

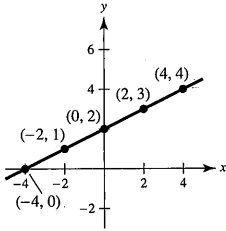
Answers to Odd-Numbered Exercises

Chapter P

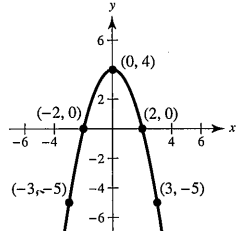
Section P.1 (page 8)

1. b 2. d 3. a 4. c

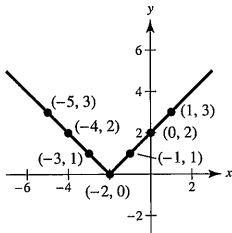
5.



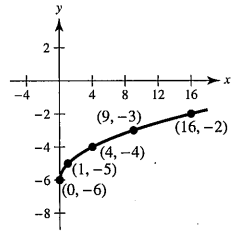
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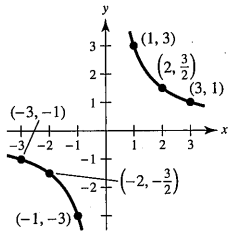
9.



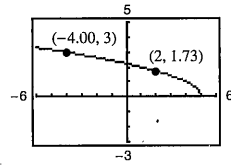
11.



13.



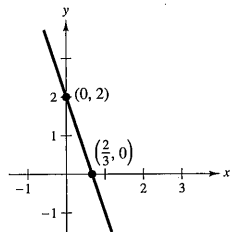
15.



(a) $y \approx 1.73$ (b) $x = -4$

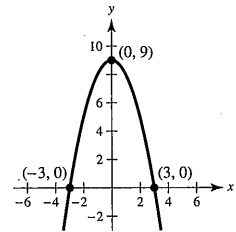
17. $(0, -5)$, $(\frac{5}{2}, 0)$ 19. $(0, -2)$, $(-2, 0)$, $(1, 0)$
 21. $(0, 0)$, $(4, 0)$, $(-4, 0)$ 23. $(0, 2)$, $(4, 0)$ 25. $(0, 0)$
 27. Symmetric with respect to the y-axis
 29. Symmetric with respect to the x-axis
 31. Symmetric with respect to the origin 33. No symmetry
 35. Symmetric with respect to the origin
 37. Symmetric with respect to the y-axis

39.



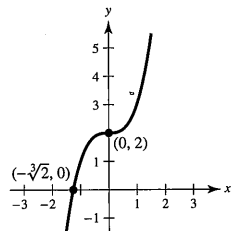
Symmetry: none

41.



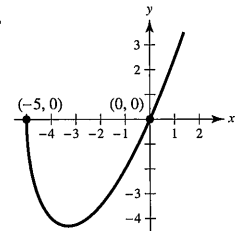
Symmetry: y-axis

43.



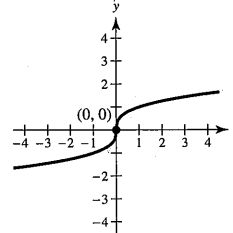
Symmetry: none

45.



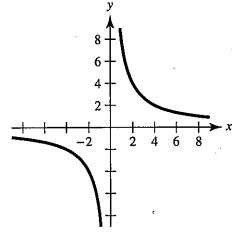
Symmetry: none

47.



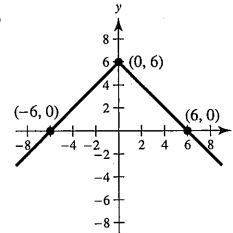
Symmetry: origin

49.



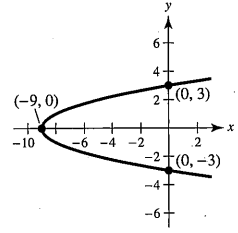
Symmetry: origin

51.



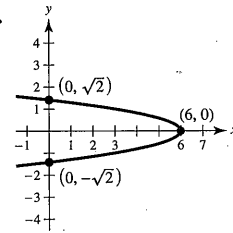
Symmetry: y-axis

53.



