Answers to Selected Exercises

CHAPTER P

Section P.1

Check Point Exercises

1. 608 **2.** \$7567 **3.** $\{3, 7\}$ **4.** $\{3, 4, 5, 6, 7, 8, 9\}$ **5. a.** $\sqrt{9}$ **b.** $0, \sqrt{9}$ **c.** $-9, 0, \sqrt{9}$ **d.** $-9, -1.3, 0, 0.\overline{3}, \sqrt{9}$ **e.** $\frac{\pi}{2}, \sqrt{10}$ **f.** $-9, -1.3, 0, 0.\overline{3}, \frac{\pi}{2}, \sqrt{9}, \sqrt{10}$ **6. a.** $\sqrt{2} - 1$ **b.** $\pi - 3$ **c.** 1 **7.** 9 **8.** $38x^2 + 23x$ **9.** $42 - 4x$

Exercise Set P.1

1. 57 **3.** 10 **5.** 88 **7.** 10 **9.** 44 **11.** 46 **13.** 10 **15.** -8 **17.** 10°C **19.** 60 ft **21.** $\{2, 4\}$ **23.** $\{s, e, t\}$ **25.** $\varnothing$ **27.** $\varnothing$ **29.** $\{1, 2, 3, 4, 5\}$ **31.** $\{1, 2, 3, 4, 5, 6, 7, 8, 10\}$ **33.** $\{a, e, i, o, u\}$ **35. a.** $\sqrt{100}$ **b.** $0, \sqrt{100}$ **c.** $-9, 0, \sqrt{100}$ **d.** $-9, -\frac{4}{5}, 0, 0.25, 9.2, \sqrt{100}$ **e.** $\sqrt{3}$ **f.** $-9, -\frac{4}{5}, 0, 0.25, \sqrt{3}, 9.2, \sqrt{100}$ **37. a.** $\sqrt{64}$ **b.** $0, \sqrt{64}$ **c.** $-11, 0, \sqrt{64}$ **d.** $-11, -\frac{5}{6}, 0, 0.75, \sqrt{64}$ **e.** $\sqrt{5}, \pi$ **f.** $-11, -\frac{5}{6}, 0, 0.75, \sqrt{5}, \pi, \sqrt{64}$ **39.** 0 **41.** Answers may vary; an example is 2. **43.** true **45.** true **47.** true **49.** true **51.** 300 **53.** $12 - \pi$ **55.** $5 - \sqrt{2}$ **57.** -1 **59.** 4 **61.** 3 **63.** 7 **65.** -1 **67.** $|17 - 2|; 15$ **69.** $|5 - (-2)|; 7$ **71.** $|-4 - (-19)|; 15$ **73.** $|-1.4 - (-3.6)|; 2.2$ **75.** commutative property of addition **77.** associative property of addition **79.** commutative property of addition **81.** distributive property of multiplication over addition **83.** inverse property of multiplication **85.** $15x + 16$ **87.** $27x - 10$ **89.** $29y - 29$ **91.** $8y - 12$ **93.** $16y - 25$ **95.** $12x^2 + 11$ **97.** $14x$ **99.** $-2x + 3y + 6$ **101.** x **103.** $>$ **105.** $=$ **107.** $<$ **109.** $=$ **111.** 45 **113.** $\frac{1}{121}$ **115.** 14 **117.** $-\frac{8}{3}$ **119.** $-\frac{1}{2}$ **121.** $x - (x + 4); -4$ **123.** $6(-5x); -30x$ **125.** $5x - 2x; 3x$ **127.** $8x - (3x + 6); 5x - 6$ **129. a.** 140 beats per minute **b.** 160 beats per minute **131. a.** \$22,213 **b.** underestimates by \$5 **c.** \$25,075 **133. a.** $1200 - 0.07x$ **b.** \$780 **145.** does not make sense **147.** makes sense **149.** false **151.** true **153.** false **155.** false **157.** $<$ **159.** $>$ **160. a.** b^7 **b.** b^{10} **c.** Add the exponents. **161. a.** b^4 **b.** b^6 **c.** Subtract the exponents. **162.** It moves the decimal point 3 places to the right.

Section P.2

Check Point Exercises

1. a. $16x^{12}y^{24}$ **b.** $-18x^3y^8$ **c.** $\frac{5y^6}{x^4}$ **d.** $\frac{y^8}{25x^2}$ **2. a.** $-2{,}600{,}000{,}000$ **b.** 0.000003017 **3. a.** 5.21×10^9 **b.** -6.893×10^{-8} **4.** 4.1×10^9 **5. a.** 3.55×10^{-1} **b.** 4×10^8 **6.** \$2500 **7.** $2.5344 \times 10^3 = 2534.4$

Exercise Set P.2

1. 50 **3.** 64 **5.** -64 **7.** 1 **9.** -1 **11.** $\frac{1}{64}$ **13.** 32 **15.** 64 **17.** 16 **19.** $\frac{1}{9}$ **21.** $\frac{1}{16}$ **23.** $\frac{y}{x^2}$ **25.** y^5 **27.** x^{10} **29.** x^5 **31.** x^{21} **33.** $\frac{1}{x^{15}}$ **35.** x^7 **37.** x^{21} **39.** $64x^6$ **41.** $-\frac{64}{x^3}$ **43.** $9x^4y^{10}$ **45.** $6x^{11}$ **47.** $18x^9y^5$ **49.** $4x^{16}$ **51.** $-5a^{11}b$ **53.** $\frac{2}{b^7}$ **55.** $\frac{1}{16x^6}$ **57.** $\frac{3y^{14}}{4x^4}$ **59.** $\frac{y^2}{25x^6}$ **61.** $-\frac{27\,b^{15}}{a^{18}}$ **63.** 1 **65.** 380 **67.** 0.0006 **69.** $-7{,}160{,}000$ **71.** 0.79 **73.** -0.00415 **75.** $-60{,}000{,}100{,}000$ **77.** 3.2×10^4 **79.** 6.38×10^{17} **81.** -5.716×10^3 **83.** 2.7×10^{-3} **85.** -5.04×10^{-9} **87.** 6.3×10^7 **89.** 6.4×10^4 **91.** 1.22×10^{-11} **93.** 2.67×10^{13} **95.** 2.1×10^3 **97.** 4×10^5 **99.** 2×10^{-8} **101.** 5×10^3 **103.** 4×10^{15} **105.** 9×10^{-3} **107.** 1 **109.** $\frac{y}{16x^8z^6}$ **111.** $\frac{1}{x^{12}y^{16}z^{20}}$ **113.** $\frac{x^{18}y^6}{4}$ **115. a.** 2.52×10^{12} **b.** 3×10^8 **c.** \$8400 **117.** $\$9.57 \times 10^{12}$ **119.** 1.06×10^{-18} g **121.** 4.064×10^9 **131.** does not make sense **133.** does not make sense **135.** false **137.** false **139.** false **141.** false **143.** $\frac{1}{4}$ **145.** about 2.94×10^9 times **147. a.** 8 **b.** 8 **c.** $\sqrt{16} \cdot \sqrt{4} = \sqrt{16 \cdot 4}$ **148. a.** 17.32 **b.** 17.32 **c.** $\sqrt{300} = 10\sqrt{3}$ **149. a.** $31x$ **b.** $31\sqrt{2}$

Section P.3

Check Point Exercises

1. a. 9 **b.** -3 **c.** $\frac{1}{5}$ **d.** 10 **e.** 14 **2. a.** $5\sqrt{3}$ **b.** $5x\sqrt{2}$ **3. a.** $\frac{5}{4}$ **b.** $5x\sqrt{3}$ **4. a.** $17\sqrt{13}$ **b.** $-19\sqrt{17x}$ **5. a.** $17\sqrt{3}$ **b.** $10\sqrt{2x}$ **6. a.** $\frac{5\sqrt{3}}{3}$ **b.** $\sqrt{3}$ **7.** $\frac{8(4 - \sqrt{5})}{11}$ or $\frac{32 - 8\sqrt{5}}{11}$ **8. a.** $2\sqrt[3]{5}$ **b.** $2\sqrt[5]{2}$ **c.** $\frac{5}{3}$ **9.** $5\sqrt[3]{3}$

10. a. 5 **b.** 2 **c.** -3 **d.** -2 **e.** $\frac{1}{3}$ **11. a.** 81 **b.** 8 **c.** $\frac{1}{4}$ **12. a.** $10x^4$ **b.** $4x^{5/2}$ **13.** $\sqrt{x}$

Exercise Set P.3

1. 6 **3.** -6 **5.** not a real number **7.** 3 **9.** 1 **11.** 13 **13.** $5\sqrt{2}$ **15.** $3|x|\sqrt{5}$ **17.** $2x\sqrt{3}$ **19.** $x\sqrt{x}$ **21.** $2x\sqrt{3x}$
23. $\frac{1}{9}$ **25.** $\frac{7}{4}$ **27.** $4x$ **29.** $5x\sqrt{2x}$ **31.** $2x^2\sqrt{5}$ **33.** $13\sqrt{3}$ **35.** $-2\sqrt{17x}$ **37.** $5\sqrt{2}$ **39.** $3\sqrt{2x}$ **41.** $34\sqrt{2}$
43. $20\sqrt{2} - 5\sqrt{3}$ **45.** $\frac{\sqrt{7}}{7}$ **47.** $\frac{\sqrt{10}}{5}$ **49.** $\frac{13(3-\sqrt{11})}{-2}$ **51.** $7(\sqrt{5}+2)$ **53.** $3(\sqrt{5}-\sqrt{3})$ **55.** 5 **57.** -2
59. not a real number **61.** 3 **63.** -3 **65.** $-\frac{1}{2}$ **67.** $2\sqrt[3]{4}$ **69.** $x\sqrt[3]{x}$ **71.** $3\sqrt[3]{2}$ **73.** $2x$ **75.** $7\sqrt[5]{2}$ **77.** $13\sqrt[3]{2}$
79. $-y\sqrt[3]{2x}$ **81.** $\sqrt{2}+2$ **83.** 6 **85.** 2 **87.** 25 **89.** $\frac{1}{16}$ **91.** $14x^{7/12}$ **93.** $4x^{1/4}$ **95.** x^2 **97.** $5x^2|y|^3$ **99.** $27y^{2/3}$
101. $\sqrt{5}$ **103.** x^2 **105.** $\sqrt[3]{x^2}$ **107.** $\sqrt[3]{x^2y}$ **109.** 3 **111.** $\frac{x^2}{7y^{3/2}}$ **113.** $\frac{x^3}{y^2}$ **115. a.** 67.5%; underestimates by 0.5% **b.** 93.1%
117. $\frac{\sqrt{5}+1}{2}$; 1.62 to 1 **119.** $P = 18\sqrt{5}$ ft; $A = 100$ ft^2 **129.** does not make sense **131.** does not make sense **133.** false **135.** false
137. Let $\square = 3$. **139.** 4 **141. a.** 8 **b.** $\frac{1}{4}$ **142.** $10x^7y^9$ **143.** $16x^8 + 6x^5$ **144.** $2x^3 + 11x^2 + 22x + 15$

Section P.4

Check Point Exercises

1. a. $-x^3 + x^2 - 8x - 20$ **b.** $20x^3 - 11x^2 - 2x - 8$ **2.** $15x^3 - 31x^2 + 30x - 8$ **3.** $28x^2 - 41x + 15$ **4. a.** $21x^2 - 25xy + 6y^2$
b. $4x^2 + 16xy + 16y^2$ **5. a.** $9x^2 + 12x + 4 - 25y^2$ **b.** $4x^2 + 4xy + y^2 + 12x + 6y + 9$

Exercise Set P.4

1. yes; $3x^2 + 2x - 5$ **3.** no **5.** 2 **7.** 4 **9.** $11x^3 + 7x^2 - 12x - 4$; 3 **11.** $12x^3 + 4x^2 + 12x - 14$; 3 **13.** $6x^2 - 6x + 2$; 2
15. $x^3 + 1$ **17.** $2x^3 - 9x^2 + 19x - 15$ **19.** $x^2 + 10x + 21$ **21.** $x^2 - 2x - 15$ **23.** $6x^2 + 13x + 5$ **25.** $10x^2 - 9x - 9$
27. $15x^4 - 47x^2 + 28$ **29.** $8x^5 - 40x^3 + 3x^2 - 15$ **31.** $x^2 - 9$ **33.** $9x^2 - 4$ **35.** $25 - 49x^2$ **37.** $16x^4 - 25x^2$ **39.** $1 - y^{10}$
41. $x^2 + 4x + 4$ **43.** $4x^2 + 12x + 9$ **45.** $x^2 - 6x + 9$ **47.** $16x^4 - 8x^2 + 1$ **49.** $4x^2 - 28x + 49$ **51.** $x^3 + 3x^2 + 3x + 1$
53. $8x^3 + 36x^2 + 54x + 27$ **55.** $x^3 - 9x^2 + 27x - 27$ **57.** $27x^3 - 108x^2 + 144x - 64$ **59.** $7x^2 + 38xy + 15y^2$ **61.** $2x^2 + xy - 21y^2$
63. $15x^2y^2 + xy - 2$ **65.** $49x^2 + 70xy + 25y^2$ **67.** $x^4y^4 - 6x^2y^2 + 9$ **69.** $x^3 - y^3$ **71.** $9x^2 - 25y^2$ **73.** $x^2 + 2xy + y^2 - 9$
75. $9x^2 + 42x + 49 - 25y^2$ **77.** $25y^2 - 4x^2 - 12x - 9$ **79.** $x^2 + 2xy + y^2 + 2x + 2y + 1$ **81.** $4x^2 + 4xy + y^2 + 4x + 2y + 1$ **83.** $48xy$
85. $-9x^2 + 3x + 9$ **87.** $16x^4 - 625$ **89.** $4x^2 - 28x + 49$ **91. a.** \$56,995; underestimates by \$225
b. $M - W = -35x^3 + 1373x^2 - 15{,}995x + 63{,}210$ **c.** \$12,348 **d.** \$10,923; overestimates by \$1425 **93.** $4x^3 - 36x^2 + 80x$ **95.** $6x + 22$
103. makes sense **105.** makes sense **107.** $x^2 + 2x$ **109.** $2x^3 + 12x^2 + 12x + 10$ **111.** 4 **112.** 2 **113.** 3

Section P.5

Check Point Exercises

1. a. $2x^2(5x - 2)$ **b.** $(x - 7)(2x + 3)$ **2.** $(x + 5)(x^2 - 2)$ **3.** $(x + 8)(x + 5)$ or $(x + 5)(x + 8)$ **4.** $(x - 7)(x + 2)$ or $(x + 2)(x - 7)$
5. $(3x - 1)(2x + 7)$ or $(2x + 7)(3x - 1)$ **6.** $(3x - y)(x - 4y)$ or $(x - 4y)(3x - y)$ **7. a.** $(x + 9)(x - 9)$ **b.** $(6x + 5)(6x - 5)$
8. $(9x^2 + 4)(3x + 2)(3x - 2)$ **9. a.** $(x + 7)^2$ **b.** $(4x - 7)^2$ **10. a.** $(x + 1)(x^2 - x + 1)$ **b.** $(5x - 2)(25x^2 + 10x + 4)$ **11.** $3x(x - 5)^2$
12. $(x + 10 + 6a)(x + 10 - 6a)$ **13.** $\frac{2x - 1}{(x - 1)^{1/2}}$

Exercise Set P.5

1. $9(2x + 3)$ **3.** $3x(x + 2)$ **5.** $9x^2(x^2 - 2x + 3)$ **7.** $(x + 5)(x + 3)$ **9.** $(x - 3)(x^2 + 12)$ **11.** $(x - 2)(x^2 + 5)$ **13.** $(x - 1)(x^2 + 2)$
15. $(3x - 2)(x^2 - 2)$ **17.** $(x + 2)(x + 3)$ **19.** $(x - 5)(x + 3)$ **21.** $(x - 5)(x - 3)$ **23.** $(3x + 2)(x - 1)$ **25.** $(3x - 28)(x + 1)$
27. $(2x - 1)(3x - 4)$ **29.** $(2x + 3)(2x + 5)$ **31.** $(3x - 2)(3x - 1)$ **33.** $(5x + 8)(4x - 1)$ **35.** $(2x + y)(x + y)$
37. $(3x + 2y)(2x - 3y)$ **39.** $(x + 10)(x - 10)$ **41.** $(6x + 7)(6x - 7)$ **43.** $(3x + 5y)(3x - 5y)$ **45.** $(x^2 + 4)(x + 2)(x - 2)$
47. $(4x^2 + 9)(2x + 3)(2x - 3)$ **49.** $(x + 1)^2$ **51.** $(x - 7)^2$ **53.** $(2x + 1)^2$ **55.** $(3x - 1)^2$ **57.** $(x + 3)(x^2 - 3x + 9)$
59. $(x - 4)(x^2 + 4x + 16)$ **61.** $(2x - 1)(4x^2 + 2x + 1)$ **63.** $(4x + 3)(16x^2 - 12x + 9)$ **65.** $3x(x + 1)(x - 1)$ **67.** $4(x + 2)(x - 3)$
69. $2(x^2 + 9)(x + 3)(x - 3)$ **71.** $(x - 3)(x + 3)(x + 2)$ **73.** $2(x - 8)(x + 7)$ **75.** $x(x - 2)(x + 2)$ **77.** prime **79.** $(x - 2)(x + 2)^2$
81. $y(y^2 + 9)(y + 3)(y - 3)$ **83.** $5y^2(2y + 3)(2y - 3)$ **85.** $(x - 6 + 7y)(x - 6 - 7y)$ **87.** $(x + y)(3b + 4)(3b - 4)$
89. $(y - 2)(x + 4)(x - 4)$ **91.** $2x(x + 6 + 2a)(x + 6 - 2a)$ **93.** $x^{1/2}(x - 1)$ **95.** $\frac{4(1 + 2x)}{x^{2/3}}$ **97.** $-(x + 3)^{1/2}(x + 2)$ **99.** $\frac{x + 4}{(x + 5)^{3/2}}$
101. $-\frac{4(4x - 1)^{1/2}(x - 1)}{3}$ **103.** $(x + 1)(5x - 6)(2x + 1)$ **105.** $(x^2 + 6)(6x^2 - 1)$ **107.** $y(y^2 + 1)(y^4 - y^2 + 1)$
109. $(x + 2y)(x - 2y)(x + y)(x - y)$ **111.** $(x - y)^2(x - y + 2)(x - y - 2)$ **113.** $(2x - y^2)(x - 3y^2)$
115. a. $(x - 0.4x)(1 - 0.4) = (0.6x)(0.6) = 0.36x$ **b.** no; 36% **117. a.** $9x^2 - 16$ **b.** $(3x + 4)(3x - 4)$ **119. a.** $x(x + y) - y(x + y)$

b. $(x + y)(x - y)$ **121.** $4a^3 - 4ab^2 = 4a(a + b)(a - b)$ **131.** makes sense **133.** makes sense **135.** true **137.** false

139. $-(x + 5)(x - 1)$ **141.** $-\dfrac{10}{(x - 5)^{3/2}(x + 5)^{1/2}}$ **143.** $b = 0, 3, 4, -c(c + 4)$, where $c > 0$ is an integer **144.** $\dfrac{(x + 5)(x + 1)}{(x + 5)(x - 5)} = \dfrac{x + 1}{x - 5}$

145. $\dfrac{2}{3}$ **146.** $\dfrac{7}{6}$

Mid-Chapter P Check Point

1. $12x^2 - x - 35$ **2.** $-x + 12$ **3.** $10\sqrt{6}$ **4.** $3\sqrt{3}$ **5.** $x + 45$ **6.** $64x^2 - 48x + 9$ **7.** $\dfrac{x^2}{y^3}$ **8.** $\dfrac{3}{4}$ **9.** $-x^2 + 5x - 6$

10. $2x^3 - 11x^2 + 17x - 5$ **11.** $-x^6 + 2x^3$ **12.** $18a^2 - 11ab - 10b^2$ **13.** $\{a, c, d, e, f, h\}$ **14.** $\{c, d\}$ **15.** $5x^2y^3 + 2xy - y^2$

16. $-\dfrac{12y^{15}}{x^3}$ **17.** $\dfrac{6y^3}{x^7}$ **18.** $|\sqrt[3]{x}|$ **19.** $16y^2 - 9x^2 - 12x - 4$ **20.** $x^2 - 4xy + 4y^2 - 2x + 4y + 1$ **21.** 1.2×10^{-2} **22.** $2\sqrt[3]{2}$

23. $x^6 - 4$ **24.** $x^4 + 4x^2 + 4$ **25.** $10\sqrt{3}$ **26.** $\dfrac{77 + 11\sqrt{3}}{46}$ **27.** $\dfrac{11\sqrt{3}}{3}$ **28.** $(7x - 1)(x - 3)$ **29.** prime **30.** $(x^2 + 3)(x + 5)$

31. $(3x - 7y)(x + y)$ **32.** $y(4 - y)(16 + 4y + y^2)$ **33.** $2x(5x + 1)^2$ **34.** $(x - 3 - 7y)(x - 3 + 7y)$ **35.** $\dfrac{(1 - x)^2}{x^{3/2}}$ **36.** $\dfrac{(x - 3)(x + 3)}{(x^2 + 1)^{1/2}}$

37. $-11, -\dfrac{3}{7}, 0, 0.45, \sqrt{25}$ **38.** $\sqrt{13} - 2$ **39.** $-x^3$ **40.** $\$4.2 \times 10^{10}$ **41.** 4 times **42. a.** model 2 **b.** underestimates by 3 channels **c.** 132

Section P.6

Check Point Exercises

1. a. -5 **b.** $6, -6$ **2. a.** $x^2, x \neq -3$ **b.** $\dfrac{x - 1}{x + 1}, x \neq -1$ **3.** $\dfrac{x - 3}{(x - 2)(x + 3)}, x \neq 2, x \neq -2, x \neq -3$ **4.** $\dfrac{3(x - 1)}{x(x + 2)}, x \neq 1, x \neq 0, x \neq -2$

5. $-2, x \neq -1$ **6.** $\dfrac{2(4x + 1)}{(x + 1)(x - 1)}, x \neq 1, x \neq -1$ **7.** $(x - 3)(x - 3)(x + 3)$ or $(x - 3)^2(x + 3)$ **8.** $\dfrac{-x^2 + 11x - 20}{2(x - 5)^2}, x \neq 5$

9. $\dfrac{2(2 - 3x)}{4 + 3x}, x \neq 0, x \neq -\dfrac{4}{3}$ **10.** $-\dfrac{1}{x(x + 7)}, x \neq 0, x \neq -7$ **11.** $\dfrac{x + 1}{x^{3/2}}$ **12.** $\dfrac{1}{\sqrt{x + 3} + \sqrt{x}}$

Exercise Set P.6

1. 3 **3.** $5, -5$ **5.** $-1, -10$ **7.** $\dfrac{3}{x - 3}, x \neq 3$ **9.** $\dfrac{x - 6}{4}, x \neq 6$ **11.** $\dfrac{y + 9}{y - 1}, y \neq 1, 2$ **13.** $\dfrac{x + 6}{x - 6}, x \neq 6, -6$ **15.** $\dfrac{1}{3}, x \neq 2, -3$

17. $\dfrac{(x - 3)(x + 3)}{x(x + 4)}, x \neq 0, -4, 3$ **19.** $\dfrac{x - 1}{x + 2}, x \neq -2, -1, 2, 3$ **21.** $\dfrac{x^2 + 2x + 4}{3x}, x \neq -2, 0, 2$ **23.** $\dfrac{7}{9}, x \neq -1$

25. $\dfrac{(x - 2)^2}{x}, x \neq 0, -2, 2$ **27.** $\dfrac{2(x + 3)}{3}, x \neq 3, -3$ **29.** $\dfrac{x - 5}{2}, x \neq 1, -5$ **31.** $\dfrac{(x + 2)(x + 4)}{x - 5}, x \neq -6, -3, -1, 3, 5$ **33.** $2, x \neq -\dfrac{5}{6}$

35. $\dfrac{2x - 1}{x + 3}, x \neq 0, -3$ **37.** $3, x \neq 2$ **39.** $\dfrac{3}{x - 3}, x \neq 3, -4$ **41.** $\dfrac{9x + 39}{(x + 4)(x + 5)}, x \neq -4, -5$ **43.** $-\dfrac{3}{x(x + 1)}, x \neq -1, 0$

45. $\dfrac{3x^2 + 4}{(x + 2)(x - 2)}, x \neq -2, 2$ **47.** $\dfrac{2x^2 + 50}{(x - 5)(x + 5)}, x \neq -5, 5$ **49.** $\dfrac{13}{6(x + 2)}, x \neq -2$ **51.** $\dfrac{4x + 16}{(x + 3)^2}, x \neq -3$

53. $\dfrac{x^2 - x}{(x + 5)(x - 2)(x + 3)}, x \neq -5, 2, -3$ **55.** $\dfrac{-x^2 - 2x + 1}{(x + 1)(x - 1)}, x \neq -1, 1$ **57.** $\dfrac{x - 1}{x + 2}, x \neq -2, -1$ **59.** $\dfrac{1}{3}, x \neq 3$ **61.** $\dfrac{x + 1}{3x - 1}, x \neq 0, \dfrac{1}{3}$

63. $\dfrac{1}{xy}, x \neq 0, y \neq 0, x \neq -y$ **65.** $\dfrac{x}{x + 3}, x \neq -2, -3$ **67.** $-\dfrac{x - 14}{7}, x \neq -2, 2$ **69.** $\dfrac{x - 3}{x + 2}, x \neq -2, -1, 3$

71. $-\dfrac{2x + h}{x^2(x + h)^2}, x \neq 0, h \neq 0, x \neq -h$ **73.** $1 - \dfrac{1}{3x}; x > 0$ **75.** $-\dfrac{2}{x^2\sqrt{x^2 + 2}}$ **77.** $\dfrac{\sqrt{x} - \sqrt{x + h}}{h\sqrt{x}\sqrt{x + h}}$ **79.** $\dfrac{1}{\sqrt{x + 5} + \sqrt{x}}$

81. $\dfrac{1}{(x + y)(\sqrt{x} - \sqrt{y})}$ **83.** $\dfrac{x^2 + 5x + 8}{(x + 2)(x + 1)}$ **85.** 2 **87.** $\dfrac{1}{y(y + 5)}$ **89.** $\dfrac{2d}{a^2 + ab + b^2}$ **91. a.** 86.67, 520, 1170; It costs \$86,670,000 to inoculate 40% of the population against this strain of flu, \$520,000,000 to inoculate 80% of the population, and \$1,170,000,000 to inoculate 90% of the population. **b.** $x = 100$ **c.** The cost increases rapidly; it is impossible to inoculate 100% of the population.

