153. False; $e^x = 0$ has no solutions.

155. The error is that both sides of the equation should be divided by 2 before taking the natural log of both sides.

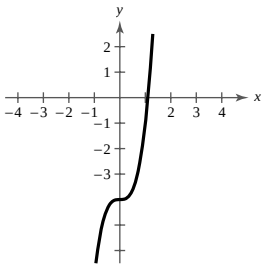
$$2e^x = 10$$
$$e^x = 5$$
$$\ln e^x = \ln 5$$
$$x = \ln 5$$

157. Inverse Property. You would take the natural log of both sides, which would give you $x \ln 5 = \ln 34$. So,

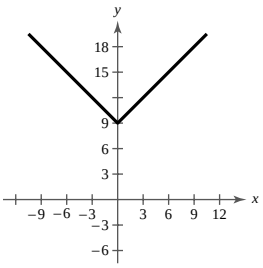
$$x = \frac{\ln 34}{\ln 5}.$$

159. Yes. The investment will double every $\frac{\ln 2}{r}$ years.

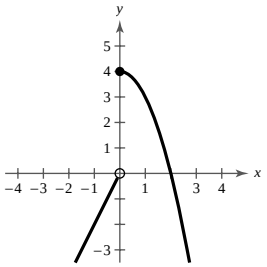
161.



163.



165.



Section 3.5 (page 228)

1. (a) iv (b) i (c) iii (d) vi (e) ii (f) v

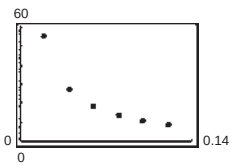
3. sigmoidal **5.** Exponential decay

7. c **8.** e **9.** b **10.** a **11.** d **12.** f

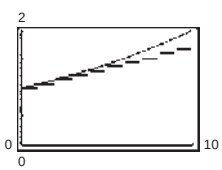
	Initial Investment	*Annual % Rate*	*Time to Double*	*Amount After 10 Years*
13.	\$10,000	3.5%	19.8 yr	\$14,190.68
15.	\$7500	3.30%	21 yr	\$10,432.26
17.	\$5000	1.25%	55.45 yr	\$5665.74
19.	\$63,762.82	4.5%	15.40 yr	\$100,000.00

21.

r	2%	4%	6%	8%	10%	12%
t	54.93	27.47	18.31	13.73	10.99	9.16



23.



Continuous compounding

Isotope	*Half-Life (years)*	*Initial Quantity*	*Amount After 1000 Years*
25. ^{226}Ra	1599	10 g	6.48 g
27. ^{14}C	5700	3 g	2.66 g

29. $y = e^{0.768x}$ **31.** $y = 4e^{-0.2773x}$

33. (a) Decreasing. The negative exponent indicates that the model is decreasing.

(b) 333,680 people; 317,565 people; 308,272 people

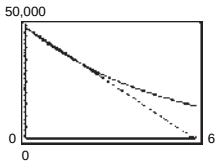
(c) 2014

35. (a) 0.0189 (b) About 1,534,104 people

37. About 15,601 yr ago

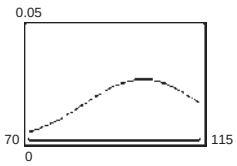
39. (a) $V = -8305t + 49{,}200$ (b) $V = 49{,}200e^{-0.2059t}$

(c)



(d) Exponential model (e) $0 < t < 2$; $t \geq 2$

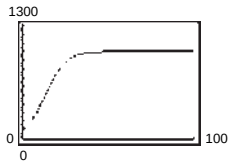
41. (a)



(b) 100

43. (a) About 203 animals (b) About 13 mo

(c)



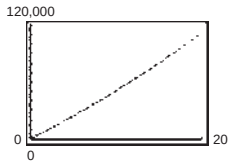
The horizontal asymptotes occur at $p = 1000$ and $p = 0$. The asymptote at $p = 1000$ means there will not be more than 1000 animals in the preserve.

45. (a) 10,000,000 (b) 125,892,541 (c) 1,258,925

47. (a) 20 dB (b) 70 dB (c) 120 dB

49. 97.49% **51.** 4.64 **53.** About 31,623 times

55. (a)



(b) 21.20 yr; yes

57. 3:00 A.M. **59.** False. The domain can be all real numbers.

61. No. Any x-value in the Gaussian model will give a positive y-value.

63. Gaussian model **65.** Exponential growth model

67. a; $(0, -3)$, $\left(\frac{9}{4}, 0\right)$ **68.** b; $(0, 2)$, $(5, 0)$

69. d; $(0, 25)$, $\left(\frac{100}{9}, 0\right)$ **70.** c; $(0, 4)$, $(2, 0)$

71. Falls to the left and rises to the right

73. Rises to the left, falls to the right

75. $2x^2 + 3 + \frac{3}{x - 4}$ **77.** Answers will vary.

Section 3.6 (page 238)

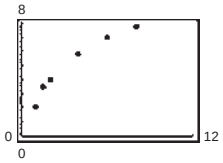
1. $y = ax^b$ **3.** Scatter plot **5.** Logarithmic model

7. Quadratic model **9.** Exponential model

11. Quadratic model

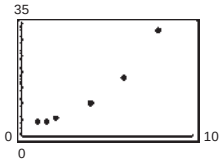
CHAPTER 3

13.



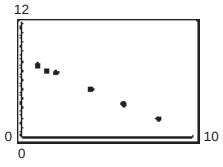
Logarithmic model

15.



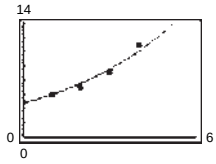
Exponential model

17.

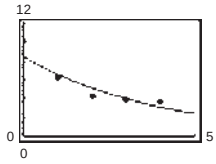


Linear model

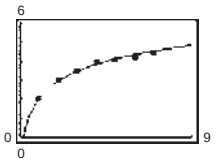
19. $y = 4.752(1.2607)^x$; 0.96773



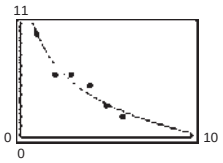
21. $y = 8.463(0.7775)^x$; 0.86639



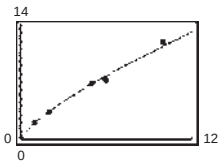
23. $y = 2.083 + 1.257 \ln x$; 0.98672



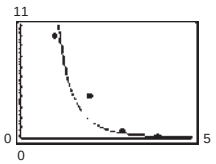
25. $y = 9.826 - 4.097 \ln x$; 0.93704



27. $y = 1.985x^{0.760}$; 0.99686

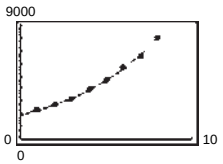


29. $y = 16.103x^{-3.174}$; 0.88161

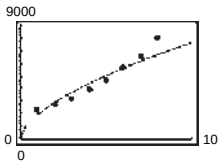


31. (a) Exponential model: $S = 1876.645(1.1980)^t$
Power model: $S = 1905.844t^{0.6018}$

(b) Exponential model:

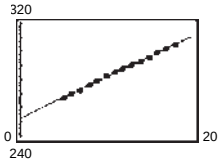


Power model:

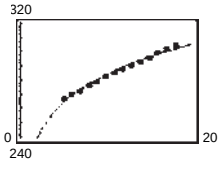


(c) Exponential model

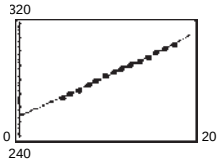
33. (a) Linear model: $P = 2.89t + 252.9$; $r^2 \approx 0.9987$



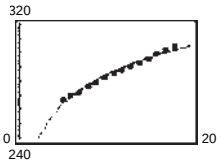
(b) Power model: $P = 222.94t^{0.1048}$; $r^2 \approx 0.9850$



(c) Exponential model: $P = 254.445(1.0102)^t$; $r^2 \approx 0.9972$



(d) Logarithmic model: $P = 29.813 \ln t + 215.36$; $r^2 \approx 0.9803$



(e) The linear model is the best fit because its coefficient of determination is closest to 1.

(f) Linear:

Year	2009	2010	2011	2012	2013	2014
Population (in millions)	307.8	310.7	313.6	316.5	319.4	322.3

Power:

Year	2009	2010	2011	2012	2013	2014
Population (in millions)	303.5	305.2	306.7	308.2	309.7	311.1

Exponential:

Year	2009	2010	2011	2012	2013	2014
Population (in millions)	308.6	311.7	314.9	318.1	321.3	324.6

Logarithmic:

Year	2009	2010	2011	2012	2013	2014
Population (in millions)	303.1	304.7	306.1	307.5	308.8	310.1

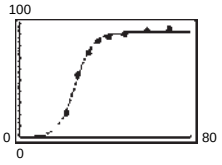
(g) and (h) Answers will vary.

35. (a) $y = 1315.584(1.0644)^t$ (b) $y = 1315.584e^{0.0624t}$

(c) About 2307 stores; Answers will vary.

37. (a) $y = \dfrac{91.3686}{1 + 765.5440e^{-0.2547x}}$

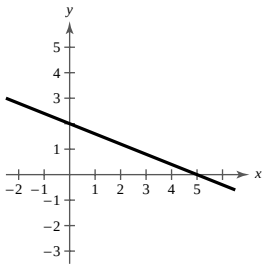
(b)



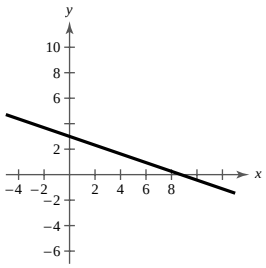
The model fits the data well.

39. True. See page 221. **41.** Answers will vary.

43. Slope: $-\frac{2}{5}$
y-intercept: $(0, 2)$



45. Slope: $-\frac{12}{35}$
y-intercept: $(0, 3)$

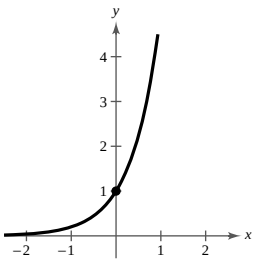


47. $y = -(x + 1)^2 + 2$ **49.** $y = -2(x - 3)^2 + 2$

Review Exercises (page 244)

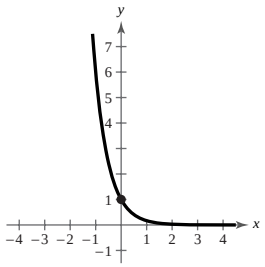
1. 10.3254 **3.** 0.0001 **5.** c **6.** d **7.** b **8.** a

9.