Symmetry: x-axis

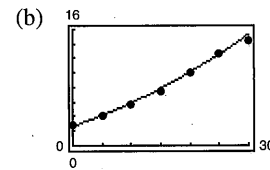
55.



Symmetry: x-axis

57. $(3, 5)$

59. $(-1, 5)$, $(2, 2)$ 61. $(-1, -2)$, $(2, 1)$
 63. $(-1, -5)$, $(0, -1)$, $(2, 1)$ 65. $(-2, 2)$, $(-3, \sqrt{3})$
 67. (a) $y = 0.005t^2 + 0.27t + 2.7$

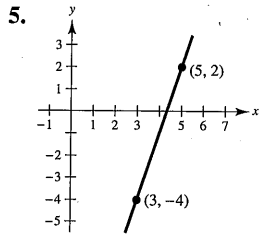


The model is a good fit for the data.

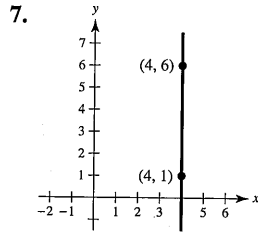
- (c) \$21.5 trillion
 69. 4480 units
 71. (a) $k = 4$ (b) $k = -\frac{1}{8}$
 (c) All real numbers k (d) $k = 1$
 73. Answers will vary. Sample answer: $y = (x + 4)(x - 3)(x - 8)$
 75. (a) Proof (b) Proof
 77. False. $(4, -5)$ is not a point on the graph of $x = y^2 - 29$.
 79. True

Section P.2 (page 16)

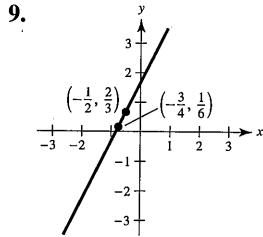
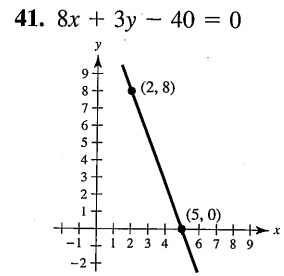
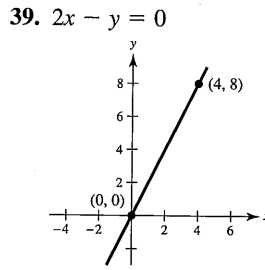
1. $m = 2$ 3. $m = -1$



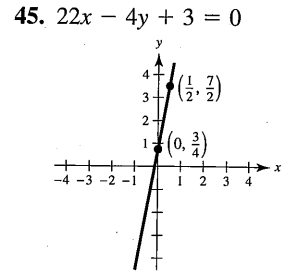
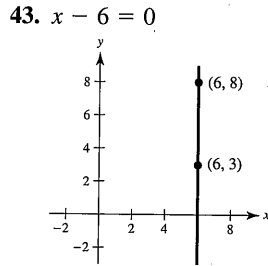
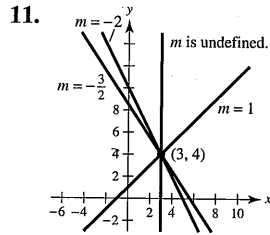
$m = 3$



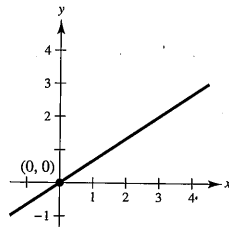
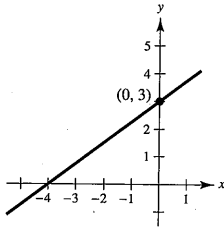
m is undefined.



