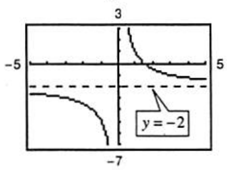
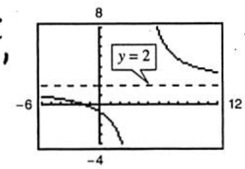
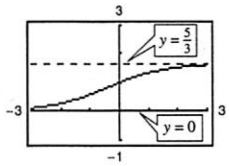
61. (a) -4 (b) 4 (c) Limit does not exist.
63. $x = \pm 3$ **65.** $x = \pm 8$ **67.** $x = \pm 5$ **69.** $-\infty$
71. $\frac{1}{3}$ **73.** $-\infty$ **75.** $\frac{4}{5}$ **77.** $-\infty$
79. (a) \$14,117.65; \$80,000.00; \$720,000.00
(b) ∞; No matter how much the company spends, the company will never be able to remove 100% of the pollutants.
81. 8 **83.** $\frac{2}{3}$ **85.** $-\infty$ **87.** 6
89.



91.



93.



AP® Exam Practice Questions for Chapter 1 *(page 120)*

1. B **2.** D **3.** A **4.** B **5.** D **6.** B
7. C **8.** B **9.** C **10.** D
11. (a) $\lim_{x\to 0} f(x) = 8$ (b) $\lim_{x\to 0} (f(x) + 4) = 12$
(c) $y = 0,\ y = 10$;

$$\lim_{x\to\infty} f(x) = \lim_{x\to\infty} \frac{10}{1 + \frac{1}{4}e^{-x}} = \lim_{x\to\infty} \frac{10}{1 + \frac{1}{4e^x}} = \frac{10}{1 + \frac{1}{4e^\infty}} = \frac{10}{1 + 0} = 10$$

$$\lim_{x\to -\infty} f(x) = \lim_{x\to -\infty} \frac{10}{1 + \frac{1}{4}e^{-x}} = \frac{10}{1 + \frac{1}{4}e^{\infty}} = \frac{10}{\infty} = 0$$

12. (a) $f(x)$ has discontinuities at $x = -3$ and $x = -\frac{1}{2}$.

(b) $$\lim_{x\to -3} f(x) = \lim_{x\to -3} \frac{x^2 + 5x + 6}{2x^2 + 7x + 3} = \lim_{x\to -3} \frac{(x + 2)\cancel{(x + 3)}}{(2x + 1)\cancel{(x + 3)}} = \lim_{x\to -3} \frac{x + 2}{2x + 1} = \frac{-3 + 2}{2(-3) + 1} = \frac{1}{5}$$

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

(d) $y = \frac{1}{2}$;

$$\lim_{x\to\infty} f(x) = \lim_{x\to\infty} \frac{x^2 + 5x + 6}{2x^2 + 7x + 3} = \lim_{x\to\infty} \frac{1 + \frac{5}{x} + \frac{6}{x^2}}{2 + \frac{7}{x} + \frac{3}{x^2}} = \frac{1 + 0 + 0}{2 + 0 + 0} = \frac{1}{2}$$

$$\lim_{x\to -\infty} f(x) = \lim_{x\to -\infty} \frac{x^2 + 5x + 6}{2x^2 + 7x + 3} = \lim_{x\to -\infty} \frac{1 + \frac{5}{x} + \frac{6}{x^2}}{2 + \frac{7}{x} + \frac{3}{x^2}} = \frac{1 + 0 + 0}{2 + 0 + 0} = \frac{1}{2}$$

13. (a) 6; $\lim_{x\to 1} (f(x) + 4) = \lim_{x\to 1} f(x) + \lim_{x\to 1} 4 = 2 + 4 = 6$
(b) 5; $\lim_{x\to 3^-} \frac{5}{g(x)} = \frac{5}{1} = 5$
(c) 0; $\lim_{x\to 2} (f(x) \cdot g(x)) = 2 \cdot 0 = 0$
(d) -2;

$$\lim_{x\to 3} \frac{f(x)}{g(x) - 1} = \lim_{x\to 3} \frac{-2x + 6}{(x - 2) - 1} = \lim_{x\to 3} \frac{-2x + 6}{x - 3} = \lim_{x\to 3} \frac{-2\cancel{(x - 3)}}{\cancel{x - 3}} = -2$$

