 135^\circ + 45^\circ = 180^\circ \checkmark$   
 37.  $r_1 = 2$ ,  $r_2 = 2$ ,  $\theta_1 = 30^\circ$ ,  $\theta_2 = 60^\circ$ ;  
 $z = \frac{z_1}{z_2} = \frac{\sqrt{3}}{2} - \frac{1}{2}i \Rightarrow r = 1$ ,  $\theta = -30^\circ$ ;  $\frac{r_1}{r_2} = \frac{2}{2} = 1 \checkmark$   
 $\theta_1 - \theta_2 = 30^\circ - 60^\circ = -30^\circ \checkmark$

39.  $z_1 z_2 = -24 + 0i$ ,  $\frac{z_1}{z_2} = -\frac{4}{3} + \frac{4\sqrt{3}}{3}i$

41.  $z_1 z_2 = 21\sqrt{3} - 21i$ ,  $\frac{z_1}{z_2} = \frac{\sqrt{3}}{7} + \frac{1}{7}i$

43.  $z_1 z_2 = -10.84 + 12.04i$ ,  $\frac{z_1}{z_2} = -1.55 - 4.76i$

45.  $z_1 z_2 = 0 + 40i$ ,  $\frac{z_1}{z_2} = \frac{5\sqrt{3}}{4} + \frac{5}{4}i$

47.  $z_1 z_2 = -10 - 10\sqrt{3}i$ ,  $\frac{z_1}{z_2} = \frac{-5}{2} + 0i$

49.  $z_1 z_2 = -2.93 + 8.5i$ ,  $\frac{z_1}{z_2} = 2.29 + 3.28i$

51. verified; verified.  $u^2 + v^2 + w^2 = uv + vw + vw$   
 $(1 + 4\sqrt{3}i) + (97 + 20\sqrt{3}i) + (-39 + 60\sqrt{3}i)$   
 $= (17 + 12\sqrt{3}i) + (-3 + 16\sqrt{3}i) + (45 + 56\sqrt{3}i)$ ,  
 $59 + 84\sqrt{3}i = 59 + 84\sqrt{3}i$

53. a.  $V(t) = 170 \sin(120\pi t)$

t	V(t)
0	0
0.001	62.6
0.002	116.4
0.003	153.8
0.004	169.7
0.005	161.7
0.006	131.0
0.007	81.9
0.008	21.3

c.  $t \approx 0.00257$  sec

55. a.  $17 \operatorname{cis} 28.1^\circ$  b.  $51 \operatorname{V}$  57. a.  $8.60 \operatorname{cis} 324.5^\circ$  b.  $15.48 \operatorname{V}$

59. a.  $13 \operatorname{cis} 22.6^\circ$  b.  $22.1 \operatorname{V}$

61.  $I = 2 \operatorname{cis} 30^\circ$ ;  $Z = 5\sqrt{2} \operatorname{cis} 45^\circ$ ;  $V = 10\sqrt{2} \operatorname{cis} 75^\circ$

63.  $I = \sqrt{13} \operatorname{cis} 326.3^\circ$ ;  $Z = \frac{17}{4} \operatorname{cis} 61.9^\circ$ ;  $V = \frac{17\sqrt{13}}{4} \operatorname{cis} 28.2^\circ$

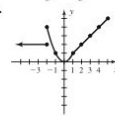
65.  $V = 4 \operatorname{cis} 60^\circ$ ;  $Z = 4\sqrt{2} \operatorname{cis} 315^\circ$ ;  $I = \frac{\sqrt{2}}{2} \operatorname{cis} 105^\circ$

67.  $V = 5 \operatorname{cis} 306.9^\circ$ ;  $Z = 8.5 \operatorname{cis} 61.9^\circ$ ;  $I = \frac{10}{17} \operatorname{cis} 245^\circ$

69.  $\frac{\sqrt{65} \operatorname{cis} 29.7^\circ}{4}$  71. verified

73.  $z_1 = \frac{24}{5} - \frac{7}{5}i$ ,  $z_2 = -\frac{24}{5} + \frac{7}{5}i$  75.  $\frac{5\pi}{24}$ ,  $\frac{13\pi}{24}$ ,  $\frac{29\pi}{24}$ ,  $\frac{37\pi}{24}$

77.



Exercises 7.6, pp. 781–783

1.  $r^5[\cos(5\theta) + i \sin(5\theta)]$ ; De Moivre's 3. complex

5.  $z_5 = 2 \operatorname{cis} 366^\circ = 2 \operatorname{cis} 6^\circ$ ,  $z_6 = 2 \operatorname{cis} 438^\circ = 2 \operatorname{cis} 78^\circ$ ,

$z_7 = 2 \operatorname{cis} 510^\circ = 2 \operatorname{cis} 150^\circ$ ; Answers will vary.

7.  $r = 3\sqrt{2}$ ;  $n = 4$ ;  $\theta = 45^\circ$ ;  $-324$  9.  $r = 2$ ;  $n = 3$ ;  $\theta = 120^\circ$ ; 8

11.  $r = 1$ ;  $n = 5$ ;  $\theta = -60^\circ$ ;  $\frac{1}{2} + \frac{\sqrt{3}}{2}i$  13.  $r = 1$ ;  $n = 6$ ;  $\theta = -45^\circ$ ;  $i$

15.  $r = 4$ ;  $n = 3$ ;  $\theta = 330^\circ$ ;  $-64i$

17.  $r = \frac{\sqrt{2}}{2}$ ;  $n = 5$ ;  $\theta = 135^\circ$ ;  $\frac{1}{8} - \frac{1}{8}i$

19. verified 21. verified 23. verified 25. verified

27.  $r = 1$ ;  $n = 5$ ;  $\theta = 0^\circ$ ; roots:  $1$ ,  $0.3090 \pm 0.9511i$ ,  $-0.8090 \pm 0.5878i$

29.  $r = 243$ ;  $n = 5$ ;  $\theta = 0^\circ$ ; roots:  $3$ ,  $0.9271 \pm 2.8532i$ ,  $-2.4271 \pm 1.7634i$

31.  $r = 27$ ;  $n = 3$ ;  $\theta = 270^\circ$ ; roots:  $3i$ ,  $\frac{-3\sqrt{3}}{2} - \frac{3}{2}i$ ,  $\frac{3\sqrt{3}}{2} - \frac{3}{2}i$

33.  $2$ ,  $0.6180 \pm 1.9021i$ ,  $-1.6180 \pm 1.1756i$

35.  $\frac{3\sqrt{3}}{2} + \frac{3}{2}i$ ,  $\frac{-3\sqrt{3}}{2} + \frac{3}{2}i$ ,  $-3i$

37.  $1.1346 + 0.1797i$ ,  $0.1797 + 1.1346i$ ,  $-1.0235 + 0.5215i$ ,  
 $-0.8123 - 0.8123i$ ,  $0.5215 - 1.0235i$

39.  $x = 1$ ,  $-\frac{1}{2} \pm \frac{\sqrt{3}}{2}i$ . These are the same results as in Example 3.

41.  $r = 16$ ;  $n = 4$ ;  $\theta = 120^\circ$ ; roots:  $\sqrt{3} + i$ ,  $-1 + \sqrt{3}i$ ,  $-\sqrt{3} - i$ ,  $1 - \sqrt{3}i$

43.  $r = 7\sqrt{2}$ ;  $n = 4$ ;  $\theta = 225^\circ$ ; roots:  $0.9855 + 1.4749i$ ,  $-1.4749 + 0.9855i$ ,  
 $-0.9855 - 1.4749i$ ,  $1.4749i - 0.9855i$

45.  $D = -4$ ,  $z_0 = 8^i \operatorname{cis} 45^\circ$ ,  $z_1 = 8^i \operatorname{cis} 165^\circ$ ,  $z_2 = 8^i \operatorname{cis} 285^\circ$ ,  
 $z_3 = 8^i \operatorname{cis} 75^\circ$ ,  $z_4 = 8^i \operatorname{cis} 195^\circ$ ,  $z_5 = 8^i \operatorname{cis} 315^\circ$  47. verified

49. a. numerator:  $-117 + 44j$ , denominator:  $-21 + 72j$  b.  $1 + \frac{4}{3}j$

c. verified 51. Answers will vary. 53.  $-7 - 24i$

55.  $z \approx -2.7320$ ,  $z \approx 0.7320$ ,  $z = 2$ .

Note: Using sum and difference identities, all three solutions can actually be given in exact form:  $-1 - \sqrt{3}$ ,  $-1 + \sqrt{3}$ ,  $2$ .

57.  $\frac{\tan^2 x}{\sec x + 1} = \frac{\sec^2 x - 1}{\sec x + 1}$   
 $= \frac{(\sec x + 1)(\sec x - 1)}{\sec x + 1}$   
 $= \sec x - 1$   
 $= \frac{1}{\cos x} - \cos x$   
 $= \frac{1 - \cos^2 x}{\cos x}$   
 $= \frac{\sin^2 x}{\cos x}$

59.  $y = -\frac{4}{5}x + \frac{12}{5}$



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SA48 Student Answer Appendix

Summary and Concept Review pp. 783–787

1.

Angles	Sides
$A = 36^\circ$	$a \approx 205.35$ cm
$B = 21^\circ$	$b \approx 125.20$ cm
$C = 123^\circ$	$c = 293$ cm

2.

Angles	Sides
$A = 28^\circ$	$a \approx 140.59$ yd
$B = 10^\circ$	$b = 52$ yd
$C = 142^\circ$	$c \approx 184.36$ yd

3. approx. 41.84 ft

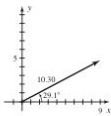
4. approx.  $20.2^\circ$  and  $159.8^\circ$

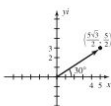
5.

Angles	Sides
$A = 35^\circ$	$a = 67$ cm
$B_1 \approx 64.0^\circ$	$b = 105$ cm
$C_1 \approx 81.0^\circ$	$c_1 \approx 115.37$ cm

Angles	Sides
$A = 35^\circ$	$a = 67$ cm
$B_2 \approx 116.0^\circ$	$b = 105$ cm
$C_2 \approx 29.0^\circ$	$c_2 \approx 56.63$ cm

6. no;  $36^\circ$  7. approx.  $36.9^\circ$  8. approx. 385.5 m  
9.  $133.2^\circ$ ,  $30.1^\circ$ , and  $16.7^\circ$  10.  $85,570.7$  m<sup>2</sup>

11.  12.  $-8i + 3j$ ;  $|u| \approx 8.54$ ;  $\theta \approx 159.4^\circ$

13. horiz. comp.  $\approx 11.08$ , vertical comp.  $\approx 14.18$   
14.  $\langle -4, -2 \rangle$ ;  $|2u + v| \approx 4.47$ ,  $\theta \approx 206.6^\circ$  15.  $\frac{7}{\sqrt{193}}i + \frac{12}{\sqrt{193}}j$   
16. QII; since the x-component is negative and the y-component is positive.  
17.  $\frac{1}{5}$  mi 18. approx.  $19.7^\circ$  19.  $\langle -25, -123 \rangle$  20. approx.  $-0.87$   
21. 4 22.  $p \cdot q = -6$ ;  $\theta \approx 97.9^\circ$  23. 4340 ft-lb 24. approx. 417.81 lb  
25. approx. 8156.77 ft-lb 26. a.  $x \approx 269.97$  ft;  $y \approx 285.74$  ft  
b. approx. 0.74 sec 27.  $2(\cos 240^\circ + i \sin 240^\circ)$  28.  $3 + 3i$   
29.  30.  $z_1 z_2 = 16 \operatorname{cis} \left( \frac{5\pi}{12} \right)$ ;  $z_1 = 4 \operatorname{cis} \left( \frac{\pi}{12} \right)$

31.  $2\sqrt{3} + 2i$  32.  $|z| \approx 10.44$ ;  $\theta \approx 16.7^\circ$ ,  $10.44 \operatorname{cis} 16.7^\circ$   
33.  $-16 - 16\sqrt{3}i$  34. verified 35.  $\frac{5\sqrt{3}}{2} + \frac{5}{2}i - \frac{5\sqrt{3}}{2} + \frac{5}{2}i, -5i$   
36.  $6, -3 \pm 3i\sqrt{3}$  37.  $2 - 2i, -2 \pm 2i$  38.  $1 \pm 2i, -1 \pm 2i$   
39. verified

Mixed Review pp. 787–788

1.

Angles	Sides
$A = 41^\circ$	$a \approx 13.44$ in.
$B = 27^\circ$	$b \approx 9.30$ in.
$C = 112^\circ$	$c = 19$ in.

Area  $\approx 57.9$  in<sup>2</sup>

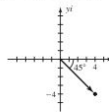
3.  $x \approx 16.09$ ,  $y \approx 13.50$  5. approx. 176.15 ft 7. approx. 793.70 mph; heading  $28.2^\circ$

9. One solution possible since side  $a >$  side  $b$

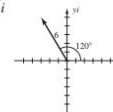
Angles	Sides
$A = 31^\circ$	$a = 36$ m
$B \approx 20.1^\circ$	$b = 24$ m
$C \approx 128.9^\circ$	$c \approx 54.4$ m

11. No; barely touches ("tangent") at  $30^\circ$

13. a.  $4\sqrt{2}(\cos 315^\circ + i \sin 315^\circ)$



b.  $-3 + 3\sqrt{3}i$



15.  $\approx 13.1^\circ$  17.  $\operatorname{comp}_v u \approx -0.87$ ,  $\operatorname{proj}_v u \approx \frac{-38}{53} + \frac{26}{53}i$

19.  $z_0 = \frac{\sqrt{6}}{2} + \frac{\sqrt{2}}{2}i$ ;  $z_1 = \frac{-\sqrt{2}}{2} + \frac{\sqrt{6}}{2}i$   
 $z_2 = \frac{-\sqrt{6}}{2} - \frac{\sqrt{2}}{2}i$ ;  $z_3 = \frac{\sqrt{2}}{2} - \frac{\sqrt{6}}{2}i$

Practice Test pp. 788–790

1. 6.58 mi 2. 137.18 ft

3.

Angles	Sides (in.)	Angles	Sides (in.)
$A_1 \approx 58.8^\circ$	$a = 15$	$A_2 \approx 121.2^\circ$	$a = 15$
$B = 20^\circ$	$b = 6$	$B = 20^\circ$	$b = 6$
$C_1 \approx 101.2^\circ$	$c_1 \approx 17.21$	$C_2 \approx 38.8^\circ$	$c_2 \approx 11.0$

4. a. No b. 2.66 mi 5. a. No b. 1 c. 8.43 sec  
6. a. 2.30 mi b. 7516.5 ft  
7.  $A \approx 438,795$  mi<sup>2</sup>,  $P \approx 61.7^\circ$ ,  $B \approx 61.2^\circ$ ,  $M \approx 57.1^\circ$   
8. speed  $\approx 73.36$  mph, bearing  $\approx 47.8^\circ$  9.  $\theta \approx 36.5^\circ$  10. 63.48 cm to the right and 130.05 cm down from the initial point on the ceiling  
11.  $|F_x| \approx 212.94$  N,  $\theta \approx 251.2^\circ$   
12. a.  $\theta \approx 42.5^\circ$  b.  $\operatorname{proj}_i u = \langle -2.4, 7.2 \rangle$   
c.  $u_1 = \langle -2.4, 7.2 \rangle$ ,  $u_2 = \langle -6.6, -2.2 \rangle$

13. 104.53 ft; 3.27 sec 14.  $2 \operatorname{cis} \left( \frac{\pi}{24} \right)$  15.  $48\sqrt{2} \operatorname{cis} 75^\circ$ ; verified

16.  $-8 - 8\sqrt{3}i$  17. verified 18.  $\frac{5\sqrt{3}}{2} + \frac{5}{2}i - \frac{5\sqrt{3}}{2} + \frac{5}{2}i, -5i$   
19.  $2.3039 \pm 1.5192i, -2.3039 \pm 1.5192i$  20.  $\approx 2,414,300$  mi<sup>2</sup>

Strengthening Core Skills p. 791

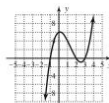
Exercise 1: 664.46 lb, 640.86 lb

Exercise 2: 106.07 lb, 106.07 lb

Exercise 3: yes

Cumulative Review Chapters 1–7 pp. 791–792

1.  $20\sqrt{3}$ ; 40;  $60^\circ$ ;  $90^\circ$  3.  $R = \frac{1}{\pi}\sqrt{A + (\pi r)^2}$   
5.  $\operatorname{QIV} \sin \theta = \frac{-3}{5}$ ;  $\cos \theta = \frac{4}{5}$ ;  $\tan \theta = \frac{-3}{4}$ ;  $\csc \theta = -\frac{5}{3}$ ;  
 $\sec \theta = \frac{5}{4}$ ;  $\cot \theta = \frac{-4}{3}$  7.  $x = \frac{-4 \pm \sqrt{6}}{5}$   
9.  $\cos = 19^\circ \approx 0.94$ ,  $\cos 125^\circ \approx -0.58$  11. a. about \$66,825  
b. 13, 13,  $7\sqrt{2}$ ;  $A = 59.5$  mi<sup>2</sup> 13. a.  $m = \frac{y_2 - y_1}{x_2 - x_1}$   
b.  $\left( \frac{x_2 + x_1}{2}, \frac{y_2 + y_1}{2} \right)$  c.  $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$   
d.  $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$  e.  $A = Pe^{rt}$   
15.  $\angle A = 37^\circ$ ,  $a = 33$  cm,  
 $\angle B = 34.4^\circ$ ,  $b = 31$  cm,  
 $\angle C = 108.6^\circ$ ,  $c = 52$  cm  
17. about 422.5 lb  
19.



$x \in (-\infty, -1) \cup (2, 3)$

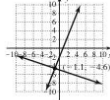
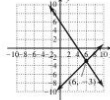
21.  $-128 - 128i\sqrt{3}$  23. about 3.6 yr 25.  $A = 2$ ,  $B = 1$ ,  $C = \frac{\pi}{4}$

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**CHAPTER 8**

**Exercises 8.1, pp. 801–805**

1. inconsistent 3. consistent; independent  
 5. Multiply the first equation by 6 and the second equation by 10.  
 7.  $y = \frac{7}{4}x - 6$ ,  $y = \frac{7}{3}x + 5$  9.  $y = x + 2$  11.  $x + 3y = -3$   
 13.  $y = x + 2$ ,  $x + 3y = -3$  15. yes 17. yes  
 19. 21.



23.  $(-4, 1)$  25.  $(3, -5)$  27. second equation,  $y(4, -3)$   
 29. second equation,  $x(10, -1)$  31. second equation,  $x(\frac{5}{2}, \frac{7}{2})$   
 33.  $(3, -1)$  35.  $(-2, -3)$  37.  $(\frac{11}{2}, 2)$  39.  $(-2, 3)$  41.  $(-3, 4)$   
 43.  $(-6, 12)$  45.  $(2, 8)$ ; consistent/independent 47.  $\emptyset$ ; inconsistent  
 49.  $\{(x, y) | 6x + y = 22\}$ ; consistent/dependent  
 51.  $(4, 1)$ ; consistent/independent 53.  $(-3, -4)$ ; consistent/independent  
 55.  $(\frac{1}{2}, \frac{4}{3})$ ; consistent/independent 57.  $(-2, \frac{5}{2})$  59.  $(2, -1)$   
 61. 1 mph 4 mph 63. 2318 adult tickets; 1482 child tickets  
 65. premium: \$3.97, regular: \$3.87 67. nursing student \$6500; science major \$3500 69. 150 quarters, 75 dimes  
 71. a. 100 lawns/mo. b. \$11,500/mo  
 73. a. 1.6 billion bu, 3 billion bu, yes; b. 2.7 billion bu, 2.25 billion bu, yes; c. \$6.65, 2.43 billion bu 75. a. 3 mph, b. 5 mph  
 77. a. 3.6 ft/sec, b. 4.4 ft/sec 79. 1776; 1865  
 81. Tahiti: 402 mi<sup>2</sup>, Tonga: 290 mi<sup>2</sup>  
 83.  $m_1 \neq m_2$ ; consistent/independent  
 85. \$6552 at 8.5%; \$11,551 at 6% 87. 472°, 832°, -248°, -608°  
 89. verified

**Exercises 8.2, pp. 814–818**

1. triple 3. equivalent; systems 5.  $z = 5$  7. Answers will vary.  
 9. Answers will vary. 11. yes, no 13.  $(5, 7, 4)$  15.  $(-2, 4, 3)$   
 17.  $(1, 1, -2)$  19.  $(4, 0, -3)$  21.  $(3, 4, 5)$  23.  $(1, 6, 9)$   
 25. no solution, inconsistent 27.  $(p, 2 - p, 2 - p)$   
 29.  $(\frac{5}{3}p - \frac{2}{3}, -p - 2, p)$ , other solutions possible  
 31.  $(p, 2p, p + 1)$  33.  $(p + 9, p - 4, p)$   
 35.  $\{(x, y, z) | x - 6y + 12z = 5\}$   
 37.  $(1, 1, 2)$  39.  $\{(x, y, z) | x - \frac{5}{2}y - 2z = 3\}$  41.  $(2, 1, \frac{-1}{3})$   
 43.  $(p + 5, p - 2, p)$  45.  $(18, -6, 10)$  47.  $(\frac{11}{3}, \frac{10}{3}, \frac{7}{3})$   
 49.  $(1, -2, 3)$  51.  $(\frac{1}{2}, \frac{1}{3}, 3)$  53.  $\approx 3,464$  units  
 55. Monet \$1,900,000; Picasso \$1,100,000; van Gogh \$4,000,000  
 57. elephant, 650 days; rhino, 464 days; camel, 406 days  
 59. Albatross: 3.6 m, Condor: 3.0 m, Quetzalcoatlus: 12.0 m  
 61. 175 \$5 gold pieces; 50 \$10 gold pieces; 25 \$20 gold pieces  
 63.  $A = -1, B = 1, C = -2$ ; verified 65.  $x^2 + y^2 - 4x + 6y + 9 = 0$   
 67.  $(-11, -5)$ ;  $(6, -\frac{53}{2})$  69.  $x = 1$

**Mid-Chapter Check, pp. 817–818**

1.  $(1, 1)$  consistent 2.  $(5, 3)$  consistent 3. 20 oz 4. No  
 5.  $2R1 = R2$  6.  $(1, 2, 3)$  7.  $(1, 2, 3)$  8.  $(p, p - 5, -p - 4)$   
 9. Morphy: 13, Mozart: 8, Pascal: 16 10. prelude: 2.75 min, storm: 2.5 min, sunrise: 2.5 min, finale: 3.25 min

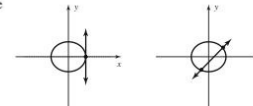
**Reinforcing Basic Concepts, p. 818**

- Exercise 1. Premium: \$4.17/gal. Regular: \$4.07/gal  

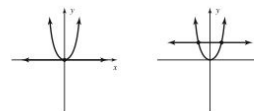
$$\begin{cases} 15.3R + 35.7P = 211.14 \\ P = R + 0.10 \end{cases}$$
  
 Exercise 2. Verified

**Exercises 8.3, pp. 823–826**

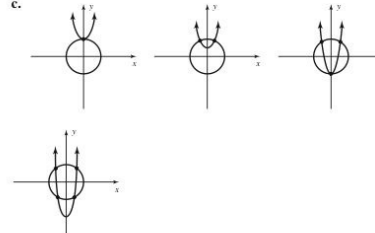
1. a. 3 or 4 not possible



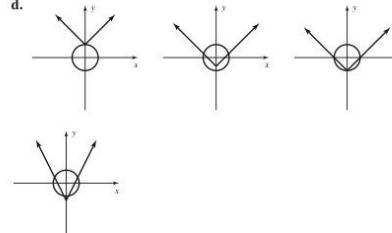
- b. 3 or 4 not possible



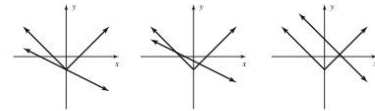
- c.



