15. (a)

x	-4	-2	0	4
$f(f^{-1}(x))$	-4	-2	0	4

(b)

x	-3	-2	0	1
$(f + f^{-1})(x)$	5	1	-3	-5

(c)

x	-3	-2	0	1
$(f \cdot f^{-1})(x)$	4	0	2	6

(d)

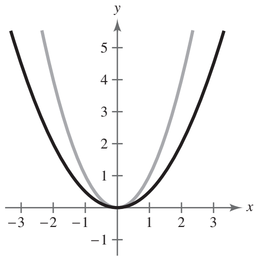
x	-4	-3	0	4
$\lvert f^{-1}(x)\rvert$	2	1	1	3

Chapter 2

Section 2.1 *(page 132)*

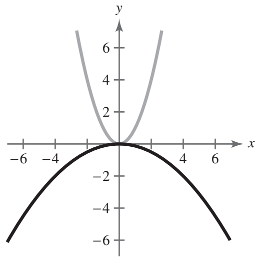
1. polynomial **3.** quadratic; parabola
5. positive; minimum
7. e **8.** c **9.** b **10.** a **11.** f **12.** d

13. (a)



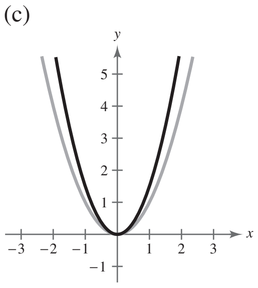
Vertical shrink

(b)



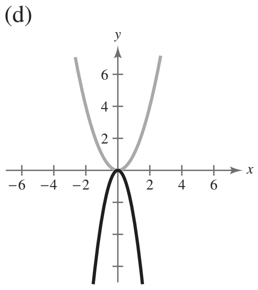
Vertical shrink and reflection in the x-axis

(c)



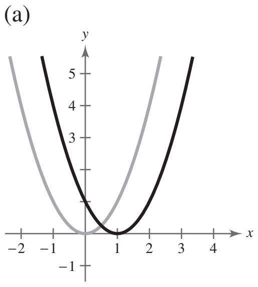
Vertical stretch

(d)



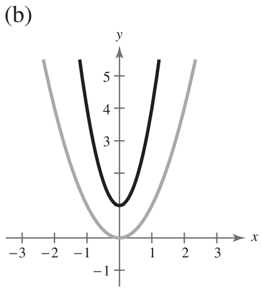
Vertical stretch and reflection in the x-axis

15. (a)



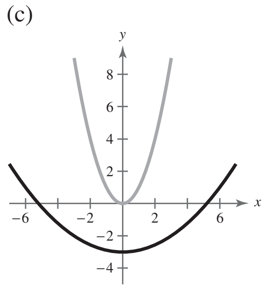
Horizontal shift one unit to the right

(b)



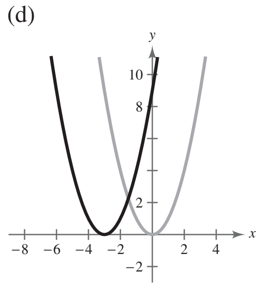
Horizontal shrink and vertical shift one unit upward

(c)



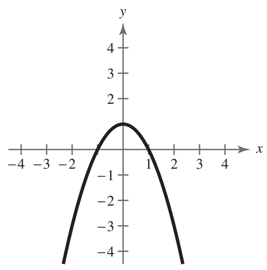
Horizontal stretch and vertical shift three units downward

(d)



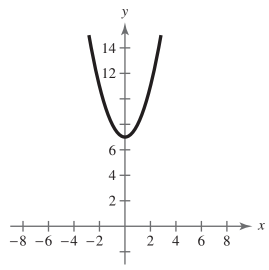
Horizontal shift three units to the left

17.



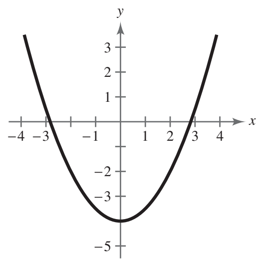
Vertex: $(0, 1)$
Axis of symmetry: y-axis
x-intercepts: $(-1, 0)$ $(1, 0)$

19.



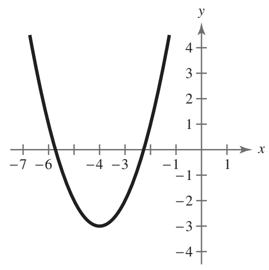
Vertex: $(0, 7)$
Axis of symmetry: y-axis
No x-intercept

21.



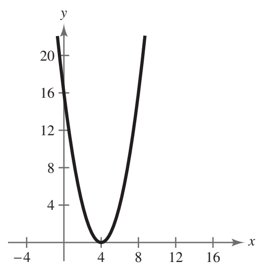
Vertex: $(0, -4)$
Axis of symmetry: y-axis
x-intercepts: $(\pm 2\sqrt{2}, 0)$

23.



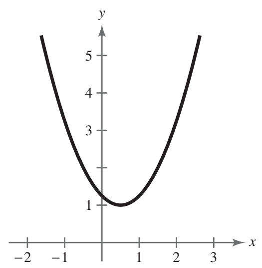
Vertex: $(-4, -3)$
Axis of symmetry: $x = -4$
x-intercepts: $(-4 \pm \sqrt{3}, 0)$

25.



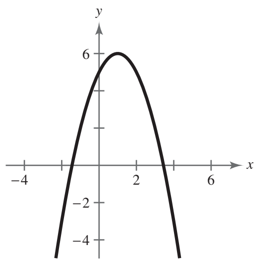
Vertex: $(4, 0)$
Axis of symmetry: $x = 4$
x-intercept: $(4, 0)$

27.



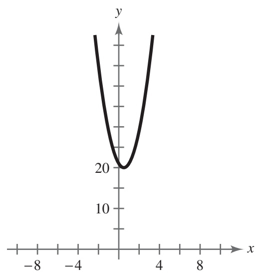
Vertex: $\left(\frac{1}{2}, 1\right)$
Axis of symmetry: $x = \frac{1}{2}$
No x-intercept

29.



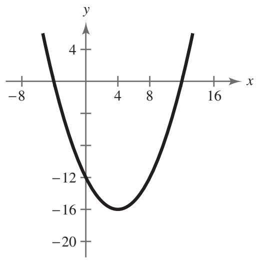
Vertex: $(1, 6)$
Axis of symmetry: $x = 1$
x-intercepts: $(1 \pm \sqrt{6}, 0)$

31.



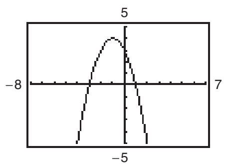
Vertex: $\left(\frac{1}{2}, 20\right)$
Axis of symmetry: $x = \frac{1}{2}$
No x-intercept

33.



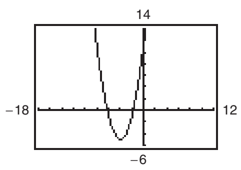
Vertex: $(4, -16)$
Axis of symmetry: $x = 4$
x-intercepts: $(-4, 0), (12, 0)$

35.



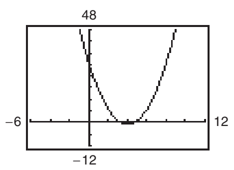
Vertex: $(-1, 4)$
Axis of symmetry: $x = -1$
x-intercepts: $(1, 0), (-3, 0)$

37.



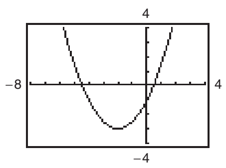
Vertex: $(-4, -5)$
Axis of symmetry: $x = -4$
x-intercepts: $(-4 \pm \sqrt{5}, 0)$

39.



Vertex: $(4, -1)$
Axis of symmetry: $x = 4$
x-intercepts: $\left(4 \pm \frac{1}{2}\sqrt{2}, 0\right)$

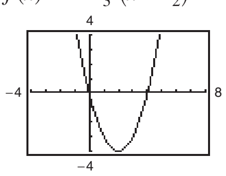
41.



Vertex: $(-2, -3)$
Axis of symmetry: $x = -2$
x-intercepts: $(-2 \pm \sqrt{6}, 0)$

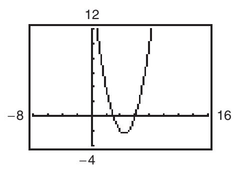
43. $y = -(x + 1)^2 + 4$ **45.** $y = -2(x + 2)^2 + 2$
47. $f(x) = (x + 2)^2 + 5$ **49.** $f(x) = 4(x - 1)^2 - 2$
51. $f(x) = \frac{3}{4}(x - 5)^2 + 12$ **53.** $f(x) = -\frac{24}{49}\left(x + \frac{1}{4}\right)^2 + \frac{3}{2}$
55. $f(x) = -\frac{16}{3}\left(x + \frac{5}{2}\right)^2$ **57.** $(5, 0), (-1, 0)$

59.



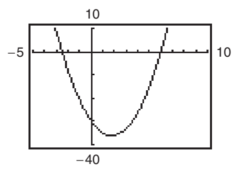
$(0, 0), (4, 0)$

61.



$(3, 0), (6, 0)$

63.



$\left(-\frac{5}{2}, 0\right), (6, 0)$

65. $f(x) = x^2 - 2x - 3$
$g(x) = -x^2 + 2x + 3$

67. $f(x) = x^2 - 10x$
$g(x) = -x^2 + 10x$

69. $f(x) = 2x^2 + 7x + 3$
$g(x) = -2x^2 - 7x - 3$

71. 55, 55 **73.** 12, 6 **75.** 16 ft **77.** 20 fixtures

79. (a) \$14,000,000; \$14,375,000; \$13,500,000
(b) \$24; \$14,400,000
Answers will vary.

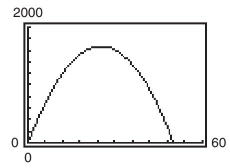
81. (a) $A = \dfrac{8x(50 - x)}{3}$

(b)

x	5	10	15	20	25	30
a	600	$1066\frac{2}{3}$	1400	1600	$1666\frac{2}{3}$	1600

$x = 25$ ft, $y = 33\frac{1}{3}$ ft

(c)

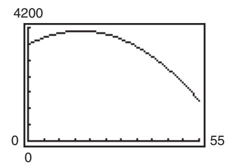


$x = 25$ ft, $y = 33\frac{1}{3}$ ft

(d) $A = -\frac{8}{3}(x - 25)^2 + \frac{5000}{3}$ (e) They are identical.