14. (a) $\frac{1}{e^2}$
(b) $f(0)$ is defined as $f(0) = e^{2(0)} = 1$. $\lim_{x\to 0^-} f(x) = 1$ and $\lim_{x\to 0^+} f(x) = 1$, so $\lim_{x\to 0} f(x) = 1$. Also, $\lim_{x\to 0} f(x) = f(0) = 1$. So, f is continuous at $x = 0$.
(c) 0

15. (a) 172; Because $T(x)$ is continuous on $[0, 10)$, $\lim_{x\to 4} T(x) = T(4) = 172$.
(b) -2 degrees per minute
(c) (6, 8); $T(x)$ is continuous and when $x = 6$, $T(x) > 166.5°$ and when $x = 8$, $T(x) < 166.5°$.
(d) Slope $= -2$

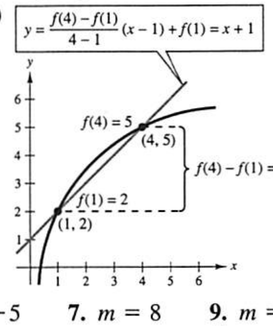
16. (a) Because $s(t)$ is a continuous function and $s(1) = 392$ and $s(2) = 377.3$, there exists a time t, $1 < t < 2$ where $s(t)$ is a value between 377.3 and 392.
(b) 9 seconds
(c) -83.3 m/sec; This is a good measure of velocity because it is the object's average rate of change right before it hits the ground; It can be improved by finding the instantaneous rate of change using calculus.
(d) $$\lim_{x\to 3} \frac{s(t) - s(3)}{t - 3} = \lim_{x\to 3} \frac{(-4.9t^2 + 396.9) - (-4.9(3)^2 + 396.9)}{t - 3} = \lim_{x\to 3} \frac{-4.9t^2 + 4.9(9)}{t - 3} = \lim_{x\to 3} \frac{-4.9(t^2 - 9)}{t - 3} = \lim_{x\to 3} \frac{-4.9\cancel{(t - 3)}(t + 3)}{\cancel{t - 3}} = \lim_{x\to 3} -4.9(t + 3) = -4.9(3 + 3) = -29.4 \text{ m/sec}$$

17. (a) $a = 2, b = 3$ (b) 9 (c) 5

Chapter 2

Section 2.1 *(page 131)*

1. $m_1 = 0, m_2 = \frac{5}{2}$
3. (a)–(c)



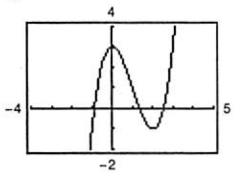
5. $m = -5$ **7.** $m = 8$ **9.** $m = 3$ **11.** $f'(x) = 0$
13. $f'(x) = -5$ **15.** $h'(s) = \frac{2}{3}$ **17.** $f'(x) = 2x + 1$

CHAPTER 2

3.

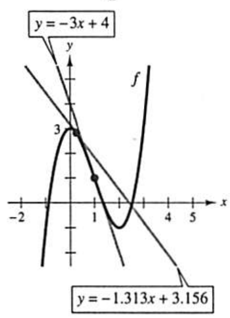
n	x_n	$f(x_n)$	$f'(x_n)$	$\frac{f(x_n)}{f'(x_n)}$	$x_n - \frac{f(x_n)}{f'(x_n)}$
1	1.6	-0.0292	-0.9996	0.0292	1.5708
2	1.5708	0	-1	0	1.5708

5. -1.587 **7.** 0.682 **9.** 1.250, 5.000 **11.** 0.567
13. 0.900, 1.100, 1.900 **15.** 1.935 **17.** 0.567
19. 4.493 **21.** (a) Proof (b) $\sqrt{5} \approx 2.236$; $\sqrt{7} \approx 2.646$
23. $f'(x_1) = 0$ **25.** 0.74 **27.** 1.12 **29.** Proof
31. (a)



(b) 1.347 (c) 2.532

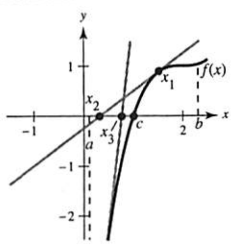
(d)



x-intercept of $y = -3x + 4$ is $\frac{4}{3}$.
x-intercept of $y = -1.313x + 3.156$ is approximately 2.404.