Horizontal asymptote: $y = 0$
y-intercept: $(0, 1)$
Increasing on $(-\infty, \infty)$

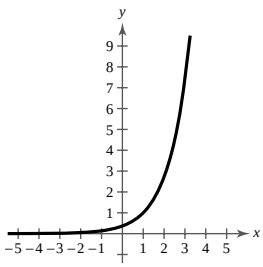
11.



Horizontal asymptote: $y = 0$
y-intercept: $(0, 1)$
Decreasing on $(-\infty, \infty)$

13.

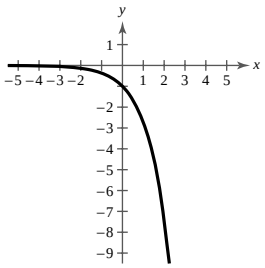
x	0	1	2	3	4
$h(x)$	0.37	1	2.72	7.39	20.09



Horizontal asymptote: $y = 0$

15.

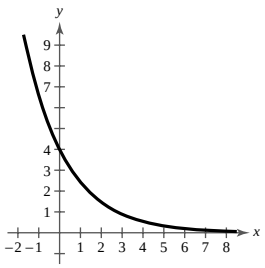
x	-2	-1	0	1	2
$h(x)$	-0.14	-0.37	-1	-2.72	-7.39



Horizontal asymptote: $y = 0$

17.

x	-1	0	1	2	3	4
$f(x)$	6.59	4	2.43	1.47	0.89	0.54



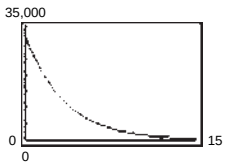
Horizontal asymptote: $y = 0$

19.

t	1	10	20
A	\$10,832.87	\$22,255.41	\$49,530.32

t	30	40	50
A	\$110,231.76	\$245,325.30	\$545,981.50

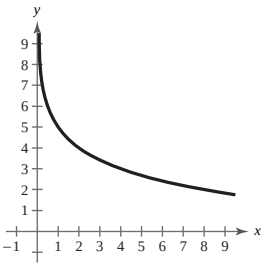
21. (a)



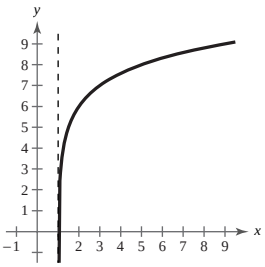
(b) \$18,000
(c) When it is first sold; Yes; Answers will vary.

23. $5^3 = 125$ **25.** $64^{1/6} = 2$ **27.** $\log_4 64 = 3$
29. $\log_{125} 25 = \frac{2}{3}$ **31.** $\log_{1/2} 8 = -3$ **33.** 3 **35.** -1

37. Domain: $(0, \infty)$
Vertical asymptote: $x = 0$
x-intercept: $(32, 0)$



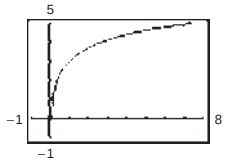
39. Domain: $(1, \infty)$
Vertical asymptote: $x = 1$
x-intercept: $(1.016, 0)$



CHAPTER 3

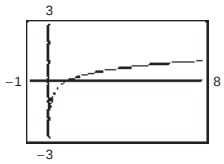
41. 3.068 **43.** 0.896

45.



Domain: $(0, \infty)$
Vertical asymptote: $x = 0$
x-intercept: $(0.05, 0)$

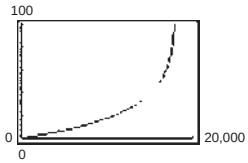
47.



Domain: $(0, \infty)$
Vertical asymptote: $x = 0$
x-intercept: $(1, 0)$

49. (a) $0 \le h < 18{,}000$

(b)



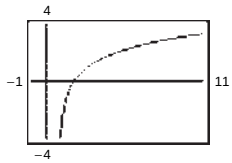
Asymptote: $h = 18{,}000$

(c) The time required to increase its altitude further increases.

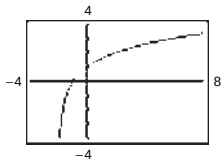
(d) 5.46 min

51. 1.585 **53.** 2.235

55.



57.



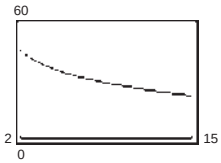
59. 1.13 **61.** 0.41 **63.** $\ln 5 - 2$ **65.** $2 + \log_{10} 2$

67. $1 + 2 \log_5 x$ **69.** $\log_{10} 5 + \frac{1}{2} \log_{10} y - 2 \log_{10} x$

71. $\ln(x + 3) - \ln x - \ln y$ **73.** $\log_2 9x$

75. $\ln \dfrac{\sqrt{2x - 1}}{(x + 1)^2}$ **77.** $\ln \dfrac{3\sqrt[3]{4 - x^2}}{x}$

79. (a)



(b)

h	4	6	8	10	12	14
s	38	33	30	27	25	23

(c) The decrease in productivity starts to level off.

81. 4 **83.** -3 **85.** -5 **87.** 4096 **89.** 9

91. e^4 **93.** $e^2 + 1$ **95.** -0.757 **97.** 4.459

99. 1.760 **101.** 3.916 **103.** 1.609, 0.693

105. 200.615 **107.** 36.945 **109.** 53.598

111. No solution **113.** 0.9 **115.** -1 **117.** 0.368

119. 10.05 yr **121.** e **122.** b **123.** f

124. d **125.** a **126.** c

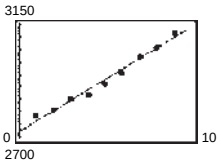
127. $k = 0.0177$; 11,407,330

129. (a) 9.52 weeks (b) 21.20 weeks

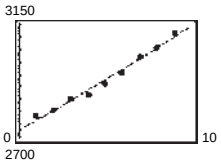
131. Logistic model

133. (a) Linear model: $N = 41.5t + 2722.1$; $r^2 \approx 0.9785$
Exponential model: $N = 2728(1.0142)^t$; $r^2 \approx 0.9818$
Power model: $N = 2727.6t^{0.0497}$; $r^2 \approx 0.8398$

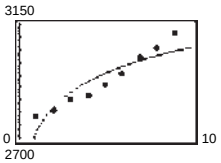
(b) Linear model:



Exponential model:



Power model:



(c) The exponential model is the best fit because its coefficient of determination is closest to 1.

(d) 3,141,090 (e) 2021–2022

135. True. $e^{x-1} = e^x \cdot e^{-1} = \dfrac{e^x}{e}$

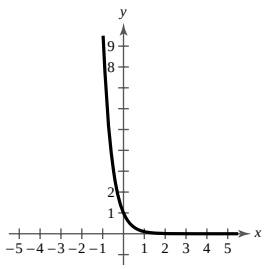
137. False. $x > 0$

139. Because $1 < \sqrt{2} < 2$, then $2^1 < 2^{\sqrt{2}} < 2^2$.

Chapter Test (page 248)

1.

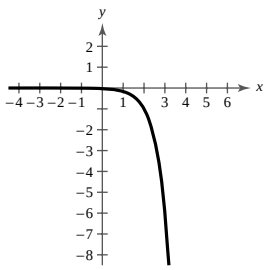
x	-2	-1	0	1	2
$f(x)$	100	10	1	0.1	0.01



Horizontal asymptote: $y = 0$
y-intercept: $(0, 1)$

2.

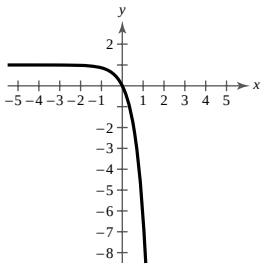
x	0	2	3	4
$f(x)$	-0.03	-1	-6	-36



Horizontal asymptote: $y = 0$
y-intercept: $\left(0, -\frac{1}{36}\right)$

3.

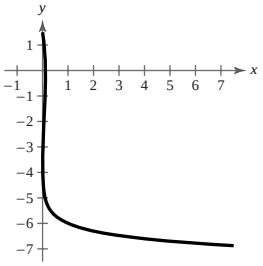
x	-2	-1	0	1	2
$f(x)$	0.9817	0.8647	0	-6.3891	-53.5982



Horizontal asymptote: $y = 1$
Intercept: $(0, 0)$

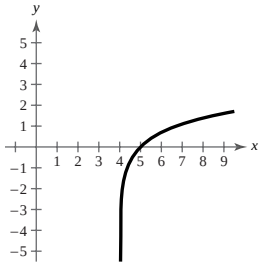
4. -0.89 **5.** 9.2 **6.** 2

7.



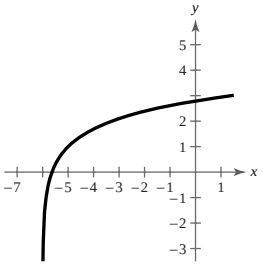
Domain: $(0, \infty)$
Vertical asymptote: $x = 0$
x-intercept: $(10^{-6}, 0)$

8.



Domain: $(4, \infty)$
Vertical asymptote: $x = 4$
x-intercept: $(5, 0)$

9.