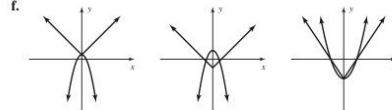
- d.



- e. 3 or 4 solutions not possible

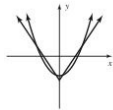


- f.

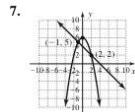


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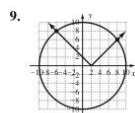
SA50 Student Answer Appendix



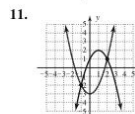
3. region; solutions 5. Answers will vary.



7. line, parabola; (-1, 5), (2, 2)

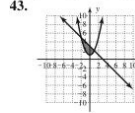


9. circle, absolute value; (-6, 8), (8, 6)

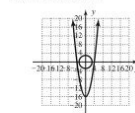


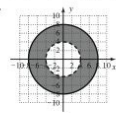
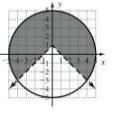
11. parabola, parabola; (-1, -2), (2, 1)

13. (-4, -3), (3, 4) 15. (2, 5), (-4, -7) 17. (-3, 4), (-4, -3), (3, 4), (4, -3) 19. (4, -3), (-4, -3) 21. no solution  
 23. (-8, 1), (-7, 4) 25. (5, log 5 + 5)  
 27. (-3, ln 9 + 1), (4, ln 16 + 1) 29. (0, 10), (ln 6, 45)  
 31. (-3, 1), (2, 1024) 33. (-3, -21), (1, -1), (2, 4)  
 35. (2, -4), (6, 4) 37. (3, 5), (3, -5)  
 39. (-2.43, -2.81), (2, 1) 41. (0.72, 2.19), (2, 3), (4, 3), (5.28, 2.19)



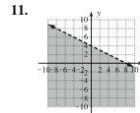
43. no solution



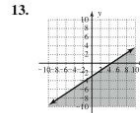
45.   
 47. no solution 49.   
 51.  $h \approx 45.8$  ft;  $h = 40$  ft;  $h = 30$  ft  
 53. The company breaks even if either 18,400 or 48,200 cars are sold.  
 55. \$1.83; \$3  $\begin{cases} 10P^2 + 6D = 144 \\ 8P^2 - 8P - 4D = 12 \end{cases}$   
 57.  $8.5 \text{ m} \times 10 \text{ m}$  59. 5 km, 9 km 61.  $8 \times 8 \times 25 \text{ ft}$   
 63. Answers will vary. 65. 18 in. by 18 in. by 77 in. 67.  $\frac{\sqrt{6} - \sqrt{2}}{4}$   
 69.  $W \approx 191.7 \text{ ft-lb}$

Exercises 8.4 pp. 835–838

1. half, planes 3. solution  
 5. The feasible region may be bordered by three or more oblique lines, with two of them intersecting outside and away from the feasible region.  
 7. No, No, No, No 9. No, Yes, Yes, No

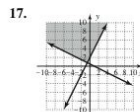


11.

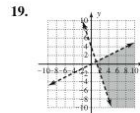


13.

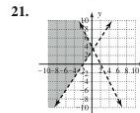
15. No, No, No, Yes



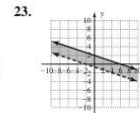
17.



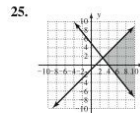
19.



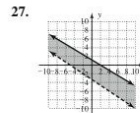
21.



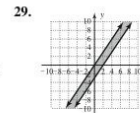
23.



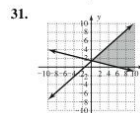
25.



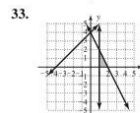
27.



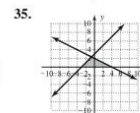
29.



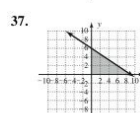
31.



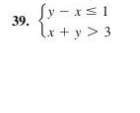
33.



35.



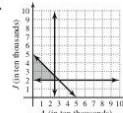
37.



39.  $\begin{cases} y - x \leq 1 \\ x + y > 3 \end{cases}$

41.  $\begin{cases} y - x \leq 1 \\ x + y < 3 \\ y \geq 0 \end{cases}$  43. (5, 3) 45. (12, 11) 47. (2, 2)

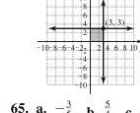
49. (4, 3) 51.  $5 < H < 10$

53.  55. 300 acres of corn; 200 acres of soybeans

$J$  (in thousands)  
 $A$  (in thousands)  
 $J + A \leq 50,000$   
 $J \geq 20,000$   
 $A \leq 25,000$

57. 240 sheet metal screws; 480 wood screws  
 59. 65 traditional, 30 Double-T's  
 61. 220,000 gallons from Tulsa to Colorado; 100,000 gal from Tulsa to Mississippi; 0 thousand gal from Houston to Colorado; 150,000 gal from Houston to Mississippi

63. (3, 3); optimal solutions occur at vertices



65. a.  $-\frac{3}{5}$  b.  $\frac{5}{4}$  c.  $-\frac{3}{4}$  67.  $324 \Omega$

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**Summary and Concept Review, pp. 839–841**

1. (4, 4)
2.  $(\frac{1}{5}, -3)$
3.  $(5, -\frac{5}{3})$
4. no solution; inconsistent 5. (5, -1); consistent 6. (7, 2); consistent 7. (3, -1); consistent 8. (2, 2); consistent 9.  $(\frac{11}{4}, -\frac{1}{6})$ ; consistent 10. Sears Tower is 1450 ft; Hancock Building is 1127 ft. 11. (0, 3, 2) 12. (1, 1, 1) 13. no solution, inconsistent 14. 3 aces, 4 face cards, 5 numbered cards 15. 1530 quarters, 1180 dimes, 710 nickels 16. circle, line, (4, 3), (-3, -4) 17. parabola, line, (3, -2) 18. parabola, circle,  $(\sqrt{3}, 2), (-\sqrt{3}, 2)$  19. circle, parabola, (1, 3), (-1, 3)

20. parabola, circle
21. note the open circle showing noninclusion at (0, -3); circle, parabola
22. 23. 24. 25. Maximum of 270 occurs at both (0, 6) and (3, 4).
26. 50 cows, 425 chickens

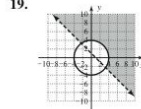
**Mixed Review, pp. 841–842**

1. a.  $\begin{cases} y = \frac{3}{2}x + 2 \\ y = \frac{3}{2}x + 2 \end{cases}$ ; consistent/dependent b.  $\begin{cases} y = \frac{4}{3}x - 3 \\ y = \frac{2}{3}x - 2 \end{cases}$ ; consistent/independent c.  $\begin{cases} y = \frac{1}{3}x - 3 \\ y = \frac{1}{3}x - \frac{5}{3} \end{cases}$ ; inconsistent
3. (-2, 3) 5. 21 veggie, 33 beef 7. (9, 1, 1) 9.  $\{(x, y, z) | x \in \mathbb{R}, y = -7x + 7, z = -5x + 6\}$  11. 13. no solution

15.

$(x, y)$	$P(x, y) = 2.5x + 3.75y$
(0, 0)	0
(0, 7)	26.25
(7.5, 0)	18.75
(2, 6)	27.5
(6, 2)	22.5

- max value 27.5 at (2, 6)  
17. (2, 5), (2, -5) (-2, 5), (-2, -5)



**Practice Test, pp. 842–843**

1. (2, 3) 2.  $(\frac{2}{5}, -\frac{4}{5})$  3. (-3, 2) 4. (2, -1, 4)
5.  $\{(x, y, z) | x = 2z - 1, y = 5z - 6, z \in \mathbb{R}\}$   
6.  $a = 5, b = 2$  7. 21.59 cm by 35.56 cm 8. Tahiti 402 mi<sup>2</sup>; Tonga 290 mi<sup>2</sup> 9. Corn 25¢, Beans 20¢, Peas 29¢ 10. \$15,000 at 7%, \$8000 at 5%, \$7000 at 9%
11. 12. (5, 0) 13. 30 plain; 20 deluxe
14.  $(-1 - \sqrt{7}, 1 - \sqrt{7}), (-1 + \sqrt{7}, 1 + \sqrt{7})$   
15.  $(\sqrt{3}, 1), (-\sqrt{3}, 1)$   
16. 15 ft, 20 ft  
17. 18.  $\begin{cases} y > 0 \\ x^2 + y^2 < 9 \end{cases}$

19. the solution is (0, 1) 20. Answers may vary. Possible solution:  $\begin{cases} x^2 + y^2 > 1 \\ x^2 + y^2 < 4 \\ x > 0, y < 0 \end{cases}$

**Strengthening Core Skills, pp. 844–845**

Exercise 1. (-1, 4), elimination

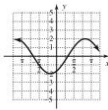
**Cumulative Review Chapters 1–8, pp. 845–846**

1. 3. 5.

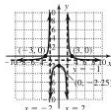
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SA52 Student Answer Appendix

7.



9.



11. a.  $D: x \in (-\infty, \infty)$  b.  $R: y \in (-\infty, 4]$  c.  $f(x) \uparrow: x \in (-\infty, -1)$   
 $f(x) \downarrow: x \in (-1, \infty)$  d. n/a e.  $\max: (-1, 4)$   
 f.  $f(x) > 0: x \in (-4, 2)$   $f(x) < 0: x \in (-\infty, -4) \cup (2, \infty)$   
 g.  $\frac{\Delta y}{\Delta x} = \frac{7}{4}$
13. a. no solution b. no solution c.  $n = 1, n = -9$  d.  $x = 3 \pm 2i$   
 e.  $x = \frac{1}{8}, x = -\frac{1}{5}$  f.  $x = -6$  g.  $x = \frac{\ln 7}{\ln 3} + 2$  h.  $x = 4$  i.  $x = 3$
15.  $a = 20, b = 20\sqrt{3}, c = 40, A = 30^\circ, B = 60^\circ, C = 90^\circ$
17.  $\sin^2 x + \cos^2 x = 1$   
 $\tan^2 x + 1 = \sec^2 x$   
 $1 + \cot^2 x = \csc^2 x$
19.  $\cot \alpha = -\frac{4}{3}, \sin \alpha = -\frac{3}{5}, \cos \alpha = \frac{4}{5}$   
 $\csc \alpha = -\frac{5}{3}, \sec \alpha = \frac{5}{4}$
21.  $\frac{\Delta y}{\Delta x} = -\frac{7}{10}$  23.  $x \in (-2, 5)$
25.  $a \approx 13.4, b = 19, c \approx 9.3, A = 41^\circ, B = 112^\circ, C = 27^\circ$
27. (1, 3)
29.  $900 \cos 69^\circ \approx 322.5 \text{ lb}$

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**CHAPTER 9**

**Exercises 9.1, pp. 855–858**

1. square 3. 2; 3; 1 5. Multiply R1 by -2 and add that result to R2. This sum will be the new R2. 7.  $3 \times 2, 5, 8$  9.  $4 \times 3, -1$

11.  $\begin{bmatrix} 1 & 2 & -1 & 1 \\ 1 & 0 & 1 & 3 \\ 2 & -1 & 1 & 3 \end{bmatrix}$ ; diagonal entries 1, 0, 1

13.  $\begin{cases} x + 4y = 5 \\ y = \frac{1}{2} \end{cases} \rightarrow (3, \frac{1}{2})$  15.  $\begin{cases} x + 2y - z = 0 \\ y + 2z = 2 \end{cases} \rightarrow (11, -4, 3)$   
 $z = 3$

17.  $\begin{cases} x + 3y - 4z = 29 \\ y - \frac{3}{2}z = \frac{21}{2} \end{cases} \rightarrow (-4, 15, 3)$   
 $z = 3$

19.  $\begin{bmatrix} 1 & -6 & -2 \\ 0 & -28 & -6 \end{bmatrix}$  21.  $\begin{bmatrix} 1 & -3 & 3 & 2 \\ 0 & 23 & -12 & -15 \\ -2 & 1 & 0 & 4 \end{bmatrix}$

23.  $\begin{bmatrix} 3 & 1 & 1 & 8 \\ 0 & -3 & -3 & -6 \\ 0 & -10 & -13 & 34 \end{bmatrix}$

25.  $2R_1 + R_2 \rightarrow R_2$  27.  $-5R_1 + R_2 \rightarrow R_2$   
 $-3R_1 + R_3 \rightarrow R_3$   $4R_1 + R_3 \rightarrow R_3$

29. (20, 10) 31. (1, 6, 9) 33. (1, 1, 2) 35. (1, 1, 1) 37.  $(-1, \frac{3}{2}, 2)$

39. linear dependence ( $p - 4, -2p + 8, p$ ) 41. coincident dependence  $\{(x, y, z) | 3x - 4y + 2z = -2\}$  43. no solution 45. linear dependence,  $(-\frac{3}{2}p - 3, \frac{3}{2}p - \frac{1}{2}, p)$  47. 28.5 units<sup>2</sup> 49. Heat: 95, Mavericks: 92

51. Poe, \$12,500; Baum, \$62,500; Wouk, \$25,000  
53.  $A = 35^\circ, B = 45^\circ, C = 100^\circ$  55. \$4 million at 4%; \$6 million at 7%; \$1.5 million at 8% 57.  $x = 84^\circ; y = 25^\circ$

59. a.  $z_1 = \sqrt{10} \operatorname{cis}[\pi + \tan^{-1}(3)]$  b.  $z_2 = \frac{-5}{2} + \frac{5\sqrt{3}}{2}i$

61.  $C > 30,000$  in the year 2011 ( $t = 6.39$ )

**Exercises 9.2, pp. 866–870**

1.  $a_i, b_{ij}$  3. scalar 5. Answers will vary.  
7.  $2 \times 2, a_{12} = -3, a_{21} = 5$  9.  $2 \times 3, a_{12} = -3, a_{23} = 6, a_{22} = 5$

11.  $3 \times 3, a_{12} = 1, a_{23} = 1, a_{31} = 5$  13. true 15. conditional.  
 $c = -2, a = -4, b = 3$

17.  $\begin{bmatrix} 10 & 0 \\ 0 & 10 \end{bmatrix}$  19. different orders, sum not possible

21.  $\begin{bmatrix} 20 & -15 \\ -25 & -10 \end{bmatrix}$  23.  $\begin{bmatrix} \frac{5}{2} & -1 & 0 \\ 0 & \frac{-7}{2} & 1 \\ 2 & \frac{3}{2} & -6 \end{bmatrix}$  25.  $\begin{bmatrix} 1 & 2 & 0 \\ 0 & -1 & 2 \\ 4 & 3 & -6 \end{bmatrix}$

27.  $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$  29.  $\begin{bmatrix} 6 & -3 & 9 \\ 12 & 0 & -6 \end{bmatrix}$  31.  $\begin{bmatrix} 12 & -24 & 90 \\ -6 & 15 & -57 \end{bmatrix}$

33.  $\begin{bmatrix} 79 & -30 \\ -50 & 19 \end{bmatrix}$  35.  $\begin{bmatrix} 42 & 18 & -60 \\ -12 & -42 & 36 \end{bmatrix}$

37.  $\begin{bmatrix} 0.71 & 0.65 \\ 1.78 & 3.55 \end{bmatrix}$  39.  $\begin{bmatrix} 1 & -1.25 & 0.25 \\ -0.5 & -0.63 & 2.13 \\ 3.75 & 3.69 & -5.94 \end{bmatrix}$

41.  $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$  43.  $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$  45.  $\begin{bmatrix} \frac{3}{19} & \frac{4}{57} \\ \frac{1}{19} & \frac{5}{57} \end{bmatrix}$  47.  $\begin{bmatrix} 0 & \frac{3}{4} & \frac{1}{4} \\ -\frac{1}{4} & \frac{3}{8} & \frac{1}{8} \\ -\frac{1}{4} & \frac{11}{16} & \frac{1}{16} \end{bmatrix}$

49.  $\begin{bmatrix} 1.75 & 2.5 \\ 7.5 & 13 \end{bmatrix}$  51.  $\begin{bmatrix} -0.26 & 0.32 & -0.07 \\ 0.63 & 0.30 & 0.10 \end{bmatrix}$  53. verified

55. verified 57.  $P = 21.448$  cm;  $A = 27.7269$  cm<sup>2</sup>

59. a.  $\begin{matrix} & T & S \\ S & 3820 & 1960 \\ D & 2460 & 1240 \\ P & 1540 & 920 \end{matrix}$   $\begin{matrix} & T & S \\ S & 4220 & 2960 \\ D & 2960 & 3240 \\ P & 1640 & 820 \end{matrix}$

b. 3900 more by Minsk  
c.  $\begin{bmatrix} 3972.8 & 2038.4 \\ 2558.4 & 1289.6 \\ 1601.6 & 956.8 \\ 4388.8 & 3078.4 \\ 3078.4 & 3369.6 \\ 1705.6 & 852.8 \end{bmatrix}$  d.  $\begin{bmatrix} 8361.6 & 5116.8 \\ 5636.8 & 4659.2 \\ 3307.2 & 1809.6 \end{bmatrix}$

61. [22,000 19,000 23,500 14,000];

total profit

North: \$22,000

South: \$19,000

East: \$23,500

West: \$14,000

63. a. \$108.20 b. \$101  
c. Science  $\begin{bmatrix} 100 & 101 & 119 \\ 108.2 & 107 & 129.5 \end{bmatrix}$

First row, total cost for science from each restaurant; Second row, total cost for math from each restaurant.