(e) If the initial estimate $x = x_1$ is not sufficiently close to the desired zero of a function, then the x-intercept of the corresponding tangent line to the function may approximate a second zero of the function.

33. Answers will vary. Sample answer: If f is a function continuous on $[a, b]$ and differentiable on (a, b), where $c \in [a, b]$ and $f(c) = 0$, then Newton's Method uses tangent lines to approximate c. First, estimate an initial x_1 close to c. (See graph.) Then determine x_2 using $x_2 = x_1 - \frac{f(x_1)}{f'(x_1)}$. Calculate a third estimate x_3 using $x_3 = x_2 - \frac{f(x_2)}{f'(x_2)}$. Continue this process until $|x_n - x_{n+1}|$ is within the desired accuracy, and let x_{n+1} be the final approximation of c.



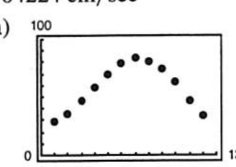
35. 4.486 hours **37.** True **39.** 0.217 **41.** A

Review Exercises for Chapter 2 *(page 204)*

1. $f'(x) = 0$ **3.** $f'(x) = 2x - 4$ **5.** 5
7. f is differentiable for all $x \neq 3$.
9. f is differentiable on the interval $(1, \infty)$.
11. 0 **13.** $3x^2 - 22x$ **15.** $\frac{3}{\sqrt{x}} + \frac{1}{\sqrt[3]{x^2}}$ **17.** $-\frac{4}{3t^3}$
19. $4 - 5\cos\theta$ **21.** $-3\sin t - 4e^t$ **23.** -1 **25.** 0

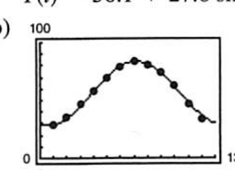
27. (a) 50 (vibrations/sec)/lb (b) 33.33 (vibrations/sec)/lb
29. (a) $s(t) = -16t^2 - 30t + 600$; $v(t) = -32t - 30$
(b) -94 ft/sec
(c) $v'(1) = -62$ ft/sec; $v'(3) = -126$ ft/sec
(d) About 5.258 sec
(e) About -198.256 ft/sec

31. $4(5x^3 - 15x^2 - 11x - 8)$ **33.** $\frac{1}{2\sqrt{x}}\sin x + \sqrt{x}\cos x$
35. $-\frac{x^2 + 1}{(x^2 - 1)^2}$ **37.** $\frac{4x^3\cos x + x^4 \sin x}{\cos^2 x}$
39. $3x^2 \sec x \tan x + 6x \sec x$ **41.** $4xe^x + 4e^x + \csc^2 x$
43. $y = 4x + 10$ **45.** $y = -8x + 1$ **47.** $y = \frac{1}{2}x + 3$
49. $-48t$ **51.** $\frac{225}{4}\sqrt{x}$ **53.** $6\sec^2\theta\tan\theta$
55. (a) Proof (b) $-7920\sqrt{3}$ mi/degree
57. $28(7x + 3)^3$ **59.** $-\frac{2x}{(x^2 + 4)^2}$ **61.** $-45\sin(9x + 1)$
63. $\sin^2 x$ **65.** $(6x + 1)^4(36x + 1)$ **67.** $\frac{3}{(x^2 + 1)^{3/2}}$
69. $\frac{1}{4}te^{t/4}(t + 8)$ **71.** $\frac{e^{2x} - e^{-2x}}{\sqrt{e^{2x} + e^{-2x}}}$ **73.** $\frac{x(2 - x)}{e^x}$
75. $\frac{1}{2x}$ **77.** $\frac{1 + 2\ln x}{2\sqrt{\ln x}}$ **79.** $\frac{x}{(a + bx)^2}$ **81.** $\frac{1}{x(a + bx)}$
83. $-\frac{3x^2}{2\sqrt{1 - x^3}}; -2$ **85.** $-\frac{8x}{(x^2 + 1)^2}; 2$
87. $-(\csc 2x)\cot 2x$; 0 **89.** $384(8x + 5)$ **91.** $2\csc^2 x \cot x$
93. (a) -18.667°F/h (b) -7.284°F/h
(c) -3.240°F/h (d) -0.747°F/h
As the time increases, the rate of change of the temperature decreases.
95. 0.04224 cm/sec^2
97. (a)



