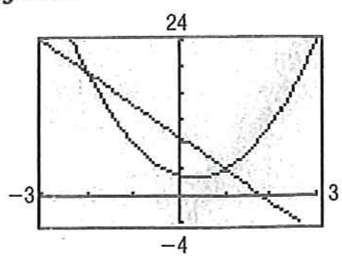
Figure 27



$$y - y_1 = m_{\text{sec}}(x - x_1) \quad \text{Point-slope form of the secant line}$$
$$y - 19 = -5(x - (-2)) \quad x_1 = -2, y_1 = g(-2) = 19, m_{\text{sec}} = -5$$
$$y - 19 = -5x - 10 \quad \text{Distribute.}$$
$$y = -5x + 9 \quad \text{Slope-intercept form of the secant line}$$

(c) Figure 27 shows the graph of g along with the secant line $y = -5x + 9$.

Now Work PROBLEM 67

1.3 Assess Your Understanding

'Are You Prepared?' *Answers are given at the end of these exercises. If you get a wrong answer, read the pages listed in red.*

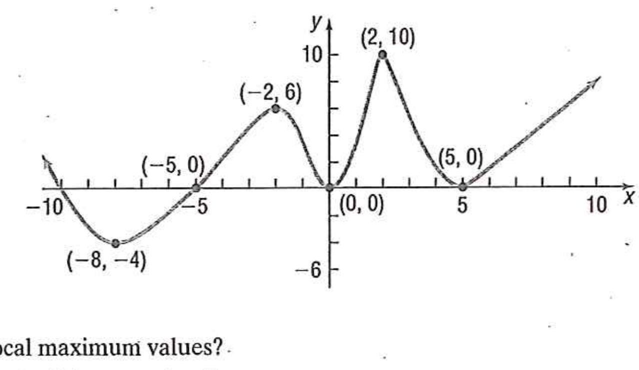
1. The interval $(2, 5)$ can be written as the inequality ________. (pp. A81–A82)
2. The slope of the line containing the points $(-2, 3)$ and $(3, 8)$ is ______. (pp. 19–21)
3. Test the equation $y = 5x^2 - 1$ for symmetry with respect to the x-axis, the y-axis, and the origin. (pp. 12–14)
4. Write the point–slope form of the line with slope 5 containing the point $(3, -2)$. (p. 23)
5. The intercepts of the equation $y = x^2 - 9$ are ________________. (pp. 11–12)

Concepts and Vocabulary

6. A function f is __________ on an open interval I if, for any choice of x_1 and x_2 in I, with $x_1 < x_2$, we have $f(x_1) < f(x_2)$.
7. A(n) ______ function f is one for which $f(-x) = f(x)$ for every x in the domain of f; a(n) ______ function f is one for which $f(-x) = -f(x)$ for every x in the domain of f.
8. ***True or False*** A function f is decreasing on an open interval I if, for any choice of x_1 and x_2 in I, with $x_1 < x_2$, we have $f(x_1) > f(x_2)$.
9. ***True or False*** A function f has a local maximum at c if there is an open interval I containing c so that for all x in I, $f(x) \le f(c)$.
10. ***True or False*** Even functions have graphs that are symmetric with respect to the origin.

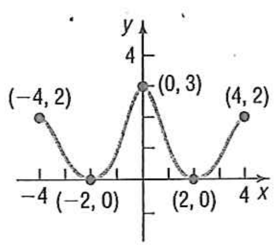
Skill Building

In Problems 11–20, use the graph of the function f given.



11. Is f increasing on the interval $(-8, -2)$?
12. Is f decreasing on the interval $(-8, -4)$?
13. Is f increasing on the interval $(2, 10)$?
14. Is f decreasing on the interval $(2, 5)$?
15. List the interval(s) on which f is increasing.
16. List the interval(s) on which f is decreasing.
17. Is there a local maximum value at 2? If yes, what is it?
18. Is there a local maximum value at 5? If yes, what is it?
19. List the number(s) at which f has a local maximum. What are the local maximum values?
20. List the number(s) at which f has a local minimum. What are the local minimum values?