93. a. 2078; underestimates by 22 calories **b.** 2662; underestimates by 38 calories **c.** $\dfrac{-33x^2 + 263x + 515}{-60x^2 + 499x + 295}$ **95.** $\dfrac{4x^2 + 14x}{(x + 3)(x + 4)}$

109. does not make sense **111.** does not make sense **113.** false **115.** true **117.** $\dfrac{1}{x^{2n} - 1}$ **119.** $\dfrac{x - y + 1}{(x - y)(x - y)}$ **121.** true

122. $-x + 10$ **123.** -5

Section P.7

Check Point Exercises

1. $\{5\}$ **2.** $\{1\}$ **3.** $\{7\}$ **4.** $\varnothing$ **5.** $q = \dfrac{pf}{p - f}$ **6.** $\{-2, 3\}$ **7. a.** $\{0, 3\}$ **b.** $\left\{\dfrac{1}{2}, -1\right\}$ **8. a.** $\{-\sqrt{7}, \sqrt{7}\}$
b. $\{-5 + \sqrt{11}, -5 - \sqrt{11}\}$ **9.** $\{-2 + \sqrt{5}, -2 - \sqrt{5}\}$ **10.** $\left\{\dfrac{-1 + \sqrt{3}}{2}, \dfrac{-1 - \sqrt{3}}{2}\right\}$ **11.** -56; no real solutions **12.** $\{6\}$

Exercise Set P.7

1. $\{11\}$ **3.** $\{7\}$ **5.** $\{13\}$ **7.** $\{2\}$ **9.** $\{9\}$ **11.** $\left\{\dfrac{33}{2}\right\}$ **13.** $\{-12\}$ **15.** $\left\{\dfrac{46}{5}\right\}$ **17. a.** 1 **b.** $\{3\}$ **19. a.** -1 **b.** $\varnothing$
21. a. 1 **b.** $\{2\}$ **23. a.** $-1, 1$ **b.** $\{-3\}$ **25. a.** $-2, 4$ **b.** $\varnothing$ **27.** $P = \dfrac{I}{rt}$ **29.** $p = \dfrac{T - D}{m}$ **31.** $a = \dfrac{2A}{h} - b$
33. $r = \dfrac{S - P}{Pt}$ **35.** $S = \dfrac{F}{B} + V$ **37.** $I = \dfrac{E}{R + r}$ **39.** $f = \dfrac{pq}{p + q}$ **41.** $f_1 = -\dfrac{ff_2}{f - f_2}$ or $f_1 = \dfrac{ff_2}{f_2 - f}$ **43.** $\{-5, 9\}$ **45.** $\{-2, 3\}$
47. $\left\{-\dfrac{5}{3}, 3\right\}$ **49.** $\left\{-\dfrac{4}{5}, 4\right\}$ **51.** $\varnothing$ **53.** $\left\{\dfrac{1}{2}\right\}$ **55.** $\{-2, 5\}$ **57.** $\{3, 5\}$ **59.** $\{0, 4\}$ **61.** $\{\pm 3\}$ **63.** $\{\pm\sqrt{10}\}$ **65.** $\{4 \pm \sqrt{5}\}$
67. $\{-7, 1\}$ **69.** $\{1 + \sqrt{3}, 1 - \sqrt{3}\}$ **71.** $\{3 + 2\sqrt{5}, 3 - 2\sqrt{5}\}$ **73.** $\{-2 + \sqrt{3}, -2 - \sqrt{3}\}$ **75.** $\{-5, -3\}$
77. $\left\{\dfrac{-5 + \sqrt{13}}{2}, \dfrac{-5 - \sqrt{13}}{2}\right\}$ **79.** $\left\{\dfrac{3 + \sqrt{57}}{6}, \dfrac{3 - \sqrt{57}}{6}\right\}$ **81.** $\left\{\dfrac{1 + \sqrt{29}}{4}, \dfrac{1 - \sqrt{29}}{4}\right\}$ **83.** 36; 2 unequal real solutions
85. 97; 2 unequal real solutions **87.** 0; 1 real solution **89.** 37; 2 unequal real solutions **91.** $\left\{-\dfrac{1}{2}, 1\right\}$ **93.** $\left\{\dfrac{1}{5}, 2\right\}$ **95.** $\{-2\sqrt{5}, 2\sqrt{5}\}$
97. $\{1 + \sqrt{2}, 1 - \sqrt{2}\}$ **99.** $\left\{\dfrac{-11 + \sqrt{33}}{4}, \dfrac{-11 - \sqrt{33}}{4}\right\}$ **101.** $\left\{0, \dfrac{8}{3}\right\}$ **103.** $\{2\}$ **105.** $\{-2, 2\}$ **107.** $\{2 \pm \sqrt{2}\}$ **109.** $\left\{0, \dfrac{7}{2}\right\}$
111. $\{2 + \sqrt{10}, 2 - \sqrt{10}\}$ **113.** $\{-5, -1\}$ **115.** $\{6\}$ **117.** $\{6\}$ **119.** $\{-6\}$ **121.** $\{10\}$ **123.** $\{-5\}$ **125.** $\{-2\}$
127. $\{-3, 1\}$ **129.** $\{-8, -6, 4, 6\}$ **131.** $\left\{\dfrac{-1 \pm \sqrt{21}}{2}\right\}$ **133.** $\{8\}$ **135.** $\dfrac{-2 - \sqrt{22}}{2}$ and $\dfrac{-2 + \sqrt{22}}{2}$ **137.** 142 pounds; 13 pounds
139. 125 liters **141.** 33-year-olds and 58-year-olds; The formula models the actual data well. **143.** 14 years after 1996, or 2010
159. does not make sense **161.** does not make sense **163.** false **165.** true **167.** 2 **169.** $C = \dfrac{LV - SN}{L - N}$ **171.** $x + 150$
172. $20 + 0.05x$ **173.** $4x + 400$

Section P.8

Check Point Exercises

1. women: \$57,989; men: \$72,026 **2.** by 50 years after 1969, or in 2019 **3.** \$1200 **4.** 50 ft by 94 ft **5.** 2 ft **6.** 120 yd **7.** 5 people

Exercise Set P.8

1. radio: 974 hr; TV: 1555 hr **3.** carpenters: \$35,580; computer programmers: \$63,420 **5.** by 38 years after 1983, or in 2021
7. a. $y = 24{,}000 - 3000x$ **b.** after 5 years **9.** 9 years after 2005, or in 2014; 22,300 **11.** \$420 **13.** \$150 **15.** \$467.20
17. 50 yd by 100 yd **19.** 36 ft by 78 ft **21.** 2 in. **23.** length: 9 ft; width: 6 ft **25.** 5 in. **27.** 5 m **29.** 3 ft **31.** 13.2 ft **33.** 13 ft
35. 21.9 yd **37.** 8 people **39.** car: 50 miles per hour; bus: 30 miles per hour **41.** 6 miles per hour **43.** 11 hr **45.** 5 ft 7 in. **47.** 10
53. does not make sense **55.** does not make sense **57.** 3 miles, 4 miles, 5 miles **59.** Coburn = 60 years old; woman = 20 years old
61. \$4000 for the mother; \$8000 for the boy; \$2000 for the girl **64.** yes **65.** $\{-3\}$ **66.** $\{14\}$

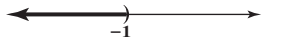
Section P.9

Check Point Exercises

1. a. $\{x|-2 \le x < 5\}$

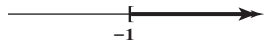
b. $\{x|1 \le x \le 3.5\}$

c. $\{x|x < -1\}$



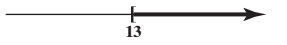
2. a. $(2, 3]$ **b.** $[1, 6)$

3. $[-1, \infty)$ or $\{x|x \ge -1\}$

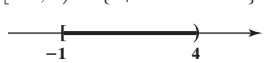


4. $\{x|x < 4\}$ or $(-\infty, 4)$

5. $\{x|x \ge 13\}$ or $[13, \infty)$



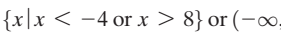
6. $[-1, 4)$ or $\{x|-1 \le x < 4\}$



7. $(-3, 7)$ or $\{x|-3 < x < 7\}$

8. $\left\{x|-\dfrac{11}{5} \le x \le 3\right\}$ or $\left[-\dfrac{11}{5}, 3\right]$

9. $\{x|x < -4 \text{ or } x > 8\}$ or $(-\infty, -4) \cup (8, \infty)$



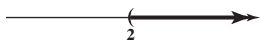
10. more than 720 mi per week

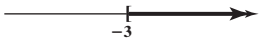
Exercise Set P.9

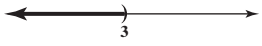
1. $\{x|1 < x \le 6\}$ 

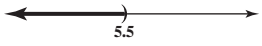
3. $\{x|-5 \le x < 2\}$ 

5. $\{x|-3 \le x \le 1\}$ 

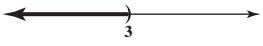
7. $\{x|x > 2\}$ 

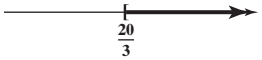
9. $\{x|x \ge -3\}$ 

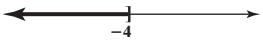
11. $\{x|x < 3\}$ 

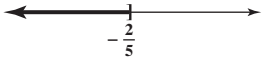
13. $\{x|x < 5.5\}$ 

15. $[-1, 0)$ **17.** $(-3, 2]$ **19.** $[1, 5)$
21. $(-\infty, 8)$ **23.** $(6, \infty)$ **25.** $[3, \infty)$

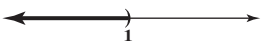
27. $(-\infty, 3)$ 

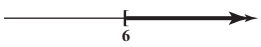
29. $\left[\frac{20}{3}, \infty\right)$ 

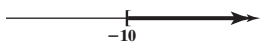
31. $(-\infty, -4]$ 

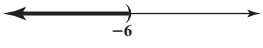
33. $\left(-\infty, -\frac{2}{5}\right]$ 

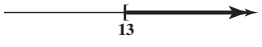
35. $[0, \infty)$ 

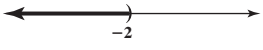
37. $(-\infty, 1)$ 

39. $[6, \infty)$ 

41. $[-10, \infty)$ 

43. $(-\infty, -6)$ 

45. $[13, \infty)$ 

47. $(-\infty, 2)$ 

49. $(3, 5)$ **51.** $[-1, 3)$ **53.** $(-5, -2]$ **55.** $[3, 6)$ **57.** $(-3, 3)$ **59.** $[-1, 3]$ **61.** $(-1, 7)$ **63.** $[-5, 3]$ **65.** $(-6, 0)$

67. $(-\infty, -3) \cup (3, \infty)$ **69.** $(-\infty, -1] \cup [3, \infty)$ **71.** $\left(-\infty, \frac{1}{3}\right) \cup (5, \infty)$ **73.** $(-\infty, -5] \cup [3, \infty)$ **75.** $(-\infty, -3) \cup (12, \infty)$

77. $(-\infty, -1] \cup [3, \infty)$ **79.** $[2, 6]$ **81.** $(-\infty, -3) \cup (5, \infty)$ **83.** $(-\infty, -1] \cup [2, \infty)$ **85.** $(-1, 9)$ **87.** $\left(-\infty, \frac{1}{3}\right) \cup (1, \infty)$

89. $\left(-\infty, -\frac{75}{14}\right) \cup \left(\frac{87}{14}, \infty\right)$ **91.** $(-\infty, -6]$ or $[24, \infty)$ **93.** $[6, \infty)$ **95.** $(-\infty, -10] \cup [2, \infty)$ **97.** $\left(-\infty, -\frac{1}{3}\right] \cup [3, \infty)$

99. $(0, 4)$ **101.** intimacy $\ge$ passion or passion $\le$ intimacy **103.** commitment $>$ passion or passion $<$ commitment

105. 9; after 3 years **107.** voting years after 2006 **109.** between 80 and 110 minutes, inclusive **111.** $h \le 41$ or $h \ge 59$

113. $15 + 0.08x < 3 + 0.12x$; more than 300 min **115.** $2 + 0.08x < 8 + 0.05x$; 199 checks or less

117. $5.50x > 3000 + 3x$; more than 1200 packages **119.** $245 + 95x \le 3000$; at most 29 bags **121. a.** $\frac{86 + 88 + x}{3} \ge 90$; at least a 96

b. $\frac{86 + 88 + x}{3} < 80$; a grade less than 66 **123.** $7.50 + 0.50x \le 3.00x$ and $7.50 + 0.50x \le 15.00$; more than 3 and less than 15 crossings per three-month period **133.** makes sense **135.** makes sense **137.** false **139.** true **141. a.** $|x - 4| < 3$ **b.** $|x - 4| \ge 3$

143. 7; 6; 5; 4; 3; 2; 1 **144.** -5; 0; 3; 4; 3; 0; -5 **145.** 3; 2; 1; 0; 1; 2; 3

Chapter P Review Exercises

1. 51 **2.** 16 **3.** 124 ft **4.** $\{a, c\}$ **5.** $\{a, b, c, d, e\}$ **6.** $\{a, b, c, d, f, g\}$ **7.** $\{a\}$ **8. a.** $\sqrt{81}$ **b.** $0, \sqrt{81}$ **c.** $-17, 0, \sqrt{81}$
d. $-17, -\frac{9}{13}, 0, 0.75, \sqrt{81}$ **e.** $\sqrt{2}, \pi$ **f.** $-17, -\frac{9}{13}, 0, 0.75, \sqrt{2}, \pi, \sqrt{81}$ **9.** 103 **10.** $\sqrt{2} - 1$ **11.** $\sqrt{17} - 3$ **12.** $|4 - (-17)|$; 21
13. commutative property of addition **14.** associative property of multiplication **15.** distributive property of multiplication over addition
16. commutative property of multiplication **17.** commutative property of multiplication **18.** commutative property of addition

19. $17x - 15$ **20.** $2x$ **21.** $5y - 17$ **22.** $10x$ **23.** 38.55%; overestimates by 3.55% **24.** -108 **25.** $\frac{5}{16}$ **26.** $\frac{1}{25}$ **27.** $\frac{1}{27}$

28. $-8x^{12}y^9$ **29.** $\frac{10}{x^8}$ **30.** $\frac{1}{16x^{12}}$ **31.** $\frac{y^8}{4x^{10}}$ **32.** 37,400 **33.** 0.0000745 **34.** 3.59×10^6 **35.** 7.25×10^{-3} **36.** 390,000

37. 0.023 **38. a.** 2.57×10^{11} **b.** 1.75×10^8 **39.** \$1469 **40.** $10\sqrt{3}$ **41.** $2|x|\sqrt{3}$ **42.** $2x\sqrt{5}$ **43.** $r\sqrt{r}$ **44.** $\frac{11}{2}$ **45.** $4x\sqrt{3}$

46. $20\sqrt{5}$ **47.** $16\sqrt{2}$ **48.** $24\sqrt{2} - 8\sqrt{3}$ **49.** $6\sqrt{5}$ **50.** $\frac{\sqrt{6}}{3}$ **51.** $\frac{5(6 - \sqrt{3})}{33}$ **52.** $7(\sqrt{7} + \sqrt{5})$ **53.** 5 **54.** -2

55. not a real number **56.** 5 **57.** $3\sqrt[3]{3}$ **58.** $y\sqrt[3]{y^2}$ **59.** $2\sqrt[4]{5}$ **60.** $13\sqrt[3]{2}$ **61.** $x\sqrt[4]{2}$ **62.** 4 **63.** $\frac{1}{5}$ **64.** 5 **65.** $\frac{1}{3}$

66. 16 **67.** $\frac{1}{81}$ **68.** $20x^{11/12}$ **69.** $3x^{1/4}$ **70.** $25x^4$ **71.** $\sqrt{y}$ **72.** $8x^3 + 10x^2 - 20x - 4$; degree 3 **73.** $8x^4 - 5x^3 + 6$; degree 4

74. $12x^3 + x^2 - 21x + 10$ **75.** $6x^2 - 7x - 5$ **76.** $16x^2 - 25$ **77.** $4x^2 + 20x + 25$ **78.** $9x^2 - 24x + 16$ **79.** $8x^3 + 12x^2 + 6x + 1$

80. $125x^3 - 150x^2 + 60x - 8$ **81.** $3x^2 + 16xy - 35y^2$ **82.** $9x^2 - 30xy + 25y^2$ **83.** $9x^4 + 12x^2y + 4y^2$ **84.** $49x^2 - 16y^2$ **85.** $a^3 - b^3$
86. $25y^2 - 4x^2 - 8x - 1$ **87.** $x^2 + 4xy + 4y^2 + 8x + 16y + 16$ **88.** $3x^2(5x + 1)$ **89.** $(x - 4)(x - 7)$ **90.** $(3x + 1)(5x - 2)$
91. $(8 - x)(8 + x)$ **92.** prime **93.** $3x^2(x - 5)(x + 2)$ **94.** $4x^3(5x^4 - 9)$ **95.** $(x + 3)(x - 3)^2$ **96.** $(4x - 5)^2$
97. $(x^2 + 4)(x + 2)(x - 2)$ **98.** $(y - 2)(y^2 + 2y + 4)$ **99.** $(x + 4)(x^2 - 4x + 16)$ **100.** $3x^2(x - 2)(x + 2)$

101. $(3x - 5)(9x^2 + 15x + 25)$ **102.** $x(x - 1)(x + 1)(x^2 + 1)$ **103.** $(x^2 - 2)(x + 5)$ **104.** $(x + 9 + y)(x + 9 - y)$ **105.** $\frac{16(1 + 2x)}{x^{3/4}}$

106. $(x + 2)(x - 2)(x^2 + 3)^{1/2}(-x^4 + x^2 + 13)$ **107.** $\frac{6(2x + 1)}{x^{3/2}}$ **108.** $x^2, x \ne -2$ **109.** $\frac{x - 3}{x - 6}, x \ne -6, 6$ **110.** $\frac{x}{x + 2}, x \ne -2$

111. $\frac{(x+3)^3}{(x-2)^2(x+2)}, x \neq 2, -2$ **112.** $\frac{2}{x(x+1)}, x \neq 0, 1, -1, -\frac{1}{3}$ **113.** $\frac{x+3}{x-4}, x \neq -3, 4, 2, 8$ **114.** $\frac{1}{x-3}, x \neq 3, -3$

115. $\frac{4x(x-1)}{(x+2)(x-2)}, x \neq 2, -2$ **116.** $\frac{2x^2-3}{(x-3)(x+3)(x-2)}, x \neq 3, -3, 2$ **117.** $\frac{11x^2-x-11}{(2x-1)(x+3)(3x+2)}, x \neq \frac{1}{2}, -3, -\frac{2}{3}$ **118.** $\frac{3}{x}, x \neq 0, 2$

119. $\frac{3x}{x-4}, x \neq 0, 4, -4$ **120.** $\frac{3x+8}{3x+10}, x \neq -3, -\frac{10}{3}$ **121.** $\frac{25\sqrt{25-x^2}}{(5-x)^2(5+x)^2}$ **122.** $\{-13\}$ **123.** $\{-3\}$ **124.** $\{-1\}$

125. all real numbers except 1 and -1 **126.** $\{7\}$ **127.** $\{-2, 1\}$ **128.** $\left\{\frac{1}{2}, 5\right\}$ **129.** $\left\{-2, \frac{10}{3}\right\}$ **130.** $\left\{\frac{7+\sqrt{37}}{6}, \frac{7-\sqrt{37}}{6}\right\}$

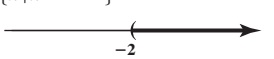
131. $\{-3, 3\}$ **132.** $\{3 \pm 2\sqrt{6}\}$ **133.** $\{4\}$ **134.** $\{2\}$ **135.** $\{2\}$ **136.** $g = \frac{s-vt}{t^2}$ **137.** $P = \frac{A}{1+rT}$ **138.** no real solutions

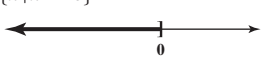
139. one repeated real solution **140.** U.S.: 20.5 million barrels; China: 6.3 million barrels; Japan: 5.5 million barrels

141. by 19 years after 2000, or in 2019 **142.** \$60 **143.** \$10,000 in sales **144.** 44 yd by 126 yd **145.** 2021; 32,100

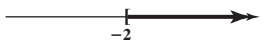
146. length: 5 yd; width: 3 yd **147.** approximately 134 m **148.** 2 in. **149.** 10 people

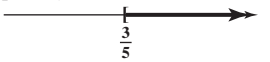
150. $\{x \mid -3 \leq x < 5\}$ 

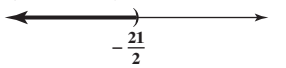
151. $\{x \mid x > -2\}$ 

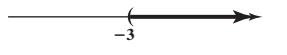
152. $\{x \mid x \leq 0\}$ 

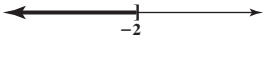
153. $[-1, 1]$ **154.** $(-2, 3)$ **155.** $[1, 3)$ **156.** $(0, 4)$

157. $[-2, \infty)$ 

158. $\left[\frac{3}{5}, \infty\right)$ 

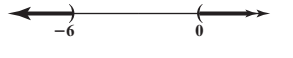
159. $\left(-\infty, -\frac{21}{2}\right)$ 

160. $(-3, \infty)$ 

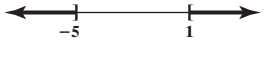
161. $(-\infty, -2]$ 

162. $(2, 3]$ 

163. $[-9, 6]$ 

164. $(-\infty, -6)$ or $(0, \infty)$ 

165. $(-\infty, -3]$ or $[-2, \infty)$ 

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

167. no more than 80 miles per day **168.** $[49\%, 99\%)$

Chapter P Test

1. $6x^2 - 27x$ **2.** $-6x + 17$ **3.** $\{5\}$ **4.** $\{1, 2, 5, a\}$ **5.** $\frac{5y^8}{x^6}$ **6.** $3r\sqrt{2}$ **7.** $11\sqrt{2}$ **8.** $\frac{3(5-\sqrt{2})}{23}$

9. $2x\sqrt[3]{2x}$ **10.** $\frac{x+3}{x-2}, x \neq 2, 1$ **11.** 2.5×10^1 **12.** $2x^3 - 13x^2 + 26x - 15$ **13.** $25x^2 + 30xy + 9y^2$ **14.** $\frac{2(x+3)}{x+1}, x \neq 3, -1, -4, -3$

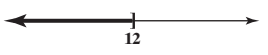
15. $\frac{x^2+2x+15}{(x+3)(x-3)}, x \neq 3, -3$ **16.** $\frac{11}{(x-3)(x-4)}, x \neq 3, 4$ **17.** $\frac{2x}{(x+2)(x+1)}$ **18.** $\frac{10x}{\sqrt{(x^2+5)^3}}$ **19.** $(x-3)(x-6)$

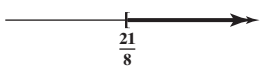
20. $(x^2+3)(x+2)$ **21.** $(5x-3)(5x+3)$ **22.** $(6x-7)^2$ **23.** $(y-5)(y^2+5y+25)$ **24.** $(x+5+3y)(x+5-3y)$ **25.** $\frac{2x+3}{(x+3)^{3/5}}$

26. $-7, -\frac{4}{5}, 0, 0.25, \sqrt{4}, \frac{22}{7}$ **27.** commutative property of addition **28.** distributive property of multiplication over addition **29.** 7.6×10^{-4}

30. $\frac{1}{243}$ **31.** 1.32×10^{10} **32. a.** 43.08%; overestimates by 0.08% **b.** $R = \frac{-0.28n+47}{0.28n+53}$ **c.** $\frac{2}{3}$; Three women will receive bachelor's degrees for every two men.; It describes the projections exactly. **33.** $\{-1\}$ **34.** $\{-6\}$ **35.** $\{5\}$ **36.** $\left\{-\frac{1}{2}, 2\right\}$ **37.** $\left\{\frac{1-5\sqrt{3}}{3}, \frac{1+5\sqrt{3}}{3}\right\}$

38. $\{1-\sqrt{5}, 1+\sqrt{5}\}$ **39.** $\{7\}$ **40.** $\{2\}$ **41.** $\{6, 12\}$ **42.** $\left\{\frac{1}{2}, 3\right\}$ **43.** $\{4\}$

44. $(-\infty, 12]$ 

45. $\left[\frac{21}{8}, \infty\right)$ 

46. $\left[-7, \frac{13}{2}\right)$ 

47. $\left(-\infty, -\frac{5}{3}\right]$ or $\left[\frac{1}{3}, \infty\right)$ 

48. $h = \frac{3V}{lw}$ **49.** $x = \frac{y-y_1}{m} + x_1$ **50.** $a = -\frac{Rs}{R-s}$ or $a = \frac{Rs}{s-R}$ **51.** 2018 **52.** 2018 **53.** quite well

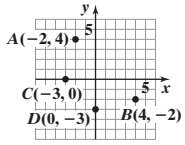
54. drive-in theaters: 1; movie theaters: 17; video rental stores: 65 **55.** 26 yr; \$33,600 **56.** length: 12 ft; width: 4 ft **57.** 10 ft **58.** \$50
59. 20 people **60.** more than 200 calls

CHAPTER 1

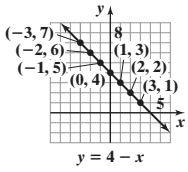
Section 1.1

Check Point Exercises

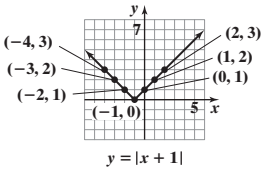
1.



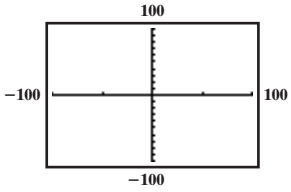
2.



3.