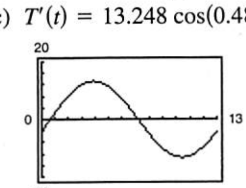
$T(t) = 56.1 + 27.6\sin(0.48t - 1.86)$

(b)



The model is a good fit.

(c) $T'(t) = 13.248\cos(0.48t - 1.86)$



(d) The temperature changes most rapidly around spring (March–May) and fall (Oct.–Nov.). The temperature changes most slowly around winter (Dec.–Feb.) and summer (June–Aug.). Yes. Explanations will vary.

99. $-\frac{x}{y}$ **101.** $\frac{y(y^2 - 3x^2)}{x(x^2 - 3y^2)}$ **103.** $\frac{y\sin x + \sin y}{\cos x - x\cos y}$

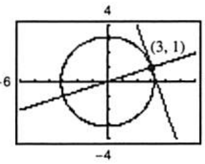
105. $y = -6x + 28$ **107.** $y = -\frac{1}{2}x + 5$

109. Tangent line:

$y = -3x + 10$

Normal line:

$y = \frac{1}{3}x$

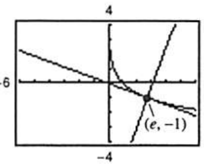


111. Tangent line:

$y = -\dfrac{1}{e}x$

Normal line:

$y = ex - e^2 - 1$



113. $\dfrac{x^3 + 8x^2 + 4}{(x+4)^2\sqrt{x^2+1}}$ **115.** $\dfrac{1}{3(\sqrt[3]{-3})^2} \approx 0.160$ **117.** $\dfrac{3}{4}$

119. $(1 - x^2)^{-3/2}$ **121.** $\dfrac{x}{|x|\sqrt{x^2-1}} + \operatorname{arcsec} x$

123. (a) $2\sqrt{2}$ units/sec (b) 4 units/sec (c) 8 units/sec

125. 450π km/h **127.** $\dfrac{d\theta}{dt} = \dfrac{1}{25}\cos^2\theta,\ -\dfrac{\pi}{4} \le \theta \le \dfrac{\pi}{4}$

129. $-0.347, -1.532, 1.879$ **131.** 1.202

133. 0.264, 1, 1.737

AP® Exam Practice Questions for Chapter 2 *(page 208)*

1. D **2.** A **3.** D **4.** A **5.** C **6.** A **7.** B
8. C **9.** B **10.** D **11.** B **12.** D

13. (a) $12xe^{2x^2}$ (b) 0.158 (c) $\dfrac{1 \pm \sqrt{5}}{4}$

14. (a) $\cos x$ (b) $\dfrac{1}{3x^{2/3}}$ (c) $\dfrac{1}{8}$ (d) $-\dfrac{1}{25}$

15. (a) $-\frac{1}{25}$ (b) -14 (c) $\frac{7}{4}$

16. (a) (i) (0, 1), (4.4, 5)
(ii) (2, 4.4)
(iii) (1, 2)
(b) (i) -2 ft/sec²
(ii) 5 ft/sec²

17. (a) $x = \dfrac{\pi}{2}, \dfrac{3\pi}{2}$; $\tan x$ and $\sec^2 x$ are undefined at these values.
(b) $k = 0$

Chapter 3

Section 3.1 *(page 217)*

1. $f'(0) = 0$ **3.** $f'(2) = 0$ **5.** $f'(-2)$ is undefined.