65. a. 10 b. 20  
c.  $\begin{matrix} & \text{Spanish Chess} & \text{Writing} \\ \text{Female} & 32.4 & 10.3 & 21.3 \\ \text{Male} & 29.9 & 9.6 & 19.5 \end{matrix}$

the approximate number of females expected to join the writing club

67.  $\begin{bmatrix} 2^{n-1} & 0 & 2^{n-1} \\ 2^n - 1 & 1 & 2^n - 1 \\ 2^{n-1} & 0 & 2^{n-1} \end{bmatrix}$

69.  $a = 2, b = 1, c = -3, d = -2$  71. 0.3211 73.  $x^2 + 2x - 5$

**Mid-Chapter Check pp. 870–871**

1.  $3 \times 3, -0.9$  2.  $2 \times 4, 0$  3. (2, -3) 4. (2, 0, -5)

5.  $(p - 3, 2p - 8, p)$

6. a.  $\begin{bmatrix} -13 & -17 \\ 35 & 9 \end{bmatrix}$  b.  $\begin{bmatrix} 4 & 6 \\ -12 & -2 \end{bmatrix}$  c.  $\begin{bmatrix} -5 & 5 \\ -5 & 15 \end{bmatrix}$

7. a.  $\begin{bmatrix} 0.8 & 0.5 & 2.2 \\ -0.1 & 0.8 & -1 \\ 2.1 & 0.3 & 1.9 \end{bmatrix}$  b.  $\begin{bmatrix} -3 & -1.5 & -6 \\ 1.5 & 0 & 3 \\ -6 & -1.5 & -6 \end{bmatrix}$  c.  $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

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8. a.  $\begin{bmatrix} 17 & -32 & -13 \\ 5 & 0 & -5 \end{bmatrix}$  b.  $\begin{bmatrix} -26 & -18 & 24 \\ 2 & -10 & -4 \end{bmatrix}$  c.  $\begin{bmatrix} 24 & 4 \\ 0 & -5 \\ 16 & -39 \end{bmatrix}$   
 d.  $\begin{bmatrix} -4 & -33 \\ -2 & 29 \end{bmatrix}$  9. used: \$80, new: \$125  
 10.  $\begin{bmatrix} 4375 & 110 \\ 2400 & 59 \end{bmatrix}$

$P_{11}$ : total rebates paid by individuals,  $P_{21}$ : total rebates paid by business,  $P_{12}$ : free AAA years given to individuals,  $P_{22}$ : free AAA years given to business

**Reinforcing Basic Concepts, p. 871**

Exercise 1:  $P_{32}$   
 Exercise 2: 1st row of  $A$  with 3rd column of  $B$   
 2nd row of  $A$  with 2nd column of  $B$   
 Exercise 3:  $[A] \rightarrow 3 \times 1; [B] \rightarrow 1 \times 3$   
 $[A] \rightarrow 3 \times 2; [B] \rightarrow 2 \times 3$   
 $[A] \rightarrow 3 \times 3; [B] \rightarrow 3 \times 3$   
 $[A] \rightarrow 3 \times n; [B] \rightarrow n \times 3; n \in \mathbb{N}$

**Exercises 9.3, pp. 881–885**

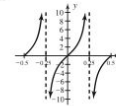
1. diagonal; zeroes 3. identity 5. Answers will vary.  
 7. verified 9. verified 11. verified 13. verified  
 15.  $\begin{bmatrix} \frac{1}{9} & \frac{2}{9} \\ -\frac{1}{9} & \frac{1}{9} \end{bmatrix}$  17.  $\begin{bmatrix} -5 & 1.5 \\ -2 & 0.5 \end{bmatrix}$  19. verified 21. verified  
 23.  $\begin{bmatrix} -\frac{2}{3} & \frac{1}{13} & \frac{10}{39} \\ \frac{1}{3} & 0 & \frac{1}{3} \\ -\frac{4}{39} & \frac{2}{13} & -\frac{19}{39} \end{bmatrix}$  25.  $\begin{bmatrix} -\frac{9}{80} & \frac{31}{400} & \frac{27}{400} \\ \frac{1}{80} & \frac{41}{400} & -\frac{3}{400} \\ \frac{1}{20} & -\frac{1}{100} & -\frac{17}{100} \end{bmatrix}$  27.  $\begin{bmatrix} 2 & -3 \\ -5 & 7 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 9 \\ 8 \end{bmatrix}$   
 29.  $\begin{bmatrix} 1 & 2 & -1 \\ 1 & 0 & 1 \\ 2 & -1 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 1 \\ 3 \\ 3 \end{bmatrix}$   
 31.  $\begin{bmatrix} -2 & 1 & -4 & 5 \\ 2 & -5 & 1 & -3 \\ -3 & 1 & 6 & 1 \\ 1 & 4 & -5 & 1 \end{bmatrix} \begin{bmatrix} w \\ x \\ y \\ z \end{bmatrix} = \begin{bmatrix} -3 \\ 4 \\ 1 \\ -9 \end{bmatrix}$   
 33. (4, 5) 35. (12, 12) 37. no solution 39. (1.5, -0.5, -1.5)  
 41. no solution 43. (-1, -0.5, 1.5, 0.5) 45. 1, yes 47. 0, no 49. 1  
 51. singular matrix 53. singular matrix 55. -34 57. 7  
 59.  $\det(A) = -5; (1, 6, 9)$  61.  $\det(A) = 0$  63.  $A^{-1} = \begin{bmatrix} \frac{1}{13} & \frac{5}{13} \\ \frac{2}{13} & \frac{1}{13} \end{bmatrix}$   
 65. singular 67. 31 behemoth, 52 gargantuan, 78 mammoth, 30 jumbo  
 69. Jumpin' Jack Flash: 3.75 min  
 Tumbling Dice: 3.75 min  
 You Can't Always Get: 7.5 min  
 Wild Horses: 5.75 min  
 71. 30 of clock A; 20 of clock B; 40 of clock C; 12 of clock D  
 73.  $p_1 = 72.25^\circ; p_2 = 74.75^\circ; p_3 = 80.25^\circ; p_4 = 82.75^\circ$   
 75.  $y = x^3 + 2x^2 - 9x - 10$   
 77. 2 oz food I, 1 oz Food II, 4 oz Food III  
 79. Answers will vary. 81. a. -45 b. 52 c. -19 d. -4  
 83.  $A = 125$ , period =  $\frac{2\pi}{3}$  85.  $x \in \left(-\infty, -\frac{9}{2}\right) \cup \left[-\frac{1}{2}, \infty\right)$

**Exercises 9.4 pp. 896–899**

1.  $a_{11}a_{22} - a_{21}a_{12}$  3. constant 5. Answers will vary.  
 7.  $D = \begin{bmatrix} 2 & 5 \\ -3 & 4 \end{bmatrix}; D_x = \begin{bmatrix} 7 & 5 \\ 1 & 4 \end{bmatrix}; D_y = \begin{bmatrix} 2 & 7 \\ -3 & 1 \end{bmatrix}$   
 9. (-5, 9) 11.  $\begin{pmatrix} -26 & 25 \\ 3 & 3 \end{pmatrix}$  13. no solution

15. a.  $D = \begin{bmatrix} 4 & -1 & 2 \\ -3 & 2 & -1 \\ 1 & -5 & 3 \end{bmatrix}$   $D_x = \begin{bmatrix} -5 & -1 & 2 \\ 8 & 2 & -1 \\ -3 & -5 & 3 \end{bmatrix}$   
 $D_y = \begin{bmatrix} 4 & -5 & 2 \\ -3 & 8 & -1 \\ 1 & -3 & 3 \end{bmatrix}$   $D_z = \begin{bmatrix} 4 & -1 & -5 \\ -3 & 2 & 8 \\ 1 & -5 & -3 \end{bmatrix}$   
 $D = 22$ , solutions possible  
 b.  $D = 0$ , Cramer's rule cannot be used

17. (1, 2, 1) 19.  $\left(\frac{3}{4}, \frac{5}{3}, \frac{-1}{3}\right)$  21. (0, -1, 2, -3) 23.  $\frac{A}{x+3} + \frac{B}{x-2}$   
 25.  $\frac{A}{x-1} + \frac{B}{x+2} + \frac{C}{x-3}$  27.  $\frac{A}{x} + \frac{B}{x-3} + \frac{C}{x+1}$   
 29.  $\frac{A}{x} + \frac{B}{x^2} + \frac{C}{x+2}$  31.  $\frac{A}{x+1} + \frac{Bx+C}{x^2+2} + \frac{Dx+E}{(x^2+2)^2}$   
 33.  $\frac{4}{x} - \frac{5}{x+1}$  35.  $\frac{-4}{2x-5} + \frac{3}{x+3}$  37.  $\frac{7}{x} + \frac{2}{x+1} - \frac{1}{x-1}$   
 39.  $\frac{-1}{x} + \frac{4}{x+1} + \frac{5}{(x+1)^2}$  41.  $\frac{3}{2-x} - \frac{4}{4+2x+x^2}$   
 43.  $\frac{5}{x+2} + \frac{x-1}{x^2+3}$  45.  $\frac{1}{x} + \frac{3x-2}{(x^2+1)^2}$   
 47.  $\frac{3}{x+1} - \frac{2}{x-3} + \frac{1}{(x-3)^3}$  49.  $320 + 32\pi = 420.5 \text{ in}^2$   
 51.  $8 \text{ cm}^2$  53.  $27 \text{ ft}^2$  55.  $19 \text{ m}^3$  57. yes 59. no 61. yes, yes, yes  
 63.  $\begin{cases} 15,000x + 25,000y = 2900 \\ 25,000x + 15,000y = 2700 \end{cases}$ ; 6%, 8%  
 65. (-1, -1, 2); answers will vary. 67.  $x^2 + y^2 - 4x - 6y - 12 = 0$   
 69.  $\angle B \approx 76.3^\circ, \angle C \approx 54.7^\circ$ , side  $c = 9.4 \text{ in.}$   
 71.  $p = \frac{1}{2}, A = 3, x = \pm \frac{1}{4}$



**Summary and Concept Review, pp. 899–901**

1. Answers will vary. 2. (-2, -4) 3. (1, 6, 9) 4. (-2, 7, 1, 8)  
 5.  $\{(x, y, z) | x = 3y + 2, y \in \mathbb{R}, z = -\frac{5}{2}y - \frac{5}{2}\}$   
 6.  $\begin{bmatrix} -7.25 & 5.25 \\ 0.875 & -2.875 \end{bmatrix}$  7.  $\begin{bmatrix} -6.75 & 6.75 \\ 1.125 & -1.125 \end{bmatrix}$  8. not possible  
 9.  $\begin{bmatrix} -2 & -6 \\ -1 & -7 \end{bmatrix}$  10.  $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$  11.  $\begin{bmatrix} 1 & 0 & 4 \\ 5.5 & -1 & -1 \\ 10 & -2.9 & 7 \end{bmatrix}$   
 12.  $\begin{bmatrix} 3 & -6 & -4 \\ -4.5 & 3 & -1 \\ -2 & 3.1 & 3 \end{bmatrix}$  13. not possible  
 14.  $\begin{bmatrix} -8 & 12 & 0 \\ -2 & -4 & 4 \\ -16 & -0.4 & -20 \end{bmatrix}$  15.  $\begin{bmatrix} 15.5 & 6.4 & 17 \\ 9 & -17 & 2 \\ 18.5 & -20.8 & 13 \end{bmatrix}$  16. D  
 17. It's an identity. 18. It's the inverse of  $B$ . 19. E 20. It is the inverse of  $F$ . 21. Matrix multiplication is not generally commutative.  
 22. (-8, -6) 23. (2, 0, -3) 24.  $\left(\frac{-19}{35}, \frac{25}{14}\right)$  25.  $\left(\frac{-37}{19}, \frac{36}{19}\right)$   
 26. (1, -1, 2) 27.  $\frac{91}{2}$  units<sup>2</sup> 28.  $\frac{5}{x-2} + \frac{2x-1}{x^2+3}$

**Mixed Review, pp. 901–902**

1. (-10, 12) 3.  $\{(x, y, z) | x = z - 1, y = 2z - 2, z \in \mathbb{R}\}$   
 5. a.  $\begin{bmatrix} -8 & 16 & -10 \\ 12 & 0 & 6 \end{bmatrix}$  b.  $\begin{bmatrix} 9 & -6 & -7 \\ -7 & -1 & 2 \end{bmatrix}$



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SA54 Student Answer Appendix

7. a. 3 b. 3 c. -4 d. 1 9.  $(-9, -3, 2)$  11.  $A^{-1} = \begin{bmatrix} 8 & -3 \\ -5 & 2 \end{bmatrix}$   
 13.  $\begin{cases} x + 2y - z = 1 \\ x + z = 3 \\ 2x - y + z = 3 \end{cases}$  15.  $(\frac{33}{31}, \frac{-10}{31}, \frac{-57}{31})$  17.  $A = 4.5 \text{ units}^2$   
 19. 137 m by 82 m

Practice Test, pp. 902–903

1.  $(-3, \frac{1}{2})$  2.  $\{(x, y, z) \mid x = -3y + \frac{16}{3}, y \in \mathbb{R}, z = 2y - 3\}$   
 3.  $(2, 1, \frac{-1}{3})$  4. a.  $\begin{bmatrix} -6 & -5 \\ 8 & 9 \end{bmatrix}$  b.  $\begin{bmatrix} 1.2 & 1.2 \\ -1.2 & -2 \end{bmatrix}$  c.  $\begin{bmatrix} -3 & 1 \\ 3 & -5 \end{bmatrix}$   
 d.  $\begin{bmatrix} -2 & -1 \\ 2.5 & 1.5 \end{bmatrix}$  e. -2  
 5. a.  $\begin{bmatrix} 0 & -0.1 & 0 \\ 0.5 & -0.6 & 0 \\ -0.2 & -0.8 & -0.9 \end{bmatrix}$  b.  $\begin{bmatrix} -0.3 & -0.06 & -0.12 \\ 0.06 & -0.06 & 0 \\ -0.18 & -0.24 & -0.48 \end{bmatrix}$   
 c.  $\begin{bmatrix} 0.31 & -0.13 & 0.08 \\ -0.01 & -0.05 & -0.02 \\ 0.39 & -0.52 & -0.02 \end{bmatrix}$  d.  $\begin{bmatrix} \frac{49}{17} & 0 & \frac{-10}{17} \\ \frac{40}{17} & 10 & \frac{-10}{17} \\ \frac{-35}{17} & -5 & \frac{30}{17} \end{bmatrix}$  e.  $\frac{17}{300}$   
 6.  $(-1, -6, 0), (1, -1, 1), (3, 4, 2)$ , answers vary as  $(2p - 1, 5p - 6, p)$   
 7.  $(2, \frac{2}{3})$  8.  $(3, -2, 3)$  9.  $(\frac{97}{34}, \frac{-18}{17})$  10.  $(1, 6, 9)$   
 11.  $(1, -1, 2)$  12.  $B = \begin{bmatrix} 6 \\ 13 \\ -11 \end{bmatrix}$  13.  $(-1, 4), (2, 1), (4, -1)$   
 14.  $5 \text{ mi}^2$  15.  $r = -2, s = 1$  16. Dr. Brown owes \$31,000; Dr. Stamper owes \$124,000 17. 7.5 hr, 15.5 hr 18. 11 one day, 6 two day, 3 five day 19. federal program: \$200,000; municipal bonds: \$1,300,000;  
 bank loan: \$300,000 20.  $\frac{1}{x-3} + \frac{3x+2}{x^2+3x+9}$

Strengthening Core Skills p. 905

Exercise 1:  $(1, -4, 1)$

Cumulative Review Chapters 1–9, pp. 905–906

1. a.  $x = \frac{2}{3}$  b.  $x = 0, 7$  c.  $x = 5, \pm i\sqrt{2}$  d.  $x = -1, 0, 4$   
 3.  $R = \pm \frac{1}{\pi} \sqrt{A + (\pi r)^2}$   
 5.
7. a.  $(a + bi) + (a - bi) = 2a$  b.  $(a + bi)(a - bi) = a^2 - (bi)^2 = a^2 + b^2$  9.  $x - 12 \pm \frac{\sqrt{15}}{3}$   
 11.  $\sin \theta = \frac{\sqrt{13}}{4}, \cos \theta = \frac{\sqrt{3}}{4}, \tan \theta = \frac{\sqrt{39}}{3}$   
 13. a.  $m = \frac{y_2 - y_1}{x_2 - x_1}$  b.  $(\frac{x_2 + x_1}{2}, \frac{y_2 + y_1}{2})$   
 c.  $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$  d.  $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$   
 e.  $A = Pe^{rt}$  15.  $\langle -3, -18 \rangle$  17. a.  $\frac{\sqrt{121 + x^2}}{11}$  b.  $\frac{x}{\sqrt{9 + x^2}}$

19.  $x \in (-\infty, -1) \cup (2, 3)$

21.  $-128 - 128i\sqrt{3}$  23. about 3.6 yr 25.  $A = 2, B = 1, C = \frac{\pi}{4}$

Modeling With Technology Exercises, pp. 914–917

1. 225 boards at \$400 a piece 3. 90,000,000 gal at \$3.07 per gallon  
 5.  $(-410.07, -226.58)$  or about 227 boards at approximately \$410 a piece  
 7.  $(-3.0442, -8.9964)$ , or about 90,000,000 gal at approximately \$3.04 per gallon 9. 214.5 ft<sup>2</sup> of skin, 231.0 ft<sup>2</sup> of wood veneer, 516 tension rods, and 498 ft of hoop 11. 955 ft<sup>2</sup> of skin, 1021.5 ft<sup>2</sup> of wood veneer, 2180 tension rods, and 2129.5 ft of hoop  
 13. 92,250 gal gasoline, 595,000 lb corn, 227,500 oz yeast, and 134,750 gal water 15. 5 Silver, 9 Gold, and 2 Platinum  
 17. one bundle of first class = 9.25 measures of grain;  
 one bundle of second class = 4.25 measures of grain;  
 one bundle of third class = 2.75 measures of grain  
 19. Answers will vary. 21. Answers will vary. 23. Answers will vary.  
 25. Answers will vary. 27. Answers will vary. 29. Answers will vary.  
 31. Answers will vary. 33. Answers will vary. 35. Answers will vary.

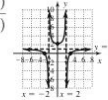


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**CHAPTER 10**

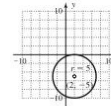
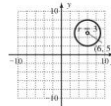
**Exercises 10.1, pp. 925–927**

1. geometry, algebra    3. perpendicular    5. point, intersecting  
 7.  $(-2, -2)$ ; verified    9.  $(2, -2)$ ; verified    11.  $(\frac{13}{2}, -9)$ ; verified  
 13.  $(x + 2)^2 + (y + 2)^2 = 5^2$     15.  $(x - 2)^2 + (y + 2)^2 = 5^2$   
 17.  $(x - \frac{13}{2})^2 + (y + 9)^2 = (\frac{25}{2})^2$   
 19. a.  $d = 13$ ; B, C, E, G;    b.  $(13, 3 + 4\sqrt{3}), (14, 8)$ ; Many others  
 21. Verified,  $d = \frac{8\sqrt{5}}{5}$     23. a. B, C, E;    b. Answers will vary.  
 25. Verified    27.  $y = -\frac{1}{16}x^2$     29.  $4x^2 + 3y^2 = 48$   
 31. Verified, verified    33.  $3x^2 - y^2 = 3$   
 35. a.  $(-\frac{12}{7}, -\frac{30}{7})$ ,    b.  $(-2, -\frac{4}{3})$     37. Verified (both add to 8)  
 39.  $x = \frac{4\pi}{3}$     41.  $h(x) = \frac{(x + 3)(x - 3)}{(x + 2)(x - 2)}$



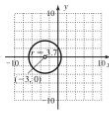
**Exercises 10.2, pp. 935–940**

1.  $c^2 = |a^2 - b^2|$     3.  $2a$ ;  $2b$     5. answers will vary.    7.  $x^2 + y^2 = 49$   
 9.  $(x - 5)^2 + y^2 = 3$     11.  $(x - 1)^2 + (y - 5)^2 = 25$   
 13.  $(x - 6)^2 + (y - 5)^2 = 9$     15.  $(x - 2)^2 + (y + 5)^2 = 25$   
 center:  $(6, 5)$ ,  $r = 3$     center:  $(2, -5)$ ,  $r = 5$

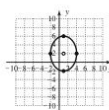


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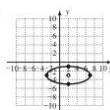
17.  $(x + 3)^2 + y^2 = 14$   
center:  $(-3, 0)$ ,  $r = \sqrt{14}$



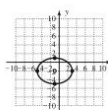
19.  $\frac{x^2}{16} + \frac{y^2}{4} = 1$ ,  $(0, 0)$ ,  $a = 4$ ,  $b = 2$



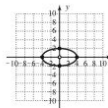
21.  $\frac{x^2}{9} + \frac{y^2}{16} = 1$ ,  $(0, 0)$ ,  $a = 3$ ,  $b = 4$



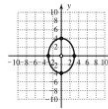
23.  $\frac{x^2}{4} + \frac{y^2}{9} = 1$ ,  $(0, 0)$ ,  $a = 2$ ,  $b = 3$



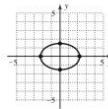
25. a.  $\frac{x^2}{16} + \frac{y^2}{4} = 1$ ,  $(0, 0)$ ,  $a = 4$ ,  $b = 2$   
b.  $(-4, 0)$ ,  $(4, 0)$ ,  $(0, -2)$ ,  $(0, 2)$  c.



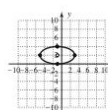
27. a.  $\frac{x^2}{9} + \frac{y^2}{16} = 1$ ,  $(0, 0)$ ,  $a = 3$ ,  $b = 4$   
b.  $(0, -4)$ ,  $(0, 4)$ ,  $(-3, 0)$ ,  $(3, 0)$  c.



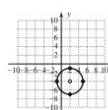
29. a.  $\frac{x^2}{5} + \frac{y^2}{2} = 1$ ,  $(0, 0)$ ,  $a = \sqrt{5}$ ,  $b = \sqrt{2}$   
b.  $(-\sqrt{5}, 0)$ ,  $(\sqrt{5}, 0)$ ,  $(0, -\sqrt{2})$ ,  $(0, \sqrt{2})$  c.



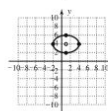
31. ellipse



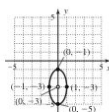
33. circle



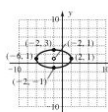
35. ellipse



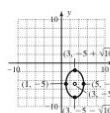
37.  $x^2 + \frac{(y + 3)^2}{4} = 1$



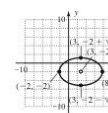
39.  $\frac{(x + 2)^2}{16} + \frac{(y - 1)^2}{4} = 1$



41.  $\frac{(x - 3)^2}{4} + \frac{(y + 5)^2}{10} = 1$

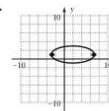


43.  $\frac{(x - 3)^2}{25} + \frac{(y + 2)^2}{10} = 1$

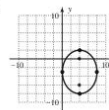


45. 20 47. 20

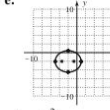
49. a.  $(2, 1)$  b.  $(-3, 1)$  and  $(7, 1)$  c.  $(2 - \sqrt{21}, 1)$  and  $(2 + \sqrt{21}, 1)$   
d.  $(2, 3)$  and  $(2, -1)$  e.



