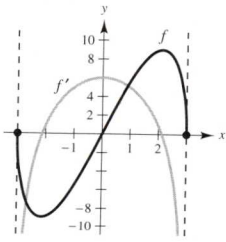
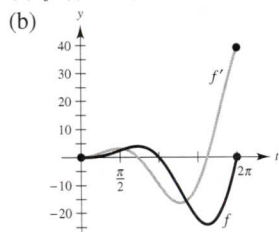


Section 3.3 (page 186)

1. (a) (0, 6) (b) (6, 8)
3. Increasing on (3, ∞); Decreasing on $(-\infty, 3)$
5. Increasing on $(-\infty, -2)$ and $(2, \infty)$; Decreasing on $(-2, 2)$
7. Increasing on $(-\infty, -1)$; Decreasing on $(-1, \infty)$
9. Increasing on $(1, \infty)$; Decreasing on $(-\infty, 1)$
11. Increasing on $(-2\sqrt{2}, 2\sqrt{2})$
Decreasing on $(-4, -2\sqrt{2})$ and $(2\sqrt{2}, 4)$
13. Increasing on $(0, \pi/2)$ and $(3\pi/2, 2\pi)$;
Decreasing on $(\pi/2, 3\pi/2)$
15. Increasing on $(0, 7\pi/6)$ and $(11\pi/6, 2\pi)$;
Decreasing on $(7\pi/6, 11\pi/6)$
17. (a) Critical number: $x = 2$
(b) Increasing on $(2, \infty)$; Decreasing on $(-\infty, 2)$
(c) Relative minimum: $(2, -4)$
19. (a) Critical number: $x = 1$
(b) Increasing on $(-\infty, 1)$; Decreasing on $(1, \infty)$
(c) Relative maximum: $(1, 5)$
21. (a) Critical numbers: $x = -2, 1$
(b) Increasing on $(-\infty, -2)$ and $(1, \infty)$; Decreasing on $(-2, 1)$
(c) Relative maximum: $(-2, 20)$; Relative minimum: $(1, -7)$
23. (a) Critical numbers: $x = -\frac{5}{3}, 1$
(b) Increasing on $(-\infty, -\frac{5}{3})$, $(1, \infty)$
Decreasing on $(-\frac{5}{3}, 1)$
(c) Relative maximum: $(-\frac{5}{3}, \frac{256}{27})$
Relative minimum: $(1, 0)$
25. (a) Critical numbers: $x = \pm 1$
(b) Increasing on $(-\infty, -1)$ and $(1, \infty)$; Decreasing on $(-1, 1)$
(c) Relative maximum: $(-1, \frac{4}{5})$; Relative minimum: $(1, -\frac{4}{5})$
27. (a) Critical number: $x = 0$
(b) Increasing on $(-\infty, \infty)$
(c) No relative extrema
29. (a) Critical number: $x = -2$
(b) Increasing on $(-2, \infty)$; Decreasing on $(-\infty, -2)$
(c) Relative minimum: $(-2, 0)$
31. (a) Critical number: $x = 5$
(b) Increasing on $(-\infty, 5)$; Decreasing on $(5, \infty)$
(c) Relative maximum: $(5, 5)$
33. (a) Critical numbers: $x = \pm\sqrt{2}/2$; Discontinuity: $x = 0$
(b) Increasing on $(-\infty, -\sqrt{2}/2)$ and $(\sqrt{2}/2, \infty)$
Decreasing on $(-\sqrt{2}/2, 0)$ and $(0, \sqrt{2}/2)$
(c) Relative maximum: $(-\sqrt{2}/2, -2\sqrt{2})$
Relative minimum: $(\sqrt{2}/2, 2\sqrt{2})$
35. (a) Critical number: $x = 0$; Discontinuities: $x = \pm 3$
(b) Increasing on $(-\infty, -3)$ and $(-3, 0)$
Decreasing on $(0, 3)$ and $(3, \infty)$
(c) Relative maximum: $(0, 0)$
37. (a) Critical numbers: $x = -3, 1$; Discontinuity: $x = -1$
(b) Increasing on $(-\infty, -3)$ and $(1, \infty)$
Decreasing on $(-3, -1)$ and $(-1, 1)$
(c) Relative maximum: $(-3, -8)$; Relative minimum: $(1, 0)$
39. (a) Critical number: $x = 0$
(b) Increasing on $(-\infty, 0)$; Decreasing on $(0, \infty)$
(c) No relative extrema
41. (a) Critical number: $x = 1$
(b) Increasing on $(-\infty, 1)$; Decreasing on $(1, \infty)$
(c) Relative maximum: $(1, 4)$
43. (a) Critical numbers: $x = \pi/6, 5\pi/6$
Increasing on $(0, \pi/6)$, $(5\pi/6, 2\pi)$
Decreasing on $(\pi/6, 5\pi/6)$
(b) Relative maximum: $(\pi/6, (\pi + 6\sqrt{3})/12)$
Relative minimum: $(5\pi/6, (5\pi - 6\sqrt{3})/12)$
45. (a) Critical numbers: $x = \pi/4, 5\pi/4$
Increasing on $(0, \pi/4)$, $(5\pi/4, 2\pi)$
Decreasing on $(\pi/4, 5\pi/4)$
(b) Relative maximum: $(\pi/4, \sqrt{2})$
Relative minimum: $(5\pi/4, -\sqrt{2})$
47. (a) Critical numbers:
 $x = \pi/4, \pi/2, 3\pi/4, \pi, 5\pi/4, 3\pi/2, 7\pi/4$
Increasing on $(\pi/4, \pi/2)$, $(3\pi/4, \pi)$, $(5\pi/4, 3\pi/2)$,
 $(7\pi/4, 2\pi)$
Decreasing on $(0, \pi/4)$, $(\pi/2, 3\pi/4)$, $(\pi, 5\pi/4)$,
 $(3\pi/2, 7\pi/4)$
(b) Relative maxima: $(\pi/2, 1)$, $(\pi, 1)$, $(3\pi/2, 1)$
Relative minima: $(\pi/4, 0)$, $(3\pi/4, 0)$, $(5\pi/4, 0)$, $(7\pi/4, 0)$
49. (a) Critical numbers: $\pi/2, 7\pi/6, 3\pi/2, 11\pi/6$
Increasing on $(0, \frac{\pi}{2})$, $(\frac{7\pi}{6}, \frac{3\pi}{2})$, $(\frac{11\pi}{6}, 2\pi)$
Decreasing on $(\frac{\pi}{2}, \frac{7\pi}{6})$, $(\frac{3\pi}{2}, \frac{11\pi}{6})$
(b) Relative maxima: $(\frac{\pi}{2}, 2)$, $(\frac{3\pi}{2}, 0)$
Relative minima: $(\frac{7\pi}{6}, -\frac{1}{4})$, $(\frac{11\pi}{6}, -\frac{1}{4})$
51. (a) $f'(x) = 2(9 - 2x^2)/\sqrt{9 - x^2}$
(b) 
(c) Critical numbers:
 $x = \pm 3\sqrt{2}/2$
(d) $f' > 0$ on $(-3\sqrt{2}/2, 3\sqrt{2}/2)$
 $f' < 0$ on $(-3, -3\sqrt{2}/2)$, $(3\sqrt{2}/2, 3)$