4. minimum x-value: -100; maximum x-value: 100; distance between tick marks on x-axis: 50; minimum y-value: -100; maximum y-value: 100; distance between tick marks on y-axis: 10

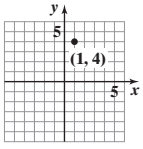


5. a. x-intercept: -3; y-intercept: 5
b. no x-intercept; y-intercept: 4
c. x-intercept: 0; y-intercept: 0

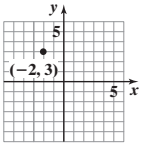
6. a. 65% **b.** 60% **c.** overestimates by 5%

Exercise Set 1.1

1.



3.



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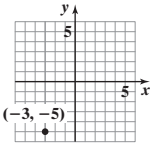
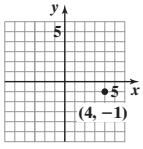
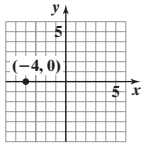


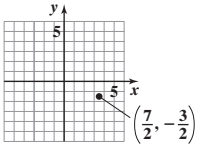
7.



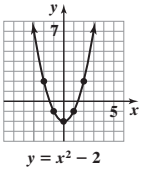
9.



11.



13.



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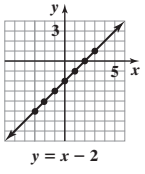

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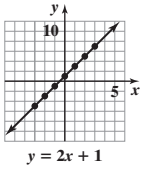
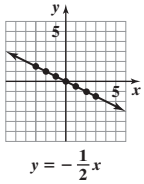


19.



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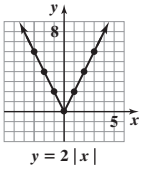

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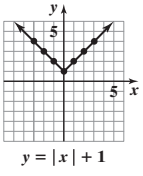

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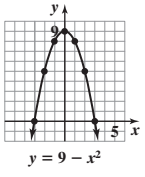
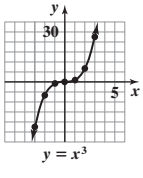
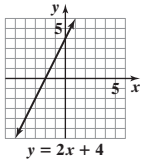


27.

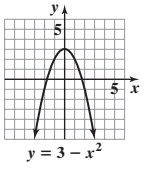


29. c **31.** b **33.** c **35.** no **37.** (2, 0) **39.** $(-2, 4)$ and (1, 1) **41. a.** 2 **b.** -4 **43. a.** 1, -2 **b.** 2 **45. a.** -1 **b.** none

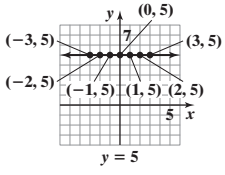
47. $y = 2x + 4$



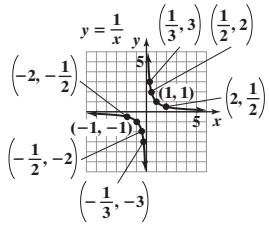
49. $y = 3 - x^2$



51.

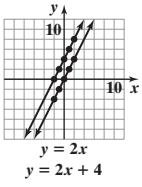


53.



55. a. 20% **b.** 18%; underestimates by 2% **c.** Answers will vary.; approximately 45% **d.** 44%; It's less than the estimate. **e.** 1990; 14%
57. 8; 1 **59.** about 1.9 **67.** makes sense **69.** does not make sense **71.** false **73.** true **75.** a **77.** b **79.** b **81.** c
83. set 1

84.

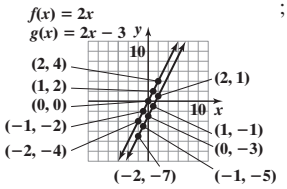


85. a. 3 **b.** -3 and 3 **c.** all real numbers **d.** all real numbers greater than or equal to 1

Section 1.2

Check Point Exercises

1. domain: {0, 10, 20, 30, 36}; range: {9.1, 6.7, 10.7, 13.2, 17.4} **2. a.** not a function **b.** function **3. a.** $y = 6 - 2x$; function
b. $y = \pm\sqrt{1 - x^2}$; not a function **4. a.** 42 **b.** $x^2 + 6x + 15$ **c.** $x^2 + 2x + 7$

5. 

; The graph of g is the graph of f shifted down by 3 units.

6. a. function **b.** function **c.** not a function **7. a.** 400 **b.** 9 **c.** approximately 425

8. a. domain: $\{x|-2 \le x \le 1\}$; range: $\{y|0 \le y \le 3\}$

b. domain: $\{x|-2 < x \le 1\}$; range: $\{y|-1 \le y < 2\}$

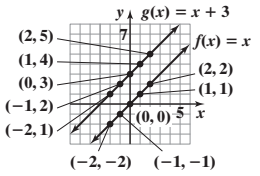
c. domain: $\{x|-3 \le x < 0\}$; range: $\{-3, -2, -1\}$

Exercise Set 1.2

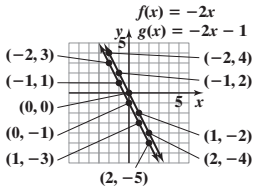
1. function; $\{1, 3, 5\}$; $\{2, 4, 5\}$ **3.** not a function; $\{3, 4\}$; $\{4, 5\}$ **5.** function; $\{3, 4, 5, 7\}$; $\{-2, 1, 9\}$ **7.** function; $\{-3, -2, -1, 0\}$; $\{-3, -2, -1, 0\}$
9. not a function; $\{1\}$; $\{4, 5, 6\}$ **11.** y is a function of x. **13.** y is a function of x. **15.** y is not a function of x. **17.** y is not a function of x.
19. y is a function of x. **21.** y is a function of x. **23.** y is a function of x. **25.** y is a function of x. **27. a.** 29 **b.** $4x + 9$ **c.** $-4x + 5$

29. a. 2 **b.** $x^2 + 12x + 38$ **c.** $x^2 - 2x + 3$ **31. a.** 13 **b.** 1 **c.** $x^4 - x^2 + 1$ **d.** $81a^4 - 9a^2 + 1$ **33. a.** 3 **b.** 7 **c.** $\sqrt{x} + 3$

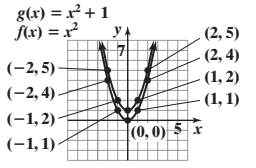
35. a. $\frac{15}{4}$ **b.** $\frac{15}{4}$ **c.** $\frac{4x^2 - 1}{x^2}$ **37. a.** 1 **b.** -1 **c.** 1

39. 

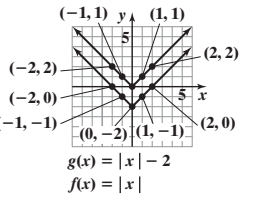
The graph of g is the graph of f shifted up by 3 units.

41. 

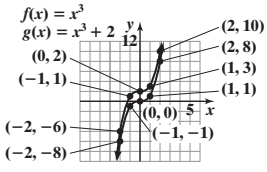
The graph of g is the graph of f shifted down by 1 unit.

43. 

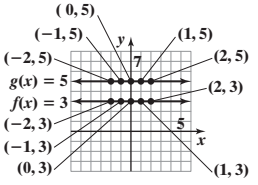
The graph of g is the graph of f shifted up by 1 unit.

45. 

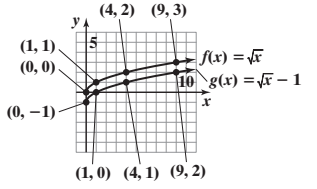
The graph of g is the graph of f shifted down by 2 units.

47. 

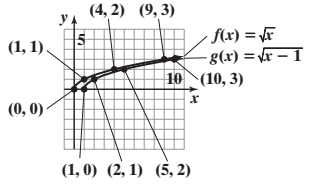
The graph of g is the graph of f shifted up by 2 units.

49. 

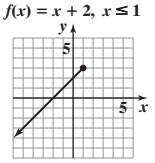
The graph of g is the graph of f shifted up by 2 units.

51. 

The graph of g is the graph of f shifted down by 1 unit.

53. 

The graph of g is the graph of f shifted to the right by 1 unit.

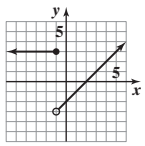
55. function **57.** function **59.** not a function **61.** function **63.** function **65.** -4 **67.** 4 **69.** 0 **71.** 2 **73.** 2
75. -2 **77. a.** $(-\infty, \infty)$ **b.** $[-4, \infty)$ **c.** -3 and 1 **d.** -3 **e.** $f(-2) = -3$ and $f(2) = 5$ **79. a.** $(-\infty, \infty)$ **b.** $[1, \infty)$ **c.** none
d. 1 **e.** $f(-1) = 2$ and $f(3) = 4$ **81. a.** $[0, 5)$ **b.** $[-1, 5)$ **c.** 2 **d.** -1 **e.** $f(3) = 1$ **83. a.** $[0, \infty)$ **b.** $[1, \infty)$ **c.** none
d. 1 **e.** $f(4) = 3$ **85. a.** $[-2, 6]$ **b.** $[-2, 6]$ **c.** 4 **d.** 4 **e.** $f(-1) = 5$ **87. a.** $(-\infty, \infty)$ **b.** $(-\infty, -2]$ **c.** none
d. -2 **e.** $f(-4) = -5$ and $f(4) = -2$ **89. a.** $(-\infty, \infty)$ **b.** $(0, \infty)$ **c.** none **d.** 1.5 **e.** $f(4) = 6$ **91. a.** $\{-5, -2, 0, 1, 3\}$
b. $\{2\}$ **c.** none **d.** 2 **e.** $f(-5) + f(3) = 4$ **93.** $-2; 10$ **95.** -38 **97.** $-2x^3 - 2x$
99. a. {(Iceland, 9.7), (Finland, 9.6), (New Zealand, 9.6), (Denmark, 9.5)} **b.** Yes, each country is paired with only one corruption rating.
c. {(9.7, Iceland), (9.6, Finland), (9.6, New Zealand), (9.5, Denmark)} **d.** No, the corruption rating 9.6 is paired with two different countries, Finland and New Zealand. **101. a.** 83; The chance that a 60-year-old will survive to age 70 is 83%. **b.** 76; The chance that a 60-year-old will survive to age 70 is 76%. **c.** f **103. a.** 127; In 2004, Americans ordered an average of 127 takeout meals per person.; by the point (20, 127)
b. 94; In 1984, Americans ordered an average of 94 meals in restaurants per person.; by the point (0, 94) **c.** 1988; 91 takeout meals and 91.6 meals in restaurants **105.** $C = 100{,}000 + 100x$, where x is the number of bicycles produced; $C(90) = 109{,}000$; It costs \$109,000 to produce 90 bicycles.
107. $T = \frac{40}{x} + \frac{40}{x + 30}$, where x is the rate on the outgoing trip; $T(30) = 2$; It takes 2 hours, traveling 30 mph outgoing and 60 mph returning.
119. does not make sense **121.** does not make sense **123.** false **125.** false **127.** Answers will vary; an example is $\{(1, 1), (2, 1)\}$.
129. 36; For 100 calling minutes, the monthly cost is \$36.
130. $f(x) = x + 2,\ x \le 1$  **131.** $4xh + 2h^2 + 3h$

Section 1.3

Check Point Exercises

1. increasing on $(-\infty, -1)$, decreasing on $(-1, 1)$, increasing on $(1, \infty)$ **2. a.** even **b.** odd **c.** neither
3. a. 20; With 40 calling minutes, the cost is \$20.; (40, 20) **b.** 28; With 80 calling minutes, the cost is \$28.; (80, 28)

4.



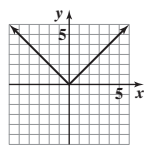
$f(x) = \begin{cases} 3 & \text{if } x \le -1 \\ x - 2 & \text{if } x > -1 \end{cases}$

5. a. $-2x^2 - 4xh - 2h^2 + x + h + 5$ **b.** $-4x - 2h + 1, h \neq 0$

Exercise Set 1.3

1. a. $(-1, \infty)$ **b.** $(-\infty, -1)$ **c.** none **3. a.** $(0, \infty)$ **b.** none **c.** none **5. a.** none **b.** $(-2, 6)$ **c.** none **7. a.** $(-\infty, -1)$ **b.** none **c.** $(-1, \infty)$ **9. a.** $(-\infty, 0)$ or $(1.5, 3)$ **b.** $(0, 1.5)$ or $(3, \infty)$ **c.** none **11. a.** $(-2, 4)$ **b.** none **c.** $(-\infty, -2)$ or $(4, \infty)$ **13. a.** $0; f(0) = 4$ **b.** $-3, 3; f(-3) = f(3) = 0$ **15. a.** $-2; f(-2) = 21$ **b.** $1; f(1) = -6$ **17.** odd **19.** neither **21.** even **23.** even **25.** even **27.** odd **29.** even **31.** odd **33. a.** $(-\infty, \infty)$ **b.** $[-4, \infty)$ **c.** 1 and 7 **d.** 4 **e.** $(4, \infty)$ **f.** $(0, 4)$ **g.** $(-\infty, 0)$ **h.** 4 **i.** -4 **j.** 4 **k.** 2 and 6 **l.** neither **35. a.** $(-\infty, 3]$ **b.** $(-\infty, 4]$ **c.** -3 and 3 **d.** 3 **e.** $(-\infty, 1)$ **f.** $(1, 3)$ **g.** $(-\infty, -3]$ **h.** A relative maximum of 4 occurs at 1. **i.** 1 **j.** positive **37. a.** -1 **b.** 7 **c.** 19 **41. a.** 8 **b.** 3 **c.** 6

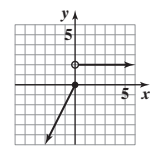
43. a.



$f(x) = \begin{cases} -x & \text{if } x < 0 \\ x & \text{if } x \ge 0 \end{cases}$

b. $[0, \infty)$

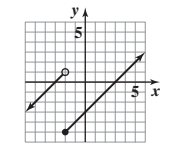
45. a.



$f(x) = \begin{cases} 2x & \text{if } x \le 0 \\ 2 & \text{if } x > 0 \end{cases}$

b. $(-\infty, 0] \cup \{2\}$

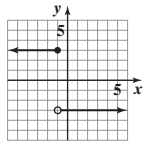
47. a.



$f(x) = \begin{cases} x + 3 & \text{if } x < -2 \\ x - 3 & \text{if } x \ge -2 \end{cases}$

b. $(-\infty, \infty)$

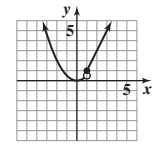
49. a.



$f(x) = \begin{cases} 3 & \text{if } x \le -1 \\ -3 & \text{if } x > -1 \end{cases}$

b. $\{-3, 3\}$

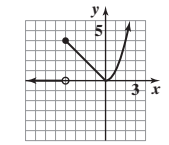
51. a.



$f(x) = \begin{cases} \frac{1}{2}x^2 & \text{if } x < 1 \\ 2x - 1 & \text{if } x \ge 1 \end{cases}$

b. $[0, \infty)$

53. a.



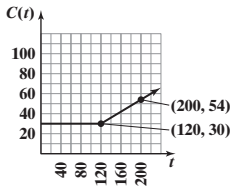
$f(x) = \begin{cases} 0 & \text{if } x < -4 \\ -x & \text{if } -4 \le x < 0 \\ x^2 & \text{if } x \ge 0 \end{cases}$

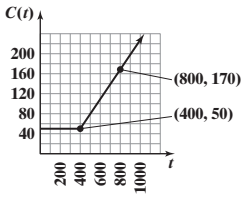
b. $[0, \infty)$

55. $4, h \neq 0$ **57.** $3, h \neq 0$ **59.** $2x + h, h \neq 0$ **61.** $2x + h - 4, h \neq 0$ **63.** $4x + 2h + 1, h \neq 0$ **65.** $-2x - h + 2, h \neq 0$

67. $-4x - 2h + 5, h \neq 0$ **69.** $-4x - 2h - 1, h \neq 0$ **71.** $0, h \neq 0$ **73.** $-\dfrac{1}{x(x+h)}, h \neq 0$ **75.** $\dfrac{1}{\sqrt{x+h} + \sqrt{x}}, h \neq 0$ **77.** -18

79. $0.30t - 6$ **81.** $C(t) = \begin{cases} 50 & \text{if } 0 \le t \le 400 \\ 50 + 0.30(t - 400) & \text{if } t > 400 \end{cases}$



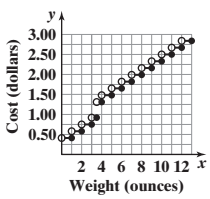


83. increasing: $(25, 55)$; decreasing: $(55, 75)$ **85.** 55 years old; 38% **87.** domain: $[25, 75]$; range: $[34, 38]$ **89.** men

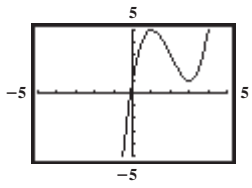
91. 2608.75; A single taxpayer with taxable income of \$20,000 owes \$2608.75. **93.** $39{,}148.75 + 0.33(x - 160{,}850)$

95. 0.76; It costs \$0.76 to mail a 3-ounce first-class letter. **97.** \$0.59

99.

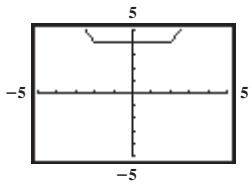


107.



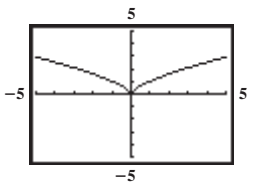
increasing: $(-\infty, 1)$ or $(3, \infty)$
decreasing: $(1, 3)$

109.



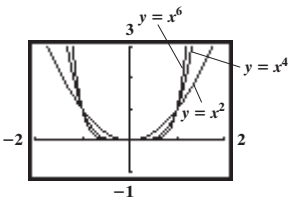
increasing: $(2, \infty)$
decreasing: $(-\infty, -2)$
constant: $(-2, 2)$

111.

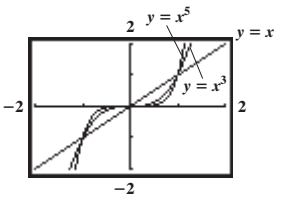


increasing: $(0, \infty)$
decreasing: $(-\infty, 0)$

113. a.



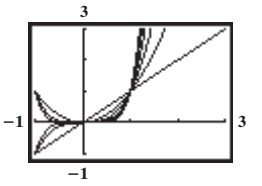
b.



c. increasing: $(0, \infty)$; decreasing: $(-\infty, 0)$

d. $f(x) = x^n$ is increasing for $(-\infty, \infty)$ when n is positive and odd.

e.



As n increases the steepness increases.

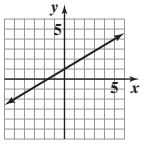
115. makes sense **117.** makes sense **122.** 3 **123.** $\left(\frac{3}{2}, 0\right)$ and $(0, -2)$ **124.** $y = \frac{-3x + 4}{2}$ or $y = -\frac{3}{2}x + 2$

Section 1.4

Check Point Exercises

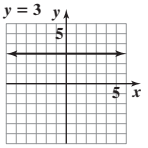
1. a. 6 **b.** $-\frac{7}{5}$ **2.** $y + 5 = 6(x - 2)$; $y = 6x - 17$ **3.** $y + 1 = -5(x + 2)$ or $y + 6 = -5(x + 1)$; $y = -5x - 11$

4.

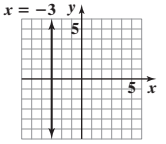


$f(x) = \frac{3}{5}x + 1$

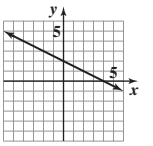
5.



6.

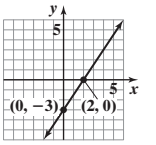


7. slope: $-\frac{1}{2}$; y-intercept: 2



$3x + 6y - 12 = 0$

8.



$3x - 2y - 6 = 0$

9. $f(x) = 0.016x + 52.0$; 61.6°F

Exercise Set 1.4

1. $\frac{3}{4}$; rises **3.** $\frac{1}{4}$; rises **5.** 0; horizontal **7.** -5; falls **9.** undefined; vertical **11.** $y - 5 = 2(x - 3)$; $y = 2x - 1$

13. $y - 5 = 6(x + 2)$; $y = 6x + 17$ **15.** $y + 3 = -3(x + 2)$; $y = -3x - 9$ **17.** $y - 0 = -4(x + 4)$; $y = -4x - 16$

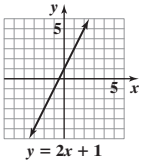
19. $y + 2 = -1\left(x + \frac{1}{2}\right)$; $y = -x - \frac{5}{2}$ **21.** $y - 0 = \frac{1}{2}(x - 0)$; $y = \frac{1}{2}x$ **23.** $y + 2 = -\frac{2}{3}(x - 6)$; $y = -\frac{2}{3}x + 2$

25. using $(1, 2)$, $y - 2 = 2(x - 1)$; $y = 2x$ **27.** using $(-3, 0)$, $y - 0 = 1(x + 3)$; $y = x + 3$ **29.** using $(-3, -1)$, $y + 1 = 1(x + 3)$; $y = x + 2$

31. using $(-3, -2)$, $y + 2 = \frac{4}{3}(x + 3)$; $y = \frac{4}{3}x + 2$ **33.** using $(-3, -1)$, $y + 1 = 0(x + 3)$; $y = -1$ **35.** using $(2, 4)$, $y - 4 = 1(x - 2)$; $y = x + 2$

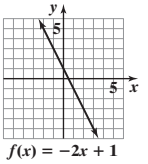
37. using $(0, 4)$, $y - 4 = 8(x - 0)$; $y = 8x + 4$

39. $m = 2$; $b = 1$



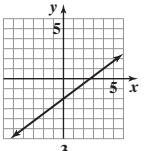
$y = 2x + 1$

41. $m = -2$; $b = 1$



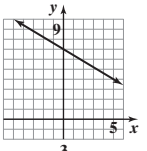
$f(x) = -2x + 1$

43. $m = \frac{3}{4}$; $b = -2$



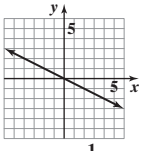
$f(x) = \frac{3}{4}x - 2$

45. $m = -\frac{3}{5}$; $b = 7$



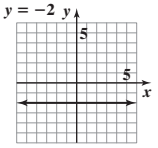
$y = -\frac{3}{5}x + 7$

47. $m = -\frac{1}{2}$; $b = 0$

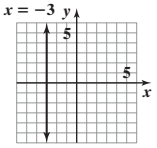


$g(x) = -\frac{1}{2}x$

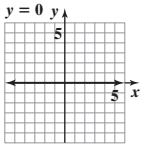
49.



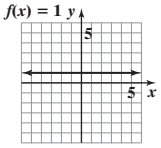
51.



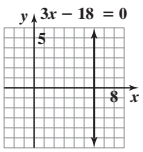
53.



55.



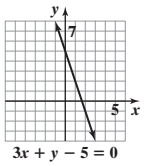
57.



59. a. $y = -3x + 5$

b. $m = -3; b = 5$

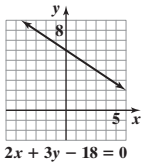
c.



61. a. $y = -\frac{2}{3}x + 6$

b. $m = -\frac{2}{3}; b = 6$

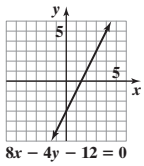
c.



63. a. $y = 2x - 3$

b. $m = 2; b = -3$

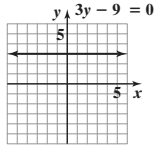
c.



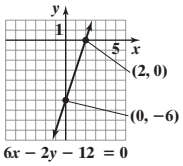
65. a. $y = 3$

b. $m = 0; b = 3$

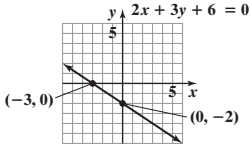
c.



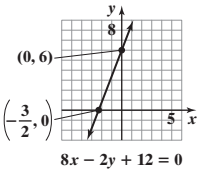
67.



69.



71.



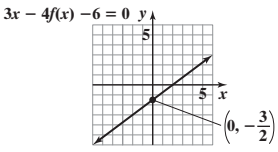
73. $m = -\frac{a}{b}$; falls

75. undefined slope; vertical

77. $m = -\frac{A}{B}; b = \frac{C}{B}$

79. -2

81.

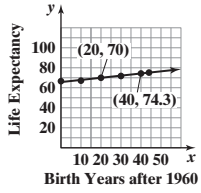


83. 5

85. m_1, m_3, m_2, m_4

87. a. $y - 31.1 = 0.78(x - 10)$ or $y - 38.9 = 0.78(x - 20)$ **b.** $f(x) = 0.78x + 23.3$ **c.** 54.5%

89. a &b.

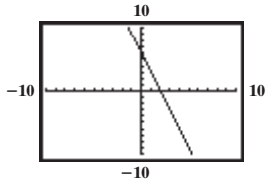


; $E(x) = 0.215x + 65.7$

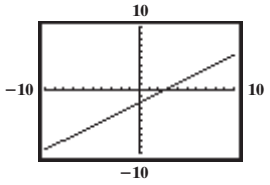
c. 78.6 yr

91. Answers will vary; an example is $y = -2.3x + 255$, where x is the percentage of adult females who are literate and y is under-five mortality per thousand.; Predictions will vary.

101. $m = -3$



103. $m = \frac{3}{4}$



105. does not make sense **107.** does not make sense

109. false **111.** true

113. coefficient of x: -6; coefficient of y: 3

118. $y = 2x + 7$ or $f(x) = 2x + 7$

119. $4x - y - 17 = 0$ **120.** 5

Section 1.5

Check Point Exercises

1. $y - 5 = 3(x + 2); y = 3x + 11$ or $f(x) = 3x + 11$ **2. a.** 3 **b.** $3x - y = 0$ **3.** $m \approx 0.25$; The number of men living alone increased at a rate of 0.25 million per year. The rate of change is 0.25 million men per year. **4. a.** 1 **b.** 7 **c.** 4 **5.** 0.01 mg per 100 ml per hr **6. a.** 12 ft/sec **b.** 10 ft/sec **c.** 8.04 ft/sec

Exercise Set 1.5

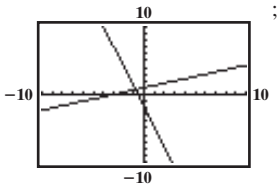
1. $y - 2 = 2(x - 4); y = 2x - 6$ or $f(x) = 2x - 6$ **3.** $y - 4 = -\frac{1}{2}(x - 2); y = -\frac{1}{2}x + 5$ or $f(x) = -\frac{1}{2}x + 5$

5. $y + 10 = -4(x + 8); y = -4x - 42$ **7.** $y + 3 = -5(x - 2); y = -5x + 7$ **9.** $y - 2 = \frac{2}{3}(x + 2); 2x - 3y + 10 = 0$

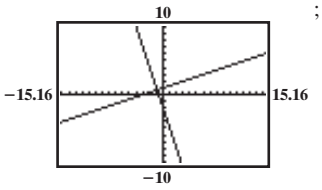
11. $y + 7 = -2(x - 4); 2x + y - 1 = 0$ **13.** 3 **15.** 10 **17.** $\frac{1}{5}$ **19. a.** 70 ft/sec **b.** 65 ft/sec **c.** 60.1 ft/sec **d.** 60.01 ft/sec

21. $f(x) = 5$ **23.** $f(x) = -\frac{1}{2}x + 1$ **25.** $f(x) = -\frac{2}{3}x - 2$ **27.** $P(x) = -1.2x + 47$ **29.** 137; There was an average increase of approximately 137 discharges per year. **31. a.** 142 **b.** overestimates by 5 discharges per year

39. a. The product of their slopes is -1.