51. a.  $(4, -3)$  b.  $(4, 2)$  and  $(4, -8)$  c.  $(4, 0)$  and  $(4, -6)$   
d.  $(0, -3)$  and  $(8, -3)$  e.

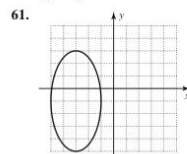


53. a.  $(-2, -2)$  b.  $(-5, -2)$  and  $(1, -2)$  c.  $(-2 + \sqrt{3}, -2)$  and  $(-2 - \sqrt{3}, -2)$  d.  $(-2, -2 + \sqrt{6})$  and  $(-2, -2 - \sqrt{6})$   
e.



55.  $\frac{x^2}{36} + \frac{y^2}{20} = 1$  57.  $\frac{(x - 3)^2}{9} + \frac{(y + 2)^2}{25} = 1$

59.  $\frac{x^2}{16} + \frac{y^2}{9} = 1$ ,  $(\pm\sqrt{7}, 0)$



61.  $\frac{(x + 3)^2}{4} + \frac{(y + 1)^2}{16} = 1$   
 $(-3, -1 \pm 2\sqrt{3})$

63.  $A = 12\pi$  units<sup>2</sup> 65.  $\sqrt{7} \approx 2.65$  ft 67. 8.9 ft  
2.25 ft 17.9 ft

69.  $\frac{x^2}{15^2} + \frac{y^2}{8^2} = 1$ ; 6.4 ft 71.  $\frac{x^2}{36^2} + \frac{y^2}{(35.25)^2} = 1$

73.  $a \approx 142$  million miles,  $b \approx 141$  million miles, orbit time  $\approx 686$  days

75.  $90,000\pi$  yd<sup>2</sup>

77.  $L = 8$  units;  $(3\sqrt{5}, 4)$ ,  $(3\sqrt{5}, -4)$ ,  $(-3\sqrt{5}, 4)$ ,  $(-3\sqrt{5}, -4)$ ; verified

79. Verified 81.  $R = \frac{kL}{d^2}$   $k = 0.003$  250  $\Omega$

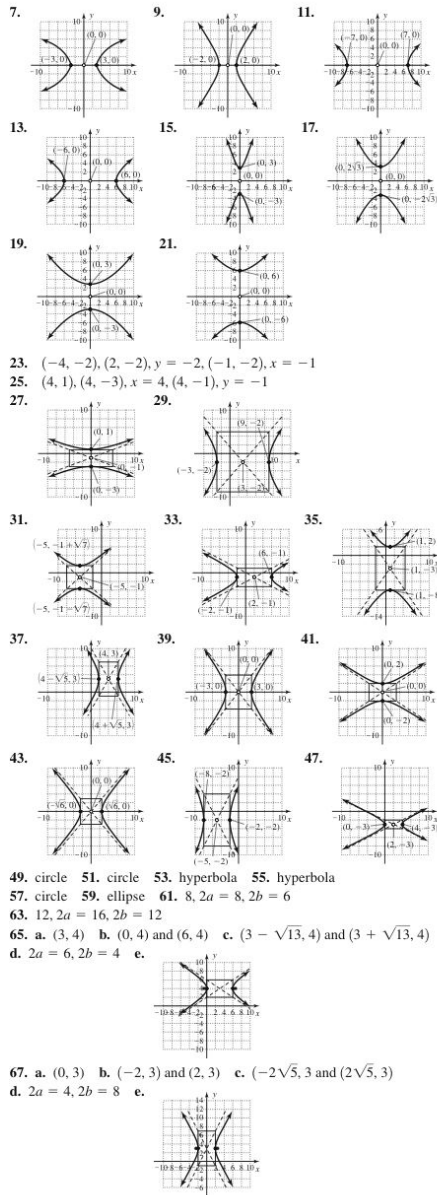
83. 261.8 mph, heading  $26.2^\circ$

**Exercises 10.3, pp. 950–953**

1. transverse 3. midway 5. Answers will vary.

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SA56 Student Answer Appendix



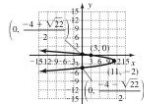
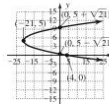
69. a.  $(3, -2)$  b.  $(1, -2)$  and  $(5, -2)$  c.  $(-1, -2)$  and  $(7, -2)$   
 d.  $2a = 4, 2b = 4\sqrt{3}$  e.
71.  $\frac{x^2}{36} - \frac{y^2}{28} = 1$  73.  $\frac{y^2}{9} - \frac{(x+2)^2}{9} = 1$   
 75.  $\frac{x^2}{4} - \frac{y^2}{9} = 1, (\pm\sqrt{13}, 0)$  77.  $\frac{(y-1)^2}{4} - \frac{(x-2)^2}{5} = 1, 4$  by  $2\sqrt{5}$   
 79. a.  $y = \frac{2}{3}\sqrt{x^2 - 9}$  b.  $x \in (-\infty, -3] \cup [3, \infty)$  c.  $y = \frac{2}{3}\sqrt{x^2 - 9}$   
 81. 40 yd 83. 40 ft  
 85.  $\frac{x^2}{225} - \frac{y^2}{2275} = 1$ , about  $(24.1, 60)$  or  $(-24.1, 60)$   
 87. a.  $\frac{(x-4)^2}{4} - (y-2)^2 = 0$  b.  $(x-2)^2 + \frac{(x-4)^2}{5} = 0$   
 89. a 91.  $\frac{(x-2)^2}{43} + \frac{(y-3)^2}{9} = 1$  93.  $700 \cos 65^\circ = 295.8$ , yes  
 95. b and c

Exercises 10.4, pp. 960–963

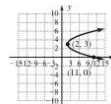
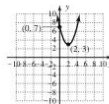
1. horizontal; right;  $a < 0$  3.  $(p, 0); x = -p$   
 5. Answers will vary.  
 7.  $x \in (-\infty, \infty), y \in [-4, \infty)$  9.  $x \in (-\infty, \infty), y \in [-18, \infty)$
- 
- 
11.  $x \in (-\infty, \infty), y \in [-10, 125, \infty)$  13.  $x \in [-4, \infty), y \in (-\infty, \infty)$
- 
- 
15.  $x \in (-\infty, 16], y \in (-\infty, \infty)$  17.  $x \in (-\infty, 0], y \in (-\infty, \infty)$
- 
- 
19.  $x \in [-9, \infty), y \in (-\infty, \infty)$  21.  $x \in [-4, \infty), y \in (-\infty, \infty)$
- 
- 
23.  $x \in (-\infty, 0], y \in (-\infty, \infty)$  25.  $x \in [-6.25, \infty), y \in (-\infty, \infty)$
- 
-

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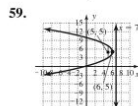
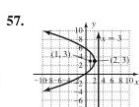
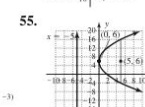
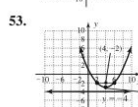
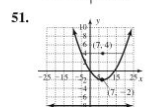
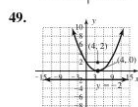
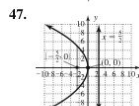
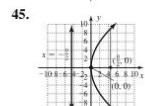
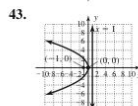
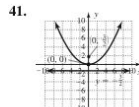
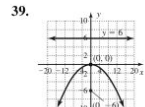
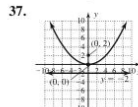
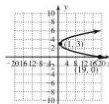
27.  $x \in [-21, \infty), y \in (-\infty, \infty)$     29.  $x \in (-\infty, 11], y \in (-\infty, \infty)$



31.  $x \in (-\infty, \infty), y \in [3, \infty)$     33.  $x \in [2, \infty), y \in (-\infty, \infty)$

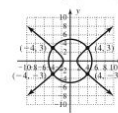


35.  $x \in [1, \infty), y \in (-\infty, \infty)$

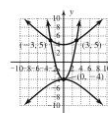


61.  $x^2 = 8y$     63.  $y^2 = 16x$     65.  $x^2 = -20y$   
 67.  $(y + 2)^2 = -12(x - 2)$     69.  $(x - 4)^2 = 12(y + 7)$   
 71.  $(x - 3)^2 = 8(y - 2)$   
 73.  $y^2 = 8(x + 1)$   
 vertex  $(-1, 0)$   
 focus  $(1, 0)$   
 75.  $(y - 2)^2 = -8(x + 2)$   
 directrix:  $x = 0$   
 endpoints  $(-4, 6)$  and  $(-4, -2)$

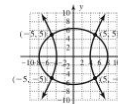
77.  $7.3/19 (\sqrt{555}, -16)$



79.  $7.3/21$

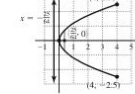


81.  $7.3/23$



83. 16 units<sup>2</sup>

85.



87. 6 in.;  $(13.5, 0)$     89. 14.97 ft,  $(0, 41.75)$

91.  $y^2 = 5x$  or  $x^2 = 5y$ , 1.25 cm

93.  $(x - 2)^2 = \frac{2}{3}(y + 8)$ ;  $p = \frac{1}{3}$ ;  $(2, -8)$     95. 18 units<sup>2</sup>

97. Answers will vary.    99. about 120 days

Mid-Chapter Check, p. 964

- - 
  - 
  - 
  - 
  -
7. a.  $\frac{(x + 3)^2}{4} + \frac{(y - 1)^2}{16} = 1$ ;  $D: x \in [-5, -1]$ ;  $R: y \in [-3, 5]$   
 b.  $(x - 3)^2 + (y - 2)^2 = 16$ ;  $D: x \in [-1, 7]$ ;  $R: y \in [-2, 6]$   
 c.  $y = (x - 3)^2 - 4$ ;  $D: x \in (-\infty, \infty)$ ;  $R: y \in [-4, \infty)$
8.    9.  $\frac{x^2}{16} + \frac{y^2}{4} = 1$     10. yes, distance  $d = 49$  mi

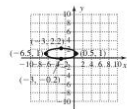
Reinforcing Basic Concepts, pp. 964-965

- $\frac{(x - 2)^2}{5} + \frac{(y + 3)^2}{3} = 1$ ;  $a = \frac{\sqrt{2}}{5}$ ,  $b = \frac{2}{3}$
- $\frac{(x - 1)^2}{14} + \frac{(y + 2)^2}{12} = 1$ ;  $a = \frac{5\sqrt{17}}{14}$ ,  $b = \frac{5\sqrt{3}}{12}$

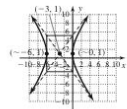
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SA58 Student Answer Appendix

$$3. \frac{(x+3)^2}{\left(\frac{7}{2}\right)^2} + \frac{(y-1)^2}{\left(\frac{6}{5}\right)^2} = 1; a = \frac{7}{2}, b = \frac{6}{5}$$

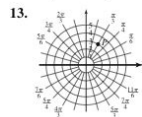
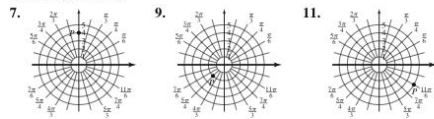


$$4. \frac{(x+3)^2}{\left(\frac{4\sqrt{5}}{3}\right)^2} - \frac{(y-1)^2}{\left(\frac{9}{2}\right)^2} = 1; a = \frac{4\sqrt{5}}{3} \approx 3, b = \frac{9}{2}$$

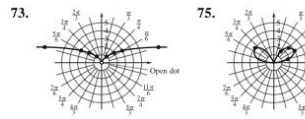
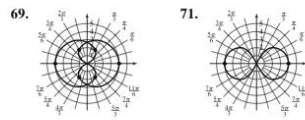
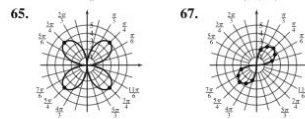
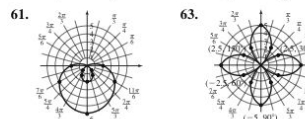
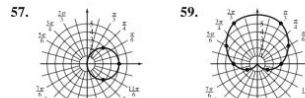
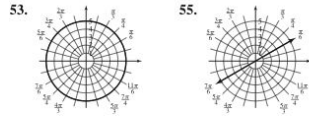


Exercises 10.5, pp. 975–978

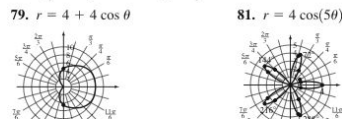
1. polar 3. II; IV  
 5. To plot the point  $(r, \theta)$  start at the origin or pole and move  $|r|$  units out along the polar axis. Then move counterclockwise an angle measure of  $\theta$ . You should be  $r$  units straight out from the pole in a direction of  $\theta$  from the positive polar axis. If  $r$  is negative, final resting place for the point  $(r, \theta)$  will be  $180^\circ$  from  $\theta$ .



15.  $\left(4, \frac{\pi}{2}\right)$  17.  $\left(4\sqrt{2}, \frac{\pi}{4}\right)$  19.  $\left(8, \frac{2\pi}{3}\right)$  21.  $\left(4\sqrt{2}, \frac{3\pi}{4}\right)$   
 23.  $\left(3\sqrt{2}, \frac{-5\pi}{4}\right), \left(-3\sqrt{2}, \frac{7\pi}{4}\right), \left(3\sqrt{2}, \frac{11\pi}{4}\right), \left(-3\sqrt{2}, \frac{-\pi}{4}\right)$   
 25.  $\left(2, \frac{5\pi}{6}\right), \left(2, \frac{-7\pi}{6}\right), \left(2, \frac{17\pi}{6}\right), \left(-2, \frac{-\pi}{6}\right)$   
 27. C 29. C 31. D 33. B 35. D 37.  $(8, 180^\circ)$  or  $(8, \pi)$   
 39.  $(4\sqrt{2}, 45^\circ)$  or  $\left(4\sqrt{2}, \frac{\pi}{4}\right)$  41.  $(10, 45^\circ)$  or  $\left(10, \frac{\pi}{4}\right)$   
 43.  $(13, 247.4^\circ)$  or  $(13, 4.3176)$  45.  $(4\sqrt{2}, 4\sqrt{2})$  47.  $(-2\sqrt{2}, 2\sqrt{2})$   
 49.  $(\sqrt{3}, 1)$  51.  $\left(\frac{5\sqrt{2}}{2}, \frac{5\sqrt{2}}{2}\right)$



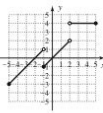
77.  $\left(\frac{4\sqrt{3} + 3\sqrt{2}}{2}, \frac{4 + 3\sqrt{2}}{2}\right); (3\sqrt{2}, 3\sqrt{2}); (4\sqrt{3}, 4);$  yes  
 $M = \left(\frac{3\sqrt{2} + 4\sqrt{3}}{2}, \frac{3\sqrt{2} + 4}{2}\right)$



87. a; this is a circle through  $(6, 0^\circ)$  symmetric about the polar axis  
 89. g; this is a circle through  $\left(6, \frac{\pi}{2}\right)$  symmetric about  $\theta = \frac{\pi}{2}$ .  
 91. f; this is a limaçon symmetric about  $\theta = \frac{\pi}{2}$  with an inner loop. Thus  $a < b$ .  
 93. b; this is a cardioid symmetric about  $\theta = \frac{\pi}{2}$  through  $\left(6, \frac{3\pi}{2}\right)$ .  
 95.  $r^2 = 7200^2 \sin(2\theta)$  97.  $r = 15 \cos(5\theta)$  or  $r = 15 \sin(5\theta)$   
 99.  $\pi; \pi; \pi$ ; Answers will vary.

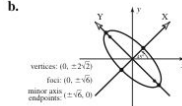
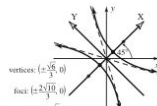
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101. Consider  $r = a\sqrt{\cos(2\theta)}$  and  $r = -a\sqrt{\cos(2\theta)}$ ; both satisfy  $r^2 = a^2\cos(2\theta)$ . Thus,  $(r, \theta)$  and  $(-r, \theta)$  will both be on the curve. The same is true with  $a\sqrt{\sin(2\theta)}$  and  $-a\sqrt{\sin(2\theta)}$ .
103.  $9\pi$  units<sup>2</sup> 105.  $3y^2 - x^2 - 12y + 9 = 0$
107.  $t = 0, \frac{2\pi}{3}, \pi, \frac{5\pi}{3}$
109.  $D: x \in [-5, 2) \cup (2, 5]$   
 $R: y \in [-3, 2) \cup (4, 5]$

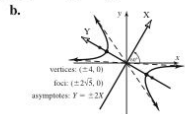


**Exercises 10.6, pp. 989–994**

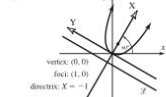
1. rotation of axes;  $\frac{B}{A-C}$  3. invariants 5. Answers will vary.
7.  $\frac{y^2}{8} - \frac{x^2}{8} = 1$  9.  $6 + 3\sqrt{2} = X, -6 + 3\sqrt{2} = Y$
11.  $\frac{5\sqrt{2}}{2} = X, \frac{5\sqrt{2}}{2} = Y$  13.  $0 = x, 4 = y$
15.  $\frac{3\sqrt{3}}{2} - 2 = x; \frac{3}{2} + 2\sqrt{3} = y$  17.  $\frac{-x^2}{2} + xy\sqrt{3} + \frac{y^2}{2} = 9$
19.  $4X^2 + 2Y^2 = 9$
21. a.  $3X^2 - Y^2 = 2$  23. a.  $4X^2 + Y^2 = 8$



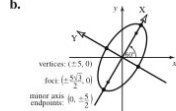
25. a.  $Y^2 - 4X^2 = 16$



27. a.  $Y^2 - 4X = 0$



29. a.  $X^2 + 4Y^2 = 25$



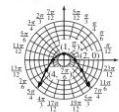
31.  $336 > 0$ ; hyperbola;  $\cos(2\beta) = \frac{7}{25}, \frac{4}{5} = \cos \beta; \frac{3}{5} = \sin \beta$

33. a. parabola b.  $\beta = 45^\circ; 2Y^2 = 5$  c. verified

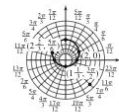
35. a. circle or ellipse b.  $\beta = 60^\circ; \frac{9}{2}X^2 + \frac{5Y^2}{2} + 2X - 2\sqrt{3}Y = 1$

(ellipse) c. verified 37. f 39. g 41. h

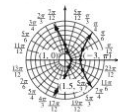
43. parabola



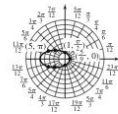
45. ellipse



47. hyperbola



49. ellipse



51.  $r = \frac{3.2}{1 - 0.8 \cos \theta}$

53.  $r = \frac{4}{1 - \cos \theta}$  55.  $r = \frac{7.5}{1 + 1.5 \sin \theta}$

57. a.  $r = \frac{12}{2 \cos \theta + 3 \sin \theta}$  b.  $\frac{r(\pi/2)}{r(0)} = \frac{-2}{3}$  and  $\frac{-A}{B} = \frac{-2}{3}$

59. Jupiter:  $e \approx 0.0486$ , Saturn:  $e \approx 0.0567$

61. about 2757.1 million miles 63. Saturn:  $e \approx 0.0567$

65.  $r \approx \frac{482.36}{1 - 0.0486 \cos \theta}$  67.  $r \approx \frac{1780.77}{1 - 0.0457 \cos \theta}$

69. In millions of miles (approx): JS: 405.3, JU: 1298.4, JN: 2310.3, SU: 893.1, SN: 1905.0, UN: 1011.9

71.  $r = \frac{0.7638}{1 \pm 0.7862 \cos \theta}$  73.  $r = \frac{0.2864}{1 \pm 0.7862 \cos \theta}$

75. \$582.45; \$445.94; \$881.32; \$97.92 77.  $y = \frac{3}{1 - \cos \theta}$

79. verified 81. Answers will vary

83.  $r = 12 \cos(\theta - \frac{\pi}{4}) = 6\sqrt{2}(\cos \theta + \sin \theta)$

85.  $425X^2 - 416Y^2 - 400 = 0$  87. (0, 0), (4, 0), (4, 4), (0, 4)

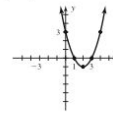
89.  $x \approx 29.0$  91. 9.2 mph at heading  $347.7^\circ$

**Exercise 10.7, pp. 1002–1006**

1. parameter 3. direction 5. Answers will vary.

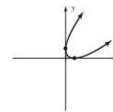
7. a. parabola with vertex at (2, -1)

b.  $y = x^2 - 4x + 3$



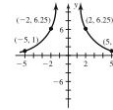
9. a. parabola

b.  $y = x \pm 2\sqrt{x} + 1$



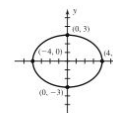
11. a. power function with  $p = -2$

b.  $y = \frac{25}{x^2}, x \neq 0$



13. a. ellipse

b.  $\frac{x^2}{16} + \frac{y^2}{9} = 1$

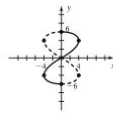


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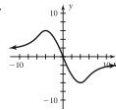
SA60 Student Answer Appendix

15. a. Lissajous figure

b.  $y = 6 \cos \left[ \frac{1}{2} \sin^{-1} \left( \frac{x}{4} \right) \right]$



17.