Domain: $(-6, \infty)$
Vertical asymptote: $x = -6$
x-intercept: $(-5.63, 0)$

10. 1.945 **11.** 0.115 **12.** 1.674

13. $\log_2 3 + 4 \log_2 a$ **14.** $\ln 5 + \frac{1}{2} \ln x - \ln 6$

15. $\ln x + \frac{1}{2} \ln(x + 1) - \ln 2 - 4$ **16.** $\log_3 13y$

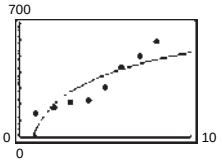
17. $\ln\left(\dfrac{x^4}{y^4}\right)$ **18.** $\ln\left[\dfrac{x(2x - 3)}{x + 2}\right]$ **19.** 4

20. 2.431 **21.** 343 **22.** 100,004 **23.** 1.321

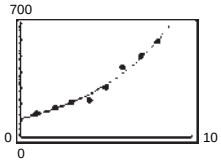
24. 1 **25.** 1.597 **26.** 1.649 **27.** 54.96%

28. (a) Logarithmic model: $R = 200.7 \ln t + 57.835$
Exponential model: $R = 115.47(1.227)^t$
Power model: $R = 119.22t^{0.6703}$

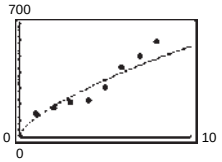
(b) Logarithmic model:



Exponential model:



Power model:



(c) Exponential model; \$2483.9 million

Cumulative Test for Chapters 1–3 (page 249)

1. (a) $y = -x + 3$
(b) Answers will vary.
Sample answer: $(0, 3), (1, 2), (2, 1)$

2. (a) $y = -2x$
(b) Answers will vary.
Sample answer: $(0, 0), (1, -2), (2, -4)$

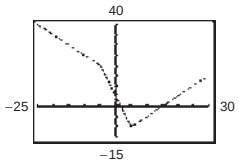
3. (a) $x = -\frac{3}{7}$
(b) Answers will vary.
Sample answer: $\left(-\frac{3}{7}, 0\right), \left(-\frac{3}{7}, 1\right), \left(-\frac{3}{7}, -3\right)$

4. (a) $\dfrac{5}{3}$ (b) Undefined (c) $\dfrac{5 + 4s}{3 + 4s}$

5. (a) -32 (b) 4 (c) 20

6. No. It doesn't pass the Vertical Line Test.

7.



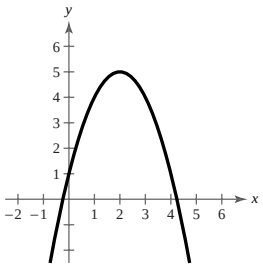
Decreasing on $(-\infty, 5)$
Increasing on $(5, \infty)$

8. (a) Vertical shrink
(b) Vertical shift
(c) Horizontal shift and reflection in the x-axis

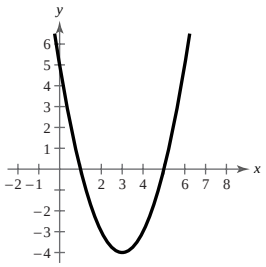
9. -53 **10.** $\frac{197}{16}$ **11.** -79 **12.** 42

13. $h^{-1}(x) = \dfrac{x + 2}{5}$

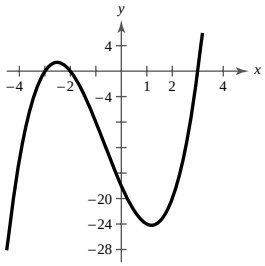
14.



15.



16.



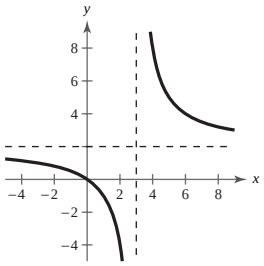
17. $x = -2, \pm 2i$ **18.** 1.424 **19.** $4x + 2 - \dfrac{15}{x + 3}$

20. $2x^2 + 7x + 48 + \dfrac{268}{x - 6}$ **21.** 41

22. Answers will vary.
Sample answer: $f(x) = x^4 + x^3 + 18x$

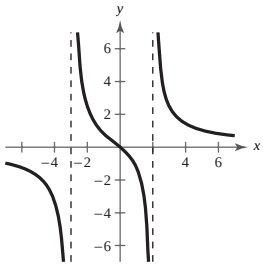
CHAPTER 3

23.



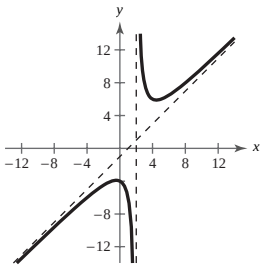
Asymptotes:
$x = 3, y = 2$

24.



Asymptotes:
$x = -3, x = 2, y = 0$

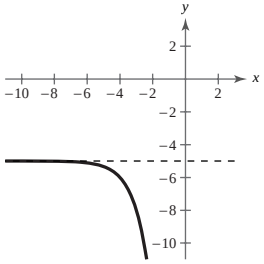
25.



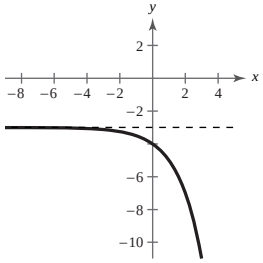
Asymptotes: $x = 2, y = x - 1$

26. 6.733 **27.** 8772.934 **28.** 0.202 **29.** 51.743

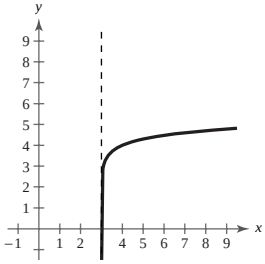
30.



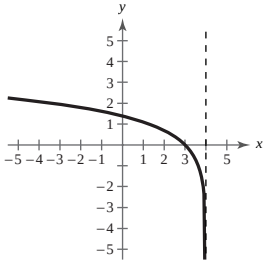
31.



32.



33.



34. 1.723 **35.** 0.872 **36.** 0.585

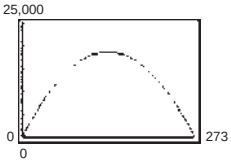
37. $\ln(x + 2) + \ln(x - 2) - \ln(x^2 + 1)$

38. $\ln\dfrac{x^2(x + 1)}{x - 1}$ **39.** 1.242 **40.** 6.585 **41.** 12.8

42. 152.018 **43.** 0, 1 **44.** No solution

45. (a) $A = x(273 - x)$

(b)

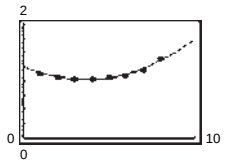


$0 < x < 273$

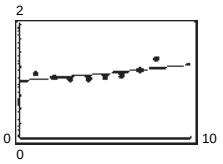
(c) 76.23 ft $\times$ 196.77 ft

46. (a) Quadratic model:
$y = 0.0178t^2 - 0.130t + 1.26$; $r^2 \approx 0.9778$
Exponential model: $y = 1.002(1.025)^t$; $r^2 \approx 0.4009$
Power model: $y = 1.041t^{0.0564}$; $r^2 \approx 0.1686$

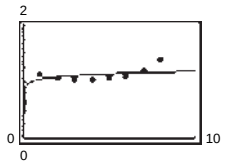
(b) Quadratic model:



Exponential model:



Power model:



(c) The quadratic model is the best fit because its coefficient of determination is closest to 1.

(d) \$1.74; Answers will vary.

Chapter 4

Section 4.1 (page 261)

1. Trigonometry **3.** standard position

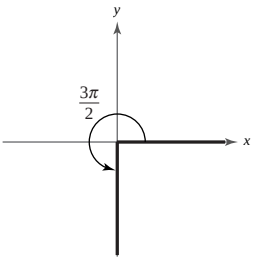
5. radian **7.** 180° **9.** No **11.** 2

13. (a) Quadrant I (b) Quadrant III

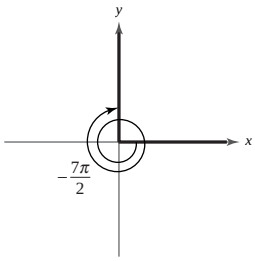
15. (a) Quadrant IV (b) Quadrant II

17. (a) Quadrant IV (b) Quadrant III

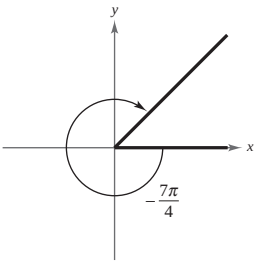
19. (a)



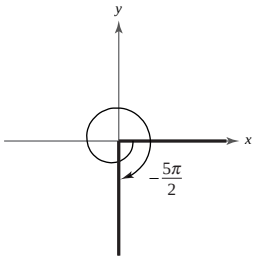
(b)



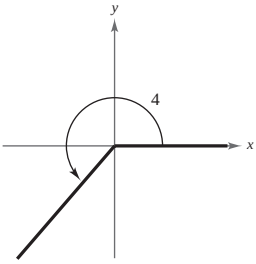
21. (a)



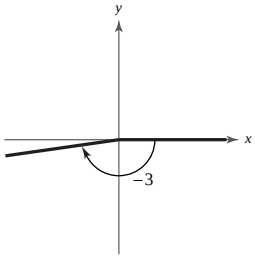
(b)



23. (a)



(b)



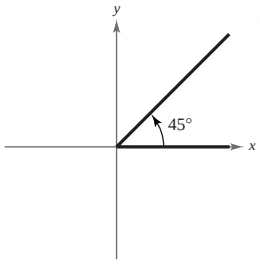
25. (a) $\dfrac{13\pi}{6}, -\dfrac{11\pi}{6}$ (b) $\dfrac{8\pi}{3}, -\dfrac{4\pi}{3}$

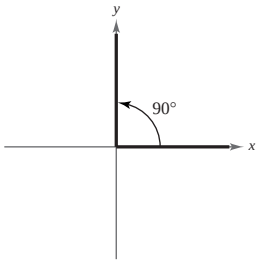
27. (a) $\dfrac{7\pi}{4}, -\dfrac{\pi}{4}$ (b) $\dfrac{28\pi}{15}, -\dfrac{32\pi}{15}$ **29.** 210°

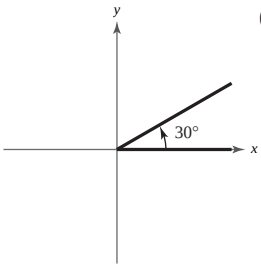
31. (a) Quadrant I (b) Quadrant III

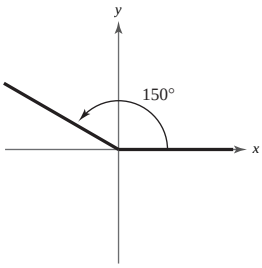
33. (a) Quadrant II (b) Quadrant IV

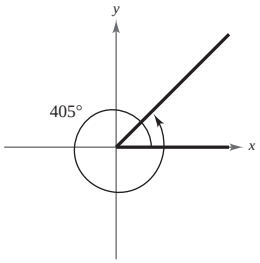
35. (a) Quadrant III (b) Quadrant I

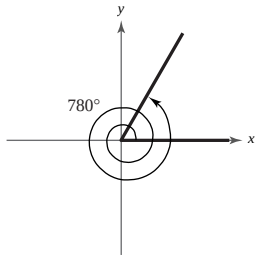
37. (a) 