In Problems 21–28, the graph of a function is given. Use the graph to find:
(a) The intercepts, if any
(b) The domain and range
(c) The intervals on which the function is increasing, decreasing, or constant
(d) Whether the function is even, odd, or neither

21.


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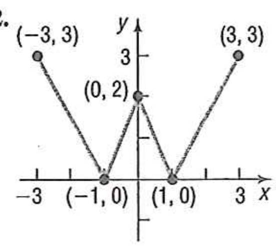

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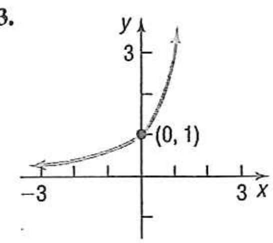

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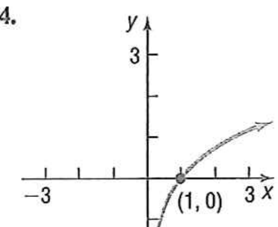

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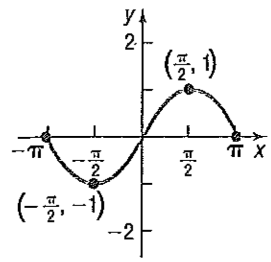

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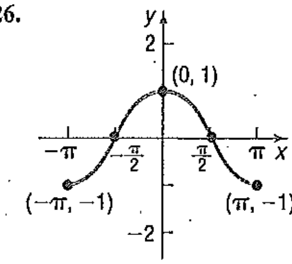
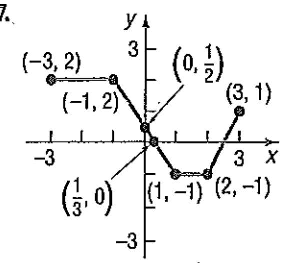


27.



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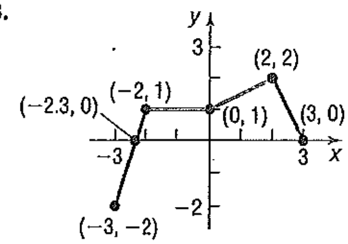
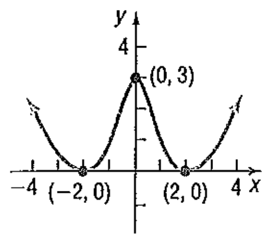


In Problems 29–32, the graph of a function f is given. Use the graph to find:

(a) The numbers, if any, at which f has a local maximum value. What are the local maximum values?

(b) The numbers, if any, at which f has a local minimum value. What are the local minimum values?

29.



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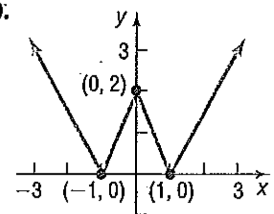

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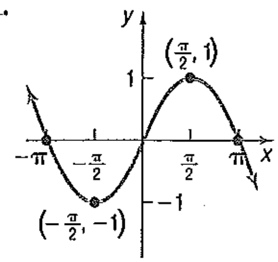

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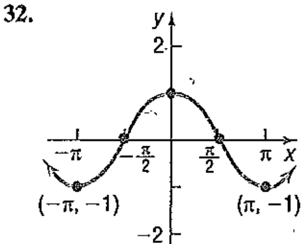


In Problems 33–44, determine algebraically whether each function is even, odd, or neither.

33. $f(x) = 4x^3$

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

35. $g(x) = -3x^2 - 5$

36. $h(x) = 3x^3 + 5$

37. $F(x) = \sqrt[3]{x}$

38. $G(x) = \sqrt{x}$

39. $f(x) = x + |x|$

40. $f(x) = \sqrt[3]{2x^2 + 1}$

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

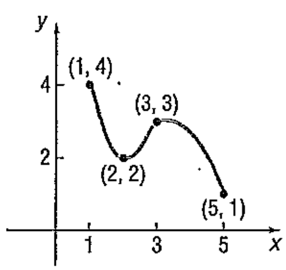
42. $h(x) = \dfrac{x}{x^2 - 1}$

43. $h(x) = \dfrac{-x^3}{3x^2 - 9}$

44. $F(x) = \dfrac{2x}{|x|}$

In Problems 45–52, for each graph of a function $y = f(x)$, find the absolute maximum and the absolute minimum, if they exist. Identify any local maxima or local minima.