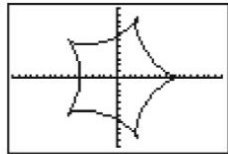
19.  $x = t, y = 3t - 2; x = \frac{1}{3}t, y = t - 2; x = \cos t, y = 3 \cos t - 2$

21.  $x = t, y = (t + 3)^2 + 1; x = t - 3, y = t^2 + 1; x = \tan t - 3, y = \sec^2 t, t \neq \frac{(2k + 1)\pi}{2}, k \in \mathbb{Z}$

23.  $x = t, y = \tan^2(t - 2) + 1, t \neq \pi k + \frac{\pi}{2} + 2, k \in \mathbb{Z}; x = t + 2, y = \sec^2 t, t \neq \left(k + \frac{1}{2}\right)\pi, k \in \mathbb{Z}; x = \tan^{-1} t + 2, y = t^2 + 1$

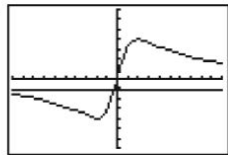
25. verified

27. a.



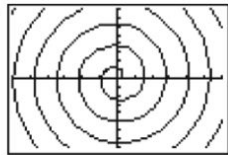
b.  $x$ -intercepts:  $t = 0, x = 10, y = 0$  and  $t = \pi, x = -6, y = 0$ ;  $y$ -intercepts:  $t \approx 1.757, x = 0, y \approx 6.5$  and  $t \approx 4.527, x = 0, y \approx -6.5$ ; minimum  $x$ -value is  $-8.1$ ; maximum  $x$ -value is  $10$ ; minimum  $y$ -value is  $-9.5$ ; the maximum  $y$ -value is  $9.5$

29. a.



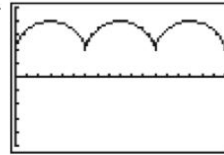
b.  $x$ -intercepts none,  $y$ -intercepts none; no minimum or maximum  $x$ -values; minimum  $y$ -value is  $-4$  and maximum  $y$ -value is  $4$

31. a.



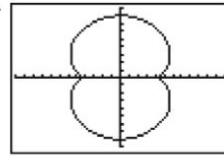
b.  $x$ -intercepts:  $t = 0, x = 2, y = 0$  and  $t \approx 4.493, x \approx -9.2, y = 0$ ; infinitely many others;  $y$ -intercepts:  $t \approx 2.798, x = 0, y \approx 5.9$  and  $t \approx 6.121, x = 0, y \approx -12.4$ ; infinitely many others; no minimum or maximum values for  $x$  or  $y$

33. a.



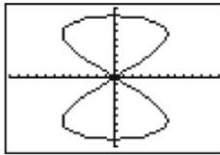
b. no  $x$ -intercepts;  $y$ -intercept is  $t = 0, x = 0, y = 2$ ; no minimum or maximum  $x$ -values; minimum  $y$ -value is  $2$ ; maximum  $y$ -value is  $4$

35. a.



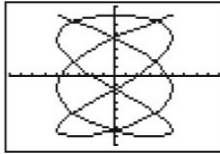
b.  $x$ -intercepts:  $t = 0, x = 4, y = 0$  and  $t = \pi, x = -4, y = 0$ ;  $y$ -intercepts:  $t = \frac{\pi}{2}, x = 0, y = 8$  and  $t = \frac{3\pi}{2}, x = 0, y = -8$ ; minimum and maximum  $x$ -values are approx.  $\pm 5.657$ ; minimum and maximum  $y$ -values are  $\pm 8$

37.



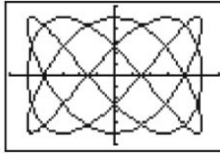
width  $12$  and length  $16$ ; including the endpoint  $t = 2\pi$ , the graph crosses itself two times from  $0$  to  $2\pi$ .

39.



width  $10$  and length  $14$ ; including the endpoint  $t = 2\pi$ , the graph crosses itself nine times from  $0$  to  $2\pi$ .

41.



width  $20$  and length  $20$ ; including the endpoint  $t = 4\pi$ , the graph crosses itself  $23$  times from  $0$  to  $4\pi$ .

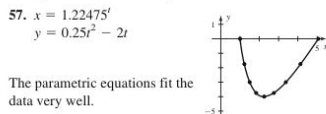
43.

The maximum value (as the graph swells to a peak) is at  $(x, y) = \left(a, \frac{b}{2}\right)$ . The minimum value (as the graph dips to the valley) is at  $(x, y) = \left(-a, -\frac{b}{2}\right)$ .

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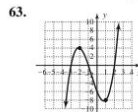
45. a. The curve is approaching  $y = 2$  as  $t$  approaches  $\frac{3\pi}{2}$ , but  $\cot\left(\frac{3\pi}{2}\right)$  is undefined, and the trig form seems to indicate a hole at  $t = \frac{3\pi}{2}$ ,  $x = 0$ ,  $y = 2$ . The algebraic form does not have this problem and shows a maximum defined at  $t = 0$ ,  $x = 0$ ,  $y = 2$ .  
 b. As  $|t| \rightarrow \infty$ ,  $y(t) \rightarrow 0$  c. The maximum value occurs at  $(0, 2k)$ .

47. a. Yes b. Yes c.  $\approx 0.82$  ft 49. No, the kick is short.  
 51. The electron is moving left and downward.  
 53.  $\left(t, \frac{6t}{17} - \frac{6}{17}, \frac{13t}{17} + \frac{21}{17}\right)$  55. Inconsistent, no solutions



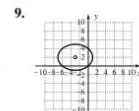
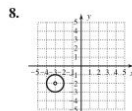
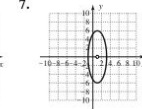
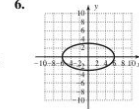
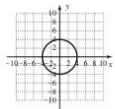
The parametric equations fit the data very well.

59. Answers will vary. 61. by 25%



**Summary and Concept Review, pp. 1006–1010**

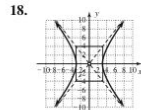
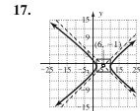
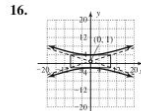
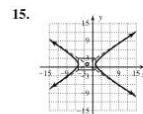
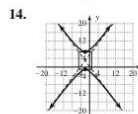
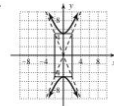
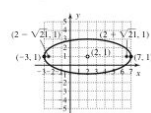
1. verified (segments are perpendicular and equal length)  
 2.  $x^2 + (y - 1)^2 = 34$  3. verified 4. verified  
 5.



10.  $\frac{x^2}{25} + \frac{y^2}{9} = 1$

11. a.  $\frac{x^2}{169} + \frac{y^2}{25} = 1$  b.  $\frac{x^2}{400} + \frac{y^2}{144} = 1$

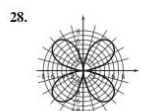
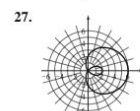
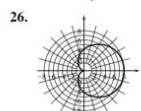
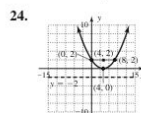
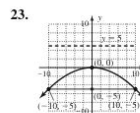
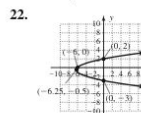
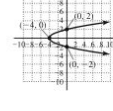
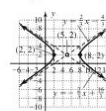
12.  $\frac{(x - 2)^2}{25} + \frac{(y - 1)^2}{4} = 1$  13.



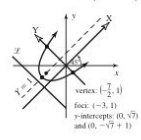
$\frac{x^2}{9} - \frac{y^2}{16} = 1$

19. a.  $\frac{x^2}{225} - \frac{y^2}{64} = 1$  b.  $\frac{y^2}{16} - \frac{x^2}{9} = 1$

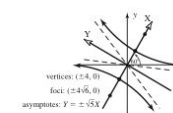
20.  $\frac{(x - 5)^2}{9} - \frac{(y - 2)^2}{4} = 1$  21.



29.  $Y^2 - 2Y - 2X - 6 = 0$   
 $(Y - 1)^2 = 2\left(X + \frac{7}{2}\right)$



30.  $5X^2 - Y^2 - 80 = 0$   
 $\frac{X^2}{16} - \frac{Y^2}{80} = 1$

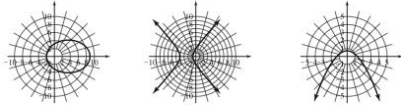




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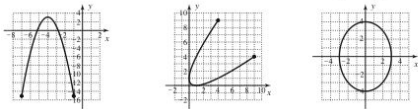
SA62 Student Answer Appendix

31. ellipse,  $e = \frac{2}{3}$ ; 32. hyperbola,  $e = \frac{3}{2}$ ; 33. parabola,  $e = 1$ ;



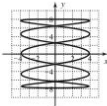
34.  $r = \frac{de}{1 - e \cos \theta}$  with  $e \approx 0.0935$  and  $d \approx 1501.1$ ; focal cord:  $\approx 280.82$  million miles

35.  $y = -2(x + 4)^2 + 3$  36.  $y = (-1 \pm \sqrt{x})^2$  37.  $\frac{x^2}{9} + \frac{y^2}{16} = 1$



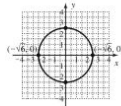
38. Answers will vary.

39.  $x \in [-4, 4]$ ;  $y \in [-8, 8]$

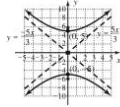


Mixed Review, pp. 1010–1011

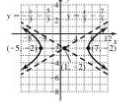
1. circle, center: (0, 0);  $r = \sqrt{6}$



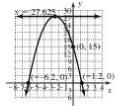
3. hyperbola; center (0, 0);  $a = 5$ ,  $b = 3$ ,  $c = \sqrt{34}$ ; vertices (0, 5), (0, -5); foci (0,  $\sqrt{34}$ ), (0,  $-\sqrt{34}$ ); asymptotes  $y = \frac{3}{5}x$ ,  $y = -\frac{3}{5}x$



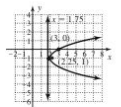
5. hyperbola; center (1, -2);  $a = 6$ ,  $b = 2$ ,  $c = 2\sqrt{10}$ ; vertices (-5, -2), (7, -2); foci (1 -  $2\sqrt{10}$ , -2), (1 +  $2\sqrt{10}$ , -2); asymptotes:  $y = \frac{1}{3}x - \frac{2}{3}$ ,  $y = -\frac{1}{3}x - \frac{2}{3}$



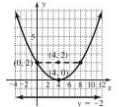
7. parabola;  $p = 0.125$ ; vertex (-2.5, 27.5); focus (-2.5, 27.375); directrix  $y = 27.625$ ; y-intercepts: approx. (-6.2, 0), (1.2, 0)



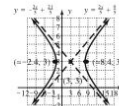
9. parabola;  $p = 0.25$ ; vertex (2, -1); focus (2.25, -1); directrix  $x = 1.75$ ; y-intercepts: none



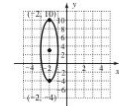
11. parabola;  $p = 2$  vertex (4, 0); focus (4, 2); directrix  $y = -2$ ; x-intercept (4, 0)



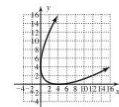
13. hyperbola; center (3, 3);  $a = 5$ ,  $b = 2$ ,  $c = \sqrt{29}$ ; vertices (8, 3), (-2, 3); foci (3 -  $\sqrt{29}$ , 3), (3 +  $\sqrt{29}$ , 3);  $\approx (-2.39, 3)$ , (8.39, 3); asymptotes  $y = \frac{2}{5}x + \frac{3}{5}$ ,  $y = -\frac{2}{5}x + \frac{21}{5}$



15. ellipse; center (-2, 3);  $a = 1$ ,  $b = 7$ ,  $c = 4\sqrt{3}$ ; vertices (-2, -4), (-2, 10); endpoints of minor axis (-3, 3), (-1, 3); foci (-2, 3 -  $4\sqrt{3}$ ), (-2, 3 +  $4\sqrt{3}$ );  $\approx (-2, -3.93)$ ,  $\approx (-2, 9.93)$



17. parabola



19. a. (2, 5), (-2, 5), (-2, -5), (2, -5)

b. (0, 2),  $(-2\sqrt{2}, \frac{2}{3})$ ,  $(2\sqrt{2}, \frac{2}{3})$

21.  $x = 50 \cos t$ ;  $y = 30 \sin t$

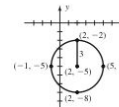
23. a. elliptic; 0.494 million miles b. parabolic; 3.1 million miles

25.  $12x^2 + 26xy + 12y^2 = 160,000$

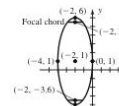
Practice Test, pp. 1011–1012

1. c 2. d 3. b 4. a

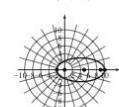
5. circle; center (2, -5); radius 3



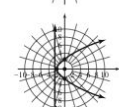
6. ellipse; center (-2, 1); vertices (-2, -4), (-2, 6); foci (-2, 1 -  $\sqrt{21}$ ), (-2, 1 +  $\sqrt{21}$ )



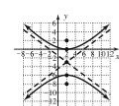
7. ellipse; center  $(\frac{80}{9}, 0)$ ; vertices  $(-\frac{80}{9}, 0)$ , (10, 0); foci (0, 0),  $(\frac{80}{9}, 0)$



8. parabola; vertex (-1.2, 0); focus (0, 0); directrix at  $y = -2.4$

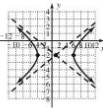


9. hyperbola; center: (2, -3); vertices: (2, 0), (2, -6); foci: (2, -8), (2, 2); asymptotes:  $y = \frac{3}{4}x - \frac{9}{2}$ ,  $y = -\frac{3}{4}x - \frac{3}{2}$

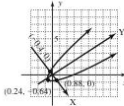


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10. hyperbola; center  $(1, -2)$ ; vertices  $(-4, -2), (6, -2)$ ; foci  $(1 - \sqrt{29}, -2), (1 + \sqrt{29}, -2)$ ;  $\approx (-4.39, -2), (6.39, -2)$ ; asymptotes:  $y = -\frac{2}{5}x - \frac{2}{5}$ ;  $y = \frac{2}{5}x - \frac{12}{5}$

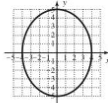


11. parabola;  $\beta = 36.87^\circ$ ;  $\cos \beta = \frac{4}{5}$ ,  $\sin \beta = \frac{3}{5}$   
 12.  $Y = \frac{25}{16}X^2 - \frac{3}{4}X - \frac{11}{20}$

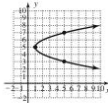


13. 14. 15.

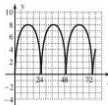
16. ellipse;  $\frac{x^2}{16} + \frac{y^2}{25} = 1$



17. parabola;  $x = (y - 5)^2 + 1$



18. max:  $y = 8$ ; min:  $y = 0$ ;  $P = 8\pi$



19. a.  $(3\frac{1}{2}, 5\frac{1}{2}), (-2, 0)$  b.  $(\sqrt{\frac{12}{5}}, \sqrt{\frac{8}{5}}), (-\sqrt{\frac{12}{5}}, -\sqrt{\frac{8}{5}})$   
 $(-\sqrt{\frac{12}{5}}, \sqrt{\frac{8}{5}}), (\sqrt{\frac{12}{5}}, -\sqrt{\frac{8}{5}})$  20.  $r \approx \frac{1654(1 - 0.967^2)}{1 - 0.967 \cos \theta}$

$e$  is very close to 1. This makes its orbit a very elongated ellipse, where the orbit of most planets is nearly circular. 21. The ball is 0.43 ft above the ground at  $x = 165$  ft, and will likely go into the goal. 22. Perihelion: 128.41 million miles Aphelion: 154.89 million miles  
 23.  $y = (x - 1)^2 - 4$ ; D:  $x \in \mathbb{R}$ ; R:  $y \in [-4, \infty)$ ; focus:  $(1, -3.75)$   
 24.  $(x - 1)^2 + (y - 1)^2 = 25$ ; D:  $x \in [-4, 6]$ ; R:  $y \in [-4, 6]$   
 25.  $\frac{(x + 2)^2}{9} + \frac{(y - 1)^2}{25} = 1$ ; D:  $x \in [-5, 1]$ ; R:  $y \in [-4, 6]$

**Strengthening Core Skills, pp. 1013–1015**

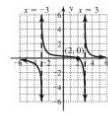
Exercise 1: Yes, the calculations are much "cleaner" with the right triangle definitions.

**Cumulative Review Chapters 1–10, pp. 1015–1016**

1.  $x = 7, x = -1$  is extraneous 3.  $x = -6$  5.  $x = 4$   
 7.  $\frac{5\pi}{6} + k\pi, k \in \mathbb{Z}$  9.  $x \approx 61.98^\circ + 360^\circ k; k \in \mathbb{Z}$ ;  
 $x \approx 118.02^\circ + 360^\circ k; k \in \mathbb{Z}$   
 11. about 24.7 pesos/kg 13. The formation is 1152.4 yd wide

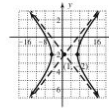
- 15.

17. horizontal asymptote:  $y = 0$   
 vertical asymptotes:  $x = 3, x = -3$ ,  
 $x$ -intercept:  $(2, 0)$ ;  $y$ -intercept:  $(0, \frac{2}{3})$



- 19.

21. center  $(1, -2)$ ;  
 foci  $(1 + 2\sqrt{10}, -2) \approx (7.32, -2)$ ,  
 $(1 - 2\sqrt{10}, -2) \approx (-5.32, -2)$ ; asymptotes  
 $y = \frac{1}{3}x - \frac{2}{3}, y = -\frac{1}{3}x - \frac{2}{3}$



- 23.

25. 61.9° 27.  $(-3, 4), (3, 4), (-3, -4), (3, -4)$

29.  $\frac{1}{x} - \frac{3}{x^2} + \frac{2x + 1}{x^2 + 1}$

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**CHAPTER 11****Exercise 11.1, pp. 1024–1026**

1. pattern; order 3. increasing 5. formula defining the sequence uses the preceding term(s); answers will vary.
7. 1, 3, 5, 7;  $a_8 = 15$ ;  $a_{12} = 23$  9. 0, 9, 24, 45;  $a_8 = 189$ ;  $a_{12} = 429$
11. -1, 2, -3, 4;  $a_8 = 8$ ;  $a_{12} = 12$  13.  $\frac{1}{2}, \frac{2}{3}, \frac{3}{4}, \frac{4}{5}$ ;  $a_8 = \frac{8}{9}$ ;  $a_{12} = \frac{12}{13}$
15.  $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}$ ;  $a_8 = \frac{1}{256}$ ;  $a_{12} = \frac{1}{4096}$  17.  $1, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}$ ;  $a_8 = \frac{1}{8}$ ;  $a_{12} = \frac{1}{12}$
19.  $\frac{-1}{2}, \frac{1}{6}, \frac{-1}{12}, \frac{1}{20}$ ;  $a_8 = \frac{1}{72}$ ;  $a_{12} = \frac{1}{156}$
21. -2, 4, -8, 16;  $a_8 = 256$ ;  $a_{12} = 4096$  23. 79 25.  $\frac{1}{3}$  27.  $\frac{1}{32}$
29.  $\left(\frac{11}{10}\right)^{10}$  31.  $\frac{1}{36}$  33. 2, 7, 32, 157, 782 35. -1, 4, 19, 364, 132,499
37. 64, 32, 16, 8, 4 39. 336 41. 36 43. 28 45.  $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}$
47.  $\frac{1}{3}, \frac{1}{120}, \frac{1}{15}, \frac{1}{120}, \frac{1}{3,991,680}$  49.  $1, 2, \frac{3}{2}, \frac{3^2}{2}$  51. 15 53. 64 55.  $\frac{137}{60}$
57. 10 59. 95 61. -4 63. 15 65. 50 67.  $\frac{-27}{112}$  69.  $\sum_{n=1}^5 (4n)$
71.  $\sum_{n=1}^6 (-1)^n n^2$  73.  $\sum_{n=1}^5 (n+3)$  75.  $\sum_{n=1}^8 \frac{n^2}{3}$  77.  $\sum_{n=32}^7 \frac{n}{2^n}$
79. 35 81. 100

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**SA64** Student Answer Appendix

83. 35 85.  $a_n = 6000(0.8)^{n-1}$ ; 6000, 4800, 3840, 3072, 2457.60, 1966.08 87. 5.20, 5.70, 6.20, 6.70, 7.20, \$13,824 89.  $\approx 2690$   
 91. verified 93. approaches  $\frac{1}{2}$  95.  $\frac{3\pi}{4}, \frac{7\pi}{4}$   
 97.  $\angle A \approx 53.1^\circ, \angle B = 90^\circ, \angle C \approx 36.9^\circ$