7. 2, absolute maximum (and relative maximum)

9. 1, absolute maximum (and relative maximum)
2, absolute minimum (and relative minimum)
3, absolute maximum (and relative maximum)

11. $x = \frac{3}{4}$ **13.** $t = \frac{8}{3}$

15. $x = \dfrac{\pi}{3}, \pi, \dfrac{5\pi}{3}$ **17.** $t = \dfrac{1}{2}$ **19.** $x = 0$

21. Minimum: (2, 1); Maximum: $(-1, 4)$

23. Minimum: $(-3, -13)$; Maximum: (0, 5)

25. Minimum: $\left(-1, -\frac{5}{2}\right)$; Maximum: (2, 2)

27. Minimum: (0, 0); Maximum: $(-1, 5)$

29. Minimum: $(1, -1)$; Maximum: $\left(0, -\frac{1}{2}\right)$

31. Minimum: $(-1, -1)$; Maximum: (3, 3)

33. Minimum value is -2 for $-2 \le x < -1$; Maximum: (2, 2)

35. Minimum: $\left(\dfrac{3\pi}{2}, -1\right)$; Maximum: $\left(\dfrac{5\pi}{6}, \dfrac{1}{2}\right)$

37. Minimum: $(\pi, -3)$; Maxima: (0, 3) and $(2\pi, 3)$

39. Minimum: (0, 0); Maximum: $(-2, \arctan 4)$

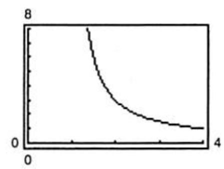
41. Minimum: $(2, 5e^2 - e^4)$; Maximum: $\left(\ln \frac{5}{2}, \frac{25}{4}\right)$

43. Minima: (0, 0) and $(\pi, 0)$; Maximum: $\left(\dfrac{3\pi}{4}, \dfrac{\sqrt{2}}{2}e^{3\pi/4}\right)$

45. $x = 0$ is a critical number but not a relative extremum; $x = -\frac{3}{2}$ and $x = 3$

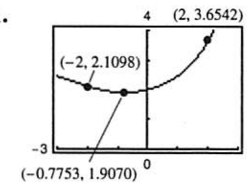
47. (a) Minimum: $(0, -3)$
Maximum: (2, 1)
(b) Minimum: $(0, -3)$
(c) Maximum: (2, 1)
(d) No extrema

49.



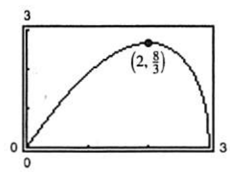
Minimum: (4, 1)

51.



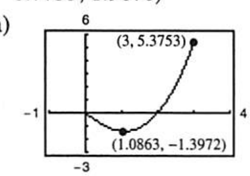
Minimum:
$(-0.7753, 1.9070)$

53. (a)



(b) Minima: (0, 0) and (3, 0)
Maximum: $\left(2, \frac{8}{3}\right)$

55. (a)



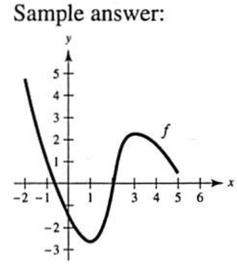
(b) Minimum
$(1.0863, -1.3972)$

57. Maximum: $\left|f''\left(\sqrt[3]{-10 + \sqrt{108}}\right)\right| = f''\left(\sqrt{3} - 1\right) \approx 1.47$

59. Maximum: $|f''(0)| = 1$

61. f is continuous on $\left[0, \dfrac{\pi}{4}\right]$ but not on $[0, \pi]$.

63. Answers will vary.
Sample answer:



65. (a) Yes (b) No

67. Maximum: $P(12) = 72$; No, P is decreasing for $I < 12$.

69. $\theta = \operatorname{arcsec}\sqrt{3} \approx 0.9553$ rad **71.** True

73. Proof **75.** D

77. (a) $y = -\dfrac{1}{2}x + \left(\dfrac{\pi}{6} + \dfrac{\sqrt{3}}{4}\right)$

(b) $x = \dfrac{\pi}{4}$, relative maximum; $x = \dfrac{3\pi}{4}$, relative minimum;
$x = \dfrac{5\pi}{4}$, relative maximum; $x = \dfrac{7\pi}{4}$, relative minimum