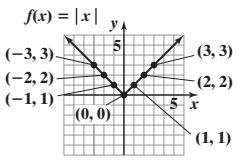
b. 

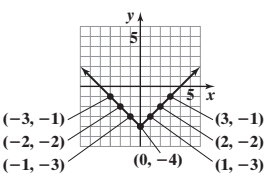
; no

c. 

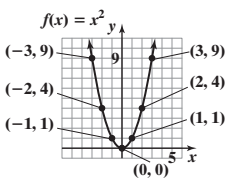
; The lines now appear to be perpendicular.

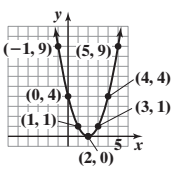
41. makes sense **43.** makes sense **45.** $-\frac{3}{7}$

46. a. 

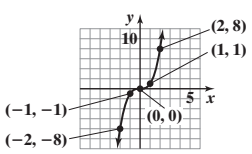
b. 

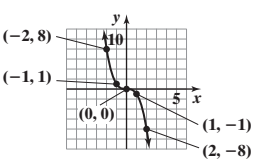
c. The graph in part (b) is the graph in part (a) shifted down 4 units.

47. a. 

b. 

c. The graph in part (b) is the graph in part (a) shifted to the right 2 units.

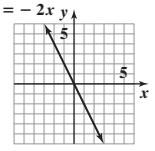
48. a. 

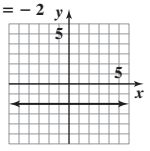
b. 

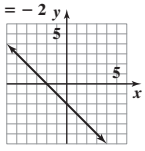
c. The graph in part (b) is the graph in part (a) reflected across the y-axis.

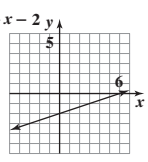
Mid-Chapter 1 Check Point

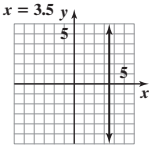
1. not a function; domain: $\{1, 2\}$; range: $\{-6, 4, 6\}$ **2.** function; domain: $\{0, 2, 3\}$; range: $\{1, 4\}$ **3.** function; domain: $\{x|-2 \le x < 2\}$ or $[-2, 2)$; range: $\{y|0 \le y \le 3\}$ or $[0, 3]$ **4.** not a function; domain: $\{x|-3 < x \le 4\}$ or $(-3, 4]$; range: $\{y|-1 \le y \le 2\}$ or $[-1, 2]$
5. not a function; domain: $\{-2, -1, 0, 1, 2\}$; range: $\{-2, -1, 1, 3\}$ **6.** function; domain: $\{x|x \le 1\}$ or $(-\infty, 1]$; range: $\{y|y \ge -1\}$ or $[-1, \infty)$
7. y is a function of x. **8.** y is not a function of x. **9.** No vertical line intersects the graph in more than one point. **10.** $(-\infty, \infty)$
11. $(-\infty, 4]$ **12.** -6 and 2 **13.** 3 **14.** $(-\infty, -2)$ **15.** $(-2, \infty)$ **16.** -2 **17.** 4 **18.** 3 **19.** -7 and 3 **20.** -6 and 2
21. $(-6, 2)$ **22.** negative **23.** neither **24.** -1

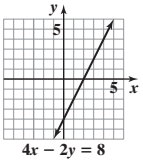
25. $y = -2x$ 

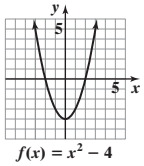
26. $y = -2$ 

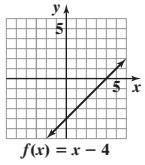
27. $x + y = -2$ 

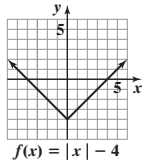
28. $y = \frac{1}{3}x - 2$ 

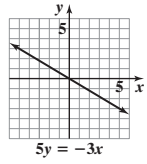
29. $x = 3.5$ 

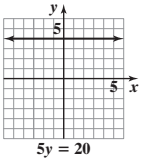
30. 

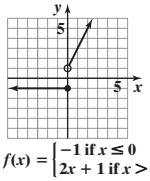
31. 

32. 

33. 

34. 

35. 

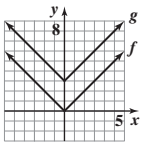
36. 

37. a. $f(-x) = -2x^2 - x - 5$; neither **b.** $-4x - 2h + 1, h \ne 0$ **38. a.** 30 **b.** 50
39. $f(x) = -2x - 5$ **40.** $f(x) = 2x - 3$ **41.** $f(x) = 3x - 13$
42. $f(x) = -\frac{5}{2}x - 13$ **43.** The lines are parallel.
44. a. 0.16 **b.** 0.16; 0.16; minute of brisk walking **45.** 2

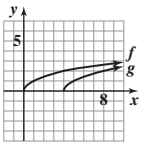
Section 1.6

Check Point Exercises

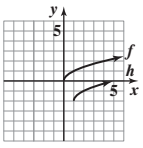
1.



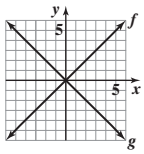
2.



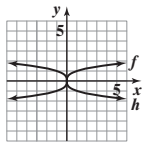
3.



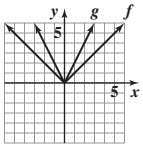
4.



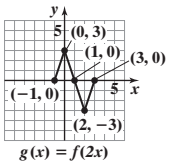
5.



6.

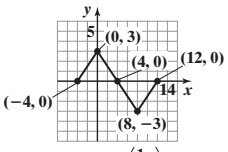


7. a.



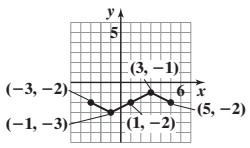
$g(x) = f(2x)$

b.



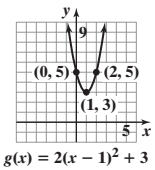
$h(x) = f\left(\frac{1}{2}x\right)$

8.



$y = -\frac{1}{3}f(x+1) - 2$

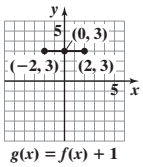
9.



$g(x) = 2(x-1)^2 + 3$

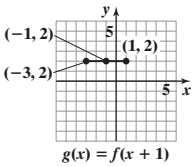
Exercise Set 1.6

1.



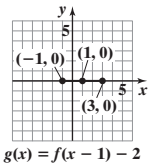
$g(x) = f(x) + 1$

3.



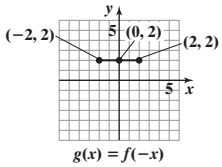
$g(x) = f(x+1)$

5.



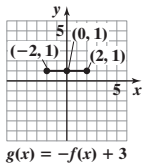
$g(x) = f(x-1) - 2$

7.



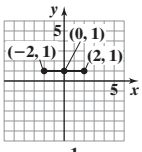
$g(x) = f(-x)$

9.



$g(x) = -f(x) + 3$

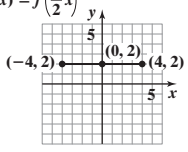
11.



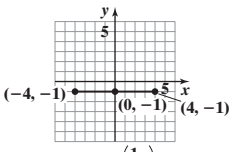
$g(x) = \frac{1}{2}f(x)$

13.

$g(x) = f\left(\frac{1}{2}x\right)$

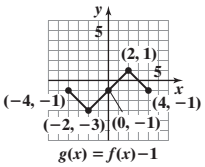


15.



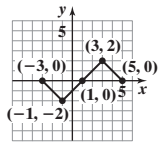
$g(x) = -f\left(\frac{1}{2}x\right) + 1$

17.



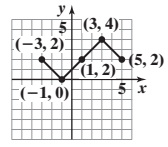
$g(x) = f(x) - 1$

19.



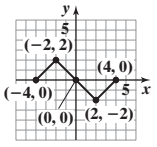
$g(x) = f(x-1)$

21.



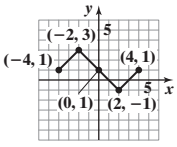
$g(x) = f(x-1) + 2$

23.



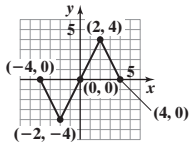
$g(x) = -f(x)$

25.



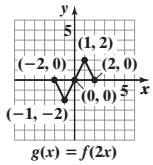
$g(x) = f(-x) + 1$

27.



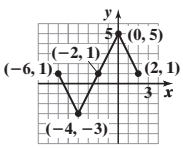
$g(x) = 2f(x)$

29.



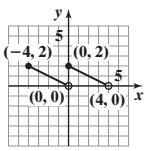
$g(x) = f(2x)$

31.



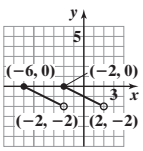
$g(x) = 2f(x+2) + 1$

33.



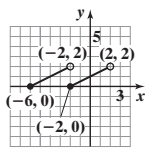
$g(x) = f(x) + 2$

35.



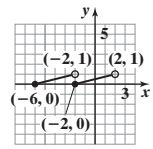
$g(x) = f(x+2)$

37.



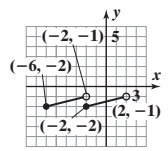
$g(x) = -f(x+2)$

39.



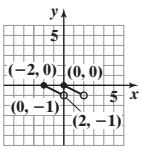
$g(x) = -\frac{1}{2}f(x+2)$

41.



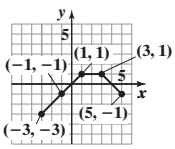
$g(x) = -\frac{1}{2}f(x+2) - 2$

43.



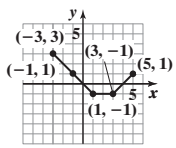
$g(x) = \frac{1}{2}f(2x)$

45.



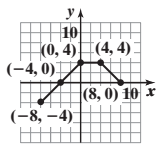
$g(x) = f(x-1) - 1$

47.



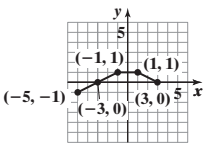
$g(x) = -f(x-1) + 1$

49.



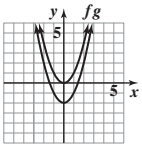
$g(x) = 2f\left(\frac{1}{2}x\right)$

51.



$g(x) = \frac{1}{2}f(x+1)$

53.



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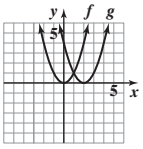

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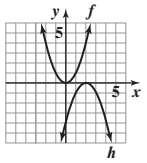

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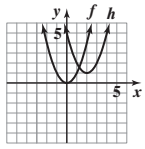

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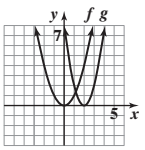

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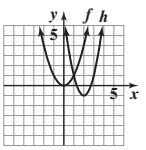

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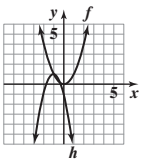

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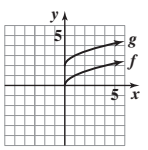

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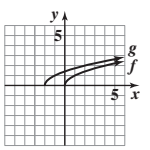

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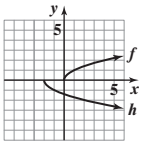

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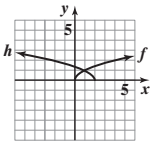

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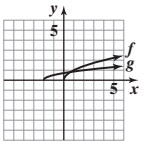

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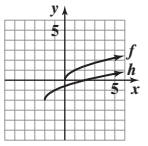

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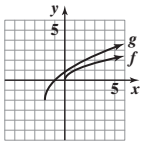

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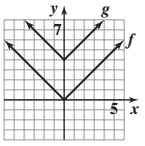

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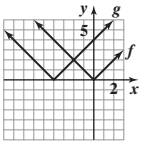

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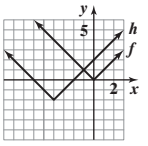

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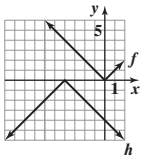

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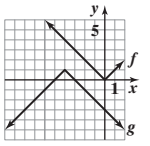

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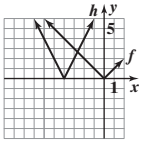

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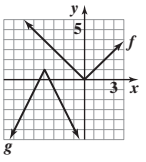

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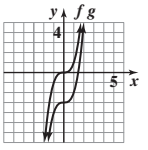

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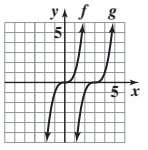

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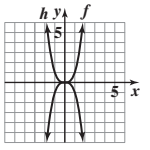

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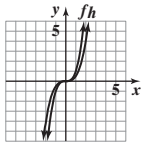

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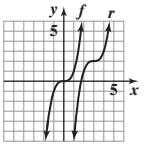

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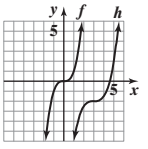

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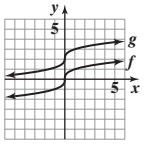

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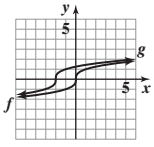

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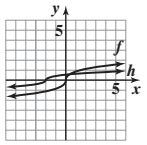

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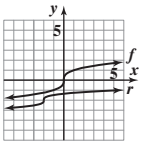

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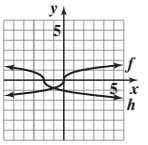

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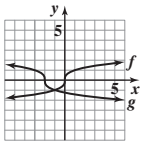

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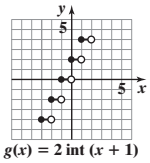
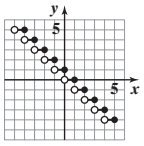


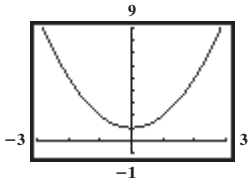
$g(x) = 2 \text{ int } (x + 1)$

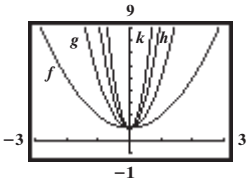
121.


$h(x) = \text{int } (-x) + 1$

123. $y = \sqrt{x - 2}$ **125.** $y = (x + 1)^2 - 4$

127. a. First, vertically stretch the graph of $f(x) = \sqrt{x}$ by the factor 2.9; then, shift the result up 20.1 units. **b.** 40.2 in.; very well **c.** 0.9 in. per month **d.** 0.2 in. per month; This is a much smaller rate of change; The graph is not as steep between 50 and 60 as it is between 0 and 10.

135. a.


b.


137. makes sense **139.** does not make sense **141.** false **143.** false **145.** $g(x) = -(x + 4)^2$ **147.** $g(x) = -\sqrt{x - 2} + 2$

149. $(-a, b)$ **151.** $(a + 3, b)$ **153.** $2x^3 + x^2 - 5x + 2$ **154.** $9x^2 - 30x + 30$ **155.** $\dfrac{2x}{3 - x}$

Section 1.7

Check Point Exercises

1. a. $(-\infty, \infty)$ **b.** $(-\infty, -7) \cup (-7, 7) \cup (7, \infty)$ **c.** $[3, \infty)$ **2. a.** $(f + g)(x) = x^2 + x - 6; (-\infty, \infty)$ **b.** $(f - g)(x) = -x^2 + x - 4; (-\infty, \infty)$

c. $(fg)(x) = x^3 - 5x^2 - x + 5; (-\infty, \infty)$ **d.** $\left(\dfrac{f}{g}\right)(x) = \dfrac{x - 5}{x^2 - 1}; (-\infty, -1) \cup (-1, 1) \cup (1, \infty)$ **3. a.** $(f + g)(x) = \sqrt{x - 3} + \sqrt{x + 1}$ **b.** $[3, \infty)$

4. a. $(f \circ g)(x) = 10x^2 - 5x + 1$ **b.** $(g \circ f)(x) = 50x^2 + 115x + 65$ **c.** 16 **5. a.** $(f \circ g)(x) = \dfrac{4x}{1 + 2x}$ **b.** $\left(-\infty, -\dfrac{1}{2}\right) \cup \left(-\dfrac{1}{2}, 0\right) \cup (0, \infty)$

6. If $f(x) = \sqrt{x}$ and $g(x) = x^2 + 5$, then $h(x) = (f \circ g)(x)$.

Exercise Set 1.7

1. $(-\infty, \infty)$ **3.** $(-\infty, 4) \cup (4, \infty)$ **5.** $(-\infty, \infty)$ **7.** $(-\infty, -3) \cup (-3, 5) \cup (5, \infty)$ **9.** $(-\infty, -7) \cup (-7, 9) \cup (9, \infty)$
11. $(-\infty, -1) \cup (-1, 1) \cup (1, \infty)$ **13.** $(-\infty, 0) \cup (0, 3) \cup (3, \infty)$ **15.** $(-\infty, 1) \cup (1, 3) \cup (3, \infty)$ **17.** $[3, \infty)$ **19.** $(3, \infty)$ **21.** $[-7, \infty)$
23. $(-\infty, 12]$ **25.** $[2, \infty)$ **27.** $[2, 5) \cup (5, \infty)$ **29.** $(-\infty, -2) \cup (-2, 2) \cup (2, 5) \cup (5, \infty)$

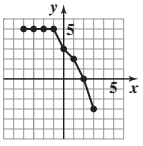
31. $(f + g)(x) = 3x + 2$; domain: $(-\infty, \infty)$; $(f - g)(x) = x + 4$; domain: $(-\infty, \infty)$; $(fg)(x) = 2x^2 + x - 3$; domain: $(-\infty, \infty)$; $\left(\dfrac{f}{g}\right)(x) = \dfrac{2x + 3}{x - 1}$; domain: $(-\infty, 1) \cup (1, \infty)$ **33.** $(f + g)(x) = 3x^2 + x - 5$; domain: $(-\infty, \infty)$; $(f - g)(x) = -3x^2 + x - 5$; domain: $(-\infty, \infty)$; $(fg)(x) = 3x^3 - 15x^2$; domain: $(-\infty, \infty)$; $\left(\dfrac{f}{g}\right)(x) = \dfrac{x - 5}{3x^2}$; domain: $(-\infty, 0) \cup (0, \infty)$ **35.** $(f + g)(x) = 2x^2 - 2$; domain: $(-\infty, \infty)$; $(f - g)(x) = 2x^2 - 2x - 4$; domain: $(-\infty, \infty)$; $(fg)(x) = 2x^3 + x^2 - 4x - 3$; domain: $(-\infty, \infty)$; $\left(\dfrac{f}{g}\right)(x) = 2x - 3$; domain: $(-\infty, -1) \cup (-1, \infty)$

37. $(f + g)(x) = 2x - 12$; domain: $(-\infty, \infty)$; $(f - g)(x) = -2x^2 - 2x + 18$; domain: $(-\infty, \infty)$; $(fg)(x) = -x^4 - 2x^3 + 18x^2 + 6x - 45$; domain: $(-\infty, \infty)$; $\left(\dfrac{f}{g}\right)(x) = \dfrac{3 - x^2}{x^2 + 2x - 15}$; domain: $(-\infty, -5) \cup (-5, 3) \cup (3, \infty)$

39. $(f + g)(x) = \sqrt{x} + x - 4$; domain: $[0, \infty)$; $(f - g)(x) = \sqrt{x} - x + 4$; domain: $[0, \infty)$; $(fg)(x) = \sqrt{x}(x - 4)$; domain: $[0, \infty)$; $\left(\dfrac{f}{g}\right)(x) = \dfrac{\sqrt{x}}{x - 4}$; domain: $[0, 4) \cup (4, \infty)$ **41.** $(f + g)(x) = \dfrac{2x + 2}{x}$; domain: $(-\infty, 0) \cup (0, \infty)$; $(f - g)(x) = 2$; domain: $(-\infty, 0) \cup (0, \infty)$; $(fg)(x) = \dfrac{2x + 1}{x^2}$; domain: $(-\infty, 0) \cup (0, \infty)$; $\left(\dfrac{f}{g}\right)(x) = 2x + 1$; domain: $(-\infty, 0) \cup (0, \infty)$ **43.** $(f + g)(x) = \dfrac{9x - 1}{x^2 - 9}$; domain: $(-\infty, -3) \cup (-3, 3) \cup (3, \infty)$; $(f - g)(x) = \dfrac{x + 3}{x^2 - 9} = \dfrac{1}{x - 3}$; domain: $(-\infty, -3) \cup (-3, 3) \cup (3, \infty)$; $(fg)(x) = \dfrac{20x^2 - 6x - 2}{(x^2 - 9)^2}$; domain: $(-\infty, -3) \cup (-3, 3) \cup (3, \infty)$; $\left(\dfrac{f}{g}\right)(x) = \dfrac{5x + 1}{4x - 2}$; domain: $(-\infty, -3) \cup \left(-3, \dfrac{1}{2}\right) \cup \left(\dfrac{1}{2}, 3\right) \cup (3, \infty)$

45. $(f + g)(x) = \sqrt{x + 4} + \sqrt{x - 1}$; domain: $[1, \infty)$; $(f - g)(x) = \sqrt{x + 4} - \sqrt{x - 1}$; domain: $[1, \infty)$; $(fg)(x) = \sqrt{x^2 + 3x - 4}$; domain: $[1, \infty)$; $\left(\dfrac{f}{g}\right)(x) = \dfrac{\sqrt{x + 4}}{\sqrt{x - 1}}$; domain: $(1, \infty)$ **47.** $(f + g)(x) = \sqrt{x - 2} + \sqrt{2 - x}$; domain: $\{2\}$; $(f - g)(x) = \sqrt{x - 2} - \sqrt{2 - x}$; domain: $\{2\}$; $(fg)(x) = \sqrt{x - 2} \cdot \sqrt{2 - x}$; domain: $\{2\}$; $\left(\dfrac{f}{g}\right)(x) = \dfrac{\sqrt{x - 2}}{\sqrt{2 - x}}$; domain: $\varnothing$ **49. a.** $(f \circ g)(x) = 2x + 14$ **b.** $(g \circ f)(x) = 2x + 7$
c. $(f \circ g)(2) = 18$ **51. a.** $(f \circ g)(x) = 2x + 5$ **b.** $(g \circ f)(x) = 2x + 9$ **c.** $(f \circ g)(2) = 9$ **53. a.** $(f \circ g)(x) = 20x^2 - 11$
b. $(g \circ f)(x) = 80x^2 - 120x + 43$ **c.** $(f \circ g)(2) = 69$ **55. a.** $(f \circ g)(x) = x^4 - 4x^2 + 6$ **b.** $(g \circ f)(x) = x^4 + 4x^2 + 2$ **c.** $(f \circ g)(2) = 6$
57. a. $(f \circ g)(x) = -2x^2 - x - 1$ **b.** $(g \circ f)(x) = 2x^2 - 17x + 41$ **c.** -11 **59. a.** $(f \circ g)(x) = \sqrt{x - 1}$ **b.** $(g \circ f)(x) = \sqrt{x} - 1$
c. $(f \circ g)(2) = 1$ **61. a.** $(f \circ g)(x) = x$ **b.** $(g \circ f)(x) = x$ **c.** $(f \circ g)(2) = 2$ **63. a.** $(f \circ g)(x) = x$ **b.** $(g \circ f)(x) = x$ **c.** 2
65. a. $(f \circ g)(x) = \dfrac{2x}{1 + 3x}$ **b.** $\left(-\infty, -\dfrac{1}{3}\right) \cup \left(-\dfrac{1}{3}, 0\right) \cup (0, \infty)$ **67. a.** $(f \circ g)(x) = \dfrac{4}{4 + x}$ **b.** $(-\infty, -4) \cup (-4, 0) \cup (0, \infty)$
69. a. $(f \circ g)(x) = \sqrt{x - 2}$ **b.** $[2, \infty)$ **71. a.** $(f \circ g)(x) = 5 - x$ **b.** $(-\infty, 1]$ **73.** $f(x) = x^4$, $g(x) = 3x - 1$
75. $f(x) = \sqrt[3]{x}$, $g(x) = x^2 - 9$ **77.** $f(x) = |x|$, $g(x) = 2x - 5$ **79.** $f(x) = \dfrac{1}{x}$, $g(x) = 2x - 3$ **81.** 5 **83.** -1 **85.** $[-4, 3]$

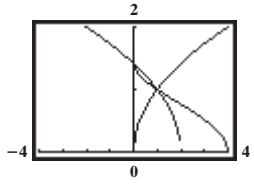
87.



89. 1 **91.** -6 **93.** 1 and 2
95. a. $(B - D)(x) = 10.9x^2 - 35x + 1641$
b. 1634.1 thousand **c.** overestimates by 0.1 thousand

97. $(R - C)(20{,}000) = -200{,}000$; The company loses \$200,000 when 20,000 radios are sold.; $(R - C)(30{,}000) = 0$; The company breaks even when 30,000 radios are sold.; $(R - C)(40{,}000) = 200{,}000$; The company makes a profit of \$200,000 when 40,000 radios are sold. **99. a.** f gives the price of the computer after a \$400 discount. g gives the price of the computer after a 25% discount. **b.** $(f \circ g)(x) = 0.75x - 400$; This models the price of a computer after first a 25% discount and then a \$400 discount. **c.** $(g \circ f)(x) = 0.75(x - 400)$; This models the price of a computer after first a \$400 discount and then a 25% discount. **d.** $f \circ g$ because $0.75x - 400 < 0.75(x - 400)$

107.