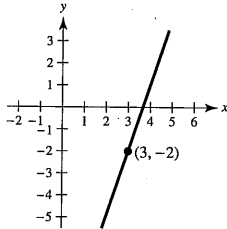
$m = 2$



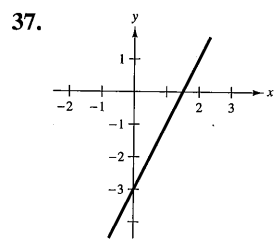
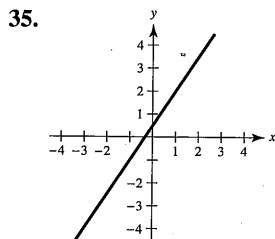
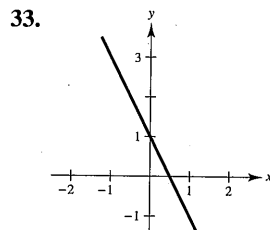
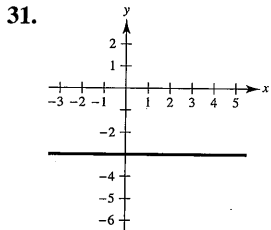
13. Answers will vary. Sample answers: (0, 2), (1, 2), (5, 2)
 15. Answers will vary. Sample answers: (0, 10), (2, 4), (3, 1)
 17. $3x - 4y + 12 = 0$ 19. $2x - 3y = 0$



21. $3x - y - 11 = 0$ 23. (a) $\frac{1}{3}$ (b) $10\sqrt{10}$ ft



25. $m = 4$, (0, -3) 27. $m = -\frac{1}{5}$, (0, 4)
 29. m is undefined, no y -intercept



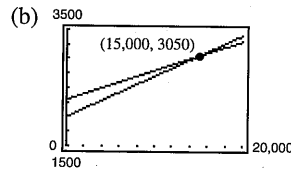
47. $x - 3 = 0$ 49. $3x + 2y - 6 = 0$ 51. $x + y - 3 = 0$
 53. $x + 2y - 5 = 0$ 55. (a) $x + 7 = 0$ (b) $y + 2 = 0$
 57. (a) $x - y + 3 = 0$ (b) $x + y - 7 = 0$
 59. (a) $2x - y - 3 = 0$ (b) $x + 2y - 4 = 0$
 61. (a) $40x - 24y - 9 = 0$ (b) $24x + 40y - 53 = 0$
 63. $V = 250t + 1350$ 65. $V = -1600t + 20,400$
 67. Not collinear, because $m_1 \neq m_2$
 69. $(0, \frac{-a^2 + b^2 + c^2}{2c})$ 71. $(b, \frac{a^2 - b^2}{c})$

73. (a) The line is parallel to the x -axis when $a = 0$ and $b \neq 0$.
 (b) The line is parallel to the y -axis when $b = 0$ and $a \neq 0$.
 (c) Answers will vary. Sample answer: $a = -5$ and $b = 8$
 (d) Answers will vary. Sample answer: $a = 5$ and $b = 2$
 (e) $a = \frac{5}{2}$ and $b = 3$

75. $5F - 9C - 160 = 0$; $72^\circ\text{F} \approx 22.2^\circ\text{C}$

77. (a) Current job: $W = 2000 + 0.07s$

Job offer: $W = 2300 + 0.05s$



You will make more money at the job offer until you sell \$15,000. When your sales exceed \$15,000, your current job will pay you more.

- (c) No, because you will make more money at your current job.

79. (a) $x = (1530 - p)/15$

- (b) (c) 49 units

45 units

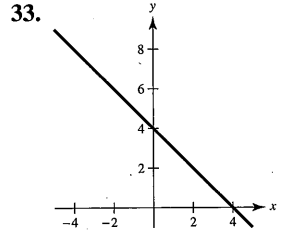
81. $12y + 5x - 169 = 0$ 83. $(5\sqrt{2})/2$ 85. $2\sqrt{2}$

87-91. Proofs 93. True 95. True

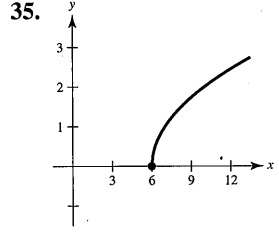
Section P3 (page 27)