(b) 

39. (a) 

(b) 

41. (a) 

(b) 

43. (a) $412°, -308°$ (b) $324°, -396°$

45. (a) $660°, -60°$ (b) $590°, -130°$

47. (a) $\frac{\pi}{6}$ (b) $\frac{5\pi}{6}$ **49.** (a) $-\frac{\pi}{9}$ (b) $-\frac{4\pi}{3}$

51. (a) $270°$ (b) $-210°$ **53.** (a) $420°$ (b) $-39°$

55. 2.007 **57.** -3.776 **59.** -0.014 **61.** $25.714°$

63. $1170°$ **65.** $-114.592°$ **67.** $64.75°$ **69.** $85.308°$

71. $-125.01°$ **73.** $280°\,36'$ **75.** $-345°\,7'\,12''$

77. $-20°\,20'\,24''$ **79.** Complement: $66°$; supplement: $156°$

81. Complement: $3°$; supplement: $93°$

83. Complement: $\frac{\pi}{6}$; supplement: $\frac{2\pi}{3}$

85. Complement: $\frac{\pi}{3}$; supplement: $\frac{5\pi}{6}$ **87.** $\frac{6}{5}$ rad

89. $\frac{8}{15}$ rad **91.** $\frac{70}{29}$ rad **93.** 14π in. **95.** 18π m

97. 22.92 ft **99.** 34.80 mi **101.** 591.32 mi

103. $4°\,2'\,33''$ **105.** 275.02° **107.** 436.97 km/min

109. (a) 80π rad/sec (b) 25π ft/sec

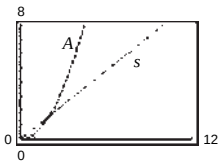
111. (a) 400π rad/min to 1000π rad/min (b) 6000π cm/min

113. False. A radian is larger: 1 rad $\approx 57.3°$.

115. True. The sum of the angles of a triangle must equal $180° = \pi$ radians, and $\frac{2\pi}{3} + \frac{\pi}{4} + \frac{\pi}{12} = \pi$.

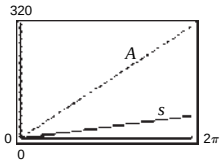
117. $\frac{50\pi}{3}$ m^2

119. (a) $A = 0.4r^2,\ r > 0;\ s = 0.8r,\ r > 0$

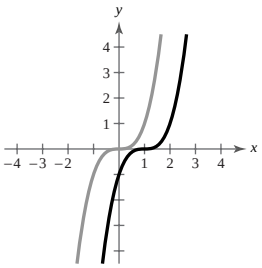


The area function changes more rapidly for $r > 1$ because it is quadratic and the arc length function is linear.

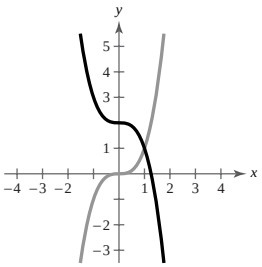
(b) $A = 50\theta,\ 0 < \theta < 2\pi;\ s = 10\theta,\ 0 < \theta < 2\pi$



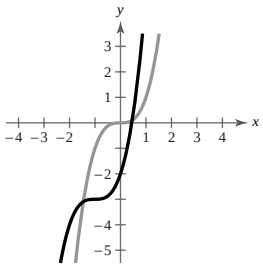
121. Answers will vary.

123. 

Horizontal shift one unit to the right

125. 

Reflection in the x-axis, vertical shift two units upward

127. 

Horizontal shift one unit to the left, vertical shift three units downward

Section 4.2 (page 270)

1. unit circle **3.** odd, even

5. Even: cos, sec; Odd: sin, csc, tan, cot **7.** 8

9. $\sin\theta = \frac{15}{17}$, $\cos\theta = -\frac{8}{17}$, $\tan\theta = -\frac{15}{8}$, $\csc\theta = \frac{17}{15}$, $\sec\theta = -\frac{17}{8}$, $\cot\theta = -\frac{8}{15}$

11. $\sin\theta = -\frac{5}{13}$, $\cos\theta = \frac{12}{13}$, $\tan\theta = -\frac{5}{12}$, $\csc\theta = -\frac{13}{5}$, $\sec\theta = \frac{13}{12}$, $\cot\theta = -\frac{12}{5}$

13. $\left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$ **15.** $\left(-\frac{\sqrt{3}}{2}, -\frac{1}{2}\right)$ **17.** $\left(-\frac{1}{2}, \frac{\sqrt{3}}{2}\right)$

19. $(0, -1)$ **21.** $\left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$

23. $\sin\frac{\pi}{4} = \frac{\sqrt{2}}{2}$, $\cos\frac{\pi}{4} = \frac{\sqrt{2}}{2}$, $\tan\frac{\pi}{4} = 1$

25. $\sin\left(-\frac{7\pi}{4}\right) = \frac{\sqrt{2}}{2}$, $\cos\left(-\frac{7\pi}{4}\right) = \frac{\sqrt{2}}{2}$, $\tan\left(-\frac{7\pi}{4}\right) = 1$

CHAPTER 4

27. $\sin\frac{2\pi}{3} = \frac{\sqrt{3}}{2}$
$\cos\frac{2\pi}{3} = -\frac{1}{2}$
$\tan\frac{2\pi}{3} = -\sqrt{3}$

29. $\sin\left(-\frac{5\pi}{3}\right) = \frac{\sqrt{3}}{2}$
$\cos\left(-\frac{5\pi}{3}\right) = \frac{1}{2}$
$\tan\left(-\frac{5\pi}{3}\right) = \sqrt{3}$

31. $\sin\left(-\frac{\pi}{6}\right) = -\frac{1}{2}$
$\cos\left(-\frac{\pi}{6}\right) = \frac{\sqrt{3}}{2}$
$\tan\left(-\frac{\pi}{6}\right) = -\frac{\sqrt{3}}{3}$

33. $\sin\frac{3\pi}{4} = \frac{\sqrt{2}}{2}$
$\cos\frac{3\pi}{4} = -\frac{\sqrt{2}}{2}$
$\tan\frac{3\pi}{4} = -1$
$\csc\frac{3\pi}{4} = \sqrt{2}$
$\sec\frac{3\pi}{4} = -\sqrt{2}$
$\cot\frac{3\pi}{4} = -1$

35. $\sin\frac{\pi}{2} = 1$
$\cos\frac{\pi}{2} = 0$
$\tan\frac{\pi}{2}$ is undefined.
$\csc\frac{\pi}{2} = 1$
$\sec\frac{\pi}{2}$ is undefined.
$\cot\frac{\pi}{2} = 0$

37. $\sin\left(-\frac{4\pi}{3}\right) = \frac{\sqrt{3}}{2}$
$\cos\left(-\frac{4\pi}{3}\right) = -\frac{1}{2}$
$\tan\left(-\frac{4\pi}{3}\right) = -\sqrt{3}$
$\csc\left(-\frac{4\pi}{3}\right) = \frac{2\sqrt{3}}{3}$
$\sec\left(-\frac{4\pi}{3}\right) = -2$
$\cot\left(-\frac{4\pi}{3}\right) = -\frac{\sqrt{3}}{3}$

39. 0 **41.** $-\frac{1}{2}$ **43.** $\frac{\sqrt{3}}{2}$ **45.** $-\frac{\sqrt{2}}{2}$

47. (a) $-\frac{1}{3}$ (b) -3 **49.** (a) $-\frac{1}{5}$ (b) -5

51. (a) $\frac{4}{5}$ (b) $-\frac{4}{5}$ **53.** 0.4339 **55.** 0.8090

57. 1.0378 **59.** -0.1288 **61.** 1.3940 **63.** -1.4486

65. -1.3386 **67.** -1.0025 **69.** -2.4950

71. (a) -0.9 (b) -0.4 **73.** (a) 0.25, 2.89 (b) 1.82, 4.46

75. 0.79 amp **77.** (a) 0.25 ft (b) 0.02 ft (c) -0.25 ft

79. False. $\sin(-t) = -\sin t$ means that the function is odd, not that the sine of a negative angle is a negative number.

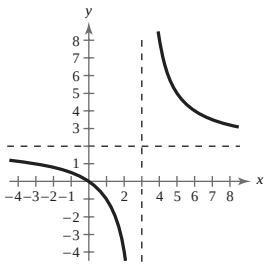
81. True. $a - 6\pi$ is coterminal with a.

83. True. The values are the same.

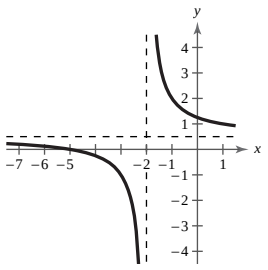
85. (a) Origin (b) $\sin(t_1 + \pi) = -\sin t_1$
(c) $\cos(t_1 + \pi) = -\cos t_1$

87. Answers will vary. **89.** It is an even function.

91.



93.



Section 4.3 (page 280)

1. (a) iii (b) vi (c) ii (d) v (e) i (f) iv

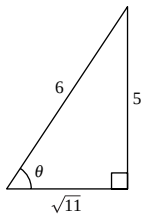
3. elevation, depression **5.** 12

7. $\sin\theta = \frac{9}{41}$
$\cos\theta = \frac{40}{41}$
$\tan\theta = \frac{9}{40}$
$\csc\theta = \frac{41}{9}$
$\sec\theta = \frac{41}{40}$
$\cot\theta = \frac{40}{9}$

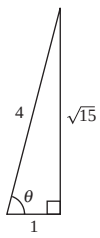
9. $\sin\theta = \frac{8}{17}$
$\cos\theta = \frac{15}{17}$
$\tan\theta = \frac{8}{15}$
$\csc\theta = \frac{17}{8}$
$\sec\theta = \frac{17}{15}$
$\cot\theta = \frac{15}{8}$

11. $\sin\theta = \frac{3}{5}$ $\csc\theta = \frac{5}{3}$
$\cos\theta = \frac{4}{5}$ $\sec\theta = \frac{5}{4}$
$\tan\theta = \frac{3}{4}$ $\cot\theta = \frac{4}{3}$
The triangles are similar and corresponding sides are proportional.