Domain: $[0, 4]$

109. makes sense **111.** does not make sense **113.** false **115.** true
117. Answers will vary; One possible answer is $f(x) = x + 1$ and $g(x) = x - 1$.
118. $\{(4, -2), (1, -1), (1, 1), (4, 2)\}$; no **119.** $y = \dfrac{5}{x - 4}$ **120.** $y = \sqrt{x + 1}$

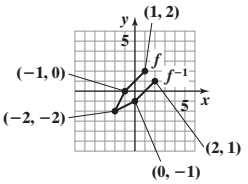
Section 1.8

Check Point Exercises

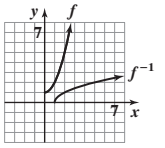
1. $f(g(x)) = 4\left(\frac{x+7}{4}\right) - 7 = x + 7 - 7 = x$; $g(f(x)) = \frac{(4x-7)+7}{4} = \frac{4x}{4} = x$ **2.** $f^{-1}(x) = \frac{x-7}{2}$ **3.** $f^{-1}(x) = \sqrt[3]{\frac{x+1}{4}}$

4. $f^{-1}(x) = \frac{3}{x+1}$ **5.** (b) and (c)

6.



7. $f^{-1}(x) = \sqrt{x-1}$



Exercise Set 1.8

1. $f(g(x)) = x$; $g(f(x)) = x$; f and g are inverses. **3.** $f(g(x)) = x$; $g(f(x)) = x$; f and g are inverses.

5. $f(g(x)) = \frac{5x-56}{9}$; $g(f(x)) = \frac{5x-4}{9}$; f and g are not inverses. **7.** $f(g(x)) = x$; $g(f(x)) = x$; f and g are inverses.

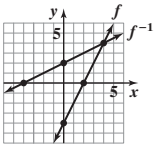
9. $f(g(x)) = x$; $g(f(x)) = x$; f and g are inverses. **11.** $f^{-1}(x) = x - 3$ **13.** $f^{-1}(x) = \frac{x}{2}$ **15.** $f^{-1}(x) = \frac{x-3}{2}$ **17.** $f^{-1}(x) = \sqrt[3]{x-2}$

19. $f^{-1}(x) = \sqrt[3]{x} - 2$ **21.** $f^{-1}(x) = \frac{1}{x}$ **23.** $f^{-1}(x) = x^2, x \geq 0$ **25.** $f^{-1}(x) = \frac{7}{x+3}$ **27.** $f^{-1}(x) = \frac{3x+1}{x-2}; x \neq 2$

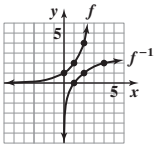
29. The function is not one-to-one, so it does not have an inverse function. **31.** The function is not one-to-one, so it does not have an inverse function.

33. The function is one-to-one, so it does have an inverse function.

35.

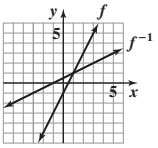


37.



39. a. $f^{-1}(x) = \frac{x+1}{2}$

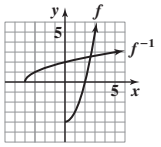
b.



c. domain of f = range of $f^{-1} = (-\infty, \infty)$; range of f = domain of $f^{-1} = (-\infty, \infty)$

41. a. $f^{-1}(x) = \sqrt{x+4}$

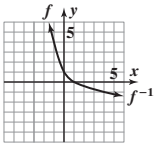
b.



c. domain of f = range of $f^{-1} = [0, \infty)$; range of f = domain of $f^{-1} = [-4, \infty)$

43. a. $f^{-1}(x) = -\sqrt{x} + 1$

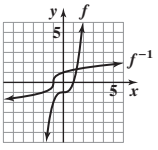
b.



c. domain of f = range of $f^{-1} = (-\infty, 1]$; range of f = domain of $f^{-1} = [0, \infty)$

45. a. $f^{-1}(x) = \sqrt[3]{x+1}$

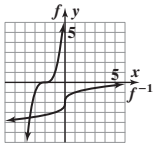
b.



c. domain of f = range of $f^{-1} = (-\infty, \infty)$; range of f = domain of $f^{-1} = (-\infty, \infty)$

47. a. $f^{-1}(x) = \sqrt[3]{x} - 2$

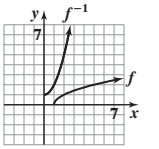
b.



c. domain of f = range of $f^{-1} = (-\infty, \infty)$; range of f = domain of $f^{-1} = (-\infty, \infty)$

49. a. $f^{-1}(x) = x^2 + 1, x \geq 0$

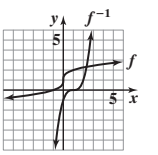
b.



c. domain of f = range of $f^{-1} = [1, \infty)$; range of f = domain of $f^{-1} = [0, \infty)$

51. a. $f^{-1}(x) = (x-1)^3$

b.



c. domain of f = range of $f^{-1} = (-\infty, \infty)$; range of f = domain of $f^{-1} = (-\infty, \infty)$

53. 5 **55.** 1 **57.** 2 **59.** -7 **61.** 3 **63.** 11

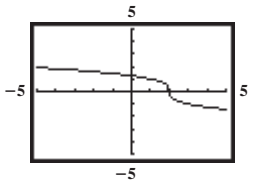
65. a. $\{(17, 9.7), (22, 8.7), (30, 8.4), (40, 8.3), (50, 8.2), (60, 8.3)\}$

b. $\{(9.7, 17), (8.7, 22), (8.4, 30), (8.3, 40), (8.2, 50), (8.3, 60)\}$; no; The inverse of f is not a function.

67. a. f is a one-to-one function. **b.** $f^{-1}(0.25)$ is the number of people in a room for a 25% probability of two people sharing a birthday. $f^{-1}(0.5)$ is the number of people in a room for a 50% probability of two people sharing a birthday. $f^{-1}(0.7)$ is the number of people in a room for a 70% probability of two people sharing a birthday.

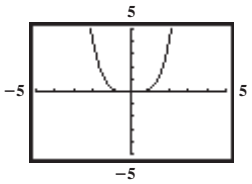
69. $f(g(x)) = \frac{9}{5}\left[\frac{5}{9}(x-32)\right] + 32 = x$ and $g(f(x)) = \frac{5}{9}\left[\left(\frac{9}{5}x + 32\right) - 32\right] = x$

77.



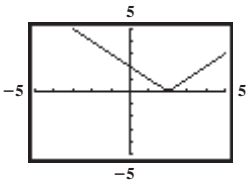
one-to-one

79.



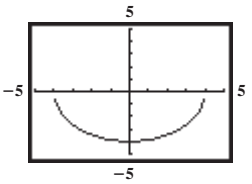
not one-to-one

81.



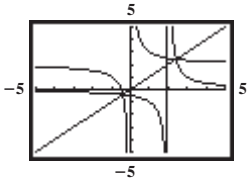
not one-to-one

83.



not one-to-one

85.



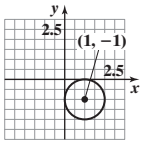
f and g are inverses.

87. makes sense **89.** makes sense **91.** false **93.** false

95. $(f \circ g)^{-1}(x) = \dfrac{x-15}{3}; (g^{-1} \circ f^{-1})(x) = \dfrac{x}{3} - 5 = \dfrac{x-15}{3}$

97. No; The space craft was at the same height, $s(t)$, for two different values of t-once during the ascent and once again during the descent.

100. $3\sqrt{5}$ **101.**



102. $\{3 \pm \sqrt{13}\}$

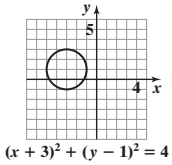
Section 1.9

Check Point Exercises

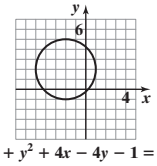
1. 13 **2.** $\left(4, -\dfrac{1}{2}\right)$ **3.** $x^2 + y^2 = 16$ **4.** $x^2 + (y+6)^2 = 100$

5. a. center: $(-3, 1)$; radius: 2 **6.** $(x+2)^2 + (y-2)^2 = 9$

b.



$(x+3)^2 + (y-1)^2 = 4$



$x^2 + y^2 + 4x - 4y - 1 = 0$

c. domain: $[-5, -1]$
range: $[-1, 3]$

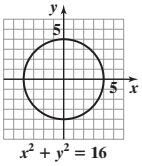
Exercise Set 1.9

1. 13 **3.** $2\sqrt{29} \approx 10.77$ **5.** 5 **7.** $\sqrt{29} \approx 5.39$ **9.** $4\sqrt{2} \approx 5.66$ **11.** $2\sqrt{5} \approx 4.47$ **13.** $2\sqrt{2} \approx 2.83$ **15.** $\sqrt{93} \approx 9.64$

17. $\sqrt{5} \approx 2.24$ **19.** $(4, 6)$ **21.** $(-4, -5)$ **23.** $\left(\dfrac{3}{2}, -6\right)$ **25.** $(-3, -2)$ **27.** $(1, 5\sqrt{5})$ **29.** $(2\sqrt{2}, 0)$ **31.** $x^2 + y^2 = 49$

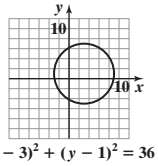
33. $(x-3)^2 + (y-2)^2 = 25$ **35.** $(x+1)^2 + (y-4)^2 = 4$ **37.** $(x+3)^2 + (y+1)^2 = 3$ **39.** $(x+4)^2 + y^2 = 100$

41. center: $(0, 0)$
radius: 4
domain: $[-4, 4]$
range: $[-4, 4]$



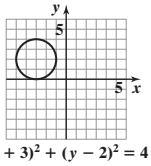
$x^2 + y^2 = 16$

43. center: $(3, 1)$
radius: 6
domain: $[-3, 9]$
range: $[-5, 7]$



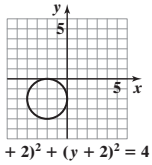
$(x-3)^2 + (y-1)^2 = 36$

45. center: $(-3, 2)$
radius: 2
domain: $[-5, -1]$
range: $[0, 4]$



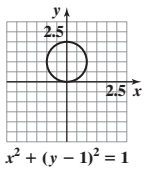
$(x+3)^2 + (y-2)^2 = 4$

47. center: $(-2, -2)$
radius: 2
domain: $[-4, 0]$
range: $[-4, 0]$



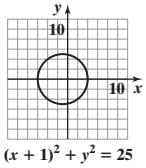
$(x+2)^2 + (y+2)^2 = 4$

49. center: $(0, 1)$
radius: 1
domain: $[-1, 1]$
range: $[0, 2]$



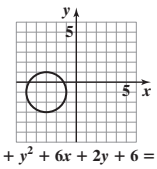
$x^2 + (y-1)^2 = 1$

51. center: $(-1, 0)$
radius: 5
domain: $[-6, 4]$
range: $[-5, 5]$



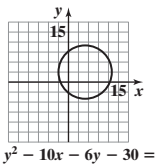
$(x+1)^2 + y^2 = 25$

53. $(x+3)^2 + (y+1)^2 = 4$
center: $(-3, -1)$
radius: 2



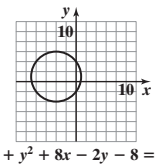
$x^2 + y^2 + 6x + 2y + 6 = 0$

55. $(x-5)^2 + (y-3)^2 = 64$
center: $(5, 3)$
radius: 8



$x^2 + y^2 - 10x - 6y - 30 = 0$

57. $(x+4)^2 + (y-1)^2 = 25$
center: $(-4, 1)$
radius: 5

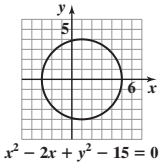


$x^2 + y^2 + 8x - 2y - 8 = 0$

59. $(x-1)^2+y^2=16$

center: $(1, 0)$

radius: 4

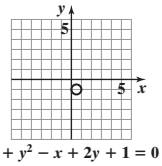


$x^2-2x+y^2-15=0$

61. $\left(x-\frac{1}{2}\right)^2+(y+1)^2=\frac{1}{4}$

center: $\left(\frac{1}{2}, -1\right)$

radius: $\frac{1}{2}$

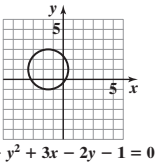


$x^2+y^2-x+2y+1=0$

63. $\left(x+\frac{3}{2}\right)^2+(y-1)^2=\frac{17}{4}$

center: $\left(-\frac{3}{2}, 1\right)$

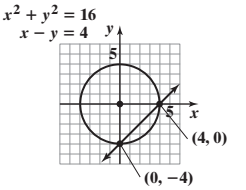
radius: $\frac{\sqrt{17}}{2}$



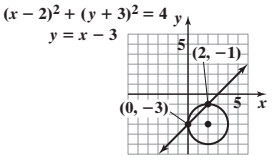
$x^2+y^2+3x-2y-1=0$

65. a. $(5, 10)$ **b.** $\sqrt{5}$ **c.** $(x-5)^2+(y-10)^2=5$

67. $\{(0, -4), (4, 0)\}$



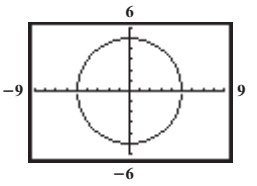
69. $\{(0, -3), (2, -1)\}$



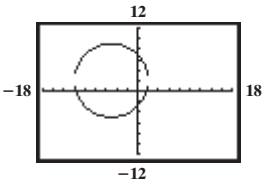
71. 2693 mi

73. $(x+2.4)^2+(y+2.7)^2=900$

83.



85.



87. makes sense

89. makes sense

91. false

93. false

95. a. Distance between (x_1, y_1) and $\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$

$$=\sqrt{\left(\frac{x_1+x_2}{2}-x_1\right)^2+\left(\frac{y_1+y_2}{2}-y_1\right)^2}$$

$$=\sqrt{\left(\frac{x_1+x_2-2x_1}{2}\right)^2+\left(\frac{y_1+y_2-2y_1}{2}\right)^2}$$

$$=\sqrt{\left(\frac{x_2-x_1}{2}\right)^2+\left(\frac{y_2-y_1}{2}\right)^2}$$

$$=\sqrt{\frac{x_2^2-2x_1x_2+x_1^2}{4}+\frac{y_2^2-2y_1y_2+y_1^2}{4}}$$

$$=\sqrt{\frac{x_1^2-2x_1x_2+x_2^2}{4}+\frac{y_1^2-2y_1y_2+y_2^2}{4}}$$

$$=\sqrt{\left(\frac{x_1-x_2}{2}\right)^2+\left(\frac{y_1-y_2}{2}\right)^2}$$

$$=\sqrt{\left(\frac{x_1+x_2-2x_2}{2}\right)^2+\left(\frac{y_1+y_2-2y_2}{2}\right)^2}$$

$$=\sqrt{\left(\frac{x_1+x_2}{2}-x_2\right)^2+\left(\frac{y_1+y_2}{2}-y_2\right)^2}$$

= Distance between (x_2, y_2) and $\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$

b. $\sqrt{\left(\frac{x_2-x_1}{2}\right)^2+\left(\frac{y_2-y_1}{2}\right)^2}+\sqrt{\left(\frac{x_2-x_1}{2}\right)^2+\left(\frac{y_2-y_1}{2}\right)^2}$

$$=2\sqrt{\left(\frac{x_2-x_1}{2}\right)^2+\left(\frac{y_2-y_1}{2}\right)^2}$$

$$=2\sqrt{\frac{(x_2-x_1)^2+(y_2-y_1)^2}{4}}$$

$$=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$$

= Distance from (x_1, y_1) to (x_2, y_2)

97. $y+4=\frac{3}{4}(x-3)$ **98.** $x-200$ **99. a.** perimeter: 140 yd; area: 1200 yd^2 **b.** perimeter: 140 yd; area: 1000 yd^2 **100.** $h=\frac{22}{\pi r^2}$; $2\pi r^2+\frac{44}{r}$

Section 1.10

Check Point Exercises

1. a. $f(x)=0.08x+15$ **b.** $g(x)=0.12x+3$ **c.** 300 min **2. a.** $N(x)=-100x+18{,}000$ **b.** $R(x)=-100x^2+18{,}000x$

3. a. $V(x)=x(15-2x)(8-2x)$ **b.** $\{x|0<x<4\}$ or $(0, 4)$ **4.** $x(100-x)=100x-x^2$ ft^2 **5.** $A(r)=2\pi r^2+\frac{2000}{r}$

6. $I(x)=0.07x+0.09(25{,}000-x)$ **7.** $d=\sqrt{x^6+x^2}$

Exercise Set 1.10

1. a. $f(x)=200+0.15x$ **b.** 800 mi **3. a.** $M(x)=239.4-0.3x$ **b.** 2152 **5. a.** $f(x)=1.25x$ **b.** $g(x)=21+0.5x$ **c.** 28 times; \$35 **7. a.** $f(x)=100+0.8x$ **b.** $g(x)=40+0.9x$ **c.** \$600; \$580 **9. a.** $N(x)=-500x+40{,}000$ **b.** $R(x)=-500x^2+40{,}000x$

11. a. $N(x)=-50x+16{,}500$ **b.** $R(x)=-50x^2+16{,}500x$ **13. a.** $Y(x)=-4x+520$ **b.** $T(x)=-4x^2+520x$

15. a. $V(x)=x(24-2x)^2$ **b.** $V(2)=800$; If a 2-in. square is cut from each corner, the volume is 800 cubic in.; $V(3)=972$; if a 3-in. square is cut from each corner, the volume is 972 cubic in.; $V(4)=1024$; if a 4-in. square is cut from each corner, the volume is 1024 cubic in.; $V(5)=980$; if a 5-in. square is cut from each corner, the volume is 980 cubic in.; $V(6)=864$; if a 6-in. square is cut from each corner, the volume is 864 cubic in. Initially, as x increases, V increases. When $x=4$, V is a maximum. As x increases beyond 4, V decreases. **c.** $(0, 12)$ **17.** $A(x)=x(20-2x)$

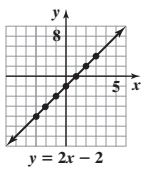
19. $P(x)=x(66-x)$ **21.** $A(x)=x(400-x)$ **23.** Let x be the length of the side perpendicular to the canal. $A(x)=x(800-2x)$

25. $A(x)=\frac{x(1000-2x)}{3}$ **27.** $A(r)=r(440-\pi r)$ **29.** Let x be the length of the interior wall. $C(x)=475x+\frac{1{,}400{,}000}{x}$

31. $A(x) = \frac{40}{x} + x^2$ **33.** $V(x) = 300x^2 - 4x^3$ **35. a.** $I(x) = 0.15x + 0.07(50{,}000 - x)$ **b.** \$31,250 at 15%, \$18,750 at 7%
37. $I(x) = 0.12x - 0.05(8000 - x)$ **39.** $d(x) = \sqrt{x^4 - 7x^2 + 16}$ **41.** $d(x) = \sqrt{x^2 - x + 1}$ **43. a.** $A(x) = 2x\sqrt{4 - x^2}$
b. $P(x) = 4x + 2\sqrt{4 - x^2}$ **45.** $f(x) = \sqrt{x^2 + 36} + \sqrt{x^2 - 20x + 164}$ **47.** $A(x) = 3x^2 + x - 4$ **49.** $V(x) = 2x^3 + 12x^2 + 12x + 10$
63. does not make sense **65.** does not make sense **67.** $T(x) = \frac{\sqrt{x^2 + 4}}{2} + \frac{6 - x}{5}$ **69.** $A(r) = 12r - \frac{4 + \pi}{2}r^2$ **71.** $15x^2 - 29x - 14$
72. $\sqrt{2}$ **73.** $-\frac{54 + 43\sqrt{2}}{46}$

Chapter 1 Review Exercises

1.



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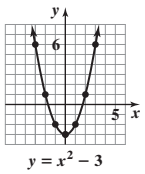

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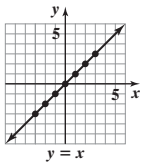

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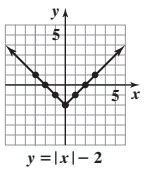
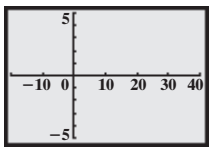
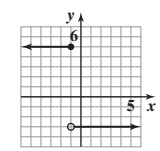


5.



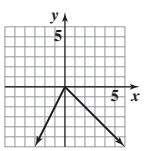
6. x-intercept: -2; y-intercept: 2 **7.** x-intercepts: -2, 2; y-intercept: -4 **8.** x-intercept: 5; no y-intercept **9.** (1985, 50%) **10.** 35%
11. 1945; 94% **12.** 1990; 28% **13.** 1950–1960; 91% **14.** 1930–1935; 38%
15. function; domain: $\{2, 3, 5\}$; range: $\{7\}$ **16.** function; domain: $\{1, 2, 13\}$; range: $\{10, 500, \pi\}$ **17.** not a function; domain: $\{12, 14\}$; range: $\{13, 15, 19\}$
18. y is a function of x. **19.** y is a function of x. **20.** y is not a function of x. **21. a.** $f(4) = -23$ **b.** $f(x + 3) = -7x - 16$
c. $f(-x) = 5 + 7x$ **22. a.** $g(0) = 2$ **b.** $g(-2) = 24$ **c.** $g(x - 1) = 3x^2 - 11x + 10$ **d.** $g(-x) = 3x^2 + 5x + 2$ **23. a.** $g(13) = 3$
b. $g(0) = 4$ **c.** $g(-3) = 7$ **24. a.** $f(-2) = -1$ **b.** $f(1) = 12$ **c.** $f(2) = 3$ **25.** not a function **26.** function **27.** function
28. not a function **29.** not a function **30.** function **31. a.** $[-3, 5)$ **b.** $[-5, 0]$ **c.** -3 **d.** -2 **e.** increasing: $(-2, 0)$ or $(3, 5)$; decreasing: $(-3, -2)$ or $(0, 3)$ **f.** $f(-2) = -3$ and $f(3) = -5$ **32. a.** $(-\infty, \infty)$ **b.** $(-\infty, 3)$ **c.** -2 and 3 **d.** 3 **e.** increasing: $(\infty, 0)$; decreasing: or $(0, \infty)$ **f.** $f(-2) = 0$ and $f(6) = -3$ **33. a.** $(-\infty, \infty)$ **b.** $[-2, 2]$ **c.** 0 **d.** 0 **e.** increasing: $(-2, 2)$; constant: $(-\infty, -2)$ or $(2, \infty)$ **f.** $f(-9) = -2$ and $f(14) = 2$ **34. a.** 0; $f(0) = -2$ **b.** -2, 3; $f(-2) = -3$, $f(3) = -5$
35. a. 0; $f(0) = 3$ **b.** none **36.** odd; symmetric with respect to the origin **37.** even; symmetric with respect to the y-axis
38. odd; symmetric with respect to the origin
39.



; $\{-3, 5\}$

$$f(x) = \begin{cases} 5 \text{ if } x \le -1 \\ -3 \text{ if } x > -1 \end{cases}$$

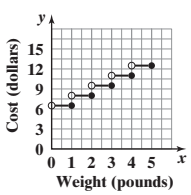
40.



; $(-\infty, 0]$

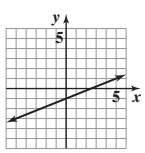
$$f(x) = \begin{cases} 2x \text{ if } x < 0 \\ -x \text{ if } x \ge 0 \end{cases}$$

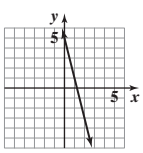
41. 8 **42.** $-4x - 2h + 1$ **43. a.** yes; The graph passes the vertical line test. **b.** (3, 12); The eagle descended.
c. (0, 3) and (12, 17); The eagle's height held steady during the first 3 seconds and the eagle was on the ground for 5 seconds.
d. (17, 30); The eagle was ascending.
44.

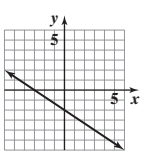


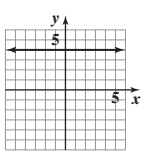
45. $-\frac{1}{2}$; falls **46.** 1; rises **47.** 0; horizontal **48.** undefined; vertical
49. $y - 2 = -6(x + 3)$; $y = -6x - 16$ **50.** using $(1, 6)$, $y - 6 = 2(x - 1)$; $y = 2x + 4$
51. $y + 7 = -3(x - 4)$; $y = -3x + 5$ **52.** $y - 6 = -3(x + 3)$; $y = -3x - 3$ **53.** $x + 6y + 18 = 0$

54. Slope: $\frac{2}{5}$; y-intercept: -1 **55.** Slope: -4; y-intercept: 5 **56.** Slope: $-\frac{2}{3}$; y-intercept: -2 **57.** Slope: 0; y-intercept: 4









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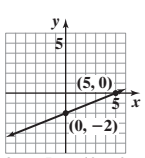

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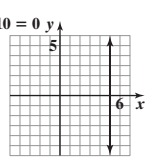
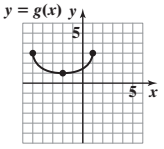


60. a. $y - 2.3 = 0.116(x - 15)$ or $y - 11 = 0.116(x - 90)$ **b.** $f(x) = 0.116x + 0.56$ **c.** approximately 5 deaths per 100,000 persons **d.** 4.3 deaths per 100,000 persons; underestimates by 0.7 death per 100,000 persons; The line passes below the point for France.

61. 182.5; Corporate profits increased at a rate of \$182.5 billion per year. The rate of change is \$182.5 billion per year. **62.** 10

63. a. 32 ft/sec **b.** −32 ft/sec **c.** The positive sign in part (a) means that the ball is moving up on $(0, 2)$. The negative sign in part (b) means that the ball is moving down on $(2, 4)$.

64.



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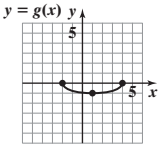

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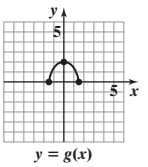

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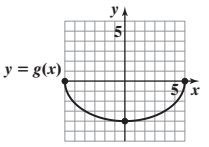

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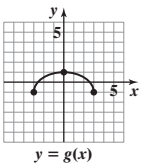

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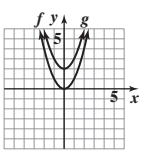

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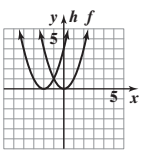

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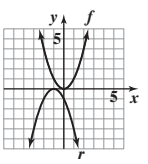

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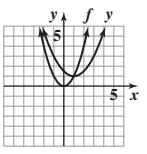

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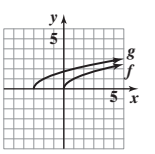
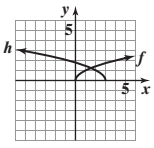


74.