39. $f(x) = \sqrt{x},\ dy = \dfrac{1}{2\sqrt{x}}\,dx$

$f(99.4) \approx \sqrt{100} + \dfrac{1}{2\sqrt{100}}(-0.6) = 9.97$

Calculator: 9.97

41. $f(x) = \sqrt[4]{x},\ dy = \dfrac{1}{4x^{3/4}}\,dx$

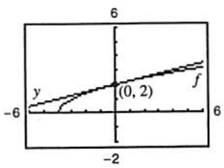
$f(624) \approx \sqrt[4]{625} + \dfrac{1}{4(625)^{3/4}}(-1) = 4.998$

Calculator: 4.998

43. $y - f(0) = f'(0)(x - 0)$

$y - 2 = \dfrac{1}{4}x$

$y = 2 + \dfrac{x}{4}$



45. (a) $f(x) = \sqrt{x};\ dy = \dfrac{1}{2\sqrt{x}}\,dx$

$f(4.02) \approx \sqrt{4} + \dfrac{1}{2\sqrt{4}}(0.02) = 2 + \dfrac{1}{4}(0.02)$

(b) $f(x) = \tan x;\ dy = \sec^2 x\,dx$

$f(0.05) \approx \tan 0 + (\sec^2 0)(0.05) = 0 + 1(0.05)$

47. True

49. False; Let $f(x) = \sqrt{x}$, $x = 1$, and $\Delta x = dx = 3$.

51. A

53. (a) $P' = \frac{1}{4}e^{-x/400}(400 - x)$ (b) 400 units
(c) \$503; 5.8%

Review Exercises for Chapter 3 *(page 274)*

1. Maximum: $(0, 0)$
Minimum: $\left(-\frac{5}{2}, -\frac{25}{4}\right)$

3. Maximum: $(4, 0)$
Minimum: $(0, -2)$

5. Maximum: $\left(3, \frac{2}{3}\right)$
Minimum: $\left(-3, -\frac{2}{3}\right)$

7. Maximum: $(2\pi, 17.57)$
Minimum: $(2.73, 0.88)$

9. $f(0) \neq f(4)$

11. Not continuous on $[-2, 2]$

13. $f'\left(\frac{2744}{729}\right) = \frac{3}{7}$

15. f is not differentiable at $x = 5$.

17. $f'(0) = 1$

19. No; The function has a discontinuity at $x = 0$, which is in the interval $[-2, 1]$.

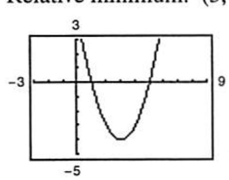
21. Increasing on $\left(-\frac{3}{2}, \infty\right)$; Decreasing on $\left(-\infty, -\frac{3}{2}\right)$

23. Increasing on $(-\infty, 1)$ and $\left(\frac{7}{3}, \infty\right)$; Decreasing on $\left(1, \frac{7}{3}\right)$

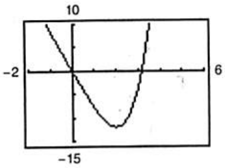
25. Increasing on $(1, \infty)$; Decreasing on $(0, 1)$

27. Increasing on $\left(-\infty, 2 - \dfrac{1}{\ln 2}\right)$; Decreasing on $\left(2 - \dfrac{1}{\ln 2}, \infty\right)$

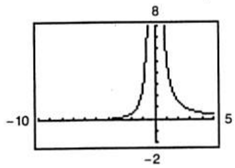
29. (a) Critical number: $x = 3$
(b) Increasing on $(3, \infty)$; Decreasing on $(-\infty, 3)$
(c) Relative minimum: $(3, -4)$
(d)



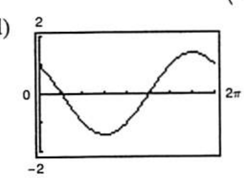
31. (a) Critical number: $t = 2$
(b) Increasing on $(2, \infty)$; Decreasing on $(-\infty, 2)$
(c) Relative minimum: $(2, -12)$
(d)