83. (a) $R = -100x^2 + 3500x, \quad 15 \le x \le 20$
(b) \$17.50; \$30,625

85. (a)



(b) 4075 cigarettes; Yes, the warning had an effect because the maximum consumption occurred in 1966.
(c) 7366 cigarettes per year; 20 cigarettes per day

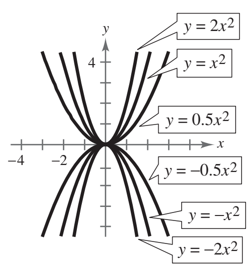
87. True. The equation has no real solutions, so the graph has no x-intercepts.

89. True. The graph of a quadratic function with a negative leading coefficient will be a downward-opening parabola.

91. $b = \pm 20$ **93.** $b = \pm 8$

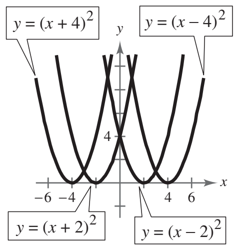
95. $f(x) = a\left(x + \dfrac{b}{2a}\right)^2 + \dfrac{4ac - b^2}{4a}$

97. (a)



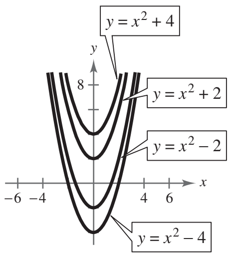
As $|a|$ increases, the parabola becomes narrower. For $a > 0$, the parabola opens upward. For $a < 0$, the parabola opens downward.

(b)



For $h < 0$, the vertex will be on the negative x-axis. For $h > 0$, the vertex will be on the positive x-axis. As $|h|$ increases, the parabola moves away from the origin.

(c)



As $|k|$ increases, the vertex moves upward (for $k > 0$) or downward (for $k < 0$), away from the origin.

99. Yes. A graph of a quadratic equation whose vertex is on the x-axis has only one x-intercept.

Section 2.2 *(page 145)*

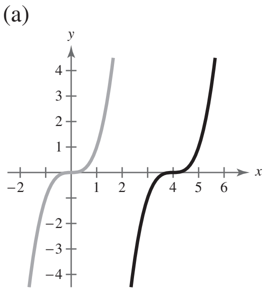
1. continuous **3.** x^n

5. (a) solution; (b) $(x - a)$; (c) x-intercept **7.** standard

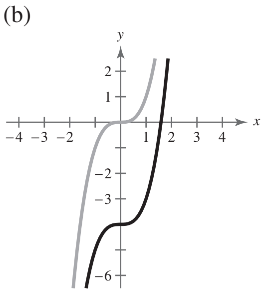
9. c **10.** g **11.** h **12.** f

13. a **14.** e **15.** d **16.** b

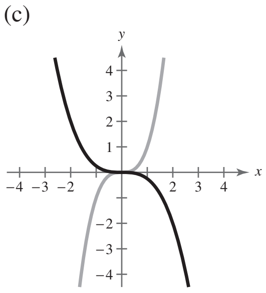
17. (a)



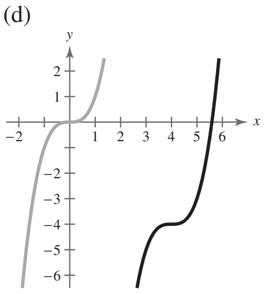
(b)



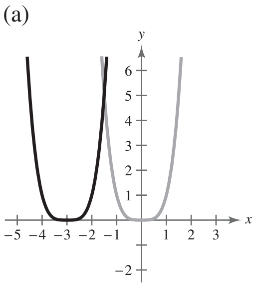
(c)



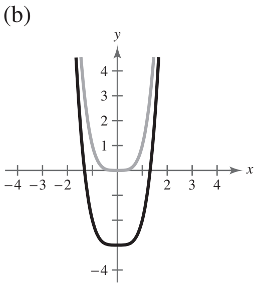
(d)



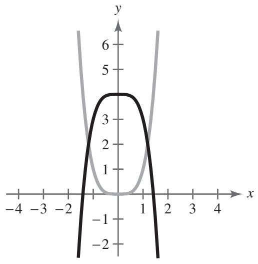
19. (a)



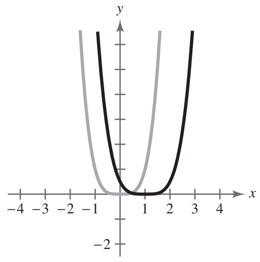
(b)



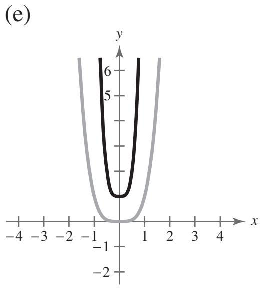
(c)



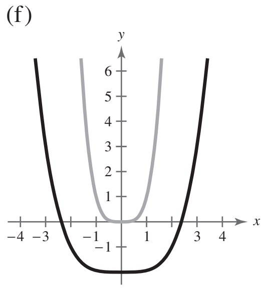
(d)



(e)



(f)



21. Falls to the left, rises to the right

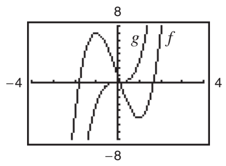
23. Falls to the left, falls to the right

25. Rises to the left, falls to the right

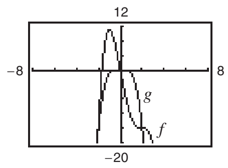
27. Rises to the left, falls to the right

29. Falls to the left, falls to the right

31.



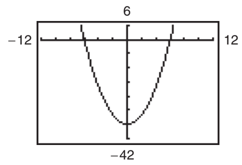
33.



35. (a) ± 6

(b) Odd multiplicity; number of turning points: 1

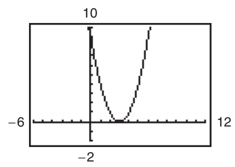
(c)



37. (a) 3

(b) Even multiplicity; number of turning points: 1

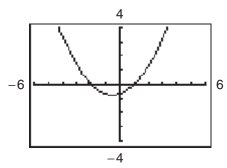
(c)



39. (a) $-2, 1$

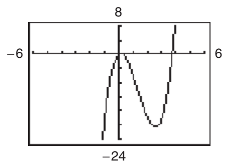
(b) Odd multiplicity; number of turning points: 1

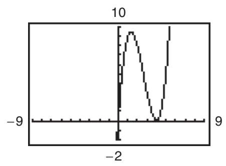
(c)

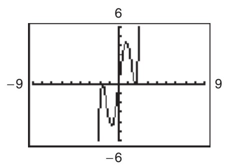


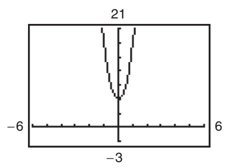
41. (a) $0, 2 \pm \sqrt{3}$

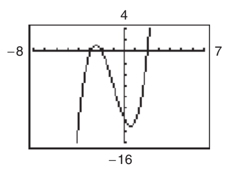
(b) Odd multiplicity; number of turning points: 2

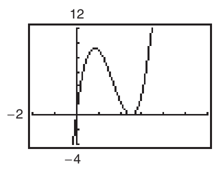
(c)


43. (a) 0, 4
(b) 0, odd multiplicity; 4, even multiplicity; number of turning points: 2
(c)


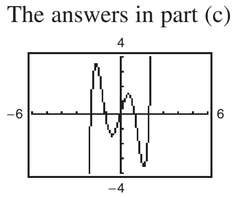
45. (a) $0, \pm\sqrt{3}$
(b) 0, odd multiplicity; $\pm\sqrt{3}$, even multiplicity; number of turning points: 4
(c)


47. (a) No real zeros
(b) Number of turning points: 1
(c)


49. (a) $\pm 2, -3$
(b) Odd multiplicity; number of turning points: 2
(c)


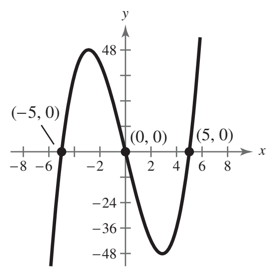
51. (a)


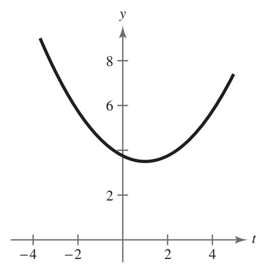
(b) x-intercepts: $(0, 0), \left(\frac{5}{2}, 0\right)$ (c) $x = 0, \frac{5}{2}$
(d) The answers in part (c) match the x-intercepts.

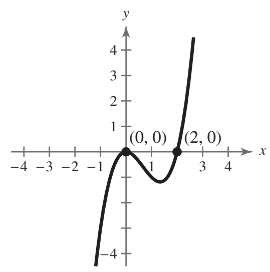
53. (a)


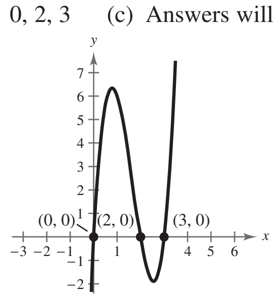
(b) x-intercepts: $(0, 0), (\pm 1, 0), (\pm 2, 0)$
(c) $x = 0, 1, -1, 2, -2$
(d) The answers in part (c) match the x-intercepts.

55. $f(x) = x^2 - 8x$ **57.** $f(x) = x^2 + 4x - 12$
59. $f(x) = x^3 + 9x^2 + 20x$
61. $f(x) = x^4 - 4x^3 - 9x^2 + 36x$ **63.** $f(x) = x^2 - 2x - 2$
65. $f(x) = x^2 + 6x + 9$ **67.** $f(x) = x^3 + 4x^2 - 5x$
69. $f(x) = x^3 - 3x$ **71.** $f(x) = x^4 + x^3 - 15x^2 + 23x - 10$
73. $f(x) = x^5 + 16x^4 + 96x^3 + 256x^2 + 256x$

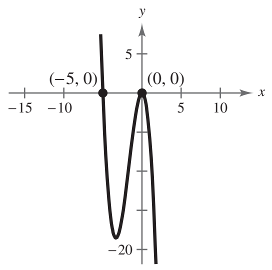
75. (a) Falls to the left, rises to the right
(b) $0, 5, -5$ (c) Answers will vary.
(d)


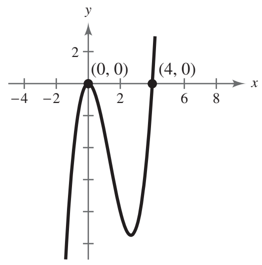
77. (a) Rises to the left, rises to the right
(b) No zeros (c) Answers will vary.
(d)


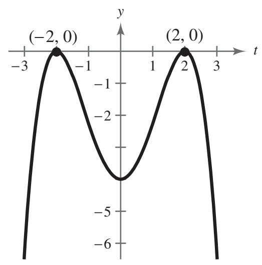
79. (a) Falls to the left, rises to the right
(b) 0, 2 (c) Answers will vary.
(d)


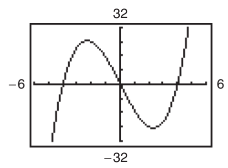
81. (a) Falls to the left, rises to the right
(b) 0, 2, 3 (c) Answers will vary.
(d)


83. (a) Rises to the left, falls to the right
(b) $-5, 0$ (c) Answers will vary.