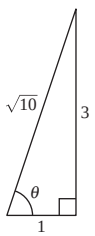
13. $\cos\theta = \frac{\sqrt{11}}{6}$
$\tan\theta = \frac{5\sqrt{11}}{11}$
$\csc\theta = \frac{6}{5}$
$\sec\theta = \frac{6\sqrt{11}}{11}$
$\cot\theta = \frac{\sqrt{11}}{5}$



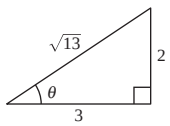
15. $\sin\theta = \frac{\sqrt{15}}{4}$
$\cos\theta = \frac{1}{4}$
$\tan\theta = \sqrt{15}$
$\csc\theta = \frac{4\sqrt{15}}{15}$
$\cot\theta = \frac{\sqrt{15}}{15}$



17. $\sin\theta = \frac{3\sqrt{10}}{10}$
$\cos\theta = \frac{\sqrt{10}}{10}$
$\csc\theta = \frac{\sqrt{10}}{3}$
$\sec\theta = \sqrt{10}$
$\cot\theta = \frac{1}{3}$



19. $\sin\theta = \frac{2\sqrt{13}}{13}$
$\cos\theta = \frac{3\sqrt{13}}{13}$
$\tan\theta = \frac{2}{3}$
$\sec\theta = \frac{\sqrt{13}}{3}$
$\csc\theta = \frac{\sqrt{13}}{2}$



21. $\frac{\pi}{6}, \frac{1}{2}$ **23.** 60°, $\sqrt{3}$ **25.** 60°, $\frac{\pi}{3}$ **27.** 30°, $\frac{\sqrt{3}}{2}$

29. 45°, $\frac{\pi}{4}$ **31.** (a) 0.1736 (b) 0.1736

33. (a) 1.3499 (b) 1.3432 **35.** (a) 5.0273 (b) 0.4142

37. $\csc\theta$ **39.** $\cot\theta$ **41.** $\cos\theta$ **43.** $\frac{\sin\theta}{\cos\theta}$ **45.** 1

47. $\cos\theta$ **49.** $\cot\theta$ **51.** $\csc\theta$

53. (a) $\sqrt{3}$ (b) $\frac{1}{2}$ (c) $\frac{\sqrt{3}}{2}$ (d) $\frac{\sqrt{3}}{3}$

55. (a) $\frac{1}{3}$ (b) $\frac{2\sqrt{2}}{3}$ (c) $\frac{\sqrt{2}}{4}$ (d) 3

57. (a) 3 (b) $\frac{2\sqrt{2}}{3}$ (c) $\frac{\sqrt{2}}{4}$ (d) $\frac{1}{3}$

59–65. Answers will vary.

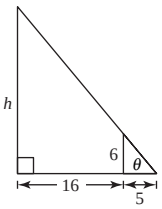
67. (a) $30° = \frac{\pi}{6}$ (b) $30° = \frac{\pi}{6}$

69. (a) $60° = \frac{\pi}{3}$ (b) $45° = \frac{\pi}{4}$

71. (a) $60° = \frac{\pi}{3}$ (b) $45° = \frac{\pi}{4}$

73. $y = 35\sqrt{3}$, $r = 70\sqrt{3}$ **75.** $x = 8$, $y = 8\sqrt{3}$

77. (a)



(b) $\tan\theta = \frac{h}{21}$

(c) $h = 25.2$ ft

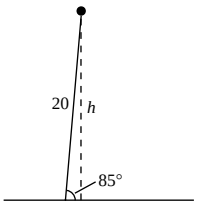
79. (a) 45°

(b) $50\sqrt{2}$ ft

(c) $\frac{25\sqrt{2}}{3}$ ft/sec; $\frac{25}{3}$ ft/sec

81. 160 ft

83. (a)



(b) $\sin 85° = \frac{h}{20}$

(c) 19.9 m

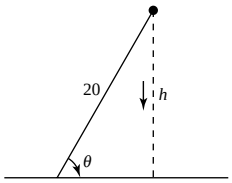
(d) The side of the triangle labeled h will become shorter.

(e)

Angle, θ	80°	70°	60°	50°
Height	19.7	18.8	17.3	15.3

Angle, θ	40°	30°	20°	10°
Height	12.9	10.0	6.8	3.5

(f) As $\theta \to 0°$, $h \to 0$.



85. False. $\frac{\sqrt{2}}{2} + \frac{\sqrt{2}}{2} \neq 1$

87. Yes, with the Pythagorean Theorem. Answers will vary.

89. (a)

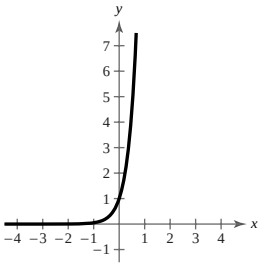
θ	0°	20°	40°	60°	80°
$\sin\theta$	0	0.3420	0.6428	0.8660	0.9848
$\cos\theta$	1	0.9397	0.7660	0.5	0.1736
$\tan\theta$	0	0.3640	0.8391	1.7321	5.6713

(b) Sine: increasing; cosine: decreasing; tangent: increasing

(c) Answers will vary.

91.

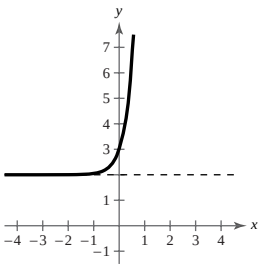
x	-1	0	1	2
$f(x)$	0.05	1	20.09	403.43



Asymptote: $y = 0$

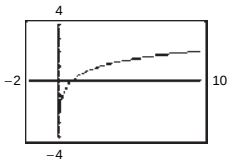
93.

x	-1	0	1	2
$f(x)$	2.05	3	22.09	405.43



Asymptote: $y = 2$

95.

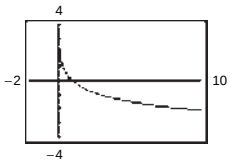


Domain: $(0, \infty)$

Vertical asymptote: $x = 0$

x-intercept: $(1, 0)$

97.



Domain: $(0, \infty)$

Vertical asymptote: $x = 0$

x-intercept: $(1, 0)$

Section 4.4 (page 289)

1. $\frac{y}{r}$ **3.** $\frac{y}{x}$ **5.** $\cos\theta$ **7.** reference angle **9.** $0, \pi$

11. (a) $\sin\theta = \frac{3}{5}$, $\cos\theta = \frac{4}{5}$, $\tan\theta = \frac{3}{4}$, $\csc\theta = \frac{5}{3}$, $\sec\theta = \frac{5}{4}$, $\cot\theta = \frac{4}{3}$

(b) $\sin\theta = -\frac{15}{17}$, $\cos\theta = -\frac{8}{17}$, $\tan\theta = \frac{15}{8}$, $\csc\theta = -\frac{17}{15}$, $\sec\theta = -\frac{17}{8}$, $\cot\theta = \frac{8}{15}$

13. (a) $\sin\theta = -\frac{1}{2}$, $\cos\theta = -\frac{\sqrt{3}}{2}$, $\tan\theta = \frac{\sqrt{3}}{3}$, $\csc\theta = -2$, $\sec\theta = -\frac{2\sqrt{3}}{3}$, $\cot\theta = \sqrt{3}$

(b) $\sin\theta = \frac{\sqrt{2}}{2}$, $\cos\theta = -\frac{\sqrt{2}}{2}$, $\tan\theta = -1$, $\csc\theta = \sqrt{2}$, $\sec\theta = -\sqrt{2}$, $\cot\theta = -1$

CHAPTER 4

15. $\sin\theta = \frac{24}{25}$, $\cos\theta = \frac{7}{25}$, $\tan\theta = \frac{24}{7}$, $\csc\theta = \frac{25}{24}$, $\sec\theta = \frac{25}{7}$, $\cot\theta = \frac{7}{24}$

17. $\sin\theta = -\frac{12}{13}$, $\cos\theta = \frac{5}{13}$, $\tan\theta = -\frac{12}{5}$, $\csc\theta = -\frac{13}{12}$, $\sec\theta = \frac{13}{5}$, $\cot\theta = -\frac{5}{12}$

19. $\sin\theta = \frac{5\sqrt{29}}{29}$, $\cos\theta = -\frac{2\sqrt{29}}{29}$, $\tan\theta = -\frac{5}{2}$, $\csc\theta = \frac{\sqrt{29}}{5}$, $\sec\theta = -\frac{\sqrt{29}}{2}$, $\cot\theta = -\frac{2}{5}$

21. $\sin\theta = \frac{4\sqrt{41}}{41}$, $\cos\theta = -\frac{5\sqrt{41}}{41}$, $\tan\theta = -\frac{4}{5}$, $\csc\theta = \frac{\sqrt{41}}{4}$, $\sec\theta = -\frac{\sqrt{41}}{5}$, $\cot\theta = -\frac{5}{4}$

23. Quadrant III

25. Quadrant I

27. $\sin\theta = \frac{3}{5}$, $\cos\theta = -\frac{4}{5}$, $\tan\theta = -\frac{3}{4}$, $\csc\theta = \frac{5}{3}$, $\sec\theta = -\frac{5}{4}$, $\cot\theta = -\frac{4}{3}$

29. $\sin\theta = -\frac{15}{17}$, $\cos\theta = \frac{8}{17}$, $\tan\theta = -\frac{15}{8}$, $\csc\theta = -\frac{17}{15}$, $\sec\theta = \frac{17}{8}$, $\cot\theta = -\frac{8}{15}$

31. $\sin\theta = \frac{\sqrt{3}}{2}$, $\cos\theta = -\frac{1}{2}$, $\tan\theta = -\sqrt{3}$, $\csc\theta = \frac{2\sqrt{3}}{3}$, $\sec\theta = -2$, $\cot\theta = -\frac{\sqrt{3}}{3}$

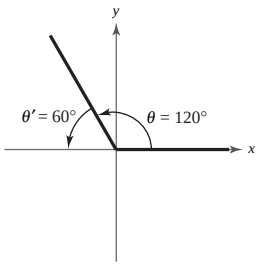
33. $\sin\theta = 0$, $\cos\theta = -1$, $\tan\theta = 0$, $\csc\theta$ is undefined., $\sec\theta = -1$, $\cot\theta$ is undefined.