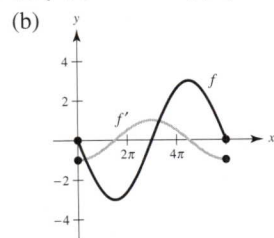
53. (a) $f'(t) = t(t \cos t + 2 \sin t)$



(c) Critical numbers:
 $t = 2.2889, 5.0870$

(d) $f' > 0$ on $(0, 2.2889), (5.0870, 2\pi)$
 $f' < 0$ on $(2.2889, 5.0870)$

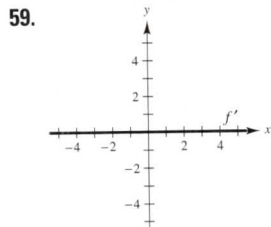
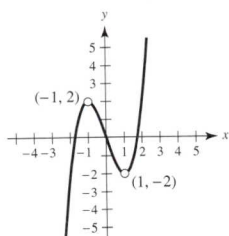
55. (a) $f'(x) = -\cos(x/3)$



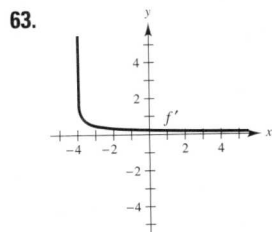
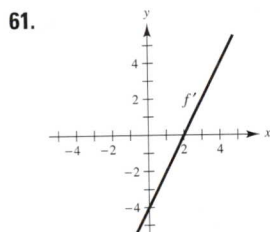
(c) Critical numbers:
 $x = 3\pi/2, 9\pi/2$

(d) $f' > 0$ on $(\frac{3\pi}{2}, \frac{9\pi}{2})$
 $f' < 0$ on $(0, \frac{3\pi}{2}), (\frac{9\pi}{2}, 6\pi)$

57. $f(x)$ is symmetric with respect to the origin.
Zeros: $(0, 0), (\pm\sqrt{3}, 0)$



$g(x)$ is continuous on $(-\infty, \infty)$
and $f(x)$ has holes at $x = 1$
and $x = -1$.