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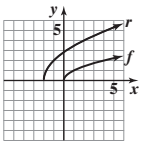

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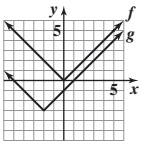

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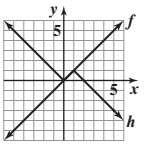

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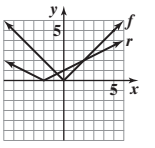

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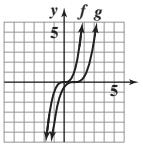

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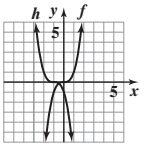

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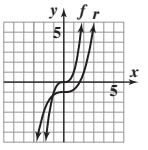

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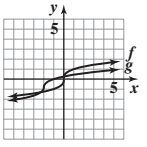

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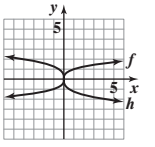

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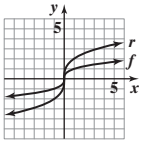


85. $(-\infty, \infty)$ **86.** $(-\infty, 7) \cup (7, \infty)$ **87.** $(-\infty, 4]$ **88.** $(-\infty, -7) \cup (-7, 3) \cup (3, \infty)$

89. $[2, 5) \cup (5, \infty)$ **90.** $[1, \infty)$ **91.** $(f + g)(x) = 4x - 6$; domain: $(-\infty, \infty)$; $(f - g)(x) = 2x + 4$; domain: $(-\infty, \infty)$; $(fg)(x) = 3x^2 - 16x + 5$; domain: $(-\infty, \infty)$; $\left(\frac{f}{g}\right)(x) = \frac{3x - 1}{x - 5}$; domain: $(-\infty, 5) \cup (5, \infty)$

92. $(f + g)(x) = 2x^2 + x$; domain: $(-\infty, \infty)$; $(f - g)(x) = x + 2$; domain: $(-\infty, \infty)$; $(fg)(x) = x^4 + x^3 - x - 1$; domain: $(-\infty, \infty)$; $\left(\frac{f}{g}\right)(x) = \frac{x^2 + x + 1}{x^2 - 1}$; domain: $(-\infty, -1) \cup (-1, 1) \cup (1, \infty)$

93. $(f + g)(x) = \sqrt{x + 7} + \sqrt{x - 2}$; domain: $[2, \infty)$; $(f - g)(x) = \sqrt{x + 7} - \sqrt{x - 2}$; domain: $[2, \infty)$; $(fg)(x) = \sqrt{x^2 + 5x - 14}$; domain: $[2, \infty)$; $\left(\frac{f}{g}\right)(x) = \frac{\sqrt{x + 7}}{\sqrt{x - 2}}$; domain: $(2, \infty)$ **94. a.** $(f \circ g)(x) = 16x^2 - 8x + 4$ **b.** $(g \circ f)(x) = 4x^2 + 11$ **c.** $(f \circ g)(3) = 124$

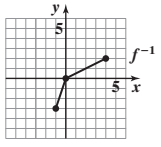
95. a. $(f \circ g)(x) = \sqrt{x + 1}$ **b.** $(g \circ f)(x) = \sqrt{x} + 1$ **c.** $(f \circ g)(3) = 2$ **96. a.** $(f \circ g)(x) = \frac{1 + x}{1 - 2x}$ **b.** $(-\infty, 0) \cup \left(0, \frac{1}{2}\right) \cup \left(\frac{1}{2}, \infty\right)$

97. a. $(f \circ g)(x) = \sqrt{x + 2}$ **b.** $[-2, \infty)$ **98.** $f(x) = x^4$, $g(x) = x^2 + 2x - 1$ **99.** $f(x) = \sqrt[3]{x}$, $g(x) = 7x + 4$ **100.** $f(g(x)) = x - \frac{7}{10}$; $g(f(x)) = x - \frac{7}{6}$; f and g are not inverses of each other. **101.** $f(g(x)) = x$; $g(f(x)) = x$; f and g are inverses of each other. **102.** $f^{-1}(x) = \frac{x + 3}{4}$

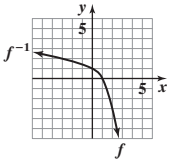
103. $f^{-1}(x) = \sqrt[3]{\frac{x - 1}{8}}$ or $\frac{\sqrt[3]{x - 1}}{2}$ **104.** $f^{-1}(x) = \frac{2}{x - 5}$ **105.** Inverse function exists. **106.** Inverse function does not exist.

107. Inverse function exists. **108.** Inverse function does not exist.

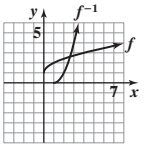
109.



110. $f^{-1}(x) = \sqrt{1 - x}$



111. $f^{-1}(x) = (x - 1)^2$, $x \geq 1$

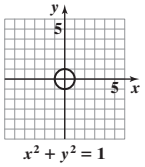


112. 13 **113.** $2\sqrt{2} \approx 2.83$ **114.** $(-5, 5)$

115. $\left(-\frac{11}{2}, -2\right)$ **116.** $x^2 + y^2 = 9$

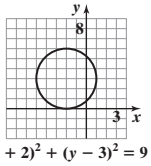
117. $(x + 2)^2 + (y - 4)^2 = 36$

118. center: $(0, 0)$; radius: 1
domain: $[-1, 1]$; range: $[-1, 1]$



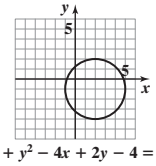
$x^2 + y^2 = 1$

119. center: $(-2, 3)$; radius: 3
domain: $[-5, 1]$; range: $[0, 6]$



$(x + 2)^2 + (y - 3)^2 = 9$

120. center: $(2, -1)$; radius: 3
domain: $[-1, 5]$; range: $[-4, 2]$



$x^2 + y^2 - 4x + 2y - 4 = 0$

121. a. $W(x) = 15x + 567$ **b.** 2009 **122. a.** $f(x) = 0.05x + 15$ **b.** $g(x) = 0.07x + 5$ **c.** 500 min

123. a. $N(x) = 640 - 2x$ **b.** $R(x) = x(640 - 2x)$ **124. a.** $V(x) = x(16 - 2x)(24 - 2x)$ **b.** $(0, 8)$

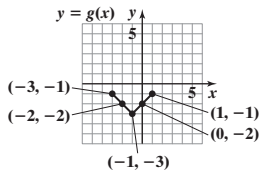
125. $A(x) = x\left(\dfrac{400 - 3x}{2}\right)$ **126.** $A(x) = 2x^2 + \dfrac{32}{x}$ **127.** $T(x) = 0.08x + 0.12(10{,}000 - x)$

Chapter 1 Test

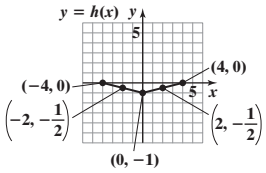
1. b, c, d **2. a.** $f(4) - f(-3) = 5$ **b.** $(-5, 6]$ **c.** $[-4, 5]$ **d.** $(-1, 2)$ **e.** $(-5, -1)$ or $(2, 6)$ **f.** 2; $f(2) = 5$ **g.** -1; $f(-1) = -4$

h. -4, 1, and 5 **i.** -3 **3. a.** -2 and 2 **b.** -1 and 1 **c.** 0 **d.** even **e.** no **f.** relative minimum

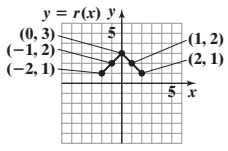
g.



h.

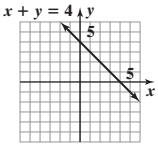


i.



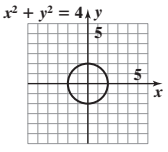
j. $-\dfrac{1}{3}$

4.



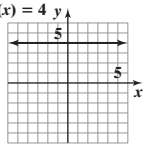
domain: $(-\infty, \infty)$
range: $(-\infty, \infty)$

5.



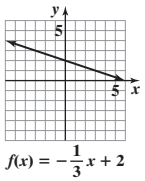
domain: $[-2, 2]$
range: $[-2, 2]$

6.



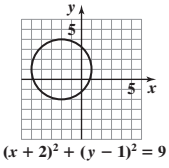
domain: $(-\infty, \infty)$
range: $\{4\}$

7.



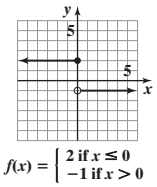
domain: $(-\infty, \infty)$
range: $(-\infty, \infty)$

8.



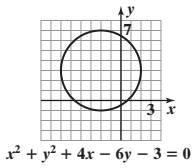
domain: $[-5, 1]$
range: $[-2, 4]$

9.



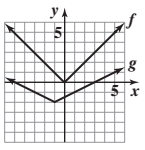
domain: $(-\infty, \infty)$
range: $\{-1, 2\}$

10.



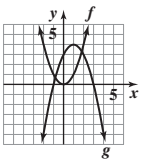
domain: $[-6, 2]$
range: $[-1, 7]$

11.



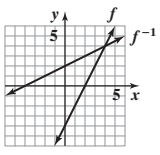
domain of f = domain of $g = (-\infty, \infty)$
range of $f = [0, \infty)$; range of $g = [-2, \infty)$

12.



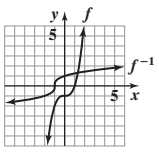
domain of f = domain of $g = (-\infty, \infty)$
range of $f = [0, \infty)$; range of $g = (-\infty, 4]$

13.



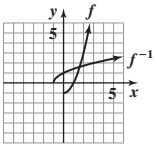
domain of f = range of $f^{-1} = (-\infty, \infty)$
range of f = domain of $f^{-1} = (-\infty, \infty)$

14.



domain of f = range of $f^{-1} = (-\infty, \infty)$
range of f = domain of $f^{-1} = (-\infty, \infty)$

15.



domain of f = range of $f^{-1} = [0, \infty)$
range of f = domain of $f^{-1} = [-1, \infty)$

16. $f(x - 1) = x^2 - 3x - 2$ **17.** $2x + h - 1$ **18.** $(g - f)(x) = -x^2 + 3x - 2$

19. $\left(\dfrac{f}{g}\right)(x) = \dfrac{x^2 - x - 4}{2x - 6}$; $(-\infty, 3) \cup (3, \infty)$ **20.** $(f \circ g)(x) = 4x^2 - 26x + 38$ **21.** $(g \circ f)(x) = 2x^2 - 2x - 14$

22. -10 **23.** $f(-x) = x^2 + x - 4$; neither **24.** using $(2, 1)$, $y - 1 = 3(x - 2)$; $y = 3x - 5$

25. $y - 6 = 4(x + 4)$; $y = 4x + 22$ **26.** $2x + y + 24 = 0$ **27. a.** $y - 476 = 5(x - 2)$ or $y - 486 = 5(x - 4)$

b. $f(x) = 5x + 466$ **c.** 516 per 100,000 residents **28.** 48 **29.** $g(-1) = 4$; $g(7) = 2$ **30.** $(-\infty, -5) \cup (-5, 1) \cup (1, \infty)$

31. $[1, \infty)$ **32.** $\dfrac{7x}{2 - 4x}$; domain: $(-\infty, 0) \cup \left(0, \dfrac{1}{2}\right) \cup \left(\dfrac{1}{2}, \infty\right)$ **33.** $f(x) = x^7$, $g(x) = 2x + 3$ **34.** 5; (3.5, 0) **35. a.** $T(x) = 41.78 - 0.19x$

b. 2012 **36. a.** $Y(x) = 50 - 1.5(x - 30)$ **b.** $T(x) = x(50 - 1.5(x - 30))$ **37.** $A(x) = x(300 - x)$ **38.** $A(x) = 2x^2 + \dfrac{32{,}000}{x}$

CHAPTER 2

Section 2.1

Check Point Exercises

1. a. $8 + i$ **b.** $-10 + 7i$ **2. a.** $63 + 14i$ **b.** $58 - 11i$ **3.** $\frac{16}{17} + \frac{21}{17}i$ **4. a.** $7i\sqrt{3}$ **b.** $1 - 4i\sqrt{3}$ **c.** $-7 + i\sqrt{3}$

5. $\{1 + i, 1 - i\}$

Exercise Set 2.1

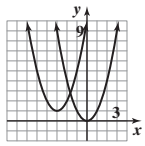
1. $8 - 2i$ **3.** $-2 + 9i$ **5.** $24 - 3i$ **7.** $-14 + 17i$ **9.** $21 + 15i$ **11.** $-19 + 7i$ **13.** $-29 - 11i$ **15.** 34 **17.** 26 **19.** $-5 + 12i$

21. $\frac{3}{5} + \frac{1}{5}i$ **23.** $1 + i$ **25.** $-\frac{24}{25} + \frac{32}{25}i$ **27.** $\frac{7}{5} + \frac{4}{5}i$ **29.** $3i$ **31.** $47i$ **33.** $-8i$ **35.** $2 + 6i\sqrt{7}$ **37.** $-\frac{1}{3} + i\frac{\sqrt{2}}{6}$

39. $-\frac{1}{8} - i\frac{\sqrt{3}}{24}$ **41.** $-2\sqrt{6} - 2i\sqrt{10}$ **43.** $24\sqrt{15}$ **45.** $\{3 + i, 3 - i\}$ **47.** $\left\{-1 + \frac{3}{2}i, -1 - \frac{3}{2}i\right\}$ **49.** $\left\{\frac{4}{3} + i\frac{\sqrt{5}}{3}, \frac{4}{3} - i\frac{\sqrt{5}}{3}\right\}$

51. $-11 - 5i$ **53.** $-5 + 10i$ **55.** $0 + 47i$ or $47i$ **57.** 0 **59.** $\frac{20}{13} + \frac{30}{13}i$ **61.** $(47 + 13i)$ volts **63.** $(5 + i\sqrt{15}) + (5 - i\sqrt{15}) = 10$; $(5 + i\sqrt{15})(5 - i\sqrt{15}) = 25 - 15i^2 = 25 + 15 = 40$ **73.** makes sense **75.** does not make sense **77.** false **79.** false

81. $\frac{14}{25} - \frac{2}{25}i$ **83.** $\frac{8}{5} + \frac{16}{5}i$ **84.** $\{1, 5\}$ **85.** $\{-1 \pm \sqrt{2}\}$ **86.**

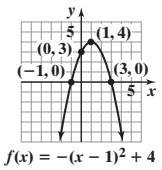


$f(x) = x^2$
$g(x) = (x + 3)^2 + 1$

Section 2.2

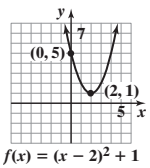
Check Point Exercises

1.



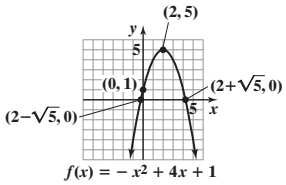
$f(x) = -(x - 1)^2 + 4$

2.



$f(x) = (x - 2)^2 + 1$

3.

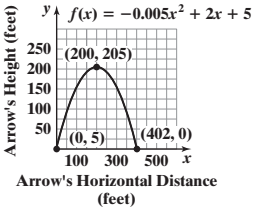


$f(x) = -x^2 + 4x + 1$

domain: $(-\infty, \infty)$; range: $(-\infty, 5]$

4. a. minimum **b.** Minimum is 984 at $x = 2$.
c. domain: $(-\infty, \infty)$; range: $[984, \infty)$

5. a. 205 ft; 200 ft **b.** 402 ft
c.

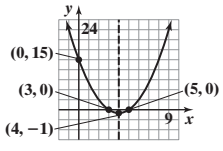


6. 4, −4; −16 **7.** 30 ft by 30 ft; 900 sq ft

Exercise Set 2.2

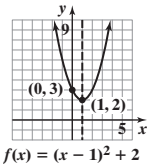
1. $h(x) = (x - 1)^2 + 1$ **3.** $j(x) = (x - 1)^2 - 1$ **5.** $h(x) = x^2 - 1$
7. $g(x) = x^2 - 2x + 1$ **9.** $(3, 1)$ **11.** $(-1, 5)$
13. $(2, -5)$ **15.** $(-1, 9)$

17. domain: $(-\infty, \infty)$
range: $[-1, \infty)$
axis of symmetry: $x = 4$



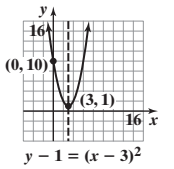
$f(x) = (x - 4)^2 - 1$

19. domain: $(-\infty, \infty)$
range: $[2, \infty)$
axis of symmetry: $x = 1$



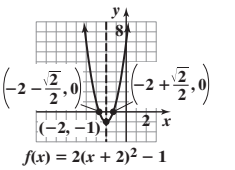
$f(x) = (x - 1)^2 + 2$

21. domain: $(-\infty, \infty)$
range: $[1, \infty)$
axis of symmetry: $x = 3$



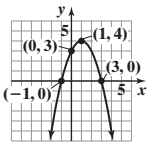
$y - 1 = (x - 3)^2$

23. domain: $(-\infty, \infty)$
range: $[-1, \infty)$
axis of symmetry: $x = -2$



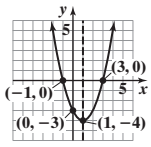
$f(x) = 2(x + 2)^2 - 1$

25. domain: $(-\infty, \infty)$
range: $(-\infty, 4]$
axis of symmetry: $x = 1$



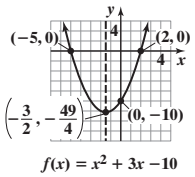
$f(x) = 4 - (x - 1)^2$

27. domain: $(-\infty, \infty)$
range: $[-4, \infty)$
axis of symmetry: $x = 1$



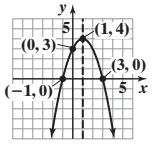
$f(x) = x^2 - 2x - 3$

29. domain: $(-\infty, \infty)$
range: $\left[-\frac{49}{4}, \infty\right)$
axis of symmetry: $x = -\frac{3}{2}$



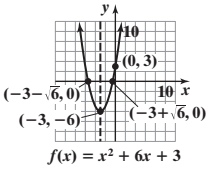
$f(x) = x^2 + 3x - 10$

31. domain: $(-\infty, \infty)$
range: $(-\infty, 4]$
axis of symmetry: $x = 1$



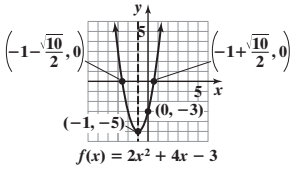
$f(x) = 2x - x^2 + 3$

33. domain: $(-\infty, \infty)$
range: $[-6, \infty)$
axis of symmetry: $x = -3$



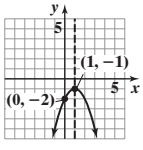
$f(x) = x^2 + 6x + 3$

35. domain: $(-\infty, \infty)$
range: $[-5, \infty)$
axis of symmetry: $x = -1$



$f(x) = 2x^2 + 4x - 3$

37. domain: $(-\infty, \infty)$
range: $(-\infty, -1]$
axis of symmetry: $x = 1$



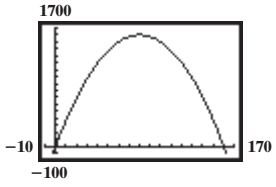
$f(x) = 2x - x^2 - 2$

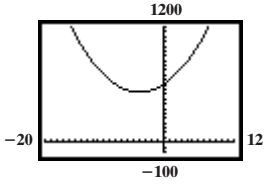
39. a. minimum **b.** Minimum is -13 at $x = 2$. **c.** domain: $(-\infty, \infty)$; range: $[-13, \infty)$

41. a. maximum **b.** Maximum is 1 at $x = 1$. **c.** domain: $(-\infty, \infty)$; range: $(-\infty, 1]$

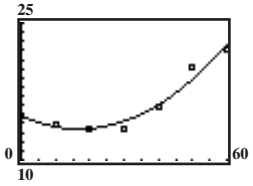
43. a. minimum **b.** Minimum is $-\frac{5}{4}$ at $x = \frac{1}{2}$. **c.** domain: $(-\infty, \infty)$; range: $\left[-\frac{5}{4}, \infty\right)$

45. domain: $(-\infty, \infty)$; range: $[-2, \infty)$ **47.** domain: $(-\infty, \infty)$; range: $(-\infty, -6]$ **49.** $f(x) = 2(x - 5)^2 + 3$ **51.** $f(x) = 2(x + 10)^2 - 5$ **53.** $f(x) = -3(x + 2)^2 + 4$ **55.** $f(x) = 3(x - 11)^2$ **57. a.** 18.35 ft; 35 ft **b.** 77.8 ft **c.** 6.1 ft **59. a.** 2.75 gal per person; underestimates by 0.05 gal **b.** 1992; 2.048 gal; seems reasonable **61.** 8 and 8; 64 **63.** 8, -8; -64 **65.** length: 300 ft; width: 150 ft; maximum area: 45,000 sq ft **67.** 12.5 yd by 12.5 yd; 156.25 sq yd **69.** 150 ft by 100 ft; 15,000 sq ft **71.** 5 in.; 50 sq in. **73.** \$65; \$422,500
75. 25; 1250 lb **85.** (80, 1600) **87.** $(-4, 520)$





89. a & d.



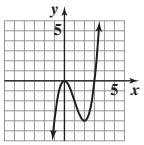
a. The values of y increase, then decrease.
b. $y = 0.005x^2 - 0.170x + 14.817$
c. 1957; about 13.372 miles/gal
91. makes sense **93.** does not make sense **95.** false
97. false **99.** $x = 3$; $(0, 11)$ **101.** $f(x) = -2(x + 3)^2 - 1$
103. \$95; \$21,675 **106.** $(x + 3)(x + 1)(x - 1)$

107. $f(2) = -1$; $f(3) = 16$; The graph passes through $(2, -1)$, which is below the x-axis, and $(3, 16)$, which is above the x-axis. Since the graph of f is continuous, it must cross the x-axis somewhere between 2 and 3 to get from one of these points to the other.
108. even; symmetric with respect to the y-axis

Section 2.3

Check Point Exercises

1. The graph rises to the left and to the right. **2.** The graph falls to the left and rises to the right. **3.** Since n is odd and the leading coefficient is negative, the function falls to the right. Since the ratio cannot be negative, the model won't be appropriate. **4.** No; the graph should fall to the left, but doesn't appear to. **5.** $\{-2, 2\}$ **6.** $\{-2, 0, 2\}$ **7.** $-\frac{1}{2}$ with multiplicity 2 and 5 with multiplicity 3; touches and turns at $-\frac{1}{2}$ and crosses at 5
8. $f(-3) = -42$; $f(-2) = 5$ **9.**

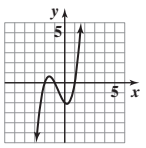


$f(x) = x^3 - 3x^2$

Exercise Set 2.3

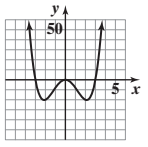
1. polynomial function; degree: 3 **3.** polynomial function; degree: 5 **5.** not a polynomial function **7.** not a polynomial function
9. not a polynomial function **11.** could be polynomial function **13.** not a polynomial function **15.** b **17.** a
19. falls to the left and rises to the right **21.** rises to the left and to the right **23.** falls to the left and to the right
25. $x = 5$ has multiplicity 1; The graph crosses the x-axis; $x = -4$ has multiplicity 2; The graph touches the x-axis and turns around.
27. $x = 3$ has multiplicity 1; The graph crosses the x-axis; $x = -6$ has multiplicity 3; The graph crosses the x-axis.
29. $x = 0$ has multiplicity 1; The graph crosses the x-axis; $x = 1$ has multiplicity 2; The graph touches the x-axis and turns around.
31. $x = 2$, $x = -2$ and $x = -7$ have multiplicity 1; The graph crosses the x-axis. **33.** $f(1) = -1; f(2) = 5$; 1.3 **35.** $f(-1) = -1; f(0) = 1$; −0.5
37. $f(-3) = -11; f(-2) = 1$; −2.1 **39.** $f(-3) = -42; f(-2) = 5$; −2.2

41. a. $f(x)$ rises to the right and falls to the left.
b. $x = -2$, $x = 1$, $x = -1$;
$f(x)$ crosses the x-axis at each.
c. The y-intercept is -2.
d. neither
e.



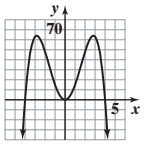
$f(x) = x^3 + 2x^2 - x - 2$

43. a. $f(x)$ rises to the left and the right.
b. $x = 0$, $x = 3$, $x = -3$;
$f(x)$ crosses the x-axis at -3 and 3;
$f(x)$ touches the x-axis at 0.
c. The y-intercept is 0.
d. y-axis symmetry
e.



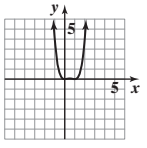
$f(x) = x^4 - 9x^2$

45. a. $f(x)$ falls to the left and the right.
b. $x = 0$, $x = 4$, $x = -4$;
$f(x)$ crosses the x-axis at -4 and 4;
$f(x)$ touches the x-axis at 0.
c. The y-intercept is 0.
d. y-axis symmetry
e.



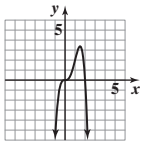
$f(x) = -x^4 + 16x^2$

47. a. $f(x)$ rises to the left and the right.
b. $x = 0$, $x = 1$;
$f(x)$ touches the x-axis at 0 and 1.
c. The y-intercept is 0.
d. neither
e.



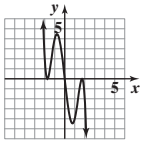
$f(x) = x^4 - 2x^3 + x^2$

49. a. $f(x)$ falls to the left and the right.
b. $x = 0$, $x = 2$;
$f(x)$ crosses the x-axis at 0 and 2.
c. The y-intercept is 0.
d. neither
e.



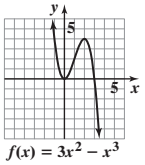
$f(x) = -2x^4 + 4x^3$

51. a. $f(x)$ rises to the left and falls to the right.
b. $x = 0$, $x = \pm\sqrt{3}$;
$f(x)$ crosses the x-axis at 0;
$f(x)$ touches the x-axis at $\sqrt{3}$ and $-\sqrt{3}$.
c. The y-intercept is 0.
d. origin symmetry
e.



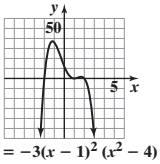
$f(x) = 6x^3 - 9x - x^5$

53. a. $f(x)$ rises to the left and falls to the right.
b. $x = 0$, $x = 3$;
$f(x)$ crosses the x-axis at 3;
$f(x)$ touches the x-axis at 0.
c. The y-intercept is 0.
d. neither
e.