35. $\sin\theta = \frac{\sqrt{2}}{2}$, $\cos\theta = -\frac{\sqrt{2}}{2}$, $\tan\theta = -1$, $\csc\theta = \sqrt{2}$, $\sec\theta = -\sqrt{2}$, $\cot\theta = -1$

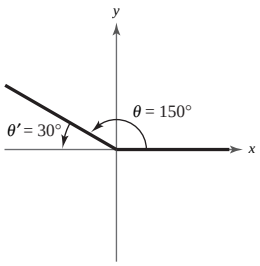
37. $\sin\theta = -\frac{2\sqrt{5}}{5}$, $\cos\theta = -\frac{\sqrt{5}}{5}$, $\tan\theta = 2$, $\csc\theta = -\frac{\sqrt{5}}{2}$, $\sec\theta = -\sqrt{5}$, $\cot\theta = \frac{1}{2}$

39. -1 **41.** 0 **43.** 1 **45.** Undefined

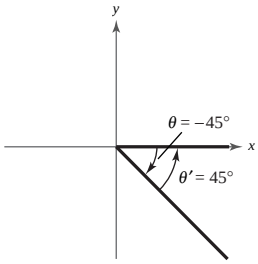
47. $\theta' = 60°$



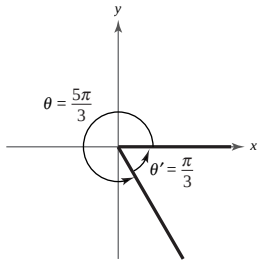
49. $\theta' = 30°$



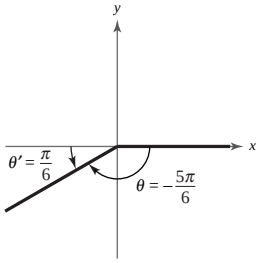
51. $\theta' = 45°$



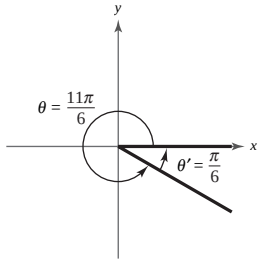
53. $\theta' = \frac{\pi}{3}$



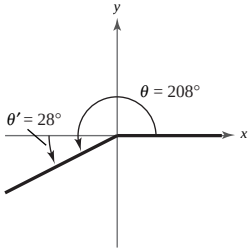
55. $\theta' = \frac{\pi}{6}$



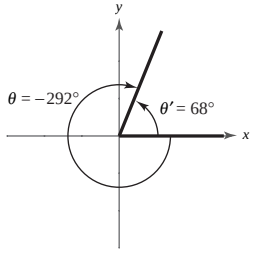
57. $\theta' = \frac{\pi}{6}$



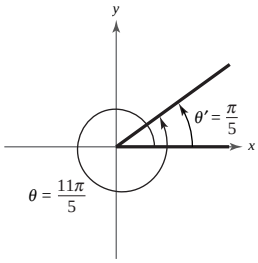
59. $\theta' = 28°$



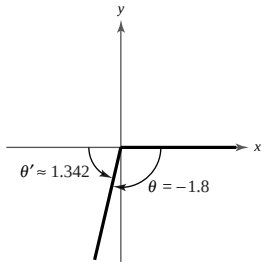
61. $\theta' = 68°$



63. $\theta' = \frac{\pi}{5}$



65. $\theta' \approx 1.342$



67. $\sin 225° = -\frac{\sqrt{2}}{2}$, $\cos 225° = -\frac{\sqrt{2}}{2}$, $\tan 225° = 1$

69. $\sin(-750°) = -\frac{1}{2}$, $\cos(-750°) = \frac{\sqrt{3}}{2}$, $\tan(-750°) = -\frac{\sqrt{3}}{3}$

71. $\sin\frac{5\pi}{3} = -\frac{\sqrt{3}}{2}$, $\cos\frac{5\pi}{3} = \frac{1}{2}$, $\tan\frac{5\pi}{3} = -\sqrt{3}$

73. $\sin\left(-\frac{\pi}{6}\right) = -\frac{1}{2}$, $\cos\left(-\frac{\pi}{6}\right) = \frac{\sqrt{3}}{2}$, $\tan\left(-\frac{\pi}{6}\right) = -\frac{\sqrt{3}}{3}$

75. $\sin\frac{11\pi}{4} = \frac{\sqrt{2}}{2}$ $\cos\frac{11\pi}{4} = -\frac{\sqrt{2}}{2}$ $\tan\frac{11\pi}{4} = -1$

77. $\sin\left(-\frac{17\pi}{6}\right) = -\frac{1}{2}$ $\cos\left(-\frac{17\pi}{6}\right) = -\frac{\sqrt{3}}{2}$ $\tan\left(-\frac{17\pi}{6}\right) = \frac{\sqrt{3}}{3}$

79. $\frac{4}{5}$ **81.** $-\sqrt{3}$ **83.** $\frac{\sqrt{65}}{4}$

85. $\cos\theta = -\frac{\sqrt{21}}{5}$ $\tan\theta = -\frac{2\sqrt{21}}{21}$ $\csc\theta = \frac{5}{2}$ $\sec\theta = -\frac{5\sqrt{21}}{21}$ $\cot\theta = -\frac{\sqrt{21}}{2}$

87. $\sin\theta = \frac{4\sqrt{17}}{17}$ $\cos\theta = -\frac{\sqrt{17}}{17}$ $\csc\theta = \frac{\sqrt{17}}{4}$ $\sec\theta = -\sqrt{17}$ $\cot\theta = -\frac{1}{4}$

89. $\sin\theta = -\frac{2}{3}$ $\cos\theta = \frac{\sqrt{5}}{3}$ $\tan\theta = -\frac{2\sqrt{5}}{5}$ $\sec\theta = \frac{3\sqrt{5}}{5}$ $\cot\theta = -\frac{\sqrt{5}}{2}$

91. 0.1736 **93.** 2.1445 **95.** -0.3420

97. 5.7588 **99.** 0.8391 **101.** -2.9238

103. (a) $30° = \frac{\pi}{6}, 150° = \frac{5\pi}{6}$ (b) $210° = \frac{7\pi}{6}, 330° = \frac{11\pi}{6}$

105. (a) $60° = \frac{\pi}{3}, 120° = \frac{2\pi}{3}$ (b) $135° = \frac{3\pi}{4}, 315° = \frac{7\pi}{4}$

107. (a) $150° = \frac{5\pi}{6}, 210° = \frac{7\pi}{6}$ (b) $120° = \frac{2\pi}{3}, 240° = \frac{4\pi}{3}$

109. (a) $\frac{1+\sqrt{3}}{2}$ (b) $\frac{\sqrt{3}-1}{2}$ (c) $\frac{3}{4}$ (d) $\frac{\sqrt{3}}{4}$ (e) $\frac{\sqrt{3}}{2}$ (f) $\frac{\sqrt{3}}{2}$

111. (a) 0 (b) $\sqrt{2}$ (c) $\frac{1}{2}$ (d) $-\frac{1}{2}$ (e) -1 (f) $\frac{\sqrt{2}}{2}$

113. (a) $\frac{1-\sqrt{3}}{2}$ (b) $-\frac{1+\sqrt{3}}{2}$ (c) $\frac{3}{4}$ (d) $-\frac{\sqrt{3}}{4}$ (e) $-\frac{\sqrt{3}}{2}$ (f) $-\frac{\sqrt{3}}{2}$

115. (a) $-\frac{1+\sqrt{3}}{2}$ (b) $\frac{1-\sqrt{3}}{2}$ (c) $\frac{3}{4}$ (d) $\frac{\sqrt{3}}{4}$ (e) $\frac{\sqrt{3}}{2}$ (f) $-\frac{\sqrt{3}}{2}$

117. (a) $-\frac{1+\sqrt{3}}{2}$ (b) $\frac{-1+\sqrt{3}}{2}$ (c) $\frac{1}{4}$ (d) $\frac{\sqrt{3}}{4}$ (e) $\frac{\sqrt{3}}{2}$ (f) $-\frac{1}{2}$

119. (a) -1 (b) 1 (c) 0 (d) 0 (e) 0 (f) 0

121. (a) -1 (b) 1 (c) 0 (d) 0 (e) 0 (f) 0

123. (a) 60.4°F (b) 92.3°F (c) 76.35°F

125. (a) 12 mi (b) 6 mi (c) 6.93 mi

127. True. $0 < \cos\theta < 1$ in Quadrant I, so $\sin\theta < \frac{\sin\theta}{\cos\theta} = \tan\theta$.

129. False. Sine is positive in Quadrant II.

131. (a)

θ	0°	20°	40°
$\sin\theta$	0	0.3420	0.6428
$\sin(180° - \theta)$	0	0.3420	0.6428

θ	60°	80°
$\sin\theta$	0.8660	0.9848
$\sin(180° - \theta)$	0.8660	0.9848

(b) $\sin\theta = \sin(180° - \theta)$

133. The calculator mode is in degrees instead of radians.

135. 7 **137.** 3.449, -1.449 **139.** 4.908, -5.908

Section 4.5 (page 299)

1. amplitude **3.** $\frac{2\pi}{b}$ **5.** 2π

7. It vertically shifts the graph d units.

9. (a) $x = -2\pi, -\pi, 0, \pi, 2\pi$ (b) $y = 0$

(c) Increasing: $\left(-2\pi, -\frac{3\pi}{2}\right), \left(-\frac{\pi}{2}, \frac{\pi}{2}\right), \left(\frac{3\pi}{2}, 2\pi\right)$

Decreasing: $\left(-\frac{3\pi}{2}, -\frac{\pi}{2}\right), \left(\frac{\pi}{2}, -\frac{3\pi}{2}\right)$

(d) Relative maxima: $\left(-\frac{3\pi}{2}, 1\right), \left(\frac{\pi}{2}, 1\right)$

Relative minima: $\left(-\frac{\pi}{2}, -1\right), \left(\frac{3\pi}{2}, -1\right)$

11. Period: π Amplitude: 3

13. Period: 4π Amplitude: $\frac{5}{2}$

15. Period: 2 Amplitude: $\frac{2}{3}$

17. Period: 2π Amplitude: 2

19. Period: 3π Amplitude: $\frac{1}{4}$

21. g is a shift of f π units to the right.