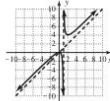
**Exercise 11.2, pp. 1031–1033**

1. common; difference 3.  $\frac{n(a_1 + a_n)}{2}$ ; nth 5. Answers will vary.  
 7. arithmetic;  $d = 3$  9. arithmetic;  $d = 2.5$   
 11. not arithmetic; all prime 13. arithmetic;  $d = \frac{1}{23}$   
 15. not arithmetic;  $a_n = n^2$  17. arithmetic;  $d = \frac{\pi}{6}$  19. 2, 5, 8, 11  
 21. 7, 5, 3, 1 23. 0.3, 0.33, 0.36, 0.39 25.  $\frac{3}{2}, 2, \frac{5}{2}, 3$  27.  $\frac{3}{4}, \frac{3}{8}, \frac{1}{2}, \frac{3}{8}$   
 29. -2, -5, -8, -11 31.  $a_1 = 2, d = 5, a_n = 5n - 3,$   
 $a_6 = 27, a_{10} = 47, a_{12} = 57$  33.  $a_1 = 5.10, d = 0.15,$   
 $a_n = 0.15n + 4.95, a_6 = 5.85, a_{10} = 6.45, a_{12} = 6.75$   
 35.  $a_1 = \frac{3}{2}, d = \frac{3}{4}, a_n = \frac{3}{4}n + \frac{3}{4}, a_6 = \frac{21}{4}, a_{10} = \frac{33}{4}, a_{12} = \frac{39}{4}$   
 37. 61 39. 1 41. 2.425 43. 9 45. 43 47. 21 49. 26  
 51.  $d = 3, a_1 = 1$  53.  $d = 0.375, a_1 = 0.65$  55.  $d = \frac{115}{126}, a_1 = \frac{-472}{63}$   
 57. 1275 59. 601.25 61. -534 63. 82.5 65. 74.04  
 67.  $210\sqrt{2}$  69.  $S_6 = 21; S_{75} = 2850$  71. at 11 p.m.  
 73. 5.5 in.; 54.25 in. 75. 220; 2520; yes

77. a. linear function b. quadratic 79.  $A = 7, P = 6, HS: \frac{1}{2}$  unit right,  
 VS: 10 units up,  $PI: \frac{1}{2} \leq r < \frac{13}{2}$  81.  $f(x) = 4ax + 972, 1364$

**Exercises 11.3, pp. 1040–1043**

1. multiplying 3.  $a_1 r^{n-1}$  5. Answers will vary. 7.  $r = 2$   
 9.  $r = -2$  11.  $a_n = n^2 + 1$  13.  $r = 0.1$  15. not geometric; ratio of terms decreases by 1 17.  $r = \frac{2}{3}$  19.  $r = \frac{1}{2}$  21.  $r = \frac{4}{x}$   
 23. not geometric;  $a_n = \frac{240}{n!}$  25. 5, 10, 20, 40 27. -6, 3,  $-\frac{3}{2}, \frac{3}{4}$   
 29.  $4, 4\sqrt{3}, 12, 12\sqrt{3}$  31. 0.1, 0.01, 0.001, 0.0001 33.  $-\frac{3}{8}, 35, \frac{25}{4}$   
 37. 16 39.  $a_1 = \frac{1}{27}, r = -3, a_n = \frac{1}{27}(-3)^{n-1}, a_6 = -9, a_{10} = -729,$   
 $a_{12} = -6561$   
 41.  $a_1 = 729, r = \frac{1}{3}, a_n = 729(\frac{1}{3})^{n-1}, a_6 = 3, a_{10} = \frac{1}{27}, a_{12} = \frac{1}{243}$   
 43.  $a_1 = \frac{1}{2}, r = \sqrt{2}, a_n = \frac{1}{2}(\sqrt{2})^{n-1}, a_6 = 2\sqrt{2}, a_{10} = 8\sqrt{2}, a_{12} = 16\sqrt{2}$   
 45.  $a_1 = 0.2, r = 0.4, a_n = 0.2(0.4)^{n-1}, a_6 = 0.002048,$   
 $a_{10} = 0.0000524288, a_{12} = 0.000008388608$  47. 5 49. 11 51. 9  
 53. 8 55. 13 57. 9 59.  $r = \frac{2}{3}, a_1 = 729$  61.  $r = \frac{3}{2}, a_1 = \frac{38}{243}$   
 63.  $r = \frac{3}{2}, a_1 = \frac{256}{81}$  65. -10,920 67.  $\frac{3872}{27} \approx 143.41$   
 69.  $\frac{2059}{8} \approx 257.375$  71. 728 73.  $\frac{85}{8} = 10.625$  75.  $\approx 1.60$   
 77. 1364 79.  $\frac{31,525}{2187} \approx 14.41$  81.  $\frac{-387}{512} \approx -0.76$  83.  $\frac{521}{25}$  85.  $\frac{3367}{1296}$   
 87.  $14 + 15\sqrt{2}$  89. no 91.  $\frac{57}{7}$  93.  $\frac{125}{3}$  95. 12 97. 4 99.  $\frac{1}{3}$   
 101.  $\frac{3}{2}$  103.  $-\frac{18}{5}$  105. 1296 107. about 6.3 ft; 120 ft  
 109. \$18,841.60; 10 yr 111. 125.4 gpm; 10 months  
 113. about 347.7 million 115. 51,200 bacteria; 12 half-hours later (6 hr)  
 117.  $\approx 0.42$  m; 8 m 119. 35.9 in<sup>3</sup>; 7 strokes 121. 6 yr  
 123.  $S_n = \log n!$  125.  $x = \frac{-5}{2} \pm \frac{\sqrt{11}}{2}i$  127.



**Exercises 11.4, pp. 1049–1051**

1. finite; universally 3. induction; hypothesis 5. Answers will vary.  
 7.  $a_n = 10n - 6$   
 $a_4 = 10(4) - 6 = 40 - 6 = 34;$   
 $a_5 = 10(5) - 6 = 50 - 6 = 44;$   
 $a_k = 10k - 6;$   
 $a_{k+1} = 10(k+1) - 6 = 10k + 10 - 6 = 10k + 4$

9.  $a_n = n$   
 $a_4 = 4;$   
 $a_5 = 5;$   
 $a_k = k;$   
 $a_{k+1} = k + 1$   
 11.  $a_n = 2^{n-1}$   
 $a_4 = 2^{4-1} = 2^3 = 8;$   
 $a_5 = 2^{5-1} = 2^4 = 16;$   
 $a_k = 2^{k-1};$   
 $a_{k+1} = 2^{k+1-1} = 2^k$   
 13.  $S_n = n(5n - 1)$   
 $S_4 = 4(5(4) - 1) = 4(20 - 1) = 4(19) = 76;$   
 $S_5 = 5(5(5) - 1) = 5(25 - 1) = 5(24) = 120;$   
 $S_k = k(5k - 1);$   
 $S_{k+1} = (k+1)(5(k+1) - 1) = (k+1)(5k + 5 - 1) = (k+1)(5k + 4)$

15.  $S_n = \frac{n(n+1)}{2}$   
 $S_4 = \frac{4(4+1)}{2} = \frac{4(5)}{2} = 10;$   
 $S_5 = \frac{5(5+1)}{2} = \frac{5(6)}{2} = 15;$   
 $S_k = \frac{k(k+1)}{2};$   
 $S_{k+1} = \frac{(k+1)(k+1+1)}{2} = \frac{(k+1)(k+2)}{2}$

17.  $S_n = 2^n - 1$   
 $S_4 = 2^4 - 1 = 16 - 1 = 15;$   
 $S_5 = 2^5 - 1 = 32 - 1 = 31;$   
 $S_k = 2^k - 1;$   
 $S_{k+1} = 2^{k+1} - 1$   
 19.  $a_n = 10n - 6; S_n = n(5n - 1)$   
 $S_4 = 4(5(4) - 1) = 4(20 - 1) = 4(19) = 76;$   
 $a_5 = 10(5) - 6 = 50 - 6 = 44;$   
 $S_5 = 5(5(5) - 1) = 5(25 - 1) = 5(24) = 120;$   
 $S_4 + a_5 = S_5$   
 $76 + 44 = 120$   
 $120 = 120$

- Verified  
 21.  $a_n = n; S_n = \frac{n(n+1)}{2}$   
 $S_4 = \frac{4(4+1)}{2} = \frac{4(5)}{2} = 10;$   
 $a_5 = 5;$   
 $S_5 = \frac{5(5+1)}{2} = \frac{5(6)}{2} = 15;$   
 $S_4 + a_5 = S_5$   
 $10 + 5 = 15$   
 $15 = 15$

- Verified  
 23.  $a_n = 2^{n-1}; S_n = 2^n - 1$   
 $S_4 = 2^4 - 1 = 16 - 1 = 15;$   
 $a_5 = 2^{5-1} = 2^4 = 16;$   
 $S_5 = 2^5 - 1 = 32 - 1 = 31;$   
 $S_4 + a_5 = S_5$   
 $15 + 16 = 31$   
 $31 = 31$

- Verified  
 25.  $a_n = n; S_n = (1 + 2 + 3 + 4 + \dots + n)^2$   
 $S_1 = 1^2 = 1^3$   
 $S_8 = (1 + 2 + 3 + 4 + 5)^2$   
 $= 15^2$   
 $= 225$   
 $1 + 8 + 27 + 64 + 125 = 225$

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- $$S_9 = (1 + 2 + \cdots + 9)^2$$

$$= 45^2$$

$$= 2025$$

$$1 + 8 + \cdots + 729 = 2025$$

$$\left[ \frac{n(n+1)}{2} \right]^2 = \frac{n^2(n+1)^2}{4}$$
27. 1. Show  $S_n$  is true for  $n = 1$ .  
 $S_1 = 1(1+1) = 1(2) = 2$   
 Verified
2. Assume  $S_k$  is true:  $2 + 4 + 6 + 8 + 10 + \cdots + 2k = k(k+1)$   
 and use it to show the truth of  $S_{k+1}$  follows. That is:  
 $2 + 4 + 6 + \cdots + 2k + 2(k+1) = (k+1)(k+2)$   
 $S_k + a_{k+1} = S_{k+1}$   
 Working with the left hand side:  
 $2 + 4 + 6 + \cdots + 2k + 2(k+1)$   
 $= k(k+1) + 2(k+1)$   
 $= k^2 + k + 2k + 2$   
 $= k^2 + 3k + 2$   
 $= (k+1)(k+2)$   
 $= S_{k+1}$   
 Since the truth of  $S_{k+1}$  follows from  $S_k$ , the formula is true for all  $n$ .
29. 1. Show  $S_n$  is true for  $n = 1$ .  
 $S_1 = \frac{5(1)(1+1)}{2} = \frac{5(2)}{2} = 5$   
 Verified
2. Assume  $S_k$  is true:  
 $5 + 10 + 15 + \cdots + 5k = \frac{5k(k+1)}{2}$   
 and use it to show the truth of  $S_{k+1}$  follows. That is:  
 $5 + 10 + 15 + \cdots + 5k + 5(k+1) = \frac{5(k+1)(k+1+1)}{2}$   
 $S_k + a_{k+1} = S_{k+1}$   
 Working with the left hand side:  
 $5 + 10 + 15 + \cdots + 5k + 5(k+1)$   
 $= \frac{5k(k+1)}{2} + 5(k+1)$   
 $= \frac{5k(k+1) + 10(k+1)}{2}$   
 $= \frac{(k+1)(5k+10)}{2}$   
 $= \frac{5(k+1)(k+2)}{2}$   
 $= S_{k+1}$   
 Since the truth of  $S_{k+1}$  follows from  $S_k$ , the formula is true for all  $n$ .
31. 1. Show  $S_n$  is true for  $n = 1$ .  
 $S_1 = 1(2(1) + 3) = 5$   
 Verified
2. Assume  $S_k$  is true:  
 $5 + 9 + 13 + 17 + \cdots + 4k + 1 = k(2k + 3)$   
 and use it to show the truth of  $S_{k+1}$  follows. That is:  
 $5 + 9 + 13 + 17 + \cdots + 4k + 1 + 4(k+1) + 1$   
 $= (k+1)(2(k+1) + 3)$   
 $S_k + a_{k+1} = S_{k+1}$   
 Working with the left hand side:  
 $5 + 9 + 13 + 17 + \cdots + 4k + 1 + 4k + 5$   
 $= k(2k + 3) + 4k + 5$   
 $= 2k^2 + 3k + 4k + 5 = 2k^2 + 7k + 5$   
 $= (k+1)(2k+5) = S_{k+1}$   
 Since the truth of  $S_{k+1}$  follows from  $S_k$ , the formula is true for all  $n$ .
33. 1. Show  $S_n$  is true for  $n = 1$ .  
 $S_1 = \frac{3(3^1 - 1)}{2} = \frac{3(3 - 1)}{2} = \frac{3(2)}{2} = 3$   
 Verified
2. Assume  $S_k$  is true:  
 $3 + 9 + 27 + \cdots + 3^k = \frac{3(3^k - 1)}{2}$   
 and use it to show the truth of  $S_{k+1}$  follows. That is:  
 $3 + 9 + 27 + \cdots + 3^k + 3^{k+1}$   
 $= \frac{3(3^{k+1} - 1)}{2}$   
 $= \frac{3(3^k - 1)}{2} + 3^{k+1}$   
 $S_k + a_{k+1} = S_{k+1}$   
 Working with the left hand side:  
 $3 + 9 + 27 + \cdots + 3^k + 3^{k+1}$   
 $= \frac{3(3^k - 1)}{2} + 3^{k+1}$   
 $= \frac{3(3^k - 1) + 2(3^{k+1})}{2}$   
 $= \frac{3^{k+1} - 3 + 2(3^{k+1})}{2}$   
 $= \frac{3(3^{k+1}) - 3}{2}$   
 $= \frac{3(3^{k+1} - 1)}{2}$   
 $= S_{k+1}$   
 Since the truth of  $S_{k+1}$  follows from  $S_k$ , the formula is true for all  $n$ .
35. 1. Show  $S_n$  is true for  $n = 1$ .  
 $S_1 = 2^{1+1} - 2 = 2^2 - 2 = 4 - 2 = 2$   
 Verified
2. Assume  $S_k$  is true:  
 $2 + 4 + 8 + \cdots + 2^k = 2^{k+1} - 2$   
 and use it to show the truth of  $S_{k+1}$  follows. That is:  
 $2 + 4 + 8 + \cdots + 2^k + 2^{k+1} = 2^{k+1} - 2$   
 $S_k + a_{k+1} = S_{k+1}$   
 Working with the left hand side:  
 $2 + 4 + 8 + \cdots + 2^k + 2^{k+1}$   
 $= 2^{k+1} - 2 + 2^{k+1}$   
 $= 2(2^{k+1}) - 2$   
 $= 2^{k+2} - 2$   
 $= S_{k+1}$   
 Since the truth of  $S_{k+1}$  follows from  $S_k$ , the formula is true for all  $n$ .
37. 1. Show  $S_n$  is true for  $n = 1$ .  
 $S_1 = \frac{1}{2(1) + 1} = \frac{1}{2 + 1} = \frac{1}{3}$   
 Verified
2. Assume  $S_k$  is true:  
 $\frac{1}{3} + \frac{1}{15} + \frac{1}{35} + \cdots + \frac{1}{(2k-1)(2k+1)} = \frac{k}{2k+1}$   
 and use it to show the truth of  $S_{k+1}$  follows. That is:  
 $\frac{1}{3} + \frac{1}{15} + \frac{1}{35} + \cdots + \frac{1}{(2k-1)(2k+1)}$   
 $+ \frac{1}{(2(k+1)-1)(2(k+1)+1)} = \frac{k+1}{2(k+1)+1}$   
 $S_k + a_{k+1} = S_{k+1}$

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SA66 Student Answer Appendix

Working with the left hand side:

$$\begin{aligned} & \frac{1}{3} + \frac{1}{15} + \frac{1}{35} + \dots + \frac{1}{(2k-1)(2k+1)} + \frac{1}{(2k+1)(2k+3)} \\ &= \frac{k}{2k+1} + \frac{1}{(2k+1)(2k+3)} \\ &= \frac{k(2k+3)+1}{(2k+1)(2k+3)} \\ &= \frac{2k^2+3k+1}{(2k+1)(2k+3)} \\ &= \frac{(2k+1)(2k+3)}{(2k+1)(2k+3)} \\ &= \frac{k+1}{2k+3} \\ &= S_{k+1} \end{aligned}$$

Since the truth of  $S_{k+1}$  follows from  $S_k$ , the formula is true for all  $n$ .

39. 1. Show  $S_n$  is true for  $n = 1$ .

$$\begin{aligned} S_1: 3^1 &\geq 2(1) + 1 \\ 3 &\geq 2 + 1 \\ 3 &\geq 3 \end{aligned}$$

Verified

2. Assume  $S_k: 3^k \geq 2k + 1$  is true and use it to show the truth of  $S_{k+1}$  follows. That is:  $3^{k+1} \geq 2k + 3$ .

Working with the left hand side:

$$\begin{aligned} 3^{k+1} &= 3(3^k) \\ &\geq 3(2k+1) \\ &\geq 6k+3 \end{aligned}$$

Since  $k$  is a positive integer,

$$\begin{aligned} 6k+3 &\geq 2k+3 \\ \text{Showing } S_{k+1}: 3^{k+1} &\geq 2k+3 \end{aligned}$$

Verified

41. 1. Show  $S_n$  is true for  $n = 1$ .

$$\begin{aligned} S_1: 3 \cdot 4^{1-1} &\leq 4^1 - 1 \\ 3 \cdot 4^0 &\leq 4 - 1 \\ 3 \cdot 1 &\leq 3 \\ 3 &\leq 3 \end{aligned}$$

Verified

2. Assume  $S_k: 3 \cdot 4^{k-1} \leq 4^k - 1$  is true and use it to show the truth of  $S_{k+1}$  follows. That is:  $3 \cdot 4^k \leq 4^{k+1} - 1$ .

Working with the left hand side:

$$\begin{aligned} 3 \cdot 4^k &= 3 \cdot 4(4^{k-1}) \\ &= 4 \cdot 3(4^{k-1}) \\ &\leq 4(4^k - 1) \\ &\leq 4^{k+1} - 4 \end{aligned}$$

Since  $k$  is a positive integer,  $4^{k+1} - 4 \leq 4^{k+1} - 1$

Showing that  $3 \cdot 4^k \leq 4^{k+1} - 1$

43.  $n^2 - 7n$  is divisible by 2

1. Show  $S_n$  is true for  $n = 1$ .

$$\begin{aligned} S_n: n^2 - 7n &= 2m \\ S_1: (1)^2 - 7(1) &= 2m \\ 1 - 7 &= 2m \\ -6 &= 2m \quad \text{Verified} \end{aligned}$$

2. Assume  $S_k: k^2 - 7k = 2m$  for  $m \in \mathbb{Z}$  and use it to show the truth of  $S_{k+1}$  follows. That is:  $(k+1)^2 - 7(k+1) = 2p$  for  $p \in \mathbb{Z}$ .

Working with the left hand side:

$$\begin{aligned} &= (k+1)^2 - 7(k+1) \\ &= k^2 + 2k + 1 - 7k - 7 \\ &= k^2 - 7k + 2k - 6 \\ &= 2m + 2k - 6 \\ &= 2(m+k-3) \end{aligned}$$

is divisible by 2.

45.  $n^3 + 3n^2 + 2n$  is divisible by 3

1. Show  $S_n$  is true for  $n = 1$ .  $S_n: n^3 + 3n^2 + 2n = 3m$

$$\begin{aligned} S_1: (1)^3 + 3(1)^2 + 2(1) &= 3m \\ 1 + 3 + 2 &= 3m \\ 6 &= 3m \\ 2 &= m \end{aligned}$$

Verified

2. Assume  $S_k: k^3 + 3k^2 + 2k = 3m$  for  $m \in \mathbb{Z}$  and use it to show the truth of  $S_{k+1}$  follows.

That is:  $S_{k+1}: (k+1)^3 + 3(k+1)^2 + 2(k+1) = 3p$  for  $p \in \mathbb{Z}$ .

Working with the left hand side:

$$\begin{aligned} &(k+1)^3 + 3(k+1)^2 + 2(k+1) \text{ is true.} \\ &= k^3 + 3k^2 + 3k + 1 + 3(k^2 + 2k + 1) + 2k + 2 \\ &= k^3 + 3k^2 + 2k + 3(k^2 + 2k + 1) + 3k + 3 \\ &= k^3 + 3k^2 + 2k + 3(k^2 + 2k + 1) + 3(k+1) \\ &= 3m + 3(k^2 + 2k + 1) + 3(k+1) \text{ is divisible by 3.} \end{aligned}$$

47.  $6^n - 1$  is divisible by 5

1. Show  $S_n$  is true for  $n = 1$ .  $S_n: 6^n - 1 = 5m$

$$\begin{aligned} S_1: 6^1 - 1 &= 5m \\ 6 - 1 &= 5m \\ 5 &= 5m \\ 1 &= m \quad \text{Verified} \end{aligned}$$

2. Assume  $S_k: 6^k - 1 = 5m$  for  $m \in \mathbb{Z}$  and use it to show the truth of  $S_{k+1}$  follows.

That is:  $S_{k+1}: 6^{k+1} - 1 = 5p$  for  $p \in \mathbb{Z}$ .

Working with the left hand side:

$$\begin{aligned} &= 6^k - 1 \\ &= 6(6^k) - 1 \\ &= 6(5m + 1) - 1 \\ &= 30m + 6 - 1 \\ &= 30m + 5 \\ &= 5(6m + 1) \end{aligned}$$

is divisible by 5, Verified

49. verified 51. verified 53.  $(x-4)^2 + (y-3)^2 = 25$   
 $(x-3)^2 + (x-4)^2 = 25$

Mid-Chapter Check, pp. 1051-1052

1. 3, 10, 17,  $a_9 = 59$  2. 4, 7, 12,  $a_9 = 84$  3. -1, 3, -5,  $a_9 = -17$

4. 360 5.  $\sum_{k=1}^n (3k-2)$  6. d 7. e 8. a 9. b 10. c

11. a.  $a_1 = 2, d = 3, a_n = 3n - 1$  b.  $a_1 = \frac{3}{2}, d = \frac{3}{4}, a_n = \frac{3}{4}n + \frac{3}{4}$

12.  $n = 25, S_{25} = 950$  13.  $n = 16, S_{16} = 128$

14.  $S_{10} = -5$  15.  $S_{10} = \frac{-29,524}{27}$

16. a.  $a_1 = 2, r = 3, a_n = 2(3)^{n-1}$  b.  $a_1 = \frac{1}{2}, r = \frac{1}{2}, a_n = (\frac{1}{2})^n$

17.  $n = 8, S_8 = \frac{1680}{27}$  18.  $\frac{-343}{6}$  19. 1785 20.  $\approx 4.5$  ft;  $\approx 127.9$  ft

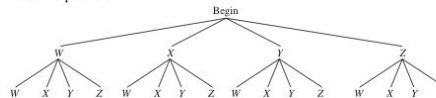
Reinforcing Basic Concepts, p. 1052

Exercise I: \$71,500

Exercises 11.5, pp. 1060-1064

1. experiment; well-defined 3. distinguishable 5. Answers will vary.