33. (a) Critical number: $x = -8$; Discontinuity: $x = 0$
(b) Increasing on $(-8, 0)$
Decreasing on $(-\infty, -8)$ and $(0, \infty)$
(c) Relative minimum: $\left(-8, -\frac{1}{16}\right)$
(d)



35. (a) Critical numbers: $x = \dfrac{3\pi}{4}, \dfrac{7\pi}{4}$
(b) Increasing on $\left(\dfrac{3\pi}{4}, \dfrac{7\pi}{4}\right)$
Decreasing on $\left(0, \dfrac{3\pi}{4}\right)$ and $\left(\dfrac{7\pi}{4}, 2\pi\right)$
(c) Relative minimum: $\left(\dfrac{3\pi}{4}, -\sqrt{2}\right)$
Relative maximum: $\left(\dfrac{7\pi}{4}, \sqrt{2}\right)$
(d)



37. $(3, -54)$; Concave upward: $(3, \infty)$;
Concave downward: $(-\infty, 3)$

39. No points of inflection; Concave upward: $(-5, \infty)$

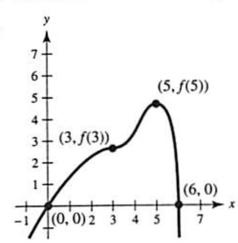
41. $\left(\dfrac{\pi}{2}, \dfrac{\pi}{2}\right), \left(\dfrac{3\pi}{2}, \dfrac{3\pi}{2}\right)$; Concave upward: $\left(\dfrac{\pi}{2}, \dfrac{3\pi}{2}\right)$;
Concave downward: $\left(0, \dfrac{\pi}{2}\right), \left(\dfrac{3\pi}{2}, 2\pi\right)$

43. Relative minimum: $(-9, 0)$

45. Relative maxima: $\left(\pm\dfrac{\sqrt{2}}{2}, \dfrac{1}{2}\right)$; Relative minimum: $(0, 0)$

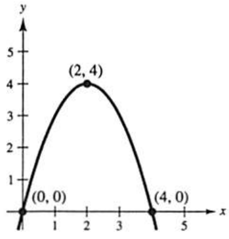
47. Relative maximum: $(-3, -12)$; Relative minimum: $(3, 12)$

49.

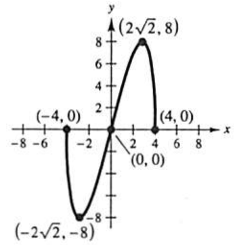


51. $x = \sqrt{\dfrac{2Qs}{r}}$

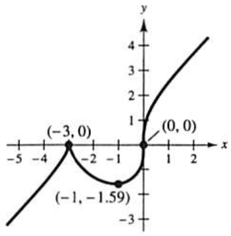
53.



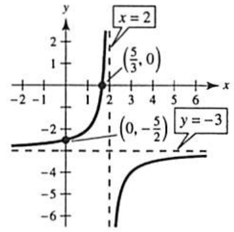
55.



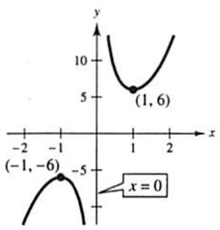
57.



59.



61.



63. $x = 50$ ft, $y = \frac{200}{3}$ ft **65.** (0, 0), (5, 0), (0, 10)

67. 14.05 ft **69.** $\dfrac{32\pi r^3}{81}$ units^3

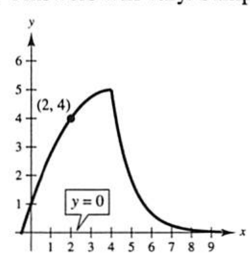
71. $\Delta y = 0.03005$; $dy = 0.03$

73. $(1 + x\sin x - \cos x)\,dx$ **75.** $\Delta p = -\frac{1}{4}$; $dp = -\frac{1}{4}$

AP® Exam Practice Questions for Chapter 3 *(page 276)*

1. B **2.** B **3.** B **4.** C **5.** D **6.** A **7.** A

8. (a) $(-\infty, 4)$
(b) Yes; It goes from increasing to decreasing and $f(x)$ is continuous.
(c) $x = 4$; At this value, $f''(x)$ changes sign.
(d) No; $f(x)$ is not differentiable on (3, 5).
(e) Answers will vary. Sample answer:



9. (a) $x \approx \pm 0.7108$ (b) $y = \dfrac{3\pi^2}{8}x - \dfrac{\pi^3}{8}$
(c) $f(1.5) \approx 1.6759$; This is an underestimate because $f'\left(\frac{\pi}{2}\right) > f'(1.5)$.