23. g is a reflection of f in the x-axis.

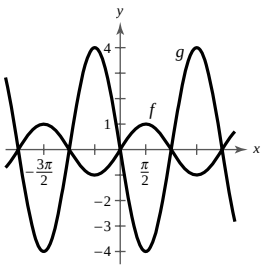
25. g is a reflection of f in the x-axis and has five times the amplitude of f.

27. g is a shift of f three units upward.

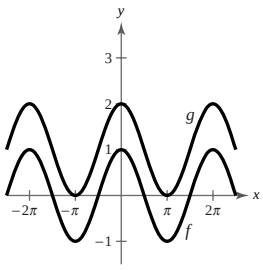
29. g has twice the amplitude of f.

31. g is a horizontal shift of f π units to the right.

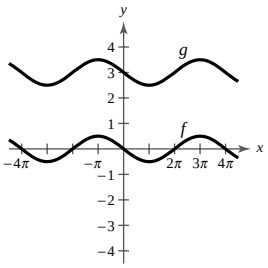
33.



35.

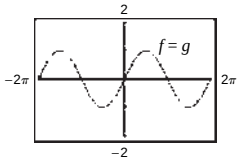


37.



CHAPTER 4

39.



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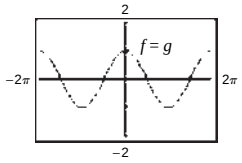
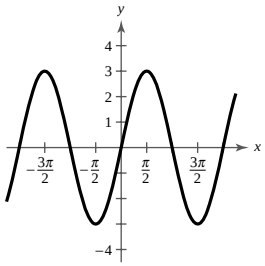


43.



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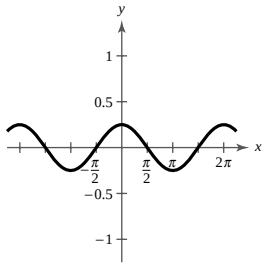

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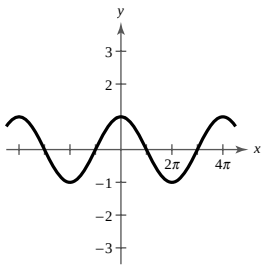

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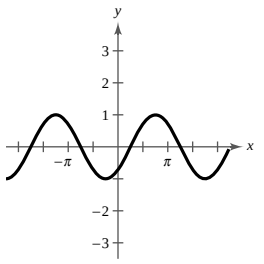

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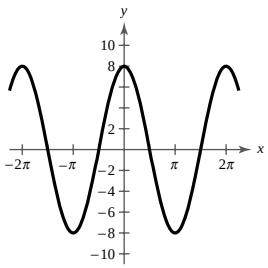
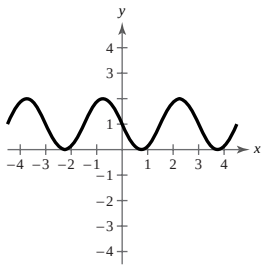


53.



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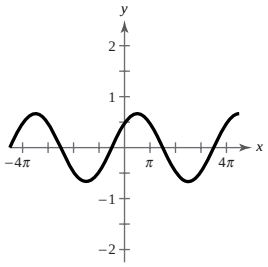
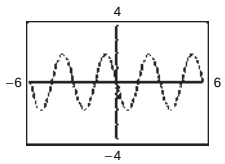
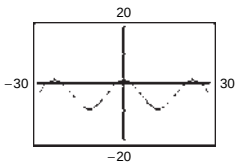


57.



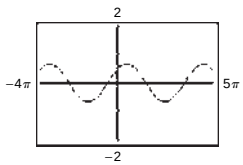
Amplitude: 2
Period: 3

59.



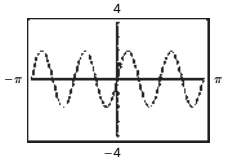
Amplitude: 5
Period: 24

61.



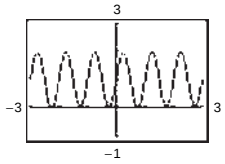
Amplitude: $\frac{2}{3}$
Period: 4π

63.



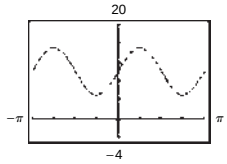
Amplitude: 2
Period: $\frac{\pi}{2}$

65.



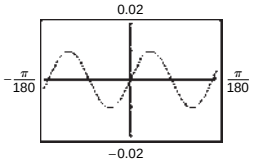
Amplitude: 1
Period: 1

67.



Amplitude: 5
Period: π

69.

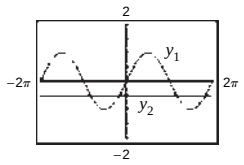


Amplitude: $\frac{1}{100}$
Period: $\frac{1}{60}$

71. $a = -4, d = 4$ **73.** $a = -6, d = 1$

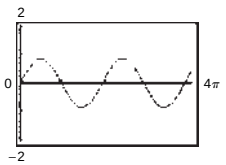
75. $a = -3, b = 2, c = 0$ **77.** $a = 1, b = 1, c = \frac{\pi}{4}$

79.



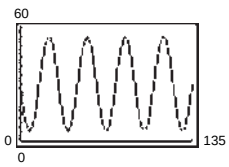
$x = -\frac{\pi}{6}, -\frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$

81. (a)



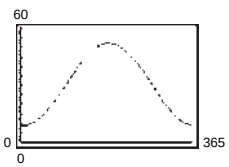
(b) 6 sec
(c) 10 cycles/min
(d) The period of the model would decrease because the time for a respiratory cycle would decrease.

83. (a)



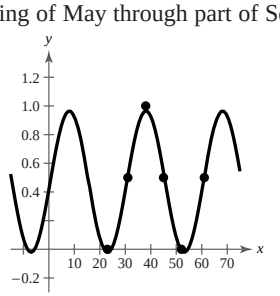
(b) Minimum height: 5 ft
Maximum height: 55 ft

85. (a) 365 days. The cycle is 1 year.
(b) 30.3 gallons per day. The average is the constant term of the model.
(c)



Consumption exceeds 40 gallons per day from the beginning of May through part of September.

87. (a) and (c)

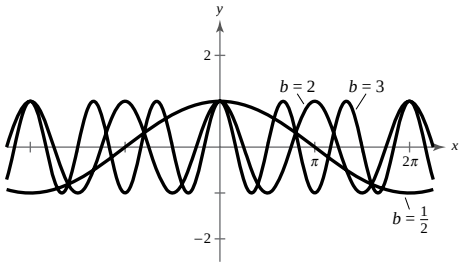


The model fits the data well.
(b) $y = 0.493 \sin(0.209x - 0.114) + 0.472$
(d) 30 days (e) 12.9%

89. True. The period of $\sin x$ is 2π. Adding 2π moves the graph one period to the right.

91. False. The function $y = \frac{1}{2}\cos 2x$ has an amplitude that is one-half that of the function $y = \cos x$.

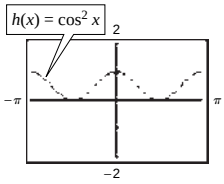
93.



The value of b affects the period of the graph.
$b = \frac{1}{2} \rightarrow \frac{1}{2}$ cycle
$b = 2 \rightarrow 2$ cycles
$b = 3 \rightarrow 3$ cycles

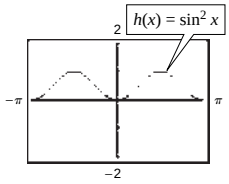
95. e **97.** c

99. (a) $h(x) = \cos^2 x$



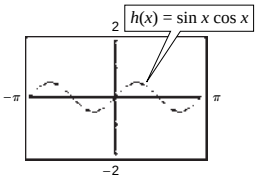
Even

(b) $h(x) = \sin^2 x$



Even

(c) $h(x) = \sin x \cos x$



Odd

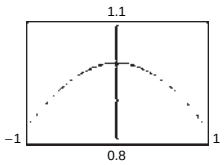
101. (a)

x	-1	-0.1	-0.01
$\frac{\sin x}{x}$	0.8415	0.9983	1.0000

x	-0.001	0	0.001
$\frac{\sin x}{x}$	1.0000	Undefined	1.0000

x	0.01	0.1	1
$\frac{\sin x}{x}$	1.0000	0.9983	0.8415

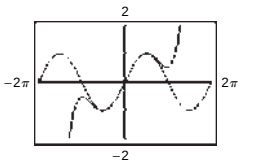
(b)



$f \rightarrow 1$ as $x \rightarrow 0$

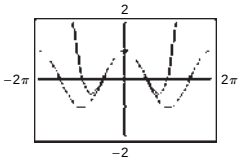
(c) The ratio approaches 1 as x approaches 0.

103. (a)



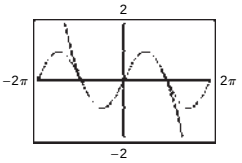
The polynomial function is a good approximation of the sine function when x is close to 0.

(b)

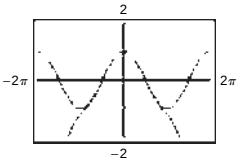


The polynomial function is a good approximation of the cosine function when x is close to 0.

(c) $\sin x \approx x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!}$

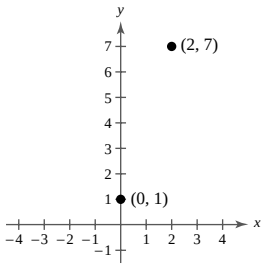


$\cos x \approx 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!}$



The accuracy increased.

105. $m = 3$



107. 487.014° **109.** Answers will vary.