1. (a) -4 (b) -25 (c) $7b - 4$ (d) $7x - 11$
 3. (a) 5 (b) 0 (c) 1 (d) $4 + 2t - t^2$
 5. (a) 1 (b) 0 (c) $-\frac{1}{2}$ (d) 1
 7. $3x^2 + 3x \Delta x + (\Delta x)^2, \Delta x \neq 0$
 9. $(\sqrt{x-1} - x + 1)/[(x-2)(x-1)]$
 11. Domain: $(-\infty, \infty)$; Range: $[0, \infty)$
 13. Domain: $(-\infty, \infty)$; Range: $(-\infty, \infty)$
 15. Domain: $[0, \infty)$; Range: $[0, \infty)$
 17. Domain: $[-4, 4]$; Range: $[0, 4]$
 19. Domain: All real numbers t such that $t \neq 4n + 2$, where n is an integer; Range: $(-\infty, -1] \cup [1, \infty)$
 21. Domain: $(-\infty, 0) \cup (0, \infty)$; Range: $(-\infty, 0) \cup (0, \infty)$
 23. Domain: $[0, 1]$
 25. Domain: All real numbers x such that $x \neq 2n\pi$, where n is an integer

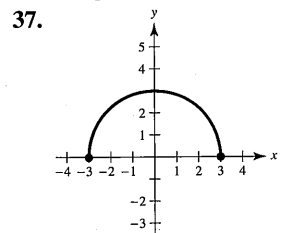
27. Domain: $(-\infty, -3) \cup (-3, \infty)$
 29. (a) -1 (b) 2 (c) 6 (d) $2t^2 + 4$
 Domain: $(-\infty, \infty)$; Range: $(-\infty, 1) \cup [2, \infty)$
 31. (a) 4 (b) 0 (c) -2 (d) $-b^2$
 Domain: $(-\infty, \infty)$; Range: $(-\infty, 0] \cup [1, \infty)$



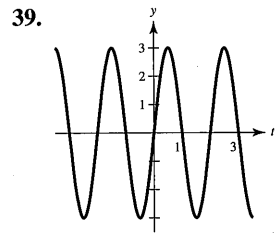
Domain: $(-\infty, \infty)$
 Range: $(-\infty, \infty)$



Domain: $[6, \infty)$
 Range: $[0, \infty)$

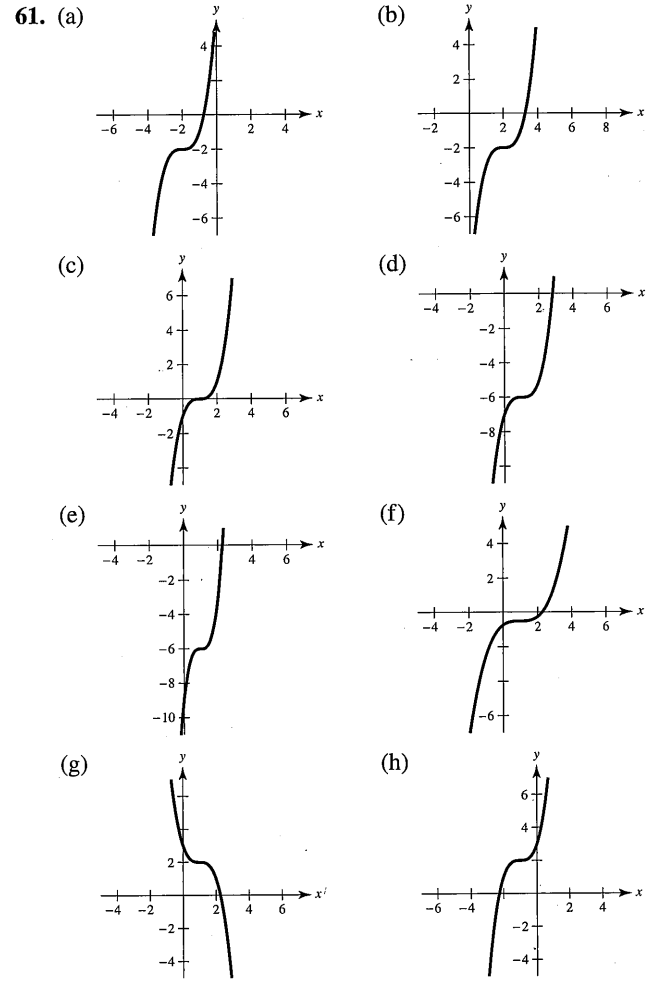


Domain: $[-3, 3]$
 Range: $[0, 3]$



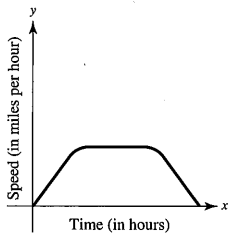
Domain: $(-\infty, \infty)$
 Range: $[-3, 3]$