45.



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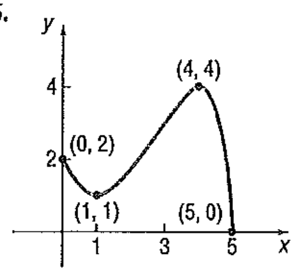

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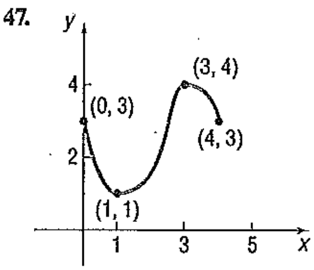

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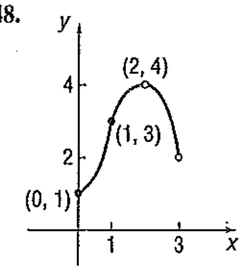

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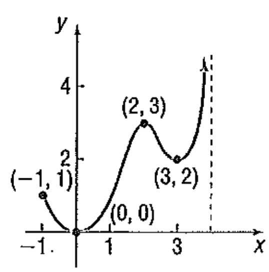

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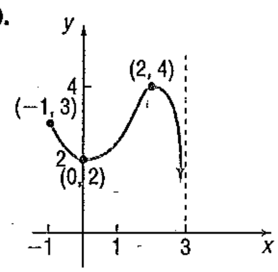

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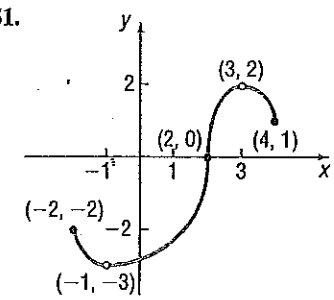

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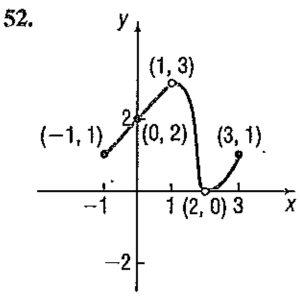

In Problems 53–60, use a graphing utility to graph each function over the indicated interval and approximate any local maximum values and local minimum values. Determine where the function is increasing and where it is decreasing. Round answers to two decimal places.

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

54. $f(x) = x^3 - 3x^2 + 5 \quad (-1, 3)$

55. $f(x) = x^5 - x^3 \quad (-2, 2)$

56. $f(x) = x^4 - x^2 \quad (-2, 2)$

57. $f(x) = -0.2x^3 - 0.6x^2 + 4x - 6 \quad (-6, 4)$

58. $f(x) = -0.4x^3 + 0.6x^2 + 3x - 2 \quad (-4, 5)$

59. $f(x) = 0.25x^4 + 0.3x^3 - 0.9x^2 + 3 \quad (-3, 2)$

60. $f(x) = -0.4x^4 - 0.5x^3 + 0.8x^2 - 2 \quad (-3, 2)$

61. Find the average rate of change of $f(x) = -2x^2 + 4$.
 (a) From 0 to 2
 (b) From 1 to 3
 (c) From 1 to 4

62. Find the average rate of change of $f(x) = -x^3 + 1$.
 (a) From 0 to 2
 (b) From 1 to 3
 (c) From −1 to 1

63. Find the average rate of change of $g(x) = x^3 - 2x + 1$.
(a) From -3 to -2
(b) From -1 to 1
(c) From 1 to 3

64. Find the average rate of change of $h(x) = x^2 - 2x + 3$.
(a) From -1 to 1
(b) From 0 to 2
(c) From 2 to 5

65. $f(x) = 5x - 2$
(a) Find the average rate of change from 1 to 3.
(b) Find an equation of the secant line containing $(1, f(1))$ and $(3, f(3))$.