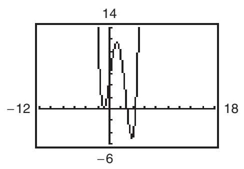
(d)


85. (a) Falls to the left, rises to the right
(b) 0, 4 (c) Answers will vary.
(d)


87. (a) Falls to the left, falls to the right
(b) ± 2 (c) Answers will vary.
(d)


89.


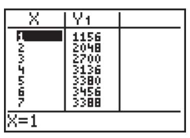
Zeros: 0, ± 4,
odd multiplicity

91.


Zeros: -1,
even multiplicity;
3, $\frac{9}{2}$, odd multiplicity

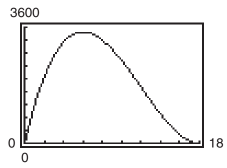
93. $[-1, 0]$, $[1, 2]$, $[2, 3]$; about -0.879, 1.347, 2.532

95. $[-2, -1]$, $[0, 1]$; about -1.585, 0.779

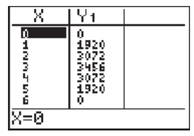
97. (a) $V(x) = x(36 - 2x)^2$ (b) Domain: $0 < x < 18$
(c)


X	Y1
1	1156
2	2048
3	2700
4	3136
5	3380
6	3456
7	3388

X=1

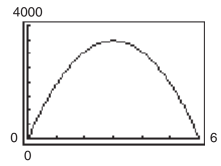
6 in. × 24 in. × 24 in.
(d)


$x = 6$; The results are the same.

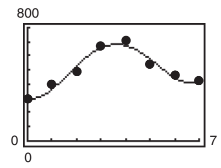
99. (a) $A = -2x^2 + 12x$ (b) $V = -384x^2 + 2304x$
(c) 0 in. $< x <$ 6 in.
(d)


X	Y1
0	0
1	1920
2	3072
3	3456
4	3072
5	1920
6	0

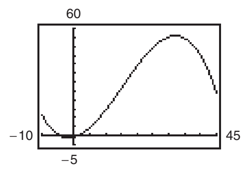
X=0

When $x = 3$, the volume is maximum at $V = 3456$; dimensions of gutter are 3 in. × 6 in. × 3 in.
(e)


The maximum value is the same.
(f) No. Answers will vary.

101. (a)


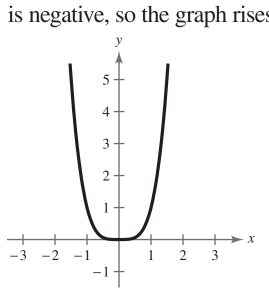
(b) The model fits the data well.
(c) Relative minima: (0.21, 300.54), (6.62, 410.74)
Relative maximum: (3.62, 681.72)
(d) Increasing: (0.21, 3.62), (6.62, 7)
Decreasing: (0, 0.21), (3.62, 6.62)
(e) Answers will vary.

103. (a)


(b) $t \approx 15$
(c) Vertex: (15.22, 2.54)
(d) The results are approximately equal.

105. False. A fifth-degree polynomial can have at most four turning points.

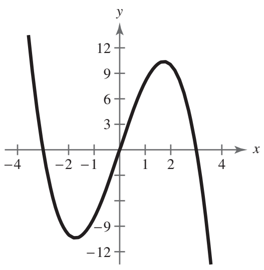
107. True. The degree of the function is odd and its leading coefficient is negative, so the graph rises to the left and falls to the right.

109.


(a) Vertical shift two units upward; Even
(b) Horizontal shift two units to the left; Neither
(c) Reflection in the y-axis; Even
(d) Reflection in the x-axis; Even
(e) Horizontal stretch; Even
(f) Vertical shrink; Even
(g) $g(x) = x^3, x \geq 0$; Neither
(h) $g(x) = x^{16}$; Even

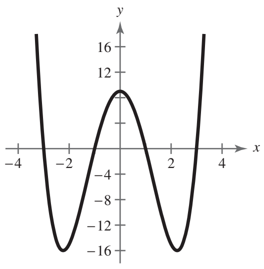
CHAPTER 2

111. (a)



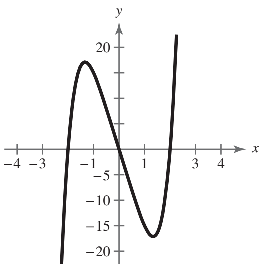
Zeros: 3
Relative minimum: 1
Relative maximum: 1
The number of zeros is the same as the degree, and the number of extrema is one less than the degree.

(b)



Zeros: 4
Relative minima: 2
Relative maximum: 1
The number of zeros is the same as the degree, and the number of extrema is one less than the degree.

(c)



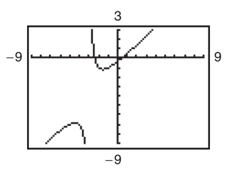
Zeros: 3
Relative minimum: 1
Relative maximum: 1
The number of zeros and the number of extrema are both less than the degree.

Section 2.3 *(page 156)*

1. $f(x)$: dividend; $d(x)$: divisor; $q(x)$: quotient; $r(x)$: remainder

3. improper **5.** Factor **7.** Answers will vary.

9. (a) and (b)



(c) Answers will vary.

11. $2x + 4, \quad x \neq -3$ **13.** $x^2 - 3x + 1, \quad x \neq -\frac{5}{4}$

15. $x^3 + 3x^2 - 1, \quad x \neq -2$ **17.** $x^2 + 3x + 9, \quad x \neq 3$

19. $7 - \dfrac{11}{x + 2}$ **21.** $x - \dfrac{x + 9}{x^2 + 1}$ **23.** $2x - 8 + \dfrac{x - 1}{x^2 + 1}$

25. $x + 3 + \dfrac{6x^2 - 8x + 3}{(x - 1)^3}$ **27.** $3x^2 - 2x + 5, \quad x \neq 5$

29. $6x^2 + 25x + 74 + \dfrac{248}{x - 3}$ **31.** $4x^2 - 9, \quad x \neq -2$

33. $-x^2 + 10x - 25, \quad x \neq -10$

35. $5x^2 + 14x + 56 + \dfrac{232}{x - 4}$

37. $10x^3 + 10x^2 + 60x + 360 + \dfrac{1360}{x - 6}$

39. $x^2 - 8x + 64, \quad x \neq -8$

41. $-3x^3 - 6x^2 - 12x - 24 - \dfrac{48}{x - 2}$

43. $-x^3 - 6x^2 - 36x - 36 - \dfrac{216}{x - 6}$

45. $4x^2 + 14x - 30, \quad x \neq -\frac{1}{2}$

47. $f(x) = (x - 4)(x^2 + 3x - 2) + 3, \quad f(4) = 3$

49. $f(x) = \left(x + \frac{2}{3}\right)(15x^3 - 6x + 4) + \frac{34}{3}, \quad f\left(-\frac{2}{3}\right) = \frac{34}{3}$

51. $f(x) = \left(x - \sqrt{2}\right)\left[x^2 + \left(3 + \sqrt{2}\right)x + 3\sqrt{2}\right] - 8,$ $f\left(\sqrt{2}\right) = -8$

53. $f(x) = \left(x - 1 + \sqrt{3}\right)\left[-4x^2 + \left(2 + 4\sqrt{3}\right)x + \left(2 + 2\sqrt{3}\right)\right],$ $f\left(1 - \sqrt{3}\right) = 0$

55. (a) -2 (b) 1 (c) $-\frac{1}{4}$ (d) 5

57. (a) -35 (b) -22 (c) -10 (d) -211

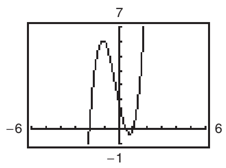
59. $(x - 2)(x + 3)(x - 1)$; Solutions: $2, -3, 1$

61. $(2x - 1)(x - 5)(x - 2)$; Solutions: $\frac{1}{2}, 5, 2$

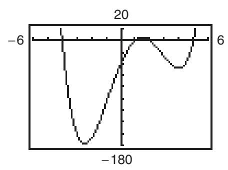
63. $\left(x + \sqrt{3}\right)\left(x - \sqrt{3}\right)(x + 2)$; Solutions: $-\sqrt{3}, \sqrt{3}, -2$

65. $(x - 1)\left(x - 1 - \sqrt{3}\right)\left(x - 1 + \sqrt{3}\right)$; Solutions: $1,\ 1 + \sqrt{3},\ 1 - \sqrt{3}$

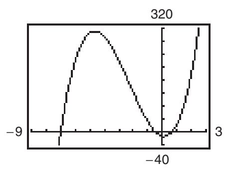
67. (a) Answers will vary. (b) $2x - 1$
(c) $f(x) = (2x - 1)(x + 2)(x - 1)$
(d) $\frac{1}{2}, -2, 1$ (e)



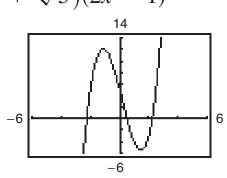
69. (a) Answers will vary. (b) $(x - 1), (x - 2)$
(c) $f(x) = (x - 1)(x - 2)(x - 5)(x + 4)$
(d) $1, 2, 5, -4$ (e)



71. (a) Answers will vary. (b) $x + 7$
(c) $f(x) = (x + 7)(2x + 1)(3x - 2)$
(d) $-7, -\frac{1}{2}, \frac{2}{3}$ (e)



73. (a) Answers will vary. (b) $x - \sqrt{5}$
(c) $f(x) = \left(x - \sqrt{5}\right)\left(x + \sqrt{5}\right)(2x - 1)$
(d) $\pm\sqrt{5}, \frac{1}{2}$ (e)



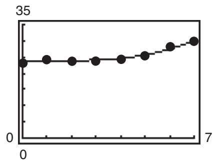
75. (a) Zeros are 2 and about ± 2.236.
(b) $x = 2$ (c) $f(x) = (x - 2)\left(x - \sqrt{5}\right)\left(x + \sqrt{5}\right)$

77. (a) Zeros are -2, about 0.268, and about 3.732.
(b) $t = -2$
(c) $h(t) = (t + 2)\left[t - \left(2 + \sqrt{3}\right)\right]\left[t - \left(2 - \sqrt{3}\right)\right]$

79. (a) Zeros are 0, 3, 4, and about ± 1.414.
(b) $x = 0$
(c) $h(x) = x(x-4)(x-3)(x+\sqrt{2})(x-\sqrt{2})$

81. $2x^2 - x - 1,\ x \neq \frac{3}{2}$ **83.** $x^2 + 3x,\ x \neq -2, -1$

85. (a) and (b)



$A = 0.0349t^3 - 0.168t^2 + 0.42t + 23.4$

(c)

t	0	1	2	3
$A(t)$	23.4	23.7	23.8	24.1

t	4	5	6	7
$A(t)$	24.6	25.7	27.4	30.1

(d) $45.7 billion; No, because the model will approach infinity quickly.