7. a. 16 possible



- b. WW, WX, WY, WZ, XW, XX, XY, XZ, YW, YX, YY, YZ, ZW, ZX, ZY, ZZ

9. 32 11. 15,625 13. 2,704,000 15. a. 59,049 b. 15,120

17. 360 if double veggies are not allowed, 432 if double veggies are allowed. 19. a. 120 b. 625 c. 12 21. 24 23. 4 25. 120 27. 6

29. 720 31. 3024 33. 40,320 35. 6; 3 37. 90 39. 336

41. a. 720 b. 120 c. 24 43. 360 45. 60 47. 60 49. 120

51. 30 53. 60, BANANA 55. 126 57. 56 59. 1 61. verified

63. verified 65. 495 67. 364 69. 252 71. 40,320 73. 336

75. 15,504 77. 70 79. a.  $\approx 1.2\%$  b.  $\approx 0.83\%$  81. 7776 83. 324

85. 800 87. 6,272,000,000 89. 518,400 91. 357,696 93. 6720

95. 8 97. 10,080 99. 5040 101. 2880 103. 5005 105. 720

107. 52,650, no 109. a.  $\frac{10!}{213!5!}$  b.  $\frac{9!}{213!4!}$  c.  $\frac{11!}{4!5!2!}$  d.  $\frac{8!}{213!3!}$

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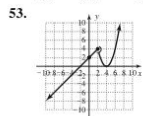
111.  113.  $\cos(5\alpha)$

**Exercises 11.6, pp. 1071–1077**

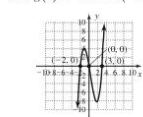
1.  $n(E)$  3. 0; 1; 1; 0 5. Answers will vary.  
 7.  $S = \{\text{HH, HT, TH, TT}\}$ ,  $\frac{1}{4}$  9.  $S = \{\text{coach of Patriots, Cougars, Angels, Sharks, Eagles, Stars}\}$ ,  $\frac{1}{6}$  11.  $P(E) = \frac{8}{9}$  13. a.  $\frac{1}{13}$  b.  $\frac{1}{4}$  c.  $\frac{1}{2}$  d.  $\frac{1}{26}$   
 15.  $P(E_1) = \frac{1}{8}$ ,  $P(E_2) = \frac{3}{8}$ ,  $P(E_3) = \frac{3}{4}$  17. a.  $\frac{3}{4}$  b. 1 c.  $\frac{1}{4}$  d.  $\frac{1}{2}$  19.  $\frac{3}{4}$   
 21.  $\frac{6}{7}$  23. 0.991 25. a.  $\frac{1}{12}$  b.  $\frac{11}{12}$  c.  $\frac{8}{9}$  d.  $\frac{5}{6}$  27.  $\frac{10}{21}$  29.  $\frac{60}{143}$   
 31. b, about 12% 33. a. 0.3651 b. 0.3651 c. 0.3969 35. 0.9  
 37.  $\frac{7}{24}$  39. 0.59 41. a.  $\frac{1}{6}$  b.  $\frac{7}{36}$  c.  $\frac{1}{3}$  d.  $\frac{4}{9}$  43. a.  $\frac{2}{25}$  b.  $\frac{9}{50}$  c. 0  
 d.  $\frac{8}{25}$  e. 1 45.  $\frac{3}{4}$  47.  $\frac{11}{15}$  49. a.  $\frac{8}{15}$  b.  $\frac{7}{9}$  c.  $\frac{8}{9}$  d.  $\frac{3}{4}$  e.  $\frac{1}{36}$  f.  $\frac{8}{12}$   
 51.  $\frac{1}{4}$ ;  $\frac{1}{256}$ ; answers will vary. 53. a. 0.33 b. 0.67 c. 1 d. 0  
 e. 0.67 f. 0.08 55. a.  $\frac{1}{2}$  b.  $\frac{1}{2}$  c. 0.2165 57. a.  $\frac{9}{16}$  b.  $\frac{1}{4}$   
 c.  $\frac{1}{16}$  d.  $\frac{5}{16}$  59. a.  $\frac{3}{26}$  b.  $\frac{3}{26}$  c.  $\frac{1}{13}$  d.  $\frac{9}{26}$  e.  $\frac{2}{13}$  f.  $\frac{11}{26}$   
 61. a.  $\frac{1}{4}$  b.  $\frac{1}{16}$  c.  $\frac{3}{16}$  63. a.  $\frac{87}{100}$  b.  $\frac{7}{25}$  c.  $\frac{1}{100}$  d.  $\frac{9}{50}$  e.  $\frac{11}{100}$   
 65. a.  $\frac{5}{429}$  b.  $\frac{8}{2145}$  67.  $\frac{87}{3360}$  69.  $\frac{1}{1,048,376}$ ; answers will vary;  
 20 heads in a row. 71.  $\sin \theta = \frac{1}{3}$ ,  $\cos \theta = -\frac{2\sqrt{2}}{3}$ ,  $\tan \theta = -\frac{1}{2\sqrt{2}}$   
 $\sec \theta = -\frac{3}{2\sqrt{2}}$ ,  $\cot \theta = -2\sqrt{2}$   
 73.  $\sin(2\theta) = -\frac{840}{841}$ ,  $\cos(2\theta) = \frac{41}{841}$ ,  $\tan(2\theta) = -\frac{840}{41}$

**Exercises 11.7, pp. 1083–1084**

1. one 3.  $(a + (-2b))^5$  5. Answers will vary.  
 7.  $x^5 + 5x^4y + 10x^3y^2 + 10x^2y^3 + 5xy^4 + y^5$   
 9.  $16x^4 + 96x^3 + 216x^2 + 216x + 81$   
 11. 41 + 38i 13. 35 15. 10 17. 1140 19. 9880 21. 1 23. 1  
 25.  $c^5 + 5c^4d + 10c^3d^2 + 10c^2d^3 + 5cd^4 + d^5$   
 27.  $a^6 - 6a^5b + 15a^4b^2 - 20a^3b^3 + 15a^2b^4 - 6ab^5 + b^6$   
 29.  $16x^4 - 96x^3 + 216x^2 - 216x + 81$   
 31.  $-11 + 2i$  33.  $x^9 + 18x^8y + 144x^7y^2 + \dots$   
 35.  $v^{24} - 6v^{22}w + \frac{33}{2}v^{20}w^2$  37.  $35x^4y^3$  39.  $1792p^2$  41.  $264x^2y^{10}$   
 43.  $\approx 0.25$  45. a.  $\approx 17.8\%$  b.  $\approx 23.0\%$  47. a.  $\approx 0.88\%$  b.  $\approx 6.9\%$   
 c.  $\approx 99.0\%$  d.  $\approx 61.0\%$  49. a. 99.33% b. 94.22%  
 51.  $\binom{6}{6} = \frac{6!}{6!0!} = 1$ ;  $\binom{6}{5} = \frac{6!}{5!1!} = 6$ ;  $\binom{6}{4} = \frac{6!}{4!2!} = 15$ ;  $\binom{6}{3} = 20$



$f(3) = 1$   
 55.  $g(x) > 0$ :  $x \in (-2, 0) \cup (3, \infty)$



**Summary and Concept Review, pp. 1085–1089**

1. 1, 6, 11, 16;  $a_{10} = 46$  2.  $1, \frac{3}{2}, \frac{5}{2}, \frac{7}{2}$ ;  $a_{10} = \frac{11}{2}$   
 3.  $a_n = n^2$ ;  $a_6 = 1296$  4.  $a_n = -17 + (n-1)(3)$ ;  $a_6 = -2$   
 5.  $\frac{255}{256}$  6.  $-112$  7. 140 8. 35 9. not defined, 2, 6, 12, 20, 30  
 10.  $\frac{1}{2}, \frac{3}{4}, \frac{5}{4}, \frac{7}{4}$  11.  $\sum_{n=1}^7 (n^2 + 3n - 2)$ ; 210 12.  $a_n = 2 + 3(n-1)$ ; 119  
 13.  $a_n = 3 + (-2)(n-1)$ ;  $-65$  14. 740 15. 1335 16. 630  
 17.  $-11.25$  18. 875 19. 3240 20. 3645 21. 32 22. 2401  
 23. 10.75 24. 6560 25.  $\frac{819}{513}$  26. does not exist 27.  $\frac{50}{9}$  28. 4  
 29.  $\frac{63,050}{6561}$  30. does not exist 31. 5 32.  $a_9 \approx \$36,980$ ;  $S_9 \approx \$314,900$   
 33.  $\approx 7111.1 \text{ ft}^3$  34.  $a_9 \approx 2105$  credit hrs;  $S_9 \approx 14,673$  credit hours  
 35. (1) Show  $S_n$  is true for  $n = 1$ :  $S_1 = \frac{1(1+1)}{2} = 1$

(2) Assume  $S_k$  is true:  
 $1 + 2 + 3 + \dots + k = \frac{k(k+1)}{2}$   
 Use it to show the truth of  $S_{k+1}$ :  
 $1 + 2 + 3 + \dots + k + (k+1) = \frac{(k+1)(k+2)}{2}$   
 left-hand side:  $1 + 2 + 3 + \dots + k + (k+1)$   
 $= \frac{k(k+1)}{2} + \frac{2(k+1)}{2} = \frac{k(k+1) + 2(k+1)}{2}$   
 $= \frac{(k+1)(k+2)}{2}$  verified

36. (1) Show  $S_n$  is true for  $n = 1$ :  $S_1 = \frac{1[2(1) + 1](1+1)}{6} = 1$

(2) Assume  $S_k$  is true:  
 $1 + 4 + 9 + \dots + k^2 = \frac{k(2k+1)(k+1)}{6}$   
 Use it to show the truth of  $S_{k+1}$ :  
 $1 + 4 + 9 + \dots + k^2 + (k+1)^2 = \frac{(k+1)(2k+3)(k+2)}{6}$   
 left-hand side:  $1 + 4 + 9 + \dots + k^2 + (k+1)^2$   
 $= \frac{k(k+1)(2k+1)}{6} + \frac{6(k+1)^2}{6} = \frac{(k+1)[(2k^2 + k + 6k + 6)]}{6}$   
 $= \frac{(k+1)(2k^2 + 7k + 6)}{6} = \frac{(k+1)(2k+3)(k+2)}{6}$   
 verified

37. (1) Show  $S_n$  is true for  $n = 1$ :  $S_1: 4^1 \geq 3(1) + 1$

(2) Assume  $S_k$  is true:  $4^k \geq 3k + 1$   
 Use it to show the truth of  $S_{k+1}$ :  
 $4^{k+1} \geq 3(k+1) + 1 = 3k + 4$   
 left-hand side:  $4^{k+1} = 4(4^k)$   
 $\geq 4(3k+1) = 12k + 4$   
 Since  $k$  is a positive integer,  $12k + 4 \geq 3k + 4$  showing  
 $4^{k+1} \geq 3k + 4$   
 verified

38. (1) Show  $S_n$  is true for  $n = 1$ :  $S_1: 6 \cdot 7^{1-1} \leq 7^1 - 1$

(2) Assume  $S_k$  is true:  $6 \cdot 7^{k-1} \leq 7^k - 1$   
 Use it to show the truth of  $S_{k+1}$ :  
 $6 \cdot 7^k \leq 7^{k+1} - 1$   
 left-hand side:  $6 \cdot 7^k = 7 \cdot 6 \cdot 7^{k-1}$   
 $\leq 7 \cdot 7^k - 1$   
 $\leq 7^{k+1} - 1$   
 verified

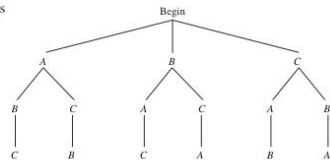
39. (1) Show  $S_n$  is true for  $n = 1$ :  $S_1: 3^1 - 1 = 2$  or  $2(1)$

(2) Assume  $S_k$  is true:  $3^k - 1 = 2p$  for  $p \in \mathbb{Z}$   
 Use it to show the truth of  $S_{k+1}$ :  
 $3^{k+1} - 1 = 2q$  for  $q \in \mathbb{Z}$   
 left-hand side:  $3^{k+1} - 1 = 3 \cdot 3^k - 1$   
 $= 3 \cdot 2p$   
 $= 2(3p) = 2q$  is divisible by 2  
 verified

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SA68 Student Answer Appendix

40. 6 ways



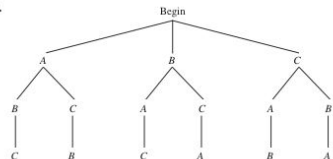
41. 720; 1000 42. 24 43. 220 44. 32  
 45. a. 5040 b. 840 c. 35 46. a. 720 b. 120 c. 24 47. 3360  
 48. a. 220 b. 1320 49.  $\frac{4}{13}$  50.  $\frac{3}{13}$  51.  $\frac{5}{6}$  52.  $\frac{2}{4}$  53.  $\frac{173}{396}$   
 54. a. 0.608 b. 0.392 c. 1 d. 0 e. 0.928 f. 0.178  
 55. a. 21 b. 56 56. a.  $x^4 - 4x^3y + 6x^2y^2 - 4xy^3 + y^4$  b.  $41 - 38i$   
 57. a.  $a^8 + 8\sqrt{3}a^7 + 84a^6 + 168\sqrt{3}a^5$   
 b.  $78,125a^7 + 218,750a^6b + 262,500a^5b^2 + 175,000a^4b^3$   
 58. a.  $280x^4y^3$  b.  $-64,064a^9b^9$

Mixed Review, pp. 1089–1090

1. a. arithmetic b.  $a_n = 4$  c.  $a_n = n!$  d. arithmetic e. geometric  
 f. geometric g. arithmetic h. geometric i.  $a_n = \frac{1}{2n}$  3. 27,600  
 5. 0.1, 0.5, 2.5, 12.5, 62.5;  $a_{15} = 610,351,562.5$  7.  $\frac{5}{6}$   
 9. a. 2 b. 200 c. 210 11. a.  $a^{20} + 20a^{19}b + 190a^{18}b^2$   
 b.  $190a^2b^{18} + 20ab^{19} + b^{20}$  c.  $52,360a^{31}b^4$  d.  $4.6 \times 10^{-18}$   
 13. verified 15. 0.01659 17.  $\frac{4}{11}$  19.  $10, 2, \frac{2}{5}, \frac{2}{125}$

Practice Test, pp. 1091–1092

1. a.  $\frac{1}{2}, \frac{4}{1}, 7$ ;  $a_8 = \frac{16}{11}$ ,  $a_{12} = \frac{8}{5}$  b. 6, 12, 20, 30;  $a_8 = 90$ ,  $a_{12} = 182$   
 c.  $3, 2\sqrt{2}, \sqrt{7}, \sqrt{6}$ ;  $a_8 = \sqrt{2}$ ,  $a_{12} = \sqrt{2}$  2. a. 165 b.  $\frac{311}{420}$  c.  $-\frac{2343}{512}$   
 d. 7 3. a.  $a_1 = 7, d = -3, a_n = 10 - 3n$   
 b.  $a_1 = -8, d = 2, a_n = 2n - 10$  c.  $a_1 = 4, r = -2, a_n = 4(-2)^{n-1}$   
 d.  $a_1 = 10, r = \frac{2}{3}, a_n = 10(\frac{2}{3})^{n-1}$   
 4. a. 199 b. 9 c.  $\frac{3}{4}$  d. 6 5. a. 1712 b. 2183 c. 2188 d. 12  
 6. a.  $\approx 8.82$  ft b.  $\approx 72.4$  ft 7. \$6756.57 8. \$22,185.27 9. verified  
 10. verified  
 11. a.



- b. ABC, ACB, BAC, BCA, CAB, CBA 12. 302,400 13. 64  
 14. 720, 120, 20 15. 900,900 16. 302,400  
 17. a.  $x^4 - 8x^3y + 24x^2y^2 - 32xy^3 + 16y^4$  b. -4  
 18. a.  $x^{10} + 10\sqrt{2}x^9 + 90x^8$  b.  $a^8 - 16a^7b^3 + 112a^6b^6$   
 19. 0.989 20. a.  $\frac{1}{4}$  b.  $\frac{5}{12}$  c.  $\frac{1}{3}$  d.  $\frac{1}{2}$  e.  $\frac{7}{12}$  f.  $\frac{1}{4}$  g.  $\frac{5}{12}$  h. 0  
 21. a. 0.08 b. 0.92 c. 1 d. 0 e. 0.95 f. 0.03  
 22. a. 0.1875 b. 0.589 c. 0.4015 d. 0.2945 e. 0.4110 f. 0.2055  
 23. a.  $\frac{59}{100}$  b.  $\frac{53}{100}$  c.  $\frac{13}{100}$  d.  $\frac{47}{100}$   
 24. a. 0.8075 b. 0.0075 c. 0.9925 25. verified

Strengthening Core Skills, pp. 1093–1094

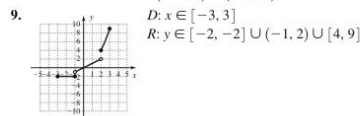
- Exercise 1.  $\frac{{}_4C_1 \cdot {}_{13}C_5 - 40}{{}_{52}C_5} \approx 0.001970$   
 Exercise 2.  $\frac{4 \cdot {}_{13}C_1 \cdot {}_{39}C_2}{{}_{52}C_5} \approx 0.326170$   
 Exercise 3.  $\frac{4 \cdot {}_{13}C_4 \cdot {}_{39}C_1}{{}_{52}C_5} \approx 0.042917$   
 Exercise 4.  $\frac{4 \cdot {}_{10}C_5}{{}_{52}C_5} \approx 0.000388$

Cumulative Review Chapters 1–11, pp. 1094–1096

1. a. 23 cards are assembled each hour. b. 184 cards  
 c.  $y = 23x - 155$  d.  $\approx 6:45$  A.M.  
 3. 

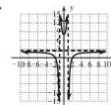
x	0	$\frac{\pi}{6}$	$\frac{\pi}{4}$	$\frac{\pi}{3}$	$\frac{\pi}{2}$	$\frac{2\pi}{3}$	$\frac{5\pi}{6}$	$\pi$
y	1	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{1}{2}$	0	$-\frac{1}{2}$	$-\frac{\sqrt{3}}{2}$	-1

  
 5.  $x = \frac{-5 \pm \sqrt{109}}{6}$ ;  $x \approx 0.91$ ;  $x \approx -2.57$   
 7. a.  $x = 0$  b.  $x \in (-1, 0)$  c.  $x \in (-\infty, -1) \cup (0, \infty)$   
 d.  $x \in (-\infty, -1) \cup (-1, 1)$  e.  $x \in (1, \infty)$  f.  $y = 3$  at  $(1, 3)$   
 g. none h.  $x = -2.3, 0.4, 2$  i.  $g(4) \approx 0.25$  j. does not exist  
 k.  $-\infty$  l. 0 m.  $x \in (-\infty, 1) \cup (-1, \infty)$



11. a.  $4x + 2h - 3$  b.  $\frac{-1}{(x+h-2)(x-2)}$

13.