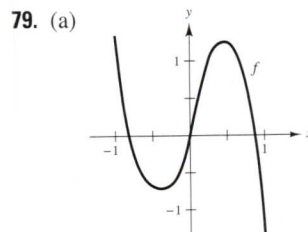
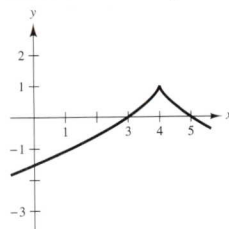
65. (a) Increasing on $(2, \infty)$; Decreasing on $(-\infty, 2)$
(b) Relative minimum: $x = 2$

67. (a) Increasing on $(-\infty, -1)$ and $(0, 1)$;
Decreasing on $(-1, 0)$ and $(1, \infty)$
(b) Relative maxima: $x = -1$ and $x = 1$
Relative minimum: $x = 0$

69. (a) Critical numbers: $x = -1, x = 1, x = 2$
(b) Relative maximum at $x = 1$, relative minimum at $x = 2$, and neither at $x = -1$

71. $g'(0) < 0$ 73. $g'(-6) < 0$ 75. $g'(0) > 0$

77. Answers will vary. Sample answer:



(b) Critical numbers: $x \approx -0.40$ and $x \approx 0.48$
(c) Relative maximum: $(0.48, 1.25)$
Relative minimum: $(-0.40, 0.75)$

81. (a) $s'(t) = 9.8(\sin \theta)t$; speed = $|9.8(\sin \theta)t|$
(b)

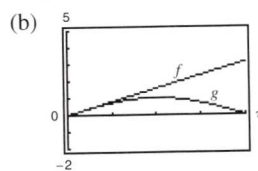
θ	0	$\pi/4$	$\pi/3$	$\pi/2$	$2\pi/3$	$3\pi/4$	π
$s'(t)$	0	$4.9\sqrt{2}t$	$4.9\sqrt{3}t$	$9.8t$	$4.9\sqrt{3}t$	$4.9\sqrt{2}t$	0

The speed is maximum at $\theta = \pi/2$.

83. (a)

x	0.5	1	1.5	2	2.5	3
$f(x)$	0.5	1	1.5	2	2.5	3
$g(x)$	0.48	0.84	1.00	0.91	0.60	0.14

$f(x) > g(x)$



(c) Proof

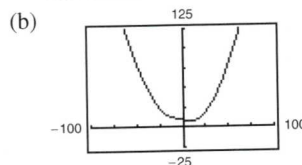
$f(x) > g(x)$

85. $r = 2R/3$

87. (a) $\frac{dR}{dT} = \frac{0.004T^3 - 4}{2\sqrt{0.001T^4 - 4T + 100}}$

Critical number: $T = 10$

Minimum resistance: About 8.3666 ohms



Minimum resistance: About 8.3666 ohms

89. (a) $v(t) = 6 - 2t$ (b) $(0, 3)$ (c) $(3, \infty)$ (d) $t = 3$

91. (a) $v(t) = 3t^2 - 10t + 4$

(b) $(0, (5 - \sqrt{13})/3)$ and $((5 + \sqrt{13})/3, \infty)$

(c) $\left(\frac{5 - \sqrt{13}}{3}, \frac{5 + \sqrt{13}}{3}\right)$ (d) $t = \frac{5 \pm \sqrt{13}}{3}$

93. Answers will vary.

95. (a) Minimum degree: 3

(b) $a_3(0)^3 + a_2(0)^2 + a_1(0) + a_0 = 0$

$a_3(2)^3 + a_2(2)^2 + a_1(2) + a_0 = 2$

$3a_3(0)^2 + 2a_2(0) + a_1 = 0$

$3a_3(2)^2 + 2a_2(2) + a_1 = 0$

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

97. (a) Minimum degree: 4

(b) $a_4(0)^4 + a_3(0)^3 + a_2(0)^2 + a_1(0) + a_0 = 0$

$a_4(2)^4 + a_3(2)^3 + a_2(2)^2 + a_1(2) + a_0 = 4$

$a_4(4)^4 + a_3(4)^3 + a_2(4)^2 + a_1(4) + a_0 = 0$

$4a_4(0)^3 + 3a_3(0)^2 + 2a_2(0) + a_1 = 0$

$4a_4(2)^3 + 3a_3(2)^2 + 2a_2(2) + a_1 = 0$

$4a_4(4)^3 + 3a_3(4)^2 + 2a_2(4) + a_1 = 0$

(c) $f(x) = \frac{1}{4}x^4 - 2x^3 + 4x^2$

99. True 101. False. Let $f(x) = x^3$.

103. False. Let $f(x) = x^3$. There is a critical number at $x = 0$, but not a relative extremum.

105–107. Proofs