87. False. $-\frac{4}{7}$ is a zero of f.

89. True. The degree of the numerator is greater than the degree of the denominator.

91. $x^{2n} + 6x^n + 9,\ x^n \neq -3$ **93.** The remainder is 0.

95. $c = -210$ **97.** $k = 7$

99. (a) $x + 1,\ x \neq 1$ (b) $x^2 + x + 1,\ x \neq 1$
(c) $x^3 + x^2 + x + 1,\ x \neq 1$
In general, $\dfrac{x^n - 1}{x - 1} = x^{n-1} + x^{n-2} + \cdots + x + 1,\ x \neq 1$

Section 2.4 *(page 164)*

1. (a) iii (b) i (c) ii **3.** principal square

5. $a = -12,\ b = 7$ **7.** $a = 6,\ b = 5$ **9.** $8 + 5i$

11. $2 - 3\sqrt{3}i$ **13.** $4\sqrt{5}i$ **15.** 14 **17.** $-1 - 10i$

19. $0.3i$ **21.** $10 - 3i$ **23.** 1 **25.** $3 - 3\sqrt{2}i$

27. $-14 + 20i$ **29.** $\frac{1}{6} + \frac{7}{6}i$ **31.** $5 + i$ **33.** $108 + 12i$

35. 24 **37.** $-13 + 84i$ **39.** -10 **41.** $9 - 2i$, 85

43. $-1 + \sqrt{5}i$, 6 **45.** $-2\sqrt{5}i$, 20 **47.** $\sqrt{6}$, 6

49. $-3i$ **51.** $\frac{8}{41} + \frac{10}{41}i$ **53.** $\frac{12}{13} + \frac{5}{13}i$ **55.** $-4 - 9i$

57. $-\frac{120}{1681} - \frac{27}{1681}i$ **59.** $-\frac{1}{2} - \frac{5}{2}i$ **61.** $\frac{62}{949} + \frac{297}{949}i$

63. $-2\sqrt{3}$ **65.** -15

67. $(21 + 5\sqrt{2}) + (7\sqrt{5} - 3\sqrt{10})i$ **69.** $1 \pm i$

71. $-2 \pm \frac{1}{2}i$ **73.** $-\frac{5}{2}, -\frac{3}{2}$ **75.** $2 \pm \sqrt{2}i$

77. $\dfrac{5}{7} \pm \dfrac{5\sqrt{15}}{7}$ **79.** $-1 + 6i$ **81.** $-14i$

83. $-432\sqrt{2}i$ **85.** i **87.** 81

89. (a) $z_1 = 9 + 16i,\ z_2 = 20 - 10i$
(b) $z = \dfrac{11{,}240}{877} + \dfrac{4630}{877}i$

91. (a) 16 (b) 16 (c) 16 (d) 16

93. False. If the complex number is real, the number equals its conjugate.

95. False.
$i^{44} + i^{150} - i^{74} - i^{109} + i^{61} = 1 - 1 + 1 - i + i = 1$

97. $i, -1, -i, 1, i, -1, -i, 1$; The pattern repeats the first four results. Divide the exponent by 4.
If the remainder is 1, the result is i.
If the remainder is 2, the result is -1.
If the remainder is 3, the result is $-i$.
If the remainder is 0, the result is 1.

99. $\sqrt{-6}\sqrt{-6} = \sqrt{6}i\sqrt{6}i = 6i^2 = -6$ **101.** Proof

Section 2.5 *(page 176)*

1. Fundamental Theorem of Algebra **3.** Rational Zero

5. linear; quadratic; quadratic **7.** Descartes's Rule of Signs

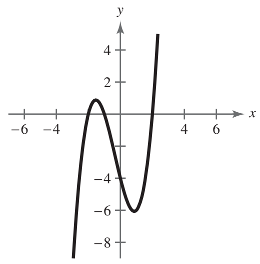
9. 0, 6 **11.** 2, -4 **13.** $-6, \pm i$ **15.** $\pm 1, \pm 2$

17. $\pm 1, \pm 3, \pm 5, \pm 9, \pm 15, \pm 45, \pm\frac{1}{2}, \pm\frac{3}{2}, \pm\frac{5}{2}, \pm\frac{9}{2}, \pm\frac{15}{2}, \pm\frac{45}{2}$

19. 1, 2, 3 **21.** 1, -1, 4 **23.** $-6, -1$ **25.** $\frac{1}{2}, -1$

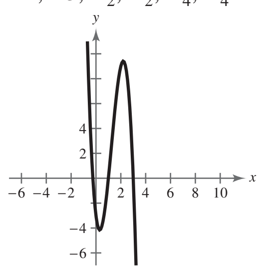
27. $-2, 3, \pm\frac{2}{3}$ **29.** -2, 1 **31.** $-4, \frac{1}{2}, 1, 1$

33. (a) $\pm 1, \pm 2, \pm 4$
(b)



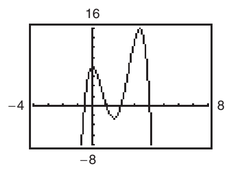
(c) $-2, -1, 2$

35. (a) $\pm 1, \pm 3, \pm\frac{1}{2}, \pm\frac{3}{2}, \pm\frac{1}{4}, \pm\frac{3}{4}$
(b)



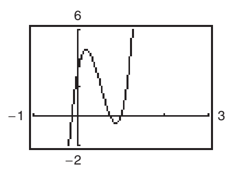
(c) $-\frac{1}{4}, 1, 3$

37. (a) $\pm 1, \pm 2, \pm 4, \pm 8, \pm\frac{1}{2}$
(b)



(c) $-\frac{1}{2}, 1, 2, 4$

39. (a) $\pm 1, \pm 3, \pm\frac{1}{2}, \pm\frac{3}{2}, \pm\frac{1}{4}, \pm\frac{3}{4}, \pm\frac{1}{8}, \pm\frac{3}{8}, \pm\frac{1}{16}, \pm\frac{3}{16}, \pm\frac{1}{32}, \pm\frac{3}{32}$
(b)



(c) $1, \frac{3}{4}, -\frac{1}{8}$

41. (a) ± 1, about ± 1.414 (b) $\pm 1, \pm\sqrt{2}$
(c) $f(x) = (x+1)(x-1)(x+\sqrt{2})(x-\sqrt{2})$

43. (a) 0, 3, 4, about ± 1.414 (b) 0, 3, 4, $\pm\sqrt{2}$
(c) $h(x) = x(x-3)(x-4)(x+\sqrt{2})(x-\sqrt{2})$

45. $x^3 - x^2 + 25x - 25$ **47.** $x^3 - 12x^2 + 46x - 52$

49. $3x^4 - 17x^3 + 25x^2 + 23x - 22$

51. (a) $(x^2 + 9)(x^2 - 3)$ (b) $(x^2 + 9)(x + \sqrt{3})(x - \sqrt{3})$
(c) $(x + 3i)(x - 3i)(x + \sqrt{3})(x - \sqrt{3})$

53. (a) $(x^2 - 2x - 2)(x^2 - 2x + 3)$
(b) $(x - 1 + \sqrt{3})(x - 1 - \sqrt{3})(x^2 - 2x + 3)$
(c) $(x - 1 + \sqrt{3})(x - 1 - \sqrt{3})(x - 1 + \sqrt{2}i)$
$(x - 1 - \sqrt{2}i)$

55. $\pm 2i, 1$ **57.** $\pm 5i, -\frac{1}{2}, 1$ **59.** $-3 \pm i, \frac{1}{4}$

61. $2, -3 \pm \sqrt{2}i, 1$ **63.** $\pm 6i$; $(x + 6i)(x - 6i)$

65. $1 \pm 4i$; $(x - 1 - 4i)(x - 1 + 4i)$

67. $\pm 2, \pm 2i$; $(x - 2)(x + 2)(x - 2i)(x + 2i)$

69. $1 \pm i$; $(z - 1 + i)(z - 1 - i)$

71. $-1, 2 \pm i$; $(x + 1)(x - 2 + i)(x - 2 - i)$

73. $-2, 1 \pm \sqrt{2}i$; $(x + 2)(x - 1 + \sqrt{2}i)(x - 1 - \sqrt{2}i)$

75. $-\frac{1}{5}, 1 \pm \sqrt{5}i$; $(5x + 1)(x - 1 + \sqrt{5}i)(x - 1 - \sqrt{5}i)$

77. $2, \pm 2i$; $(x - 2)^2(x + 2i)(x - 2i)$

79. $\pm i, \pm 3i$; $(x + i)(x - i)(x + 3i)(x - 3i)$

81. $-10, -7 \pm 5i$ **83.** $-\frac{3}{4}, 1 \pm \frac{1}{2}i$ **85.** $-2, -\frac{1}{2}, \pm i$

87. One positive zero **89.** One negative zero

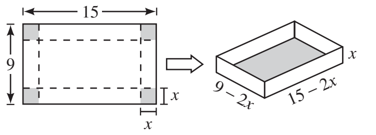
91. One positive zero, one negative zero

93. One or three positive zeros **95–97.** Answers will vary.

99. $1, -\frac{1}{2}$ **101.** $-\frac{3}{4}$ **103.** $\pm 2, \pm\frac{3}{2}$ **105.** $\pm 1, \frac{1}{4}$

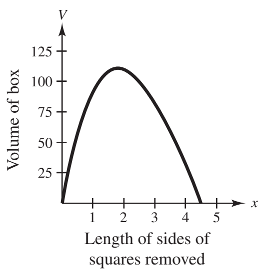
107. d **108.** a **109.** b **110.** c

111. (a)



(b) $V(x) = x(9 - 2x)(15 - 2x)$
Domain: $0 < x < \frac{9}{2}$

(c)



1.82 cm × 5.36 cm × 11.36 cm

(d) $\frac{1}{2}, \frac{7}{2}, 8$; 8 is not in the domain of V.