66. $f(x) = -4x + 1$
(a) Find the average rate of change from 2 to 5.
(b) Find an equation of the secant line containing $(2, f(2))$ and $(5, f(5))$.

67. $g(x) = x^2 - 2$
(a) Find the average rate of change from -2 to 1.
(b) Find an equation of the secant line containing $(-2, g(-2))$ and $(1, g(1))$.

68. $g(x) = x^2 + 1$
(a) Find the average rate of change from -1 to 2.
(b) Find an equation of the secant line containing $(-1, g(-1)$ and $(2, g(2))$.

69. $h(x) = x^2 - 2x$
(a) Find the average rate of change from 2 to 4.
(b) Find an equation of the secant line containing $(2, h(2))$ and $(4, h(4))$.

70. $h(x) = -2x^2 + x$
(a) Find the average rate of change from 0 to 3.
(b) Find an equation of the secant line containing $(0, h(0))$ and $(3, h(3))$.

Mixed Practice

71. $g(x) = x^3 - 27x$
(a) Determine whether g is even, odd, or neither.
(b) There is a local minimum value of -54 at 3. Determine a local maximum value.

72. $f(x) = -x^3 + 12x$
(a) Determine whether f is even, odd, or neither.
(b) There is a local maximum value of 16 at 2. Determine a local minimum value.

73. $F(x) = -x^4 + 8x^2 + 8$
(a) Determine whether F is even, odd, or neither.
(b) There is a local maximum value of 24 at $x = 2$. Determine a second local maximum value.
(c) Suppose the area under the graph of F between $x = 0$ and $x = 3$ that is bounded below by the x-axis is 47.4 square units. Using the result from part (a), determine the area under the graph of F between $x = -3$ and $x = 0$ bounded below by the x-axis.

74. $G(x) = -x^4 + 32x^2 + 144$
(a) Determine whether G is even, odd, or neither.
(b) There is a local maximum value of 400 at $x = 4$. Determine a second local maximum value.
(c) Suppose the area under the graph of G between $x = 0$ and $x = 6$ that is bounded below by the x-axis is 1612.8 square units. Using the result from part (a), determine the area under the graph of G between $x = -6$ and $x = 0$ bounded below by the x-axis.

Applications and Extensions

75. **Minimum Average Cost** The average cost per hour in dollars, $\overline{C}$, of producing x riding lawn mowers can be modeled by the function

$$\overline{C}(x) = 0.3x^2 + 21x - 251 + \frac{2500}{x}$$

(a) Use a graphing utility to graph $\overline{C} = \overline{C}(x)$.
(b) Determine the number of riding lawn mowers to produce in order to minimize average cost.
(c) What is the minimum average cost?

76. **Medicine Concentration** The concentration C of a medication in the bloodstream t hours after being administered is modeled by the function

$$C(t) = -0.002t^4 + 0.039t^3 - 0.285t^2 + 0.766t + 0.085$$

(a) After how many hours will the concentration be highest?
(b) A woman nursing a child must wait until the concentration is below 0.5 before she can feed her or him. After taking the medication, how long must she wait before feeding her child?

77. **National Debt** The size of the total debt owed by the United States federal government continues to grow. In fact, according to the Department of the Treasury, the debt per person living in the United States is approximately \$45,000 (or over \$300,000 per U.S. household). The following data represent the U.S. debt for the years 2001–2012. Since the debt D depends on the year y, and each input corresponds to exactly one output, the debt is a function of the year. Thus $D(y)$, represents the debt for each year y.

Year	Debt (billions of dollars)	Year	Debt (billions of dollars)
2001	5807	2007	9008
2002	6228	2008	10,025
2003	6783	2009	11,910
2004	7379	2010	13,562
2005	7933	2011	14,790
2006	8507	2012	16,066

Source: www.treasurydirect.gov

(a) Plot the points (2001, 5807), (2002, 6228), and so on in a Cartesian plane.
(b) Draw a line segment from the point (2001, 5807) to (2006, 8507). What does the slope of this line segment represent?
(c) Find the average rate of change of the debt from 2002 to 2004.
(d) Find the average rate of change of the debt from 2006 to 2008.