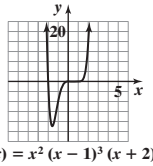
$f(x) = 3x^2 - x^3$

55. a. $f(x)$ falls to the left and the right.
b. $x = 1$, $x = -2$, $x = 2$;
$f(x)$ crosses the x-axis at -2 and 2;
$f(x)$ touches the x-axis at 1.
c. The y-intercept is 12.
d. neither
e.



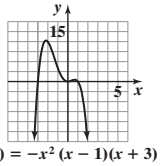
$f(x) = -3(x - 1)^2 (x^2 - 4)$

57. a. $f(x)$ rises to the left and the right.
b. $x = -2, x = 0, x = 1$;
$f(x)$ crosses the x-axis at -2 and 1;
$f(x)$ touches the x-axis at 0.
c. The y-intercept is 0.
d. neither
e.



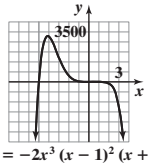
$f(x) = x^2(x-1)^3(x+2)$

59. a. $f(x)$ falls to the left and the right.
b. $x = -3, x = 0, x = 1$;
$f(x)$ crosses the x-axis at -3 and 1;
$f(x)$ touches the x-axis at 0.
c. The y-intercept is 0.
d. neither
e.



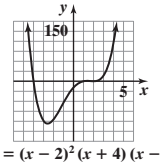
$f(x) = -x^2(x-1)(x+3)$

61. a. $f(x)$ falls to the left and the right.
b. $x = -5, x = 0, x = 1$;
$f(x)$ crosses the x-axis at -5 and 0;
$f(x)$ touches the x-axis at 1.
c. The y-intercept is 0.
d. neither
e.



$f(x) = -2x^3(x-1)^2(x+5)$

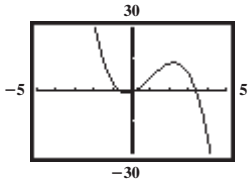
63. a. $f(x)$ rises to the left and the right.
b. $x = -4, x = 1, x = 2$;
$f(x)$ crosses the x-axis at -4 and 1;
$f(x)$ touches the x-axis at 2.
c. The y-intercept is -16.
d. neither
e.



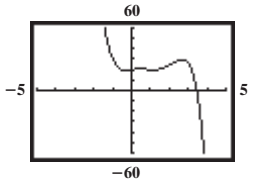
$f(x) = (x-2)^2(x+4)(x-1)$

65. a. -2, odd; 1, odd; 4, odd **b.** $f(x) = (x+2)(x-1)(x-4)$ **c.** 8 **67. a.** -1, odd; 3, even **b.** $f(x) = (x+1)(x-3)^2$ **c.** 9
69. a. -3, even; 2, even **b.** $f(x) = -(x+3)^2(x-2)^2$ **c.** -36 **71. a.** -2, even; -1, odd; 1, odd **b.** $f(x) = (x+2)^2(x+1)(x-1)^3$
c. -4 **73. a.** $f(3) = 404{,}444$; $g(3) = 404{,}443$; function f **b.** falls to the right; No, since the graph falls to the right, the number of people living with HIV and AIDS will eventually be negative; model breakdown will occur. **75. a.** from 1 through 4 min and from 8 through 10 min
b. from 4 through 8 min and from 10 through 12 min **c.** 3 **d.** 4 **e.** negative; The graph falls to the left and falls to the right.
f. 116 ± 1 beats per min; 10 min **g.** 64 ± 1 beats per min; 8 min

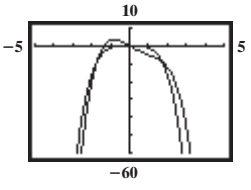
95.



97.



99.



101. does not make sense **103.** makes sense **105.** false **107.** false **109.** $f(x) = x^3 - 2x^2$ **110.** $35\frac{2}{21}$
111. $6x^3 - x^2 - 5x + 4$ **112.** $(x-3)(2x-1)(x+2)$

Section 2.4

Check Point Exercises

1. $x + 5$ **2.** $2x^2 + 3x - 2 + \frac{1}{x-3}$ **3.** $2x^2 + 7x + 14 + \frac{21x-10}{x^2-2x}$ **4.** $x^2 - 2x - 3$ **5.** -105 **6.** $\left\{-1, -\frac{1}{3}, \frac{2}{5}\right\}$

Exercise Set 2.4

1. $x + 3$ **3.** $x^2 + 3x + 1$ **5.** $2x^2 + 3x + 5$ **7.** $4x + 3 + \frac{2}{3x-2}$ **9.** $2x^2 + x + 6 - \frac{38}{x+3}$ **11.** $4x^3 + 16x^2 + 60x + 246 + \frac{984}{x-4}$
13. $2x + 5$ **15.** $6x^2 + 3x - 1 - \frac{3x-1}{3x^2+1}$ **17.** $2x + 5$ **19.** $3x - 8 + \frac{20}{x+5}$ **21.** $4x^2 + x + 4 + \frac{3}{x-1}$
23. $6x^4 + 12x^3 + 22x^2 + 48x + 93 + \frac{187}{x-2}$ **25.** $x^3 - 10x^2 + 51x - 260 + \frac{1300}{x+5}$ **27.** $x^4 + x^3 + 2x^2 + 2x + 2$ **29.** $x^3 + 4x^2 + 16x + 64$
31. $2x^4 - 7x^3 + 15x^2 - 31x + 64 - \frac{129}{x+2}$ **33.** -25 **35.** -133 **37.** 240 **39.** 1 **41.** $x^2 - 5x + 6$; $x = -1, x = 2, x = 3$
43. $\left\{-\frac{1}{2}, 1, 2\right\}$ **45.** $\left\{-\frac{3}{2}, -\frac{1}{3}, \frac{1}{2}\right\}$ **47.** 2; The remainder is zero; $\{-3, -1, 2\}$ **49.** 1; The remainder is zero; $\left\{\frac{1}{3}, \frac{1}{2}, 1\right\}$
51. a. The remainder is 0. **b.** 3 mm **53.** $0.5x^2 - 0.4x + 0.3$ **55. a.** 70; When the tax rate is 30%, tax revenue is \$700 billion.; (30, 70)
b. $80 + \frac{800}{x-110}$; $f(30) = 70$; yes **c.** No, f is a rational function because it is a quotient of two polynomials. **67.** makes sense
69. does not make sense **71.** true **73.** false **75.** $x - 2$ **79.** $\{-2 \pm \sqrt{5}\}$ **80.** $\{-2 \pm i\sqrt{2}\}$ **81.** -3

Section 2.5

Check Point Exercises

1. $\pm1, \pm2, \pm3, \pm6$ **2.** $\pm1, \pm3, \pm\frac{1}{2}, \pm\frac{1}{4}, \pm\frac{3}{2}, \pm\frac{3}{4}$ **3.** $\{-5, -4, 1\}$ **4.** $\left\{2, \frac{-3-\sqrt{5}}{2}, \frac{-3+\sqrt{5}}{2}\right\}$ **5.** $\{1, 2-3i, 2+3i\}$

6. $f(x) = x^3 + 3x^2 + x + 3$ **7.** 4, 2, or 0 positive zeros, no possible negative zeros

Exercise Set 2.5

1. $\pm1, \pm2, \pm4$ **3.** $\pm1, \pm2, \pm3, \pm6, \pm\frac{1}{3}, \pm\frac{2}{3}$ **5.** $\pm1, \pm2, \pm3, \pm6, \pm\frac{1}{2}, \pm\frac{1}{4}, \pm\frac{3}{2}, \pm\frac{3}{4}$ **7.** $\pm1, \pm2, \pm3, \pm4, \pm6, \pm12$ **9. a.** $\pm1, \pm2, \pm4$

b. $-2, -1$, or 2 **c.** $\{-2, -1, 2\}$ **11. a.** $\pm1, \pm2, \pm3, \pm6, \pm\frac{1}{2}, \pm\frac{3}{2}$ **b.** $-2, \frac{1}{2}$, or 3 **c.** $\left\{-2, \frac{1}{2}, 3\right\}$ **13. a.** $\pm1, \pm2, \pm3, \pm6$

b. -1 **c.** $\left\{-1, \frac{-3-\sqrt{33}}{2}, \frac{-3+\sqrt{33}}{2}\right\}$ **15. a.** $\pm1, \pm\frac{1}{2}, \pm2$ **b.** -2 **c.** $\left\{-2, \frac{-1+i}{2}, \frac{-1-i}{2}\right\}$ **17. a.** $\pm1, \pm2, \pm3, \pm4, \pm6, \pm12$

b. $-3, 1$, or 4 **c.** $\{-3, 1, 4\}$ **19. a.** $\pm1, \pm2, \pm3, \pm4, \pm6, \pm12$ **b.** -2 **c.** $\{-2, 1+\sqrt{7}, 1-\sqrt{7}\}$ **21. a.** $\pm1, \pm5, \pm\frac{1}{2}, \pm\frac{5}{2}, \pm\frac{1}{3}, \pm\frac{5}{3}, \pm\frac{1}{6}, \pm\frac{5}{6}$

b. $-5, \frac{1}{3}$, or $\frac{1}{2}$ **c.** $\left\{-5, \frac{1}{3}, \frac{1}{2}\right\}$ **23. a.** $\pm1, \pm2, \pm4$ **b.** -2 or 2 **c.** $\{-2, 2, 1+\sqrt{2}, 1-\sqrt{2}\}$ **25.** $f(x) = 2x^3 - 2x^2 + 50x - 50$

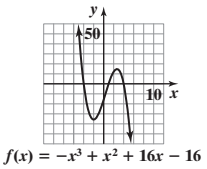
27. $f(x) = x^3 - 3x^2 - 15x + 125$ **29.** $f(x) = x^4 + 10x^2 + 9$ **31.** $f(x) = x^4 - 9x^3 + 21x^2 + 21x - 130$ **33.** no positive real roots; 3 or 1 negative real roots **35.** 3 or 1 positive real roots; no negative real roots **37.** 2 or 0 positive real roots; 2 or 0 negative real roots

39. $x = -2, x = 5, x = 1$ **41.** $\left\{-\frac{1}{2}, \frac{1+\sqrt{17}}{2}, \frac{1-\sqrt{17}}{2}\right\}$ **43.** $-1, 2+2i$, and $2-2i$ **45.** $\{-1, -2, 3+\sqrt{13}, 3-\sqrt{13}\}$

47. $x = -1, x = 2, x = -\frac{1}{3}, x = 3$ **49.** $\left\{1, -\frac{3}{4}, i\sqrt{2}, -i\sqrt{2}\right\}$ **51.** $\left\{-2, \frac{1}{2}, \sqrt{2}, -\sqrt{2}\right\}$

53. a. $-4, 1$, and 4

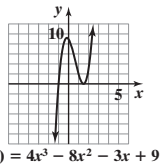
b.



$f(x) = -x^3 + x^2 + 16x - 16$

55. a. -1 and $\frac{3}{2}$

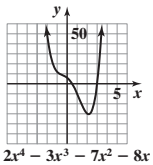
b.



$f(x) = 4x^3 - 8x^2 - 3x + 9$

57. a. $\frac{1}{2}, 3, -1 \pm i$

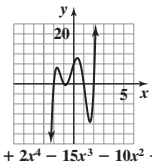
b.



$f(x) = 2x^4 - 3x^3 - 7x^2 - 8x + 6$

59. a. $-2, -1, -\frac{2}{3}, 1$, and 2

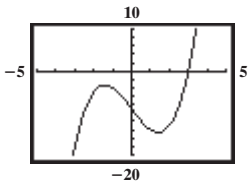
b.



$f(x) = 3x^5 + 2x^4 - 15x^3 - 10x^2 + 12x + 8$

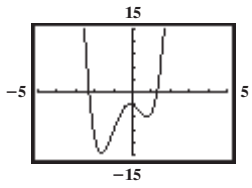
61. 7.8 in., 10 in. **63. a.** (7.8, 2000), (10, 2000) **b.** (0, 15) **73.** $\left\{\frac{1}{2}, \frac{2}{3}, 2\right\}$ **75.** $\left\{\pm\frac{1}{2}\right\}$ **77.** 5, 3, or 1 positive real zeros; no negative real zeros

79.



1 real zero, 2 nonreal complex zeros

81.



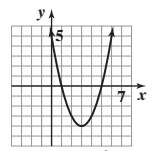
2 real zeros, 2 nonreal complex zeros

83. makes sense **85.** makes sense **87.** false
89. true **91.** 3 in. **93.** 3 **95.** 5
98. $x = 1$ and $x = 2$ **99.** $x = 1$ **100.** $y = 0$

Mid-Chapter 2 Check Point

1. $-1 - i$ **2.** $-3 + 6i$ **3.** $7 + i$ **4.** i **5.** $3i\sqrt{3}$ **6.** $1 - 4i\sqrt{3}$ **7.** $\frac{3}{4} \pm i\frac{\sqrt{23}}{4}$

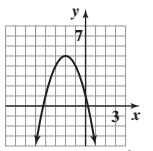
8.



$f(x) = (x-3)^2 - 4$

domain: $(-\infty, \infty)$
range: $[-4, \infty)$

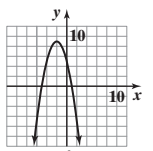
9.



$f(x) = 5 - (x+2)^2$

domain: $(-\infty, \infty)$
range: $(-\infty, 5]$

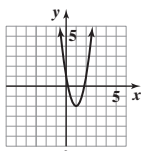
10.



$f(x) = -x^2 - 4x + 5$

domain: $(-\infty, \infty)$
range: $(-\infty, 9]$

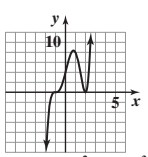
11.



$f(x) = 3x^2 - 6x + 1$

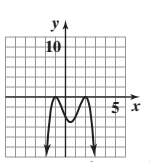
domain: $(-\infty, \infty)$
range: $[-2, \infty)$

12. -1 and 2



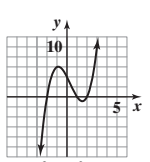
$f(x) = (x-2)^2(x+1)^3$

13. -1 and 2



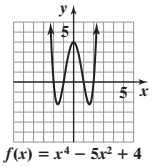
$f(x) = -(x-2)^2(x+1)^2$

14. $-2, 1$, and 2



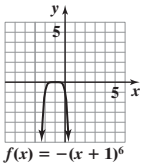
$f(x) = x^3 - x^2 - 4x + 4$

15. $-2, -1, 1$, and 2



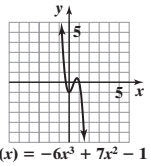
$f(x) = x^4 - 5x^2 + 4$

16. -1



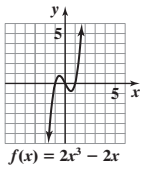
$f(x) = -(x + 1)^6$

17. $-\frac{1}{3}, \frac{1}{2}$, and 1



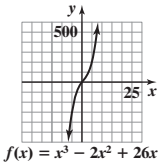
$f(x) = -6x^3 + 7x^2 - 1$

18. $-1, 0$, and 1



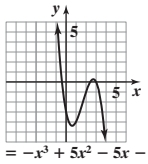
$f(x) = 2x^3 - 2x$

19. $0, 1 \pm 5i$



$f(x) = x^3 - 2x^2 + 26x$

20. $3, 1 \pm \sqrt{2}$



$f(x) = -x^3 + 5x^2 - 5x - 3$

21. $\{-2, 1\}$ **22.** $\left\{\frac{1}{3}, \frac{1}{2}, 1\right\}$ **23.** $\left\{-\frac{1}{2}, \frac{2}{3}, \frac{7}{2}\right\}$ **24.** $\left\{-10, -\frac{5}{2}, 10\right\}$ **25.** $\{-3, 4, \pm i\}$ **26.** $\left\{-3, \frac{1}{2}, 1 \pm \sqrt{3}\right\}$

27. 75 cabinets per day; \$1200 **28.** $-9, -9$; 81 **29.** 10 in.; 100 sq in. **30.** $2x^2 - x - 3 + \frac{x + 1}{3x^2 - 1}$ **31.** $2x^3 - 5x^2 - 3x + 6$

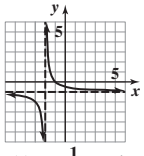
32. $f(x) = -2x^3 + 2x^2 - 2x + 2$ **33.** $f(x) = x^4 - 4x^3 + 13x^2 - 36x + 36$ **34.** yes

Section 2.6

Check Point Exercises

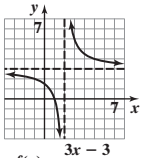
1. a. $\{x|x \neq 5\}$ **b.** $\{x|x \neq -5, x \neq 5\}$ **c.** all real numbers **2. a.** $x = 1, x = -1$ **b.** $x = -1$ **c.** none
3. a. $y = 3$ **b.** $y = 0$ **c.** none

4.



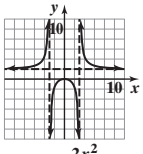
$g(x) = \frac{1}{x + 2} - 1$

5.



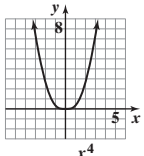
$f(x) = \frac{3x - 3}{x - 2}$

6.



$f(x) = \frac{2x^2}{x^2 - 9}$

7.



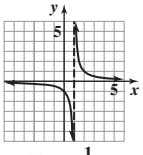
$f(x) = \frac{x^4}{x^2 + 2}$

8. $y = 2x - 1$ **9. a.** $C(x) = 500{,}000 + 400x$ **b.** $\overline{C}(x) = \frac{500{,}000 + 400x}{x}$ **c.** $\overline{C}(1000) = 900$: The average cost per wheelchair of producing 1000 wheelchairs per month is \$900.; $\overline{C}(10{,}000) = 450$: The average cost per wheelchair of producing 10,000 wheelchairs per month is \$450.; $\overline{C}(100{,}000) = 405$: The average cost per wheelchair of producing 100,000 wheelchairs per month is \$405. **d.** $y = 400$; The cost per wheelchair approaches \$400 as more wheelchairs are produced. **10.** $T(x) = \frac{20}{x} + \frac{20}{x - 10}$

Exercise Set 2.6

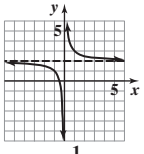
1. $\{x|x \neq 4\}$ **3.** $\{x|x \neq 5, x \neq -4\}$ **5.** $\{x|x \neq 7, x \neq -7\}$ **7.** all real numbers **9.** $-\infty$ **11.** $-\infty$ **13.** 0 **15.** $+\infty$
17. $-\infty$ **19.** 1 **21.** $x = -4$ **23.** $x = 0, x = -4$ **25.** $x = -4$ **27.** no vertical asymptotes **29.** $y = 0$ **31.** $y = 4$
33. no horizontal asymptote **35.** $y = -\frac{2}{3}$

37.



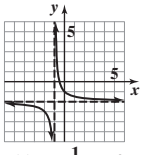
$g(x) = \frac{1}{x - 1}$

39.



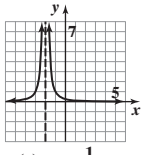
$h(x) = \frac{1}{x} + 2$

41.



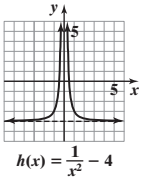
$g(x) = \frac{1}{x + 1} - 2$

43.



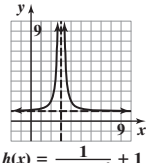
$g(x) = \frac{1}{(x + 2)^2}$

45.



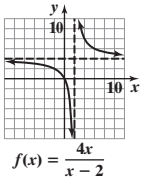
$h(x) = \frac{1}{x^2} - 4$

47.



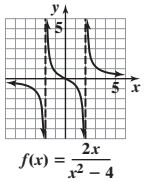
$h(x) = \frac{1}{(x - 3)^2} + 1$

49.



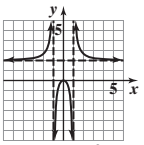
$f(x) = \frac{4x}{x - 2}$

51.



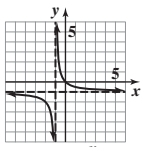
$f(x) = \frac{2x}{x^2 - 4}$

53.



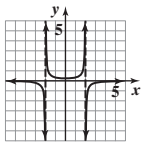
$f(x) = \dfrac{2x^2}{x^2 - 1}$

55.



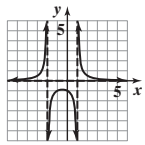
$f(x) = \dfrac{-x}{x + 1}$

57.



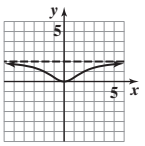
$f(x) = -\dfrac{1}{x^2 - 4}$

59.



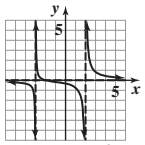
$f(x) = \dfrac{2}{x^2 + x - 2}$

61.



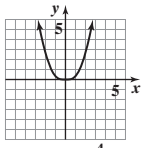
$f(x) = \dfrac{2x^2}{x^2 + 4}$

63.



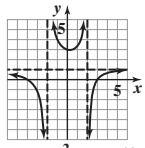
$f(x) = \dfrac{x + 2}{x^2 + x - 6}$

65.



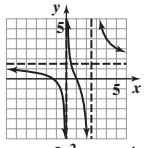
$f(x) = \dfrac{x^4}{x^2 + 2}$

67.



$f(x) = \dfrac{x^2 + x - 12}{x^2 - 4}$

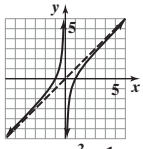
69.



$f(x) = \dfrac{3x^2 + x - 4}{2x^2 - 5x}$

71. **a.** Slant asymptote: $y = x$

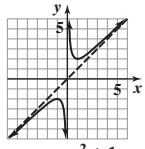
b.



$f(x) = \dfrac{x^2 - 1}{x}$

73. **a.** Slant asymptote: $y = x$

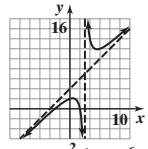
b.



$f(x) = \dfrac{x^2 + 1}{x}$

75. **a.** Slant asymptote: $y = x + 4$

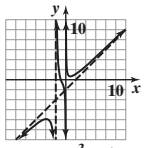
b.



$f(x) = \dfrac{x^2 + x - 6}{x - 3}$

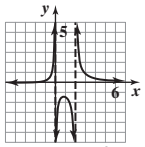
77. **a.** Slant asymptote: $y = x - 2$

b.



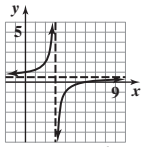
$f(x) = \dfrac{x^3 + 1}{x^2 + 2x}$

79.



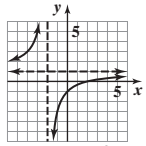
$f(x) = \dfrac{x + 2}{2x(x - 2)}$

81.



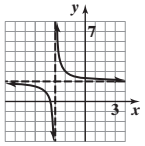
$f(x) = \dfrac{x - 6}{2(x - 3)}$

83.



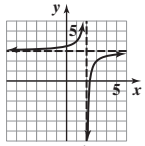
$f(x) = \dfrac{x - 2}{x + 2}$

85. $f(x) = \dfrac{1}{x + 3} + 2$



$g(x) = \dfrac{1}{x + 3} + 2$

87. $f(x) = \dfrac{-1}{x - 2} + 3$



$g(x) = \dfrac{-1}{x - 2} + 3$

89. **a.** $C(x) = 100x + 100{,}000$ **b.** $\overline{C}(x) = \dfrac{100x + 100{,}000}{x}$

c. $\overline{C}(500) = 300$, when 500 bicycles are produced, it costs \$300 to produce each bicycle; $\overline{C}(1000) = 200$, when 1000 bicycles are produced, it costs \$200 to produce each bicycle; $\overline{C}(2000) = 150$, when 2000 bicycles are produced, it costs \$150 to produce each bicycle; $\overline{C}(4000) = 125$, when 4000 bicycles are produced, it costs \$125 to produce each bicycle.

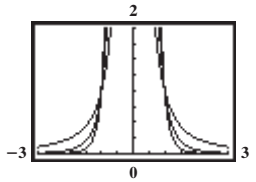
d. $y = 100$; The cost per bicycle approaches \$100 as more bicycles are produced.

91. **a.** 6.0 **b.** after 6 minutes; about 4.8 **c.** 6.5 **d.** $y = 6.5$; Over time, the pH level rises back to normal. **e.** It quickly drops below normal and then slowly begins to approach the normal level. **93.** 90; An incidence ratio of 10 means 90% of the deaths are smoking related.

95. $y = 100$; The percentage of deaths cannot exceed 100% as the incidence ratios increase. **97.** **a.** $f(x) = \dfrac{11x^2 + 40x + 1040}{12x^2 + 230x + 2190}$ **b.** 63%

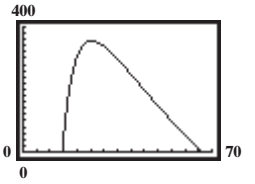
c. 64%; overestimates by 1% **d.** $y = \dfrac{11}{12}$; 92%; Answers may vary. **99.** $T(x) = \dfrac{10}{x} + \dfrac{5}{x}$ **101.** $A(x) = 2x + \dfrac{50}{x} + 52$

113.



The graph approaches the horizontal asymptote faster and the vertical asymptote slower as n increases.