113. $x \approx 38.4$, or \$384,000

115. (a) $V(x) = x^3 + 9x^2 + 26x + 24 = 120$
(b) 4 ft × 5 ft × 6 ft

117. $x \approx 40$, or 4000 units

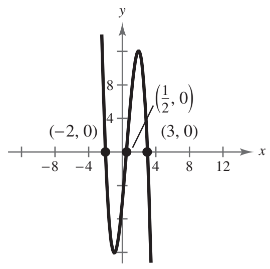
119. No. Setting $p = 9{,}000{,}000$ and solving the resulting equation yields imaginary roots.

121. False. The most complex zeros it can have is two, and the Linear Factorization Theorem guarantees that there are three linear factors, so one zero must be real.

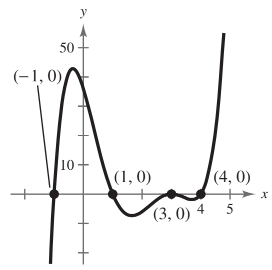
123. r_1, r_2, r_3 **125.** $5 + r_1, 5 + r_2, 5 + r_3$

127. The zeros cannot be determined.

129. Answers will vary. There are infinitely many possible functions for f. Sample equation and graph:
$f(x) = -2x^3 + 3x^2 + 11x - 6$

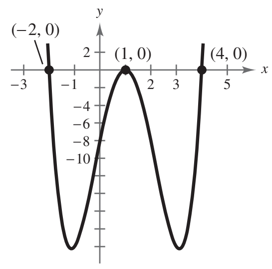


131. Answers will vary. Sample graph:



133. $f(x) = x^4 + 5x^2 + 4$ **135.** $f(x) = x^3 - 3x^2 + 4x - 2$

137. (a) $-2, 1, 4$
(b) The graph touches the x-axis at $x = 1$.
(c) The least possible degree of the function is 4, because there are at least four real zeros (1 is repeated) and a function can have at most the number of real zeros equal to the degree of the function. The degree cannot be odd by the definition of multiplicity.
(d) Positive. From the information in the table, it can be concluded that the graph will eventually rise to the left and rise to the right.
(e) $f(x) = x^4 - 4x^3 - 3x^2 + 14x - 8$
(f)



139. (a) Not correct because f has $(0, 0)$ as an intercept.
(b) Not correct because the function must be at least a fourth-degree polynomial.
(c) Correct function
(d) Not correct because k has $(-1, 0)$ as an intercept.

Section 2.6 *(page 190)*

1. rational functions **3.** horizontal asymptote

5. (a)

x	$f(x)$	x	$f(x)$	x	$f(x)$
0.5	-2	1.5	2	5	0.25
0.9	-10	1.1	10	10	$0.\overline{1}$
0.99	-100	1.01	100	100	$0.\overline{01}$
0.999	-1000	1.001	1000	1000	$0.\overline{001}$

(b) Vertical asymptote: $x = 1$
Horizontal asymptote: $y = 0$
(c) Domain: all real numbers x except $x = 1$

7. (a)

x	$f(x)$	x	$f(x)$	x	$f(x)$
0.5	-1	1.5	5.4	5	3.125
0.9	-12.79	1.1	17.29	10	$3.\overline{03}$
0.99	-147.8	1.01	152.3	100	$3.\overline{0003}$
0.999	-1498	1.001	1502	1000	3

(b) Vertical asymptotes: $x = \pm 1$
Horizontal asymptote: $y = 3$
(c) Domain: all real numbers x except $x = \pm 1$

9. Domain: all real numbers x except $x = 0$
Vertical asymptote: $x = 0$
Horizontal asymptote: $y = 0$

11. Domain: all real numbers x except $x = 5$
Vertical asymptote: $x = 5$
Horizontal asymptote: $y = -1$

13. Domain: all real numbers x except $x = \pm 1$
Vertical asymptotes: $x = \pm 1$

15. Domain: all real numbers x
Horizontal asymptote: $y = 3$

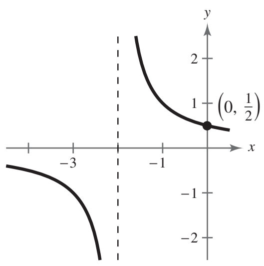
17. d **18.** a **19.** c **20.** b **21.** 3 **23.** 9

25. Domain: all real numbers x except $x = \pm 4$;
Vertical asymptote: $x = -4$; horizontal asymptote: $y = 0$

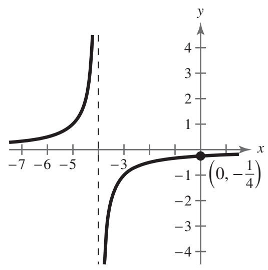
27. Domain: all real numbers x except $x = -1, 5$;
Vertical asymptote: $x = -1$; horizontal asymptote: $y = 1$

29. Domain: all real numbers x except $x = -1, \frac{1}{2}$;
Vertical asymptote: $x = \frac{1}{2}$; horizontal asymptote: $y = \frac{1}{2}$

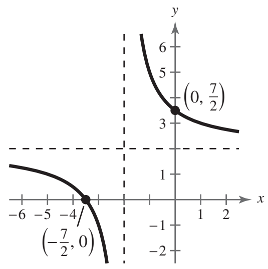
31. (a) Domain: all real numbers x except $x = -2$
(b) y-intercept: $\left(0, \frac{1}{2}\right)$
(c) Vertical asymptote: $x = -2$
Horizontal asymptote: $y = 0$
(d)



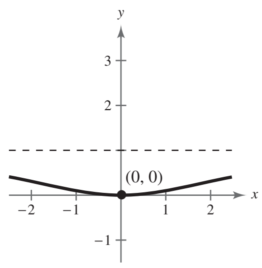
33. (a) Domain: all real numbers x except $x = -4$
(b) y-intercept: $\left(0, -\frac{1}{4}\right)$
(c) Vertical asymptote: $x = -4$
Horizontal asymptote: $y = 0$
(d)



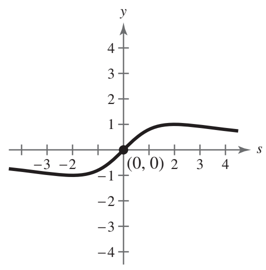
35. (a) Domain: all real numbers x except $x = -2$
(b) x-intercept: $\left(-\frac{7}{2}, 0\right)$
y-intercept: $\left(0, \frac{7}{2}\right)$
(c) Vertical asymptote: $x = -2$
Horizontal asymptote: $y = 2$
(d)



37. (a) Domain: all real numbers x
(b) Intercept: $(0, 0)$
(c) Horizontal asymptote: $y = 1$
(d)

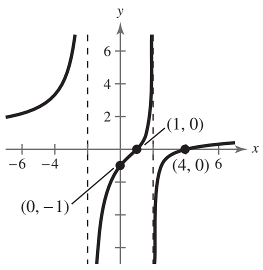


39. (a) Domain: all real numbers s
(b) Intercept: $(0, 0)$ (c) Horizontal asymptote: $y = 0$
(d)

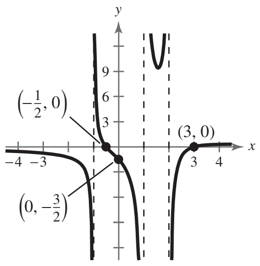


41. (a) Domain: all real numbers x except $x = \pm 2$
(b) x-intercepts: $(1, 0)$ and $(4, 0)$
y-intercept: $(0, -1)$
(c) Vertical asymptotes: $x = \pm 2$
Horizontal asymptote: $y = 1$

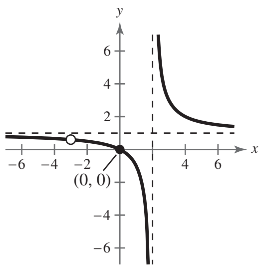
(d)



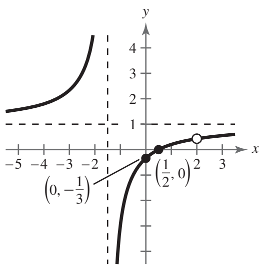
43. (a) Domain: all real numbers x except $x = \pm 1, 2$
(b) x-intercepts: $(3, 0), \left(-\frac{1}{2}, 0\right)$
y-intercept: $\left(0, -\frac{3}{2}\right)$
(c) Vertical asymptotes: $x = 2, x = \pm 1$
Horizontal asymptote: $y = 0$
(d)



45. (a) Domain: all real numbers x except $x = 2, -3$
(b) Intercept: $(0, 0)$
(c) Vertical asymptote: $x = 2$
Horizontal asymptote: $y = 1$
(d)

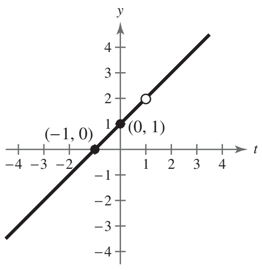


47. (a) Domain: all real numbers x except $x = -\frac{3}{2}, 2$
(b) x-intercept: $\left(\frac{1}{2}, 0\right)$
y-intercept: $\left(0, -\frac{1}{3}\right)$
(c) Vertical asymptote: $x = -\frac{3}{2}$
Horizontal asymptote: $y = 1$
(d)



49. (a) Domain: all real numbers t except $t = 1$
(b) t-intercept: $(-1, 0)$
y-intercept: $(0, 1)$
(c) Vertical asymptote: None
Horizontal asymptote: None

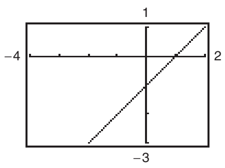
(d)



51. (a) Domain of f: all real numbers x except $x = -1$
Domain of g: all real numbers x
(b) $x - 1$; Vertical asymptotes: None
(c)

x	-3	-2	-1.5	-1	-0.5	0	1
$f(x)$	-4	-3	-2.5	Undef.	-1.5	-1	0
$g(x)$	-4	-3	-2.5	-2	-1.5	-1	0

(d)

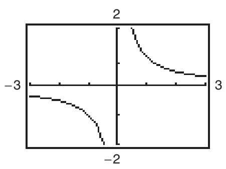


(e) Because there are only a finite number of pixels, the graphing utility may not attempt to evaluate the function where it does not exist.