41. The student travels $\frac{1}{2}$ mile/minute during the first 4 minutes, is stationary for the next 2 minutes, and travels 1 mile/minute during the final 4 minutes.
 43. y is not a function of x . 45. y is a function of x .
 47. y is not a function of x . 49. y is not a function of x .
 51. Horizontal shift to the right two units
 $y = \sqrt{x-2}$
 53. Horizontal shift to the right two units and vertical shift down one unit
 $y = (x-2)^2 - 1$
 55. d 56. b 57. c 58. a 59. e 60. g

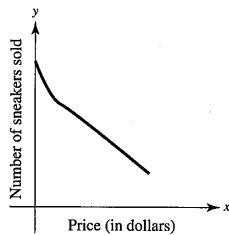


63. (a) $3x$ (b) $3x - 8$ (c) $12x - 16$ (d) $\frac{3}{4}x - 1$
 65. (a) 0 (b) 0 (c) -1 (d) $\sqrt{15}$
 (e) $\sqrt{x^2 - 1}$ (f) $x - 1 (x \geq 0)$
 67. $(f \circ g)(x) = x$; Domain: $[0, \infty)$
 $(g \circ f)(x) = |x|$; Domain: $(-\infty, \infty)$
 No, their domains are different.
 69. $(f \circ g)(x) = 3/(x^2 - 1)$;
 Domain: $(-\infty, -1) \cup (-1, 1) \cup (1, \infty)$
 $(g \circ f)(x) = (9/x^2) - 1$; Domain: $(-\infty, 0) \cup (0, \infty)$
 No
 71. (a) 4 (b) -2
 (c) Undefined. The graph of g does not exist at $x = -5$.
 (d) 3 (e) 2
 (f) Undefined. The graph of f does not exist at $x = -4$.
 73. Answers will vary.
 Sample answer: $f(x) = \sqrt{x}$; $g(x) = x - 2$; $h(x) = 2x$
 75. (a) $(\frac{3}{2}, 4)$ (b) $(\frac{3}{2}, -4)$
 77. f is even. g is neither even nor odd. h is odd.
 79. Even; zeros: $x = -2, 0, 2$
 81. Odd; zeros: $x = 0, \frac{\pi}{2} + n\pi$, where n is an integer
 83. $f(x) = -5x - 6, -2 \leq x \leq 0$ 85. $y = -\sqrt{-x}$

87. Answers will vary.
Sample answer:



89. Answers will vary.
Sample answer:



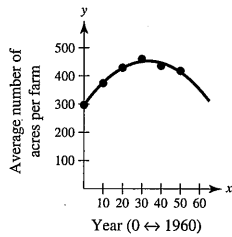
91. $c = 25$

93. (a) $T(4) = 16^\circ\text{C}$, $T(15) \approx 23^\circ\text{C}$

(b) The changes in temperature occur 1 hour later.

(c) The temperatures are 1° lower.

95. (a)



(b) $A(25) \approx 443$ acres/farm

97. $f(x) = |x| + |x - 2| = \begin{cases} 2x - 2, & x \geq 2 \\ 2, & 0 < x < 2 \\ -2x + 2, & x \leq 0 \end{cases}$

99–101. Proofs 103. $L = \sqrt{x^2 + \left(\frac{2x}{x-3}\right)^2}$

105. False. For example, if $f(x) = x^2$, then $f(-1) = f(1)$.

107. True

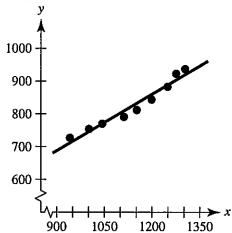
109. False. $f(x) = 0$ is symmetric with respect to the x -axis.