115. **a.**



b. The graph increases and reaches a maximum of about 356 arrests per 100,000 drivers at age 25.

c. at age 25, about 356 arrests

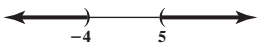
117. does not make sense **119.** does not make sense **121.** true **123.** true

128. $\left\{-3, \frac{5}{2}\right\}$ **129.** $\{-2, -1, 2\}$ **130.** $\frac{-x-5}{x+3}$ or $-\frac{x+5}{x+3}$

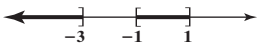
Section 2.7

Check Point Exercises

1. $\{x|x < -4 \text{ or } x > 5\}$ or $(-\infty, -4) \cup (5, \infty)$



2. $\{x|x \le -3 \text{ or } -1 \le x \le 1\}$ or $(-\infty, -3] \cup [-1, 1]$



3. $\{x|x < -1 \text{ or } x \ge 1\}$ or $(-\infty, -1) \cup [1, \infty)$

4. between 1 and 4 seconds, excluding $t = 1$ and $t = 4$

Exercise Set 2.7

1. $(-\infty, -2)$ or $(4, \infty)$

3. $[-3, 7]$

5. $(-\infty, 1)$ or $(4, \infty)$

7. $(-\infty, -4)$ or $(-1, \infty)$

9. $\varnothing$

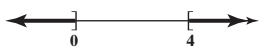
11. $\left[-4, \frac{2}{3}\right]$

13. $\left(-3, \frac{5}{2}\right)$

15. $\left(-1, -\frac{3}{4}\right)$

17. $\left[-2, \frac{1}{3}\right]$

19. $(-\infty, 0]$ or $[4, \infty)$



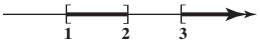
21. $\left(-\infty, -\frac{3}{2}\right)$ or $(0, \infty)$

23. $[0, 1]$

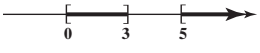
25. $[2 - \sqrt{2}, 2 + \sqrt{2}]$

27. $\varnothing$

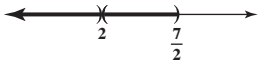
29. $[1, 2]$ or $[3, \infty)$



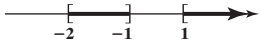
31. $[0, 3] \cup [5, \infty)$



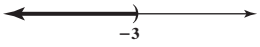
33. $(-\infty, 2) \cup \left(2, \frac{7}{2}\right)$



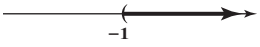
35. $[-2, -1]$ or $[1, \infty)$



37. $(-\infty, -3)$



39. $(-1, \infty)$



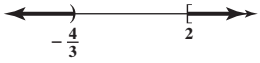
41. $\{0\}$ or $[9, \infty)$

43. $(-\infty, -3)$ or $(4, \infty)$

45. $(-4, -3)$

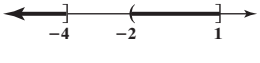
47. $[2, 4)$

49. $\left(-\infty, -\frac{4}{3}\right)$ or $[2, \infty)$



51. $(-\infty, 0)$ or $(3, \infty)$

53. $(-\infty, -4] \cup (-2, 1]$



55. $(-\infty, -5)$ or $(-3, \infty)$

57. $\left(-\infty, \frac{1}{2}\right)$ or $\left[\frac{7}{5}, \infty\right)$

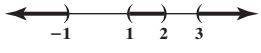
59. $(-\infty, -6]$ or $(-2, \infty)$

61. $\left(-\infty, \frac{1}{2}\right] \cup [2, \infty)$ **63.** $(-\infty, -1) \cup [1, \infty)$

65. $(-\infty, -8) \cup (-6, 4) \cup (6, \infty)$

67. $(-3, 2)$

69. $(-\infty, -1) \cup (1, 2) \cup (3, \infty)$



71. $\left[-6, -\frac{1}{2}\right] \cup [1, \infty)$ **73.** $(-\infty, -2) \cup [-1, 2)$ **75.** between 0 and $\frac{1}{2}$ second **77. a.** dry: 160 ft; wet: 185 ft **b.** dry pavement: graph (b); wet pavement: graph (a) **c.** extremely well; Function values and data are identical **d.** speeds exceeding 76 miles per hour; points on (b) to the right of (76, 540)

79. The sides (in feet) are in $(0, 6]$ or $[19, 25)$. **87.** $\left[-3, \frac{1}{2}\right]$ **89.** $(1, 4]$ **91.** $(-4, -1) \cup [2, \infty)$ **93. a.** $f(x) = 0.1375x^2 - 0.7x + 37.8$ **b.** speeds exceeding 52 miles per hour **95.** does not make sense **97.** does not make sense **99.** false **101.** true

103. Answers may vary. One possible solution is $\frac{x-3}{x+4} \ge 0$. **105.** $\{2\}$ **107.** $(-\infty, 2) \cup (2, \infty)$

109.
$$\begin{aligned} 27 - 3x^2 &\ge 0 \\ 3x^2 &\le 27 \\ x^2 &\le 9 \\ -3 \le x &\le 3 \end{aligned}$$

110. a. 16 **b.** $y = 16x^2$ **c.** 400 **111. a.** 96 **b.** $y = \frac{96}{x}$ **c.** 32 **112.** 8

Section 2.8

Check Point Exercises

1. 66 gal **2.** 9375 lb **3.** 512 cycles per second **4.** 24 min **5.** 96π cubic feet

Exercise Set 2.8

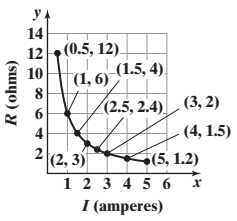
1. 156 **3.** 30 **5.** $\frac{5}{6}$ **7.** 240 **9.** 50 **11.** $x = kyz;\ y = \frac{x}{kz}$ **13.** $x = \frac{kz^3}{y};\ y = \frac{kz^3}{x}$ **15.** $x = \frac{kyz}{\sqrt{w}};\ y = \frac{x\sqrt{w}}{kz}$

17. $x = kz(y + w);\ y = \frac{x - kzw}{kz}$ **19.** $x = \frac{kz}{y - w};\ y = \frac{xw + kz}{x}$ **21.** 5.4 ft **23.** 80 in. **25.** about 607 lb **27.** 32°

29. 90 milliroentgens per hour **31.** This person has a BMI of 24.4 and is not overweight. **33.** 1800 Btu per hour

35. $\frac{1}{4}$ of what it was originally **37. a.** $C = \frac{kP_1P_2}{d^2}$ **b.** $k \approx 0.02;\ C = \frac{0.02\,P_1P_2}{d^2}$ **c.** 17,875 daily phone calls

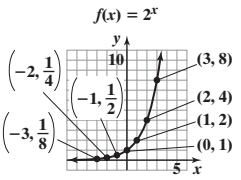
39. a.



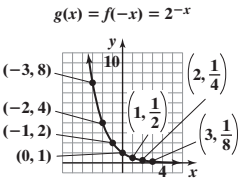
b. Current varies inversely as resistance. **c.** $R = \frac{6}{I}$

49. does not make sense **51.** makes sense **53.** The destructive power is four times as much. **55.** Reduce the resistance by a factor of $\frac{1}{3}$.

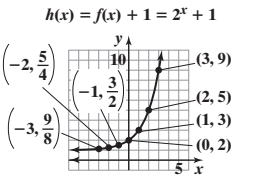
58.



59.



60.

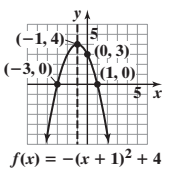


Chapter 2 Review Exercises

1. $-9 + 4i$ **2.** $-12 - 8i$ **3.** $17 + 19i$ **4.** $-7 - 24i$ **5.** 113 **6.** $\frac{15}{13} - \frac{3}{13}i$ **7.** $\frac{1}{5} + \frac{11}{10}i$ **8.** $i\sqrt{2}$ **9.** $-96 - 40i$

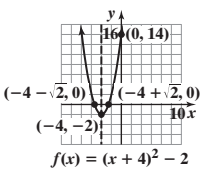
10. $2 + i\sqrt{2}$ **11.** $\{1 + i\sqrt{3}, 1 - i\sqrt{3}\}$ **12.** $\left\{\frac{3}{2} + \frac{1}{2}i, \frac{3}{2} - \frac{1}{2}i\right\}$

13.



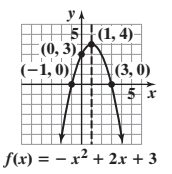
axis of symmetry; $x = -1$
domain: $(-\infty, \infty)$; range: $(-\infty, 4]$

14.



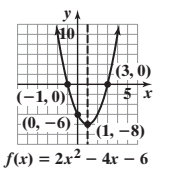
axis of symmetry: $x = -4$
domain: $(-\infty, \infty)$; range: $[-2, \infty)$

15.



axis of symmetry: $x = 1$
domain: $(-\infty, \infty)$; range: $(-\infty, 4]$

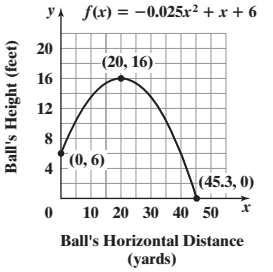
16.



axis of symmetry: $x = 1$
domain: $(-\infty, \infty)$; range: $[-8, \infty)$

17. a. maximum is -57 at $x = 7$ **b.** domain: $(-\infty, \infty)$; range: $(-\infty, -57]$ **18. a.** minimum is 685 at $x = -3$ **b.** domain: $(-\infty, \infty)$; range: $[685, \infty)$

19. a. 16 ft; 20 yd **b.** 6 ft **c.** 45.3 yd **d.**



20. 250 yd by 500 yd; 125,000 sq yard **21.** -7 and 7; -49

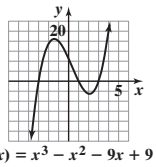
22. $x = 166\frac{2}{3}$ ft by $y = 125$ ft **23.** 36; 5256 lb **24.** c **25.** b **26.** a **27.** d **28.** No; the graph falls to the right, so eventually there would be a negative number of thefts, which is not possible. **29.** The graph falls to the right; eventually the elk population will be extinct.

30. $x = 1$, multiplicity 1, crosses; $x = -2$, multiplicity 2, touches; $x = -5$, multiplicity 3, crosses

31. $x = -5$, multiplicity 1, crosses; $x = 5$, multiplicity 2, touches

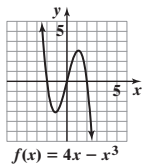
32. $f(1)$ is negative and $f(2)$ is positive, so by the Intermediate Value Theorem, f has a real zero between 1 and 2.

33. **a.** The graph falls to the left and rises to the right.
b. no symmetry
c.



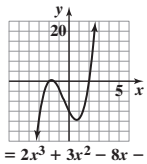
$f(x) = x^3 - x^2 - 9x + 9$

34. **a.** The graph rises to the left and falls to the right.
b. origin symmetry
c.



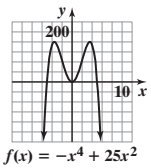
$f(x) = 4x - x^3$

35. **a.** The graph falls to the left and rises to the right.
b. no symmetry
c.



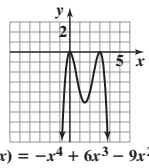
$f(x) = 2x^3 + 3x^2 - 8x - 12$

36. **a.** The graph falls to the left and to the right.
b. y-axis symmetry
c.



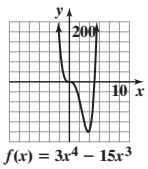
$f(x) = -x^4 + 25x^2$

37. **a.** The graph falls to the left and to the right.
b. no symmetry
c.



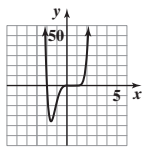
$f(x) = -x^4 + 6x^3 - 9x^2$

38. **a.** The graph rises to the left and to the right.
b. no symmetry
c.



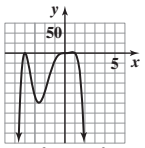
$f(x) = 3x^4 - 15x^3$

39.



$f(x) = 2x^2(x - 1)^3(x + 2)$

40.



$f(x) = -x^3(x + 4)^2(x - 1)$

41. $4x^2 - 7x + 5 - \dfrac{4}{x + 1}$

42. $2x^2 - 4x + 1 - \dfrac{10}{5x - 3}$

43. $2x^2 + 3x - 1$ **44.** $3x^3 - 4x^2 + 7$

45. $3x^3 + 6x^2 + 10x + 10 + \dfrac{20}{x - 2}$ **46.** -5697

47. $2, \frac{1}{2}, -3$ **48.** $\{4, -2 \pm \sqrt{5}\}$ **49.** $\pm 1, \pm 5$ **50.** $\pm 1, \pm 2, \pm 4, \pm 8, \pm\frac{8}{3}, \pm\frac{4}{3}, \pm\frac{2}{3}, \pm\frac{1}{3}$ **51.** 2 or 0 positive real zeros; no negative real zeros

52. 3 or 1 positive real zeros; 2 or 0 negative real zeros **53.** No sign variations exist for either $f(x)$ or $f(-x)$, so no real roots exist.

54. **a.** $\pm 1, \pm 2, \pm 4$ **b.** 1 positive real zero; 2 or no negative real zeros **c.** -2 or 1 **d.** $-2, 1$

55. **a.** $\pm 1, \pm\frac{1}{2}, \pm\frac{1}{3}, \pm\frac{1}{6}$ **b.** 2 or 0 positive real zeros; 1 negative real zero **c.** $-1, \frac{1}{3}$, or $\frac{1}{2}$ **d.** $-1, \frac{1}{3}, \frac{1}{2}$

56. **a.** $\pm 1, \pm 3, \pm 5, \pm 15, \pm\frac{1}{2}, \pm\frac{1}{4}, \pm\frac{1}{8}, \pm\frac{3}{2}, \pm\frac{3}{4}, \pm\frac{3}{8}, \pm\frac{5}{2}, \pm\frac{5}{4}, \pm\frac{5}{8}, \pm\frac{15}{2}, \pm\frac{15}{4}, \pm\frac{15}{8}$ **b.** 3 or 1 positive real solutions; no negative real solutions
c. $\frac{1}{2}, \frac{3}{2}$, or $\frac{5}{2}$ **d.** $\left\{\frac{1}{2}, \frac{3}{2}, \frac{5}{2}\right\}$ **57.** **a.** $\pm 1, \pm\frac{1}{2}$ **b.** 2 or 0 positive real solutions; 1 negative solution **c.** $\frac{1}{2}$ **d.** $\left\{\frac{1}{2}, \frac{-5 - \sqrt{29}}{2}, \frac{-5 + \sqrt{29}}{2}\right\}$

58. **a.** $\pm 1, \pm 2, \pm 3, \pm 6$ **b.** 2 or zero positive real solutions; 2 or zero negative real solutions **c.** $-2, -1, 1$, or 3 **d.** $\{-2, -1, 1, 3\}$

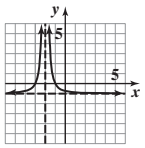
59. **a.** $\pm 1, \pm 2, \pm\frac{1}{2}, \pm\frac{1}{4}$ **b.** 1 positive real root; 1 negative real root **c.** $-\frac{1}{2}$ or $\frac{1}{2}$ **d.** $\left\{-\frac{1}{2}, \frac{1}{2}, i\sqrt{2}, -i\sqrt{2}\right\}$

60. **a.** $\pm 1, \pm 2, \pm 4, \pm\frac{1}{2}$ **b.** 2 or no positive zeros; 2 or no negative zeros **c.** $-2, -1, \frac{1}{2}$, or 2 **d.** $\left\{-2, -1, \frac{1}{2}, 2\right\}$

61. $f(x) = x^3 - 6x^2 + 21x - 26$ **62.** $f(x) = 2x^4 + 12x^3 + 20x^2 + 12x + 18$ **63.** $-2, \frac{1}{2}, \pm i$; $f(x) = (x - i)(x + i)(x + 2)(2x - 1)$

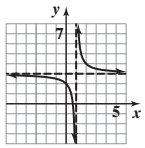
64. $-1, 4$; $g(x) = (x + 1)^2(x - 4)^2$ **65.** 4 real zeros, one with multiplicity two **66.** 3 real zeros; 2 nonreal complex zeros
67. 2 real zeros, one with multiplicity two; 2 nonreal complex zeros **68.** 1 real zero; 4 nonreal complex zeros

69.



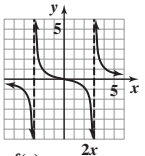
$g(x) = \dfrac{1}{(x + 2)^2} - 1$

70.



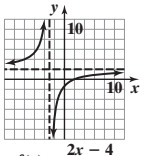
$h(x) = \dfrac{1}{x - 1} + 3$

71. Vertical asymptote: $x = 3$ and $x = -3$
horizontal asymptote: $y = 0$



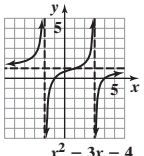
$f(x) = \dfrac{2x}{x^2 - 9}$

72. Vertical asymptote: $x = -3$
horizontal asymptote: $y = 2$



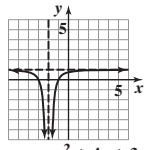
$f(x) = \dfrac{2x - 4}{x + 3}$

73. Vertical asymptotes: $x = 3, -2$
horizontal asymptote: $y = 1$



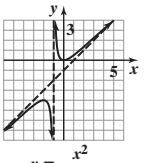
$h(x) = \dfrac{x^2 - 3x - 4}{x^2 - x - 6}$

74. Vertical asymptote: $x = -2$
horizontal asymptote: $y = 1$



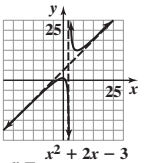
$r(x) = \dfrac{x^2 + 4x + 3}{(x + 2)^2}$

75. Vertical asymptote: $x = -1$
no horizontal asymptote
slant asymptote: $y = x - 1$



$y = \dfrac{x^2}{x + 1}$

76. Vertical asymptote: $x = 3$
no horizontal asymptote
slant asymptote: $y = x + 5$

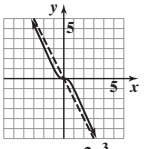


$y = \dfrac{x^2 + 2x - 3}{x - 3}$

77. No vertical asymptote

no horizontal asymptote

slant asymptote: $y = -2x$

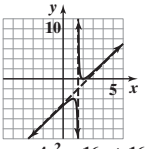


$f(x) = \dfrac{-2x^3}{x^2 + 1}$

78. Vertical asymptote: $x = \dfrac{3}{2}$

no horizontal asymptote

slant asymptote: $y = 2x - 5$



$g(x) = \dfrac{4x^2 - 16x + 16}{2x - 3}$

79. a. $C(x) = 25x + 50{,}000$

b. $\overline{C}(x) = \dfrac{25x + 50{,}000}{x}$

c. $\overline{C}(50) = 1025$, when 50 calculators are manufactured, it costs \$1025 to manufacture each;
$\overline{C}(100) = 525$, when 100 calculators are manufactured, it costs \$525 to manufacture each;
$\overline{C}(1000) = 75$, when 1000 calculators are manufactured, it costs \$75 to manufacture each;
$\overline{C}(100{,}000) = 25.5$, when 100,000 calculators are manufactured, it costs \$25.50 to manufacture each.

d. $y = 25$; costs will approach \$25.

80. $y = 3000$; The number of fish in the pond approaches 3000.

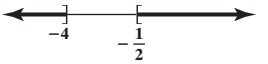
81. $y = 0$; As the number of years of education increases the percentage rate of unemployment approaches zero.

82. a. $P(x) = 3.06x + 235$ **b.** $R(x) = \dfrac{1.58x + 114.4}{3.06x + 235}$ **c.** $y = 0.52$; Over time the percentage of men in the U.S. population will approach 52%.

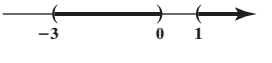
83. $T(x) = \dfrac{4}{x + 3} + \dfrac{2}{x}$ **84.** $P(x) = 2x + \dfrac{2000}{x}$

85. $\left(-3, \dfrac{1}{2}\right)$

86. $(-\infty, -4] \cup \left[-\dfrac{1}{2}, \infty\right)$

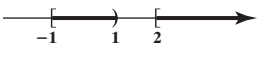


87. $(-3, 0) \cup (1, \infty)$

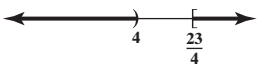


88. $(-\infty, -2) \cup (6, \infty)$

89. $[-1, 1) \cup [2, \infty)$



90. $(-\infty, 4) \cup \left[\dfrac{23}{4}, \infty\right)$



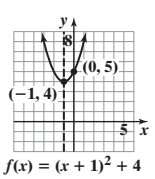
91. a. 261 ft; overestimates by 1 ft **b.** speeds exceeding 40 miles per hour **92.** from 1 to 2 sec **93.** 134.4 cm^3 **94.** 1600 ft

95. 440 vibrations per second **96.** 112 decibels **97.** 16 hr **98.** 800 ft^3 **99. a.** $L = \dfrac{1890}{R}$ **b.** an approximate model **c.** 70 yr

Chapter 2 Test

1. $47 + 16i$ **2.** $2 + i$ **3.** $38i$ **4.** $\{2 + i, 2 - i\}$

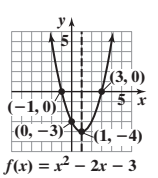
5.



$f(x) = (x + 1)^2 + 4$

axis of symmetry: $x = -1$
domain: $(-\infty, \infty)$; range: $[4, \infty)$

6.



$f(x) = x^2 - 2x - 3$

axis of symmetry: $x = 1$
domain: $(-\infty, \infty)$; range: $[-4, \infty)$

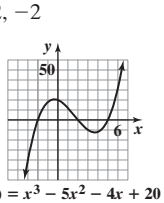
7. a. maximum of 2 at $x = 3$;
b. domain: $(-\infty, \infty)$; range: $(-\infty, 2]$

8. 23 computers;
maximum daily profit = \$16,900

9. 7 and 7; 49

10. a. 5, 2, -2

b.



$f(x) = x^3 - 5x^2 - 4x + 20$

11. Since the degree of the polynomial is odd and the leading coefficient is positive, the graph of f should fall to the left and rise to the right. The x-intercepts should be -1, 0, and 1.

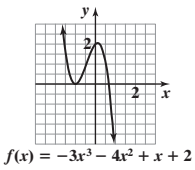
12. a. 2 **b.** $\dfrac{1}{2}, \dfrac{2}{3}$ **13.** $\pm 1, \pm 2, \pm 3, \pm 6, \pm\dfrac{1}{2}, \pm\dfrac{3}{2}$

14. 3 or 1 positive real zeros; no negative real zeros.

15. $\{-3, -3 - \sqrt{11}, -3 + \sqrt{11}\}$ **16. a.** $\pm 1, \pm 3, \pm 5, \pm 15, \pm\dfrac{1}{2}, \pm\dfrac{3}{2}, \pm\dfrac{5}{2}, \pm\dfrac{15}{2}$ **b.** $-\sqrt{5}, -1, \dfrac{3}{2}$, and $\sqrt{5}$ **17.** $(x - 1)(x + 2)^2$

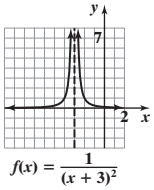
18. $f(x) = 2x^4 - 2$

19. -1 and $\frac{2}{3}$



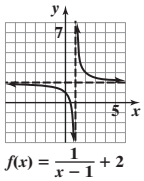
$f(x) = -3x^3 - 4x^2 + x + 2$

20. $(-\infty, -3) \cup (-3, \infty)$



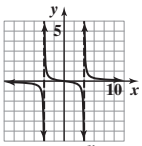
$f(x) = \frac{1}{(x+3)^2}$

21. $(-\infty, 1) \cup (1, \infty)$



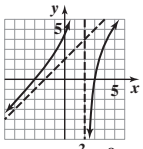
$f(x) = \frac{1}{x-1} + 2$

22. domain: $\{x | x \neq 4, x \neq -4\}$



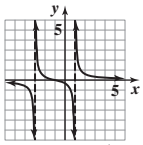
$f(x) = \frac{x}{x^2 - 16}$

23. domain: $\{x | x \neq 2\}$



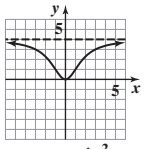
$f(x) = \frac{x^2 - 9}{x - 2}$

24. domain: $\{x | x \neq -3, x \neq 1\}$



$f(x) = \frac{x+1}{x^2 + 2x - 3}$

25. domain: all real numbers



$f(x) = \frac{4x^2}{x^2 + 3}$

26. a. $\overline{C}(x) = \frac{300{,}000 + 10x}{x}$ **b.** $y = 10$; As the number of satellite radio players increases, the average cost approaches \$10.

27. $(-3, 4)$

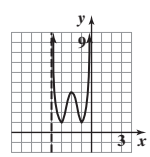
28. $(-\infty, 3) \cup [10, \infty)$

29. 45 foot-candles

Cumulative Review Exercises (Chapters P–2)

1. domain: $(-2, 2)$; range: $[0, \infty)$ **2.** -1 and 1, both of multiplicity 2 **3.** 0 **4.** 3 **5.** $x \to -2^+$; $x \to 2^-$

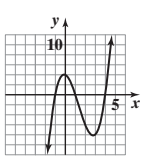
6.



$g(x) = f(x + 2) + 1$

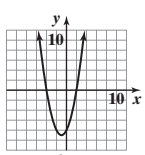
7. $\{2, -1\}$ **8.** $\left\{\frac{5 + \sqrt{13}}{6}, \frac{5 - \sqrt{13}}{6}\right\}$ **9.** $\left\{\frac{1}{3}, -\frac{2}{3}\right\}$ **10.** $\{-3, -1, 2\}$ **11.** $(-\infty, 1) \cup (4, \infty)$

12. $(-\infty, -1) \cup \left(\frac{5}{3}, \infty\right)$ **13.**



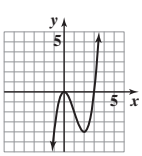
$f(x) = x^3 - 4x^2 - x + 4$

14.



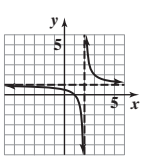
$f(x) = x^2 + 2x - 8$

15.



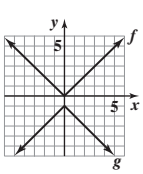
$f(x) = x^2(x - 3)$

16.

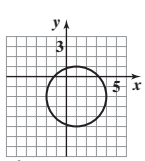


$f(x) = \frac{x-1}{x-2}$

17.



18.



$x^2 + y^2 - 2x + 4y - 4 = 0$

19. $(f \circ g)(x) = 32x^2 - 20x + 2$ **20.** $4x + 2h - 1$

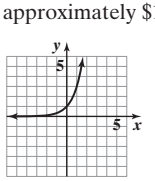
CHAPTER 3

Section 3.1

Check Point Exercises

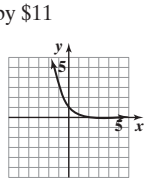
1. approximately \$160; overestimates by \$11

2.



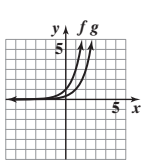
$f(x) = 3^x$

3.



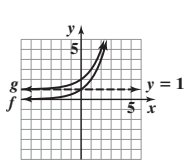
$f(x) = \left(\frac{1}{3}\right)^x$

4.



$f(x) = 3^x$
$g(x) = 3^x - 1$

5.



$f(x) = 2^x$
$g(x) = 2^x + 1$

6. approximately 4446 **7. a.** \$14,859.47 **b.** \$14,918.25