15. a.  $x^3 = 125$  b.  $e^5 = 2x - 1$   
 17. a.  $x \approx 3.19$  b.  $x = 334$  19.  $(5, 10, 15)$   
 21.  $(-3, 3)$ ;  $(-7, 3)$ ;  $(1, 3)$ ;  $(-3 - 2\sqrt{3}, 3)$ ;  $(-3 + 2\sqrt{3}, 3)$   
 23. a. verified b.  $\frac{\sqrt{6} + \sqrt{2}}{4}$  25. 1333 27. a.  $\approx 7.0\%$  b.  $\approx 91.9\%$   
 c.  $\approx 98.9\%$  d.  $(\frac{12}{0})^{12}(0.96)^0$ ; virtually nil

29.  $\cos(2\theta) = \cos^2\theta - \sin^2\theta$   
 $= 1 - 2\sin^2\theta$   
 $= 2\cos^2\theta - 1$   
 $\frac{1}{2} = 1 - 2\sin^2\theta$   
 $\frac{1}{4} = \sin^2\theta$   
 $\pm\frac{1}{2} = \sin\theta$   
 $\theta = \frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{13\pi}{6}$



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Coburn: Algebra and  
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Coburn: Algebra and  
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▼ **Special Constants**

$\pi \approx 3.1416$	$\frac{\pi}{2} \approx 3.1416$	$\frac{\pi}{3} \approx 1.0472$	$\frac{\pi}{4} \approx 0.7854$	$\frac{\pi}{6} \approx 0.5236$	$\frac{\pi}{12} \approx 0.2618$
$e \approx 2.7183$	$\sqrt{2} \approx 1.4142$	$\sqrt{3} \approx 1.7321$	$\frac{\sqrt{2}}{2} \approx 0.7071$	$\frac{\sqrt{3}}{2} \approx 0.8660$	$\frac{\sqrt{3}}{3} \approx 0.5774$






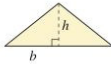
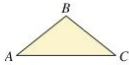
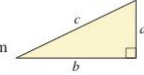

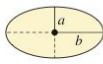
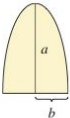
▼ **Special Products**

$(x + a)(x + b) = x^2 + (a + b)x + ab$ $(a + b)^2 = a^2 + 2ab + b^2$ $(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$	$(a + b)(a - b) = a^2 - b^2$ $(a - b)^2 = a^2 - 2ab + b^2$ $(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3$
--	--

▼ **Special Factorizations**

$x^2 + (a + b)x + ab = (x + a)(x + b)$ $a^2 + 2ab + b^2 = (a + b)^2$ $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$	$a^2 - b^2 = (a + b)(a - b)$ $a^2 - 2ab + b^2 = (a - b)^2$ $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$
--	--

▼ **Formulas from Plane Geometry: P → perimeter, C → circumference, A → area**

<p><b>Rectangle</b> </p> <p><math>P = 2l + 2w</math> <math>A = lw</math></p>	<p><b>Square</b> </p> <p><math>P = 4s</math> <math>A = s^2</math></p>	<p><b>Regular Polygon</b> </p> <p><math>P = ns</math> <math>A = \frac{a}{2}P</math></p>
<p><b>Parallelogram</b> </p> <p><math>A = bh</math></p>	<p><b>Trapezoid</b> </p> <p><math>A = \frac{h}{2}(a + b)</math></p>	<p><b>Triangle</b> </p> <p><math>A = \frac{1}{2}bh</math></p>
<p><b>Triangle</b> </p> <p>Sum of angles <math>A + B + C = 180^\circ</math></p>	<p><b>Right Triangle</b> </p> <p>Pythagorean Theorem <math>a^2 + b^2 = c^2</math></p>	<p><b>Circle</b> </p> <p><math>A = \pi r^2</math> <math>C = 2\pi r = \pi d</math></p>
<p><b>Ellipse</b> </p> <p><math>A = \pi ab</math> <math>C \approx \pi \sqrt{2(a^2 + b^2)}</math></p>	<p><b>Right Parabolic Segment</b> </p> <p><math>A = \frac{4}{3}ab</math></p>	

▼ **Formulas from Solid Geometry: S → surface area, V → volume**

<p><b>Rectangular Solid</b></p> <p><math>V = lwh</math> <math>S = lw + lh + wh</math></p>	<p><b>Cube</b></p> <p><math>V = s^3</math> <math>S = 6s^2</math></p>	<p><b>Right Circular Cylinder</b></p> <p><math>V = \pi r^2 h</math> <math>S = 2\pi r(r + h)</math></p>
<p><b>Right Circular Cone</b></p> <p><math>V = \frac{1}{3}\pi r^2 h</math> <math>S = \pi r(r + s)</math></p>	<p><b>Right Square Pyramid</b></p> <p><math>V = \frac{1}{3}s^2 h</math> <math>S = b^2 + b\sqrt{b^2 + 4h^2}</math></p>	<p><b>Sphere</b></p> <p><math>V = \frac{4}{3}\pi r^3</math> <math>S = 4\pi r^2</math></p>

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**Formulas from Analytical Geometry:  $P_1 \rightarrow (x_1, y_1), P_2 \rightarrow (x_2, y_2)$**

**Distance between  $P_1$  and  $P_2$**

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

**Equation of Line Containing  $P_1$  and  $P_2$**

Point-Slope Form

$$y - y_1 = m(x - x_1)$$

**Parallel Lines**

Slopes Are Equal:  $m_1 = m_2$

**Intersecting Lines**

Slopes Are Unequal:  $m_1 \neq m_2$

**Slope of Line Containing  $P_1$  and  $P_2$**

$$m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

**Equation of Line Containing  $P_1$  and  $P_2$**

Slope-Intercept Form (slope  $m$ , y-intercept  $b$ )

$$y = mx + b, \text{ where } b = y_1 - mx_1$$

**Perpendicular Lines**

Slopes Have a Product of  $-1$ :  $m_1 m_2 = -1$

**Dependent (Coincident) Lines**

Slopes and y-Intercepts Are Equal:  $m_1 = m_2, b_1 = b_2$

**Logarithms and Logarithmic Properties**

$$y = \log_b x \Leftrightarrow b^y = x$$

$$\log_b b = 1$$

$$\log_b 1 = 0$$

$$\log_b b^x = x$$

$$b^{\log_b x} = x$$

$$\log_b x = \frac{\log_c x}{\log_b c}$$

$$\log_b MN = \log_b M + \log_b N$$

$$\log_b \frac{M}{N} = \log_b M - \log_b N$$

$$\log_b M^p = p \cdot \log_b M$$

**Applications of Exponentials and Logarithms**

$A \rightarrow$  amount accumulated

$P \rightarrow$  initial deposit,  $p \rightarrow$  periodic payment

$n \rightarrow$  compounding periods/year

$r \rightarrow$  interest rate per year

$R \rightarrow$  interest rate per time period  $\left(\frac{r}{n}\right)$

$t \rightarrow$  time in years

**Interest Compounded  $n$  Times per Year**

$$A = P \left(1 + \frac{r}{n}\right)^{nt}$$

**Interest Compounded Continuously**

$$A = Pe^{rt}$$

**Accumulated Value of an Annuity**

$$A = \frac{P}{R} [(1 + R)^{nt} - 1]$$

**Payments Required to Accumulate Amount  $A$**

$$P = \frac{AR}{(1 + R)^{nt} - 1}$$

**Sequences and Series:**

$a_1 \rightarrow$  1st term,  $a_n \rightarrow$  nth term,  $S_n \rightarrow$  sum of  $n$  terms,  $d \rightarrow$  common difference,  $r \rightarrow$  common ratio

**Arithmetic Sequences**

$$a_1, a_2 = a_1 + d, a_3 = a_1 + 2d, \dots, a_n = a_1 + (n - 1)d$$

$$S_n = \frac{n}{2}(a_1 + a_n)$$

$$S_n = \frac{n}{2}[2a_1 + (n - 1)d]$$

**Geometric Sequences**

$$a_1, a_2 = a_1 r, a_3 = a_1 r^2, \dots, a_n = a_1 r^{n-1}$$

$$S_n = \frac{a_1 - a_1 r^n}{1 - r}$$

$$S_\infty = \frac{a_1}{1 - r}; |r| < 1$$

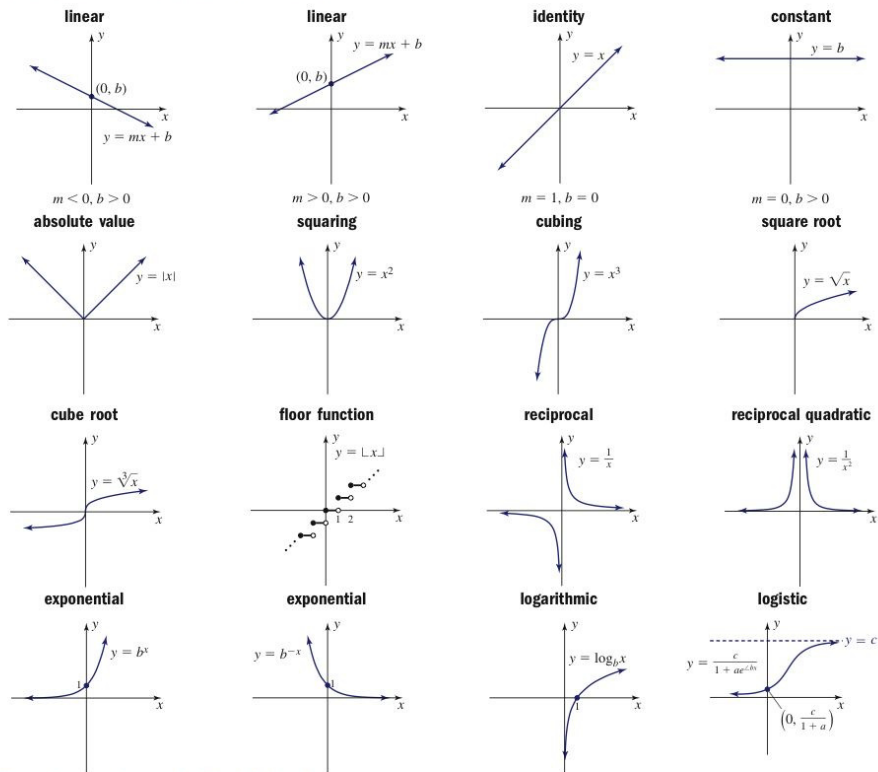
**Binomial Theorem**

$$(a + b)^n = \binom{n}{0} a^n b^0 + \binom{n}{1} a^{n-1} b^1 + \binom{n}{2} a^{n-2} b^2 + \dots + \binom{n}{n-1} a^1 b^{n-1} + \binom{n}{n} a^0 b^n$$

$$n! = n(n - 1)(n - 2) \dots (3)(2)(1) \quad \binom{n}{k} = \frac{n!}{k!(n - k)!} \quad 0! = 1$$

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**▼ The Toolbox and Other Functions**



**▼ Transformations of Basic Graphs**

**Given Function**

$$y = f(x)$$

**Transformation of Given Function**

$$y = af(x \pm h) \pm k$$

vertical reflections      horizontal shift  $h$  units, opposite direction of sign      vertical shift  $k$  units, same direction as sign

**▼ Average Rate of Change of  $f(x)$**

For linear function models, the average rate of change on the interval  $[x_1, x_2]$  is constant, and given by the slope formula:  $\frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$ . The average rate of change for other function models is non-constant. By writing the slope formula in function form using  $y_1 = f(x_1)$  and  $y_2 = f(x_2)$ , we can compute the average rate of change of other functions on this interval:

$$\frac{\Delta y}{\Delta x} = \frac{f(x_2) - f(x_1)}{x_2 - x_1}$$



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**Quick Counting and Probability**

**Fundamental Counting Principle:** Given an experiment with two tasks completed in sequence, if the first can be completed in  $m$  ways and the second in  $n$  ways, the experiment can be completed in  $m \times n$  ways.

**Permutations—Order Is a Consideration:** (Al, Bo, Ray) and (Ray, Bo, Al) finish the race in a different order.

The permutations of  $r$  objects selected from a set of  $n$  (unique) objects is given by  ${}_nP_r = \frac{n!}{(n-r)!}$ .

**Combinations—Order Is Not a Consideration:** (Al, Bo, Ray) and (Ray, Bo, Al) form the same committee.

The combinations of  $r$  objects selected from a set of  $n$  (unique) objects is given by  ${}_nC_r = \frac{n!}{r!(n-r)!}$ .

**Basic Probability:** Given  $S$  is a sample space of equally likely events and  $E$  is an event defined relative to  $S$ .

The probability of  $E$  is  $P(E) = \frac{n(E)}{n(S)}$ , where  $n(E)$  and  $n(S)$  represent the number of elements in each.

For any event  $E_1$ :  $0 \leq P(E_1) \leq 1$  and  $P(E_1) + P(\neg E_1) = 1$ .

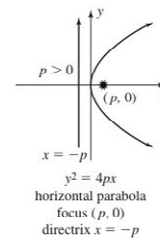
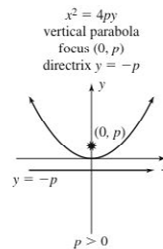
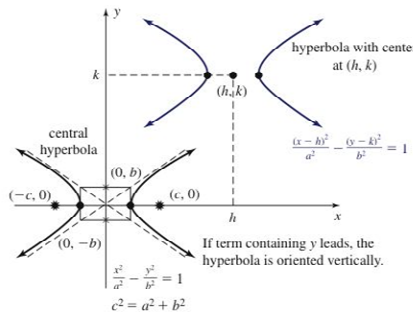
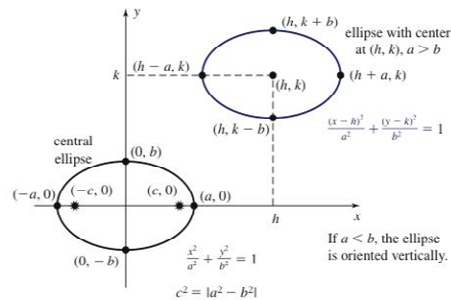
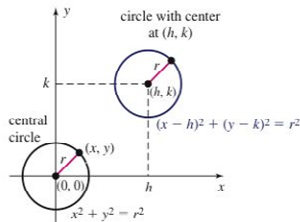
**Probability of  $E_1$  and  $E_2$**

$$P(E_1 \cap E_2) = P(E_1)P(E_2)$$

**Probability of  $E_1$  or  $E_2$**

$$P(E_1 \cup E_2) = P(E_1) + P(E_2) - P(E_1 \cap E_2)$$

**Conic Sections**



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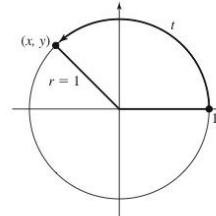
**Commonly used, small case Greek letters**

$\alpha$	alpha	$\beta$	beta	$\gamma$	gamma	$\delta$	delta	$\epsilon$	epsilon
$\zeta$	zeta	$\theta$	theta	$\lambda$	lamda	$\mu$	mu	$\pi$	pi
$\rho$	rho	$\sigma$	sigma	$\phi$	phi	$\psi$	psi	$\omega$	omega

**Trigonometric Functions of a Real Number**

For any real number  $t$  and point  $P(x, y)$  on the unit circle associated with  $t$ :

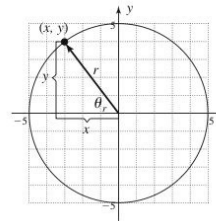
$$\begin{aligned} \cos t &= x & \sin t &= y & \tan t &= \frac{y}{x}; x \neq 0 \\ \sec t &= \frac{1}{x}; x \neq 0 & \csc t &= \frac{1}{y}; y \neq 0 & \cot t &= \frac{x}{y}; y \neq 0 \end{aligned}$$



**Trigonometry and the Coordinate Plane**

For  $P(x, y)$  a point on the terminal side of an angle  $\theta$  in standard position:

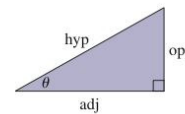
$$\begin{aligned} \cos \theta &= \frac{x}{r} & \sin \theta &= \frac{y}{r} & \tan \theta &= \frac{y}{x}; x \neq 0 \\ \sec \theta &= \frac{r}{x}; x \neq 0 & \csc \theta &= \frac{r}{y}; y \neq 0 & \cot \theta &= \frac{x}{y}; y \neq 0 \end{aligned}$$



**Right Triangle Trigonometry**

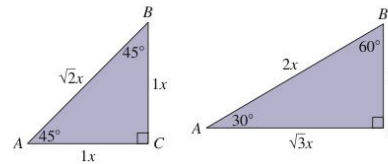
For right  $\triangle ABC$  with indicated sides **adjacent** and **opposite** to acute angle  $\theta$ :

$$\begin{aligned} \cos \theta &= \frac{\text{adj}}{\text{hyp}} & \sin \theta &= \frac{\text{opp}}{\text{hyp}} & \tan \theta &= \frac{\text{opp}}{\text{adj}} \\ \sec \theta &= \frac{\text{hyp}}{\text{adj}} & \csc \theta &= \frac{\text{hyp}}{\text{opp}} & \cot \theta &= \frac{\text{adj}}{\text{opp}} \end{aligned}$$

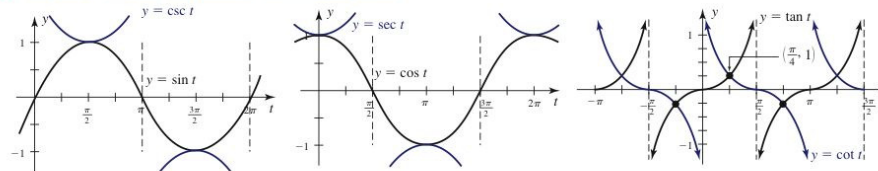


**Special Triangles and Special Angles**

$\theta$	$\sin \theta$	$\cos \theta$	$\tan \theta$	$\csc \theta$	$\sec \theta$	$\cot \theta$
$0^\circ$	0	1	0	—	1	—
$30^\circ$	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}}$	2	$\frac{2}{\sqrt{3}}$	$\sqrt{3}$
$45^\circ$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{2}}{2}$	1	$\sqrt{2}$	$\sqrt{2}$	1
$60^\circ$	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$	$\frac{2}{\sqrt{3}}$	2	$\frac{1}{\sqrt{3}}$
$90^\circ$	1	0	—	1	—	0



**Graphs of the Trigonometric Functions**



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**Fundamental Identities**

**Reciprocal Identities**

$$\sec \theta = \frac{1}{\cos \theta}$$

$$\csc \theta = \frac{1}{\sin \theta}$$

$$\cot \theta = \frac{1}{\tan \theta}$$

**Ratio Identities**

$$\tan \theta = \frac{\sin \theta}{\cos \theta}$$

$$\cot \theta = \frac{\cos \theta}{\sin \theta}$$

**Pythagorean Identities**

$$\sin^2 \theta + \cos^2 \theta = 1$$

$$1 + \tan^2 \theta = \sec^2 \theta$$

$$1 + \cot^2 \theta = \csc^2 \theta$$

**Identities due to Symmetry**

$$\sin(-\theta) = -\sin \theta$$

$$\cos(-\theta) = \cos \theta$$

$$\tan(-\theta) = -\tan \theta$$

**Cofunction Identities**

$$\sin\left(\frac{\pi}{2} - x\right) = \cos x$$

$$\tan\left(\frac{\pi}{2} - x\right) = \cot x$$

$$\sec\left(\frac{\pi}{2} - x\right) = \csc x$$

$$\cos\left(\frac{\pi}{2} - x\right) = \sin x$$

$$\cot\left(\frac{\pi}{2} - x\right) = \tan x$$

$$\csc\left(\frac{\pi}{2} - x\right) = \sec x$$

**Sum and Difference Identities**

$$\cos(\alpha \pm \beta) = \cos \alpha \cos \beta \mp \sin \alpha \sin \beta$$

$$\sin(\alpha \pm \beta) = \sin \alpha \cos \beta \pm \cos \alpha \sin \beta$$

$$\tan(\alpha \pm \beta) = \frac{\tan \alpha \pm \tan \beta}{1 \mp \tan \alpha \tan \beta}$$

**Double-Angle Identities**

$$\sin(2\alpha) = 2 \sin \alpha \cos \alpha$$

$$\cos(2\alpha) = \cos^2 \alpha - \sin^2 \alpha$$

$$= 2 \cos^2 \alpha - 1$$

$$= 1 - 2 \sin^2 \alpha$$

$$\tan(2\alpha) = \frac{2 \tan \alpha}{1 - \tan^2 \alpha}$$

**Half-Angle Identities**

$$\sin \frac{\theta}{2} = \pm \sqrt{\frac{1 - \cos \theta}{2}}$$

$$\cos \frac{\theta}{2} = \pm \sqrt{\frac{1 + \cos \theta}{2}}$$

$$\tan \frac{\theta}{2} = \frac{1 - \cos \theta}{\sin \theta}$$

$$= \frac{\sin \theta}{1 + \cos \theta}$$

**Power Reduction Identities**

$$\sin^2 \theta = \frac{1 - \cos(2\theta)}{2}$$

$$\cos^2 \theta = \frac{1 + \cos(2\theta)}{2}$$

$$\tan^2 \theta = \frac{1 - \cos(2\theta)}{1 + \cos(2\theta)}$$

**Product-to-Sum Identities**

$$\sin \alpha \cos \beta = \frac{1}{2}[\sin(\alpha + \beta) + \sin(\alpha - \beta)]$$

$$\cos \alpha \sin \beta = \frac{1}{2}[\sin(\alpha + \beta) - \sin(\alpha - \beta)]$$

$$\cos \alpha \cos \beta = \frac{1}{2}[\cos(\alpha + \beta) + \cos(\alpha - \beta)]$$

$$\sin \alpha \sin \beta = \frac{1}{2}[\cos(\alpha - \beta) - \cos(\alpha + \beta)]$$

**Sum-to-Product Identities**

$$\sin \alpha + \sin \beta = 2 \sin\left(\frac{\alpha + \beta}{2}\right) \cos\left(\frac{\alpha - \beta}{2}\right)$$

$$\sin \alpha - \sin \beta = 2 \cos\left(\frac{\alpha + \beta}{2}\right) \sin\left(\frac{\alpha - \beta}{2}\right)$$

$$\cos \alpha + \cos \beta = 2 \cos\left(\frac{\alpha + \beta}{2}\right) \cos\left(\frac{\alpha - \beta}{2}\right)$$

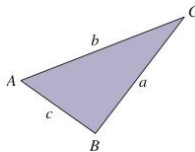
$$\cos \alpha - \cos \beta = -2 \sin\left(\frac{\alpha + \beta}{2}\right) \sin\left(\frac{\alpha - \beta}{2}\right)$$

**Law of Sines**

$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$$

**Area of a Triangle**

$$A = \frac{1}{2}bc \sin A$$



**Law of Cosines**

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$b^2 = a^2 + c^2 - 2ac \cos B$$

$$c^2 = a^2 + b^2 - 2ab \cos C$$

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