111. Putnam Problem A1, 1988

Section P.4 (page 34)

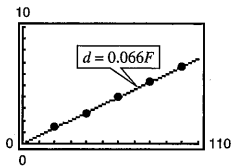
1. (a) and (b)

(c) \$790



3. (a) $d = 0.066F$

(b)

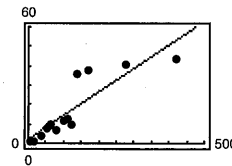


The model fits well.

(c) 3.63 cm

5. (a) $y = 0.122x + 2.07$, $r \approx 0.87$

(b)

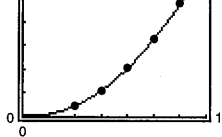


(c) Greater per capita energy consumption by a country tends to correspond to greater per capita gross national product of the country. The three countries that differ most from the linear model are Canada, Italy, and Japan.

(d) $y = 0.142x - 1.66$, $r \approx 0.97$

7. (a) $S = 180.89x^2 - 205.79x + 272$

(b)



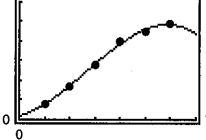
(c) When $x = 2$, $S \approx 583.98$ pounds.

(d) About 4 times greater

(e) About 4.37 times greater; No; Answers will vary.

9. (a) $y = -1.806x^3 + 14.58x^2 + 16.4x + 10$

(b)



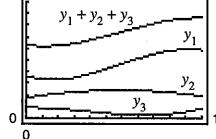
(c) 214 hp

11. (a) $y_1 = -0.0172t^3 + 0.305t^2 - 0.87t + 7.3$

$y_2 = -0.038t^2 + 0.45t + 3.5$

$y_3 = 0.0063t^3 - 0.072t^2 + 0.02t + 1.8$

(b)



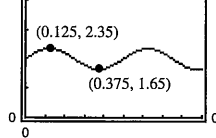
About 15.31 cents/mi

13. (a) Yes. At time t , there is one and only one displacement y .

(b) Amplitude: 0.35; Period: 0.5

(c) $y = 0.35 \sin(4\pi t) + 2$

(d)



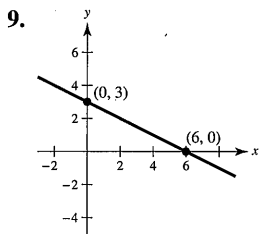
The model appears to fit the data well.

15. Answers will vary. 17. Putnam Problem A2, 2004

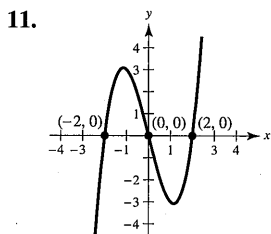
Review Exercises for Chapter P (page 37)

1. $(\frac{8}{5}, 0)$, $(0, -8)$ 3. $(3, 0)$, $(0, \frac{3}{4})$ 5. Not symmetric

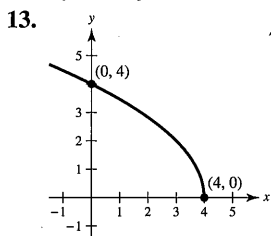
7. Symmetric with respect to the x -axis, the y -axis, and the origin



Symmetry: none

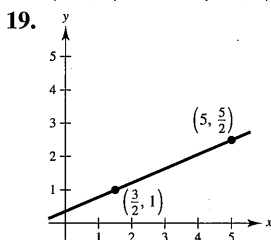


Symmetry: origin



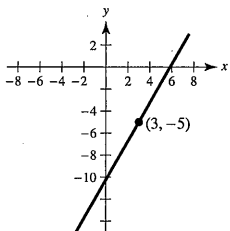
Symmetry: none

15. $(-2, 3)$ 17. $(-2, 3), (3, 8)$

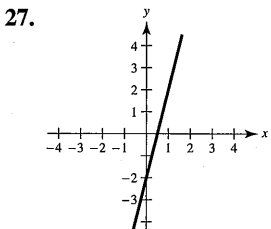
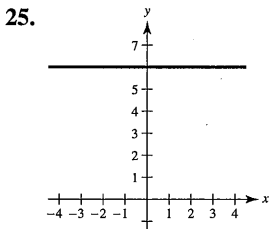
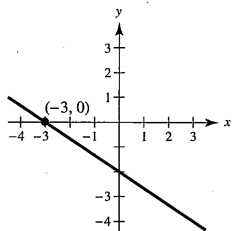