53. (a) Domain of f: all real numbers x except $x = 0, 2$
Domain of g: all real numbers x except $x = 0$
(b) $\frac{1}{x}$; Vertical asymptote: $x = 0$
(c)

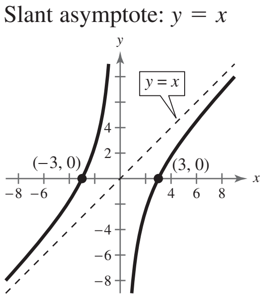
x	-0.5	0	0.5	1	1.5	2	3
$f(x)$	-2	Undef.	2	1	$\frac{2}{3}$	Undef.	$\frac{1}{3}$
$g(x)$	-2	Undef.	2	1	$\frac{2}{3}$	$\frac{1}{2}$	$\frac{1}{3}$

(d)

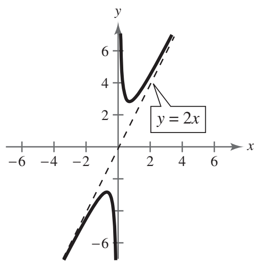


(e) Because there are only a finite number of pixels, the graphing utility may not attempt to evaluate the function where it does not exist.

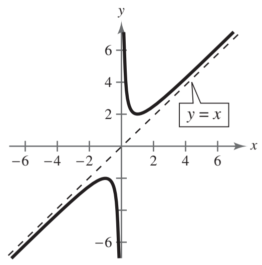
55. (a) Domain: all real numbers x except $x = 0$
(b) x-intercepts: $(-3, 0), (3, 0)$
(c) Vertical asymptote: $x = 0$
Slant asymptote: $y = x$
(d)



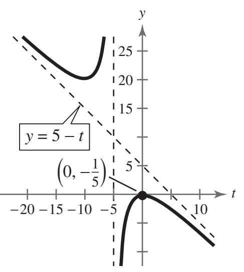
57. (a) Domain: all real numbers x except $x = 0$
(b) No intercepts
(c) Vertical asymptote: $x = 0$
Slant asymptote: $y = 2x$
(d)



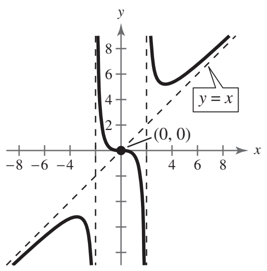
59. (a) Domain: all real numbers x except $x = 0$
(b) No intercepts
(c) Vertical asymptote: $x = 0$
Slant asymptote: $y = x$
(d)



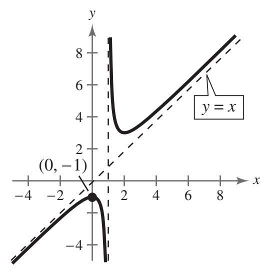
61. (a) Domain: all real numbers t except $t = -5$
(b) y-intercept: $\left(0, -\frac{1}{5}\right)$
(c) Vertical asymptote: $t = -5$
Slant asymptote: $y = -t + 5$
(d)



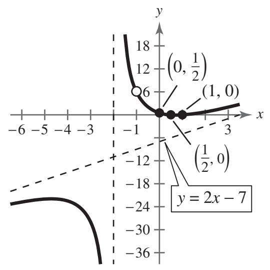
63. (a) Domain: all real numbers x except $x = \pm 2$
(b) Intercept: $(0, 0)$
(c) Vertical asymptotes: $x = \pm 2$
Slant asymptote: $y = x$
(d)



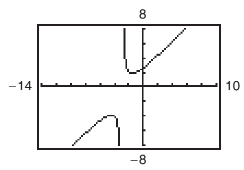
65. (a) Domain: all real numbers x except $x = 1$
(b) y-intercept: $(0, -1)$
(c) Vertical asymptote: $x = 1$
Slant asymptote: $y = x$
(d)



67. (a) Domain: all real numbers x except $x = -1, -2$
(b) y-intercept: $\left(0, \frac{1}{2}\right)$
x-intercepts: $\left(\frac{1}{2}, 0\right), (1, 0)$
(c) Vertical asymptote: $x = -2$
Slant asymptote: $y = 2x - 7$
(d)

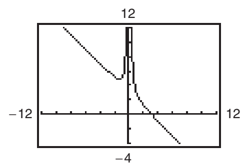


69.



Domain: all real numbers x except $x = -3$
Vertical asymptote: $x = -3$
Slant asymptote: $y = x + 2$
$y = x + 2$

71.

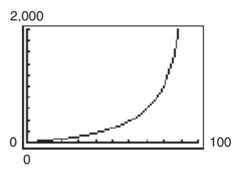


Domain: all real numbers x except $x = 0$
Vertical asymptote: $x = 0$
Slant asymptote: $y = -x + 3$
$y = -x + 3$

73. (a) $(-1, 0)$ (b) -1

75. (a) $(1, 0), (-1, 0)$ (b) ± 1

77. (a)

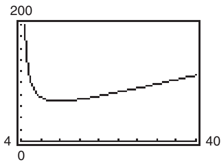


(b) $28.33 million; $170 million; $765 million
(c) No. The function is undefined at $p = 100$.

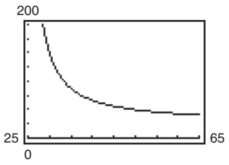
79. (a) 333 deer, 500 deer, 800 deer (b) 1500 deer

81. (a) $A = \dfrac{2x(x + 11)}{x - 4}$ (b) $(4, \infty)$

CHAPTER 2

(c) 

11.75 in. × 5.87 in.

83. (a) Answers will vary.
(b) Vertical asymptote: $x = 25$
Horizontal asymptote: $y = 25$
(c) 

(d)

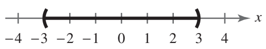
x	30	35	40	45	50	55	60
y	150	87.5	66.7	56.3	50	45.8	42.9

(e) Sample answer: No. You might expect the average speed for the round trip to be the average of the average speeds for the two parts of the trip.
(f) No. At 20 miles per hour you would use more time in one direction than is required for the round trip at an average speed of 50 miles per hour.

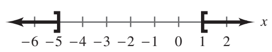
85. False. Polynomials do not have vertical asymptotes.
87. False. If the degree of the numerator is greater than the degree of the denominator, no horizontal asymptote exists. However, a slant asymptote exists only if the degree of the numerator is one greater than the degree of the denominator.
89. c

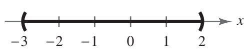
Section 2.7 *(page 201)*

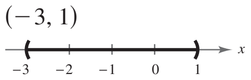
1. positive; negative **3.** zeros; undefined values
5. (a) No (b) Yes (c) Yes (d) No
7. (a) Yes (b) No (c) No (d) Yes
9. $-\frac{2}{3}, 1$ **11.** 4, 5

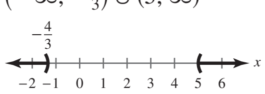
13. $(-3, 3)$


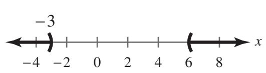
15. $[-7, 3]$

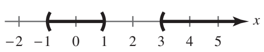

17. $(-\infty, -5] \cup [1, \infty)$


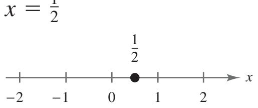
19. $(-3, 2)$


21. $(-3, 1)$


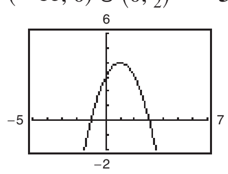
23. $\left(-\infty, -\frac{4}{3}\right) \cup (5, \infty)$


25. $(-\infty, -3) \cup (6, \infty)$


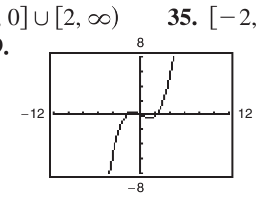
27. $(-1, 1) \cup (3, \infty)$


29. $x = \frac{1}{2}$


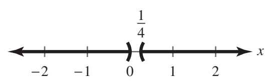
31. $(-\infty, 0) \cup \left(0, \frac{3}{2}\right)$ **33.** $[-2, 0] \cup [2, \infty)$ **35.** $[-2, \infty)$

37. 

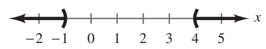
(a) $x \le -1,\ x \ge 3$
(b) $0 \le x \le 2$

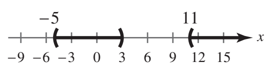
39. 

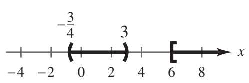
(a) $-2 \le x \le 0,$
$2 \le x < \infty$
(b) $x \le 4$

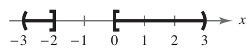
41. $(-\infty, 0) \cup \left(\frac{1}{4}, \infty\right)$


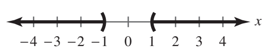
43. $\left(-\infty, \frac{5}{3}\right] \cup (5, \infty)$

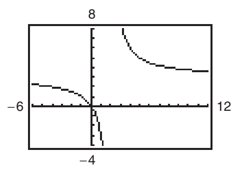

45. $(-\infty, -1) \cup (4, \infty)$


47. $(-5, 3) \cup (11, \infty)$


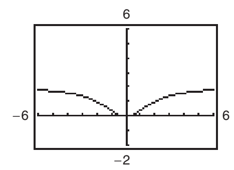
49. $\left(-\frac{3}{4}, 3\right) \cup [6, \infty)$


51. $(-3, -2] \cup [0, 3)$


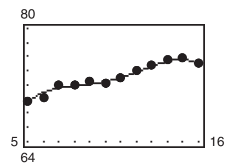
53. $(-\infty, -1) \cup (1, \infty)$


55. 