10. (a) $2\pi + 1$; Critical number: $x = \dfrac{\pi}{4}$,
$$f(\pi) = 2\pi + 1 > f\left(\frac{\pi}{4}\right) > f(0)$$
(b) $f(x)$ is continuous on $[0, \pi]$ and differentiable on $(0, \pi)$; $x = \dfrac{\pi}{2}$

11. (a) (0, 2)
(b) $(-2, -0.8)$, $(1.3, \infty)$; $f(x)$ is concave downward when $f'(x)$ is decreasing.
(c) Negative; $f'(x)$ is negative so the slope of $f(x)$ is negative there.

12. (a) $(-\infty, 0)$, $(0, \infty)$
(b) $f(x)$ is never concave downward because $f''(x) > 0$ for all real x.
(c) $f(x)$ has no points of inflection because it does not change concavity.

13. (a) $f'(-1) = -\dfrac{2}{3}$; $f''(-1) = -\dfrac{1}{3}$
(b) $x = -3$; $f'(x)$ changes from positive to negative, so f has a relative maximum at $x = -3$.
(c) $(-4, 0)$ and $(1, 4)$; f is concave downward when f' is decreasing.
(d) $x = -4$, $x = 0$, and $x = 1$; $f''(0)$ and $f''(1)$ are undefined, and $f''(-4) = 0$.
(e) Decreasing;
$$g(x) = f(x) + \sin^2 x$$
$$g'(x) = f'(x) + 2\sin x\cos x$$
$$g'\left(-\frac{\pi}{4}\right) = f'\left(-\frac{\pi}{4}\right) + 2\sin\left(-\frac{\pi}{4}\right)\cos\left(-\frac{\pi}{4}\right)$$
$$= f'\left(-\frac{\pi}{4}\right) + 2\left(-\frac{\sqrt{2}}{2}\right)\left(\frac{\sqrt{2}}{2}\right)$$
$$= f'\left(-\frac{\pi}{4}\right) - 1$$
From the graph, $f'\left(-\frac{\pi}{4}\right)$ is negative. So, $g'\left(-\frac{\pi}{4}\right)$ is negative, which means that g is decreasing at $x = -\dfrac{\pi}{4}$.

Chapter 4

Section 4.1 *(page 287)*

1. Proof **3.** $y = 3t^3 + C$ **5.** $y = \dfrac{2}{5}x^{5/2} + C$

	Original Integral	*Rewrite*	*Integrate*	*Simplify*
7.	$\int \sqrt[3]{x}\,dx$	$\int x^{1/3}\,dx$	$\dfrac{x^{4/3}}{4/3} + C$	$\dfrac{3}{4}x^{4/3} + C$
9.	$\int \dfrac{1}{x\sqrt{x}}\,dx$	$\int x^{-3/2}\,dx$	$\dfrac{x^{-1/2}}{-1/2} + C$	$-\dfrac{2}{\sqrt{x}} + C$

11. $\frac{3}{4}x^4 - 2x^3 + 2x + C$ **13.** $\frac{2}{5}x^{5/2} + x^2 + x + C$

15. $\dfrac{3}{5}x^{5/3} + C$ **17.** $-\dfrac{1}{4x^4} + C$ **19.** $\dfrac{2}{3}x^{3/2} + 12x^{1/2} + C$

21. $x^3 + \dfrac{1}{2}x^2 - 2x + C$ **23.** $5\sin x - 4\cos x + C$

25. $-2\cos x - 5e^x + C$ **27.** $\tan y + C$

29. $x^2 - \dfrac{4^x}{\ln 4} + C$ **31.** $\dfrac{1}{2}x^2 - 5\ln|x| + C$