$m = \frac{3}{7}$

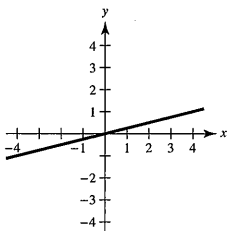
21. $7x - 4y - 41 = 0$



23. $2x + 3y + 6 = 0$



29. $x - 4y = 0$



31. (a) $7x - 16y + 101 = 0$
 (b) $5x - 3y + 30 = 0$
 (c) $4x - 3y + 27 = 0$
 (d) $x + 3 = 0$

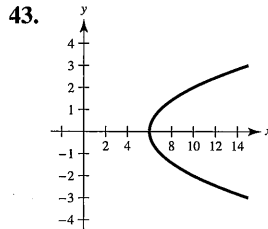
33. $V = 12,500 - 850t$; \$9950

35. (a) 4 (b) 29 (c) -11 (d) $5t + 9$

37. $8x + 4 \Delta x, \Delta x \neq 0$

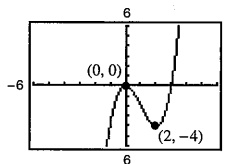
39. Domain: $(-\infty, \infty)$; Range: $[3, \infty)$

41. Domain: $(-\infty, \infty)$; Range: $(-\infty, 0]$



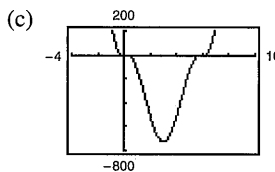
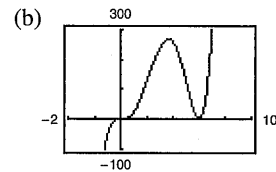
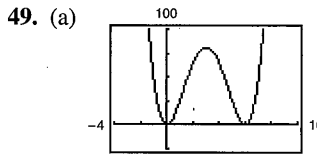
Not a function

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

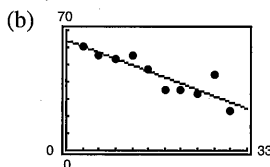


(a) $g(x) = -x^3 + 3x^2 + 1$

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



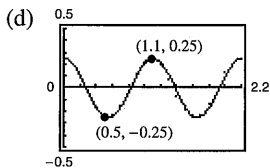
51. (a) $y = -1.204x + 64.2667$



(c) The data point $(27, 44)$ is probably an error. Without this point, the new model is $y = -1.4344x + 66.4387$.

53. (a) Yes. For each time t , there corresponds one and only one displacement y .

(b) Amplitude: 0.25; Period: 1.1 (c) $y \approx \frac{1}{4} \cos(5.7t)$

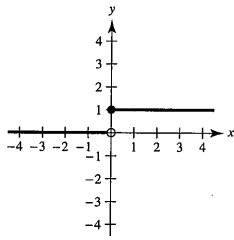


The model appears to fit the data.

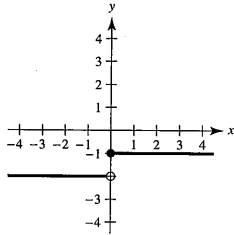
P.S. Problem Solving (page 39)

1. (a) Center: $(3, 4)$; Radius: 5
 (b) $y = -\frac{3}{4}x$ (c) $y = \frac{3}{4}x - \frac{9}{2}$ (d) $(3, -\frac{9}{4})$

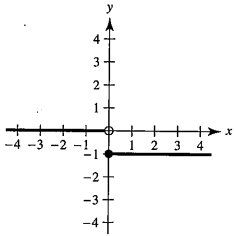
3.