(a) $0 \le x < 2$
(b) $2 < x \le 4$

57. 

(a) $|x| \ge 2$
(b) $-\infty < x < \infty$

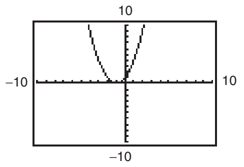
59. $[-2, 2]$ **61.** $(-\infty, 4] \cup [5, \infty)$
63. $(-5, 0] \cup (7, \infty)$ **65.** $(-3.51, 3.51)$
67. $(-0.13, 25.13)$ **69.** $(2.26, 2.39)$
71. (a) $t = 10$ sec (b) 4 sec $< t <$ 6 sec
73. 13.8 m $\le L \le$ 36.2 m
75. $40{,}000 \le x \le 50{,}000$; \$50.00 $\le p \le$ \$55.00
77. (a) and (c) 

The model fits the data well.
(b) $N = -0.00412t^4 + 0.1705t^3 - 2.538t^2 + 16.55t + 31.5$
(d) 2003 to 2006
(e) No; The model decreases sharply after 2006.

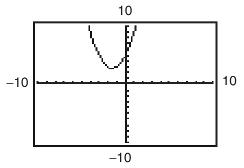
79. $R_1 \ge 2$ ohms
81. True. The test intervals are $(-\infty, -3)$, $(-3, 1)$, $(1, 4)$, and $(4, \infty)$.
83. (a) $(-\infty, -4] \cup [4, \infty)$
(b) If $a > 0$ and $c > 0$, $b \le -2\sqrt{ac}$ or $b \ge 2\sqrt{ac}$.

85. (a) $\left(-\infty, -2\sqrt{30}\right] \cup \left[2\sqrt{30}, \infty\right)$
(b) If $a > 0$ and $c > 0$, $b \le -2\sqrt{ac}$ or $b \ge 2\sqrt{ac}$.

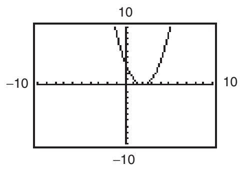
87.



For part (b), the y-values that are less than or equal to 0 occur only at $x = -1$.



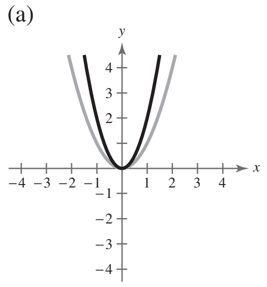
For part (c), there are no y-values that are less than 0.



For part (d), the y-values that are greater than 0 occur for all values of x except 2.

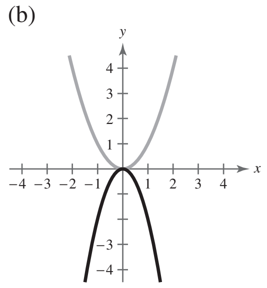
Review Exercises *(page 206)*

1. (a)



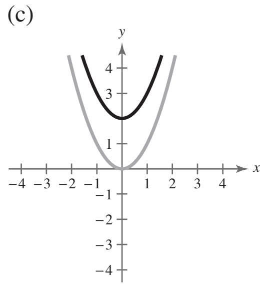
Vertical stretch

(b)



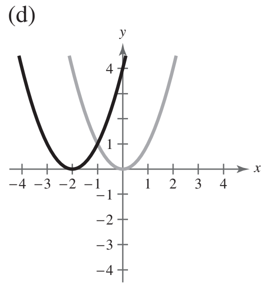
Vertical stretch and reflection in the x-axis

(c)



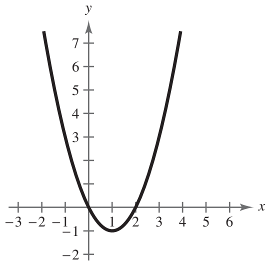
Vertical shift two units upward

(d)



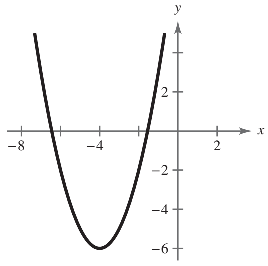
Horizontal shift two units to the left

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



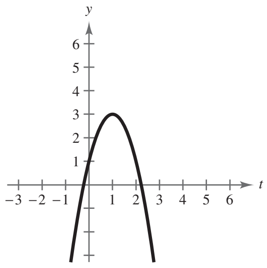
Vertex: $(1, -1)$
Axis of symmetry: $x = 1$
x-intercepts: $(0, 0), (2, 0)$

5. $f(x) = (x + 4)^2 - 6$



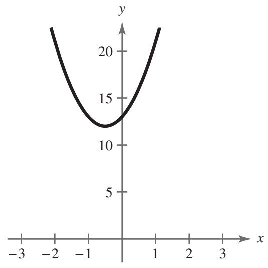
Vertex: $(-4, -6)$
Axis of symmetry: $x = -4$
x-intercepts: $\left(-4 \pm \sqrt{6}, 0\right)$

7. $f(t) = -2(t - 1)^2 + 3$



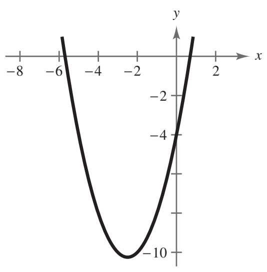
Vertex: $(1, 3)$
Axis of symmetry: $t = 1$
t-intercepts: $\left(1 \pm \dfrac{\sqrt{6}}{2}, 0\right)$

9. $h(x) = 4\left(x + \frac{1}{2}\right)^2 + 12$



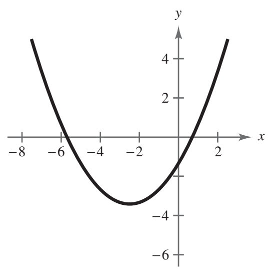
Vertex: $\left(-\frac{1}{2}, 12\right)$
Axis of symmetry: $x = -\frac{1}{2}$
No x-intercept

11. $h(x) = \left(x + \frac{5}{2}\right)^2 - \frac{41}{4}$



Vertex: $\left(-\frac{5}{2}, -\frac{41}{4}\right)$
Axis of symmetry: $x = -\frac{5}{2}$
x-intercepts: $\left(\dfrac{\pm\sqrt{41} - 5}{2}, 0\right)$

13. $f(x) = \frac{1}{3}\left(x + \frac{5}{2}\right)^2 - \frac{41}{12}$



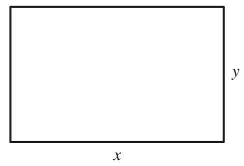
Vertex: $\left(-\frac{5}{2}, -\frac{41}{12}\right)$
Axis of symmetry: $x = -\frac{5}{2}$
x-intercepts: $\left(\dfrac{\pm\sqrt{41} - 5}{2}, 0\right)$

15. $f(x) = -\frac{1}{2}(x - 4)^2 + 1$

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

19. $y = -\frac{11}{36}\left(x + \frac{3}{2}\right)^2$

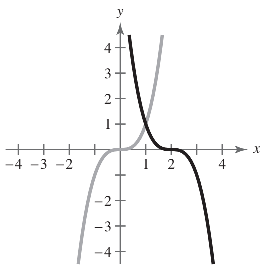
21. (a)



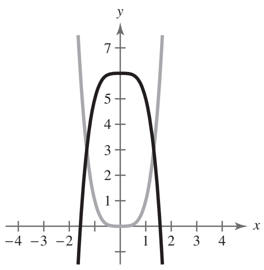
(b) $y = 500 - x$
$A(x) = 500x - x^2$
(c) $x = 250$, $y = 250$

23. 1091 units

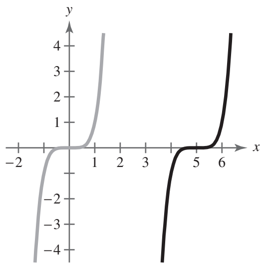
25.



27.



29.



31. Falls to the left, falls to the right

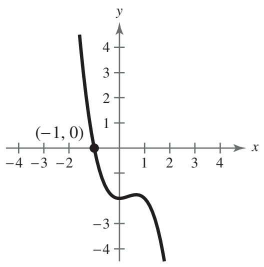
33. Rises to the left, rises to the right

35. $-8, \frac{4}{3}$, odd multiplicity; turning points: 1

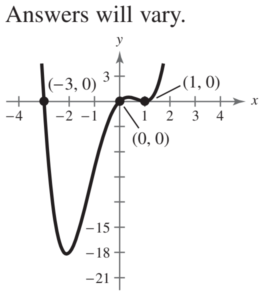
37. $0, \pm\sqrt{3}$, odd multiplicity; turning points: 2

39. 0, even multiplicity; $\frac{2}{3}$, odd multiplicity; turning points: 2

41. (a) Rises to the left, falls to the right (b) -1
(c) Answers will vary.
(d)



43. (a) Rises to the left, rises to the right (b) $-3, 0, 1$
(c) Answers will vary.
(d)



45. (a) $[-1, 0]$ (b) About -0.900

47. (a) $[-1, 0], [1, 2]$ (b) About -0.200, about 1.772

49. $6x + 3 + \dfrac{17}{5x - 3}$ **51.** $5x + 4, \quad x \neq \dfrac{5}{2} \pm \dfrac{\sqrt{29}}{2}$

53. $x^2 - 3x + 2 - \dfrac{1}{x^2 + 2}$

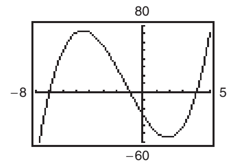
55. $6x^3 + 8x^2 - 11x - 4 - \dfrac{8}{x - 2}$

57. $2x^2 - 9x - 6, \quad x \neq 8$

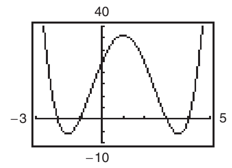
59. (a) Yes (b) Yes (c) Yes (d) No

61. (a) -421 (b) -9

63. (a) Answers will vary.
(b) $(x + 7), (x + 1)$
(c) $f(x) = (x + 7)(x + 1)(x - 4)$
(d) $-7, -1, 4$
(e)



65. (a) Answers will vary. (b) $(x + 1), (x - 4)$
(c) $f(x) = (x + 1)(x - 4)(x + 2)(x - 3)$
(d) $-2, -1, 3, 4$
(e)