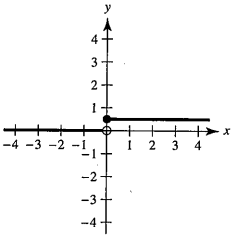
(a)



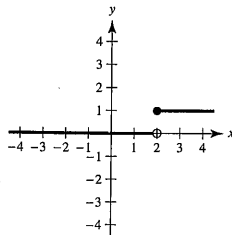
(c)



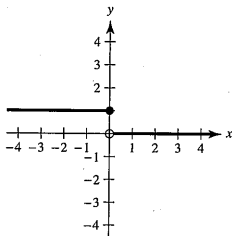
(e)



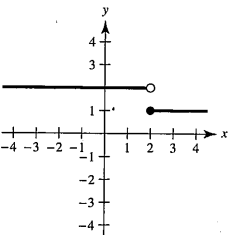
(b)



(d)

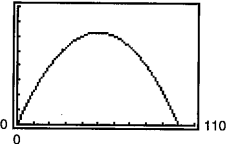


(f)



5. (a) $A(x) = x[(100 - x)/2]$; Domain: $(0, 100)$

(b) 1600



Dimensions $50 \text{ m} \times 25 \text{ m}$
yield maximum area of
 1250 m^2 .

(c) $50 \text{ m} \times 25 \text{ m}$; Area = 1250 m^2

7. $T(x) = [2\sqrt{4 + x^2} + \sqrt{(3 - x)^2 + 1}]/4$

9. (a) 5, less (b) 3, greater (c) 4.1, less

(d) $4 + h$ (e) 4; Answers will vary.

11. (a) Domain: $(-\infty, 1) \cup (1, \infty)$; Range: $(-\infty, 0) \cup (0, \infty)$

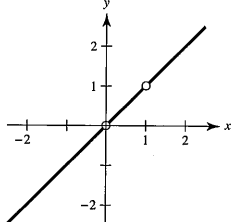
(b) $f(f(x)) = \frac{x - 1}{x}$

Domain: $(-\infty, 0) \cup (0, 1) \cup (1, \infty)$

(c) $f(f(f(x))) = x$

Domain: $(-\infty, 0) \cup (0, 1) \cup (1, \infty)$

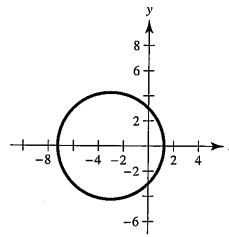
(d)



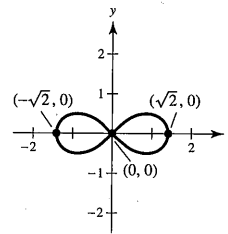
The graph is not a line
because there are holes at
 $x = 0$ and $x = 1$.

13. (a) $x \approx 1.2426, -7.2426$

(b) $(x + 3)^2 + y^2 = 18$



15. Proof



Chapter 1

Section 1.1 (page 47)

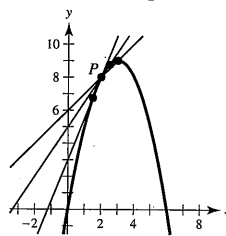
1. Precalculus: 300 ft

3. Calculus: Slope of the tangent line at $x = 2$ is 0.16.

5. (a) Precalculus: 10 square units

(b) Calculus: 5 square units

7. (a)



(b) $1; \frac{3}{2}; \frac{5}{2}$

(c) 2. Use points closer to P.

9. Area ≈ 10.417 ; Area ≈ 9.145 ; Use more rectangles.

Section 1.2 (page 55)

1.

x	3.9	3.99	3.999	4
$f(x)$	0.2041	0.2004	0.2000	?

x	4.001	4.01	4.1
$f(x)$	0.2000	0.1996	0.1961

$$\lim_{x \rightarrow 4} \frac{x - 4}{x^2 - 3x - 4} \approx 0.2000 \quad \left(\text{Actual limit is } \frac{1}{5} \right)$$

3.

x	-0.1	-0.01	-0.001	0
$f(x)$	0.5132	0.5013	0.5001	?

x	0.001	0.01	0.1
$f(x)$	0.4999	0.4988	0.4881

$$\lim_{x \rightarrow 0} \frac{\sqrt{x + 1} - 1}{x} \approx 0.5000 \quad \left(\text{Actual limit is } \frac{1}{2} \right)$$