67. $8 + 10i$ **69.** $-1 + 3i$ **71.** $3 + 7i$

73. $63 + 77i$ **75.** $-4 - 46i$ **77.** $39 - 80i$

79. $\dfrac{23}{17} + \dfrac{10}{17}i$ **81.** $\dfrac{21}{13} - \dfrac{1}{13}i$ **83.** $\pm\dfrac{\sqrt{10}}{5}i$ **85.** $1 \pm 3i$

87. 0, 3 **89.** 2, 9 **91.** $-4, 6, \pm 2i$

93. $\pm 1, \pm 3, \pm 5, \pm 15, \pm\frac{1}{2}, \pm\frac{3}{2}, \pm\frac{5}{2}, \pm\frac{15}{2}, \pm\frac{1}{4}, \pm\frac{3}{4}, \pm\frac{5}{4}, \pm\frac{15}{4}$

95. $-6, -2, 5$ **97.** 1, 8 **99.** $-4, 3$

101. $f(x) = 3x^4 - 14x^3 + 17x^2 - 42x + 24$

103. $4, \pm i$ **105.** $-3, \frac{1}{2}, 2 \pm i$

107. $0, 1, -5; f(x) = x(x - 1)(x + 5)$

109. $-4, 2 \pm 3i; g(x) = (x + 4)^2(x - 2 - 3i)(x - 2 + 3i)$

111. Two or no positive zeros, one negative zero

113. Answers will vary.

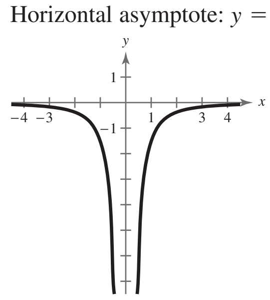
115. Domain: all real numbers x except $x = -10$

117. Domain: all real numbers x except $x = 6, 4$

119. Vertical asymptote: $x = -3$
Horizontal asymptote: $y = 0$

121. Vertical asymptote: $x = 6$
Horizontal asymptote: $y = 0$

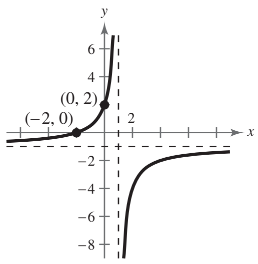
123. (a) Domain: all real numbers x except $x = 0$
(b) No intercepts
(c) Vertical asymptote: $x = 0$
Horizontal asymptote: $y = 0$
(d)



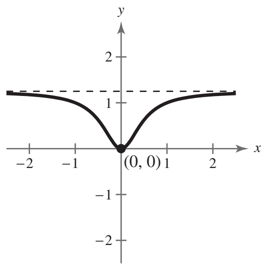
125. (a) Domain: all real numbers x except $x = 1$
(b) x-intercept: $(-2, 0)$
y-intercept: $(0, 2)$

(c) Vertical asymptote: $x = 1$
Horizontal asymptote: $y = -1$

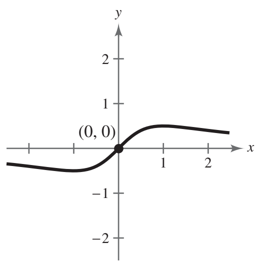
(d)



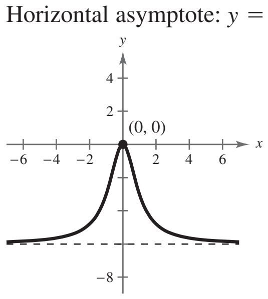
127. (a) Domain: all real numbers x
(b) Intercept: $(0, 0)$
(c) Horizontal asymptote: $y = \frac{5}{4}$
(d)



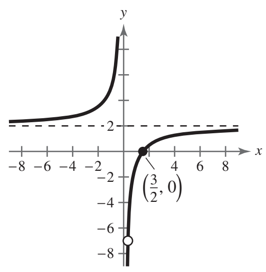
129. (a) Domain: all real numbers x
(b) Intercept: $(0, 0)$
(c) Horizontal asymptote: $y = 0$
(d)



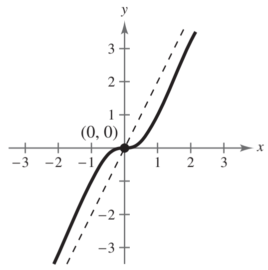
131. (a) Domain: all real numbers x
(b) Intercept: $(0, 0)$
(c) Horizontal asymptote: $y = -6$
(d)



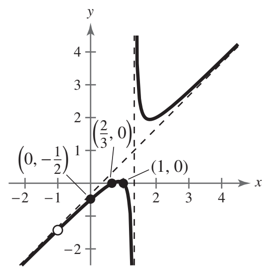
133. (a) Domain: all real numbers x except $x = 0, \frac{1}{3}$
(b) x-intercept: $\left(\frac{3}{2}, 0\right)$
(c) Vertical asymptote: $x = 0$
Horizontal asymptote: $y = 2$
(d)



135. (a) Domain: all real numbers x
(b) Intercept: $(0, 0)$ (c) Slant asymptote: $y = 2x$
(d)

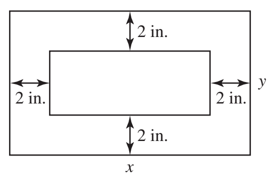


137. (a) Domain: all real numbers x except $x = \frac{4}{3}, -1$
(b) y-intercept: $\left(0, -\frac{1}{2}\right)$
x-intercepts: $\left(\frac{2}{3}, 0\right), (1, 0)$
(c) Vertical asymptote: $x = \frac{4}{3}$
Slant asymptote: $y = x - \frac{1}{3}$
(d)



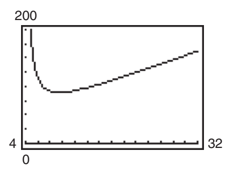
139. $\overline{C} = 0.5 = \$0.50$

141. (a)



(b) $A = \dfrac{2x(2x + 7)}{x - 4}$ (c) $4 < x < \infty$

(d)



9.48 in. × 9.48 in.

143. $\left(-\frac{2}{3}, \frac{1}{4}\right)$ **145.** $[-4, 0] \cup [4, \infty)$
147. $[-5, -1) \cup (1, \infty)$ **149.** $(-\infty, 0) \cup [4, 5]$
151. 4.9%
153. False. A fourth-degree polynomial can have at most four zeros, and complex zeros occur in conjugate pairs.

155. Find the vertex of the quadratic function and write the function in standard form. If the leading coefficient is positive, the vertex is a minimum. If the leading coefficient is negative, the vertex is a maximum.

157. An asymptote of a graph is a line to which the graph becomes arbitrarily close as x increases or decreases without bound.

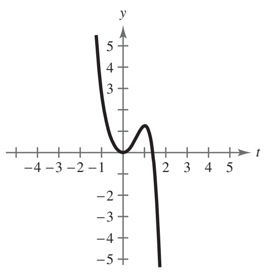
Chapter Test *(page 210)*

1. (a) Reflection in the x-axis followed by a vertical shift two units upward
(b) Horizontal shift $\frac{3}{2}$ units to the right

2. $y = (x - 3)^2 - 6$

3. (a) 50 ft
(b) 5. Yes, changing the constant term results in a vertical translation of the graph and therefore changes the maximum height.

4. Rises to the left, falls to the right



5. $3x + \dfrac{x - 1}{x^2 + 1}$ **6.** $2x^3 + 4x^2 + 3x + 6 + \dfrac{9}{x - 2}$

7. $(2x - 5)(x + \sqrt{3})(x - \sqrt{3})$;
Zeros: $\frac{5}{2}, \pm\sqrt{3}$

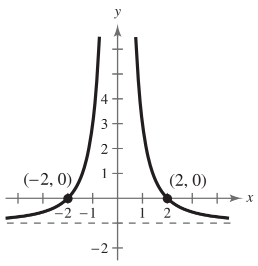
8. (a) $-3 + 5i$ (b) 7 **9.** $2 - i$

10. $f(x) = x^4 - 7x^3 + 17x^2 - 15x$

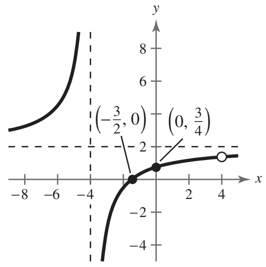
11. $f(x) = 4x^2 - 16x + 16$

12. $-5, -\frac{2}{3}, 1$ **13.** $-2, 4, -1 \pm \sqrt{2}i$

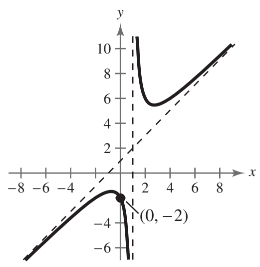
14. x-intercepts: $(-2, 0), (2, 0)$
Vertical asymptote: $x = 0$
Horizontal asymptote: $y = -1$



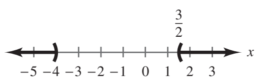
15. x-intercept: $\left(-\frac{3}{2}, 0\right)$
y-intercept: $\left(0, \frac{3}{4}\right)$
Vertical asymptote: $x = -4$
Horizontal asymptote: $y = 2$



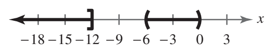
16. y-intercept: $(0, -2)$
Vertical asymptote: $x = 1$
Slant asymptote: $y = x + 1$



17. $x < -4$ or $x > \frac{3}{2}$



18. $x \le -12$ or $-6 < x < 0$



Problem Solving *(page 213)*

1. Answers will vary. **3.** 2 in. × 2 in. × 5 in.

5. (a) and (b) $y = -x^2 + 5x - 4$

7. (a) $f(x) = (x - 2)x^2 + 5 = x^3 - 2x^2 + 5$
(b) $f(x) = -(x + 3)x^2 + 1 = -x^3 - 3x^2 + 1$

9. $(a + bi)(a - bi) = a^2 + abi - abi - b^2i^2$
$= a^2 + b^2$

11. (a) As $|a|$ increases, the graph stretches vertically. For $a < 0$, the graph is reflected in the x-axis.
(b) As $|b|$ increases, the vertical asymptote is translated. For $b > 0$, the graph is translated to the right. For $b < 0$, the graph is reflected in the x-axis and is translated to the left.

Chapter 3

Section 3.1 *(page 224)*

1. algebraic **3.** One-to-One **5.** $A = P\left(1 + \dfrac{r}{n}\right)^{nt}$

7. 0.863 **9.** 0.006 **11.** 1767.767

13. d **14.** c **15.** a **16.** b