Section 4.6 (page 311)

1. vertical **3.** tangent, cotangent

5. (a) $x = -2\pi, -\pi, 0, \pi, 2\pi$ (b) $y = 0$

(c) Increasing on $\left(-2\pi, -\frac{3\pi}{2}\right), \left(-\frac{3\pi}{2}, -\frac{\pi}{2}\right), \left(-\frac{\pi}{2}, \frac{\pi}{2}\right), \left(\frac{\pi}{2}, \frac{3\pi}{2}\right), \left(\frac{3\pi}{2}, 2\pi\right)$

(d) No relative extrema

(e) $x = -\frac{3\pi}{2}, -\frac{\pi}{2}, \frac{\pi}{2}, \frac{3\pi}{2}$

7. (a) No x-intercepts (b) $y = 1$

(c) Increasing on $\left(-2\pi, -\frac{3\pi}{2}\right), \left(-\frac{3\pi}{2}, -\pi\right), \left(0, \frac{\pi}{2}\right), \left(\frac{\pi}{2}, \pi\right)$

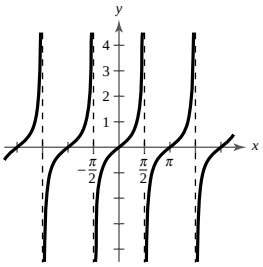
Decreasing on $\left(-\pi, -\frac{\pi}{2}\right), \left(-\frac{\pi}{2}, 0\right), \left(\pi, \frac{3\pi}{2}\right), \left(\frac{3\pi}{2}, 2\pi\right)$

(d) Relative minima: $(-2\pi, 1), (0, 1), (2\pi, 1)$
Relative maxima: $(-\pi, -1), (\pi, -1)$

(e) $x = -\frac{3\pi}{2}, -\frac{\pi}{2}, \frac{\pi}{2}, \frac{3\pi}{2}$

CHAPTER 4

9.



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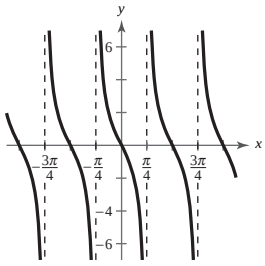

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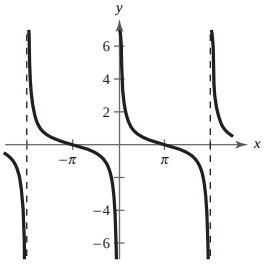
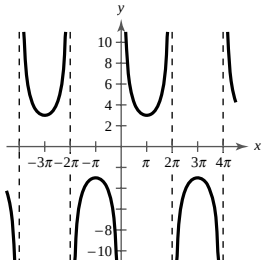
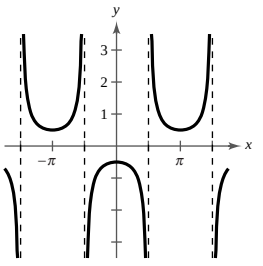


15.



17.



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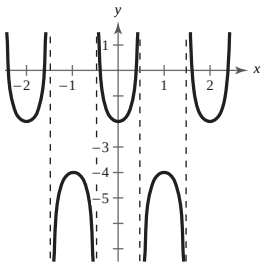

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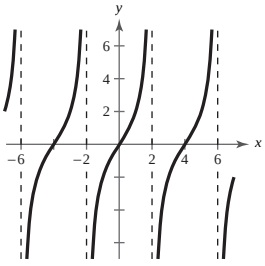
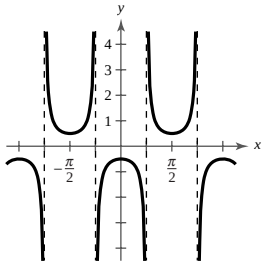
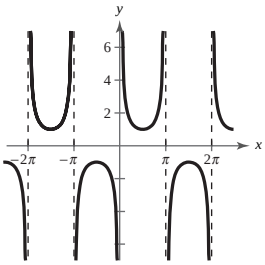


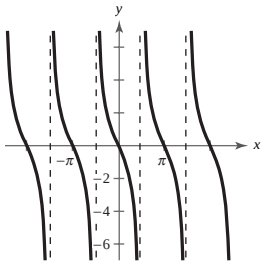
23.



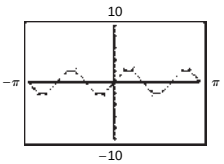
25.



27.

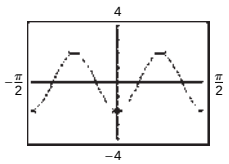


29.



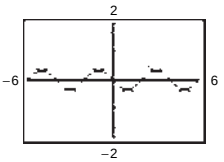
Answers will vary.

31.



Answers will vary.

33.



Answers will vary.

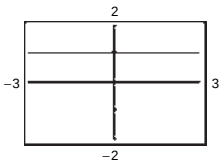
35. $-5.498, -2.356, 0.785, 3.927$

37. $-4.189, -2.094, 2.094, 4.189$

39. $-5.236, -2.094, 1.047, 4.189$

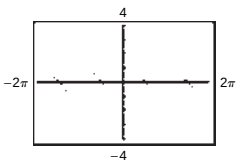
41. Even **43.** Odd **45.** Odd

47.



Not equivalent;
y_1 is undefined at $x = 0$.

49.



Equivalent

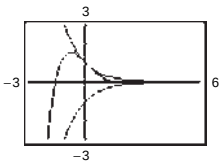
51. d; as x approaches 0, $f(x)$ approaches 0.

52. a; as x approaches 0, $f(x)$ approaches 0.

53. b; as x approaches 0, $g(x)$ approaches 0.

54. c; as x approaches 0, $g(x)$ approaches 0.

55.

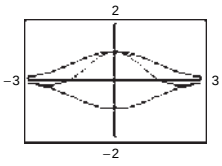


$-e^{-x} \le e^{-x}\cos x \le e^{-x}$

Touches $y = \pm e^{-x}$ at $x = n\pi$

Intercepts at $x = \dfrac{\pi}{2} + n\pi$

57.



$-e^{-x^2/4} \le e^{-x^2/4}\cos x \le e^{-x^2/4}$

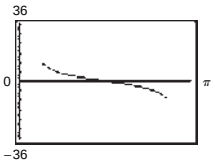
Touches $y = \pm e^{-x}$ at $x = n\pi$

Intercepts at $x = \dfrac{\pi}{2} + n\pi$

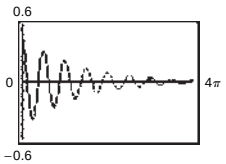
59. (a) $f \to -\infty$ (b) $f \to \infty$ (c) $f \to -\infty$ (d) $f \to \infty$

61. (a) $f \to \infty$ (b) $f \to -\infty$ (c) $f \to \infty$ (d) $f \to -\infty$

63. $d = 5\cot x$



65. (a)



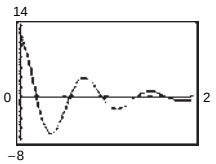
(b) Not periodic and damped; approaches 0 as t increases.

67. (a) Yes. To each t there corresponds one and only one value of y.

(b) 1.3 oscillations/sec (c) $y = 12(0.221)^t \cos(8.2t)$

(d) $y = 12e^{-1.5t}\cos(8.2t)$

(e)

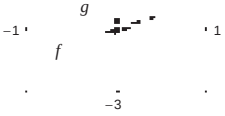


Answers will vary.

69. True. The sine function is damped.

71. True. $\sec x = \csc\left(x - \dfrac{\pi}{2}\right) = \dfrac{1}{\sin\left(x - \dfrac{\pi}{2}\right)}$

73. (a)



(b) $\left(-1, \frac{1}{3}\right)$ (c) $\left(-1, \frac{1}{3}\right)$; The intervals are the same.

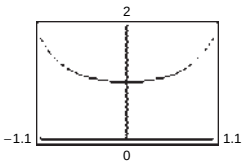
75. (a)

x	-1	-0.1	-0.01
$\frac{\tan x}{x}$	1.5574	1.0033	1.0000

x	-0.001	0	0.001
$\frac{\tan x}{x}$	1.0000	Undefined	1.0000

x	0.01	0.1	1
$\frac{\tan x}{x}$	1.0000	1.0033	1.5574

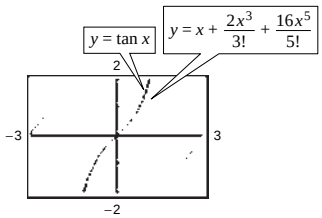
(b)



$f \to 1$ as $x \to 0$

(c) The ratio approaches 1 as x approaches 0.

77.



The polynomial function is a good approximation of the tangent function when x is close to 0.

79. Distributive Property **81.** Additive Identity Property

83. Not one-to-one **85.** One-to-one. $f^{-1}(x) = \dfrac{x^2 + 14}{3}$, $x \geq 0$

87. Domain: all real numbers x
Intercepts: $(-4, 0)$, $(1, 0)$, $(0, -4)$
No asymptotes

89. Domain: all real numbers x
Intercept: $(0, 5)$
Asymptote: $y = 2$

Section 4.7 (page 322)

1. $y = \sin^{-1} x$, $-1 \leq x \leq 1$ **3.** $\sin^{-1} x$ or $\arcsin x$

5. (a) $\frac{\pi}{6}$ (b) 0 **7.** (a) $\frac{\pi}{2}$ (b) 0

9. (a) $\frac{\pi}{6}$ (b) $-\frac{\pi}{4}$ **11.** (a) $-\frac{\pi}{3}$ (b) $\frac{\pi}{3}$

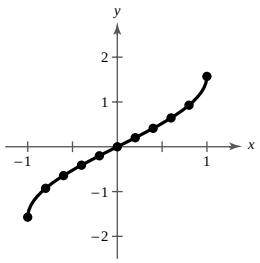
13. (a) $\frac{\pi}{3}$ (b) $-\frac{\pi}{6}$

15. (a)

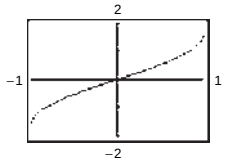
x	-1	-0.8	-0.6	-0.4	-0.2
y	-1.571	-0.927	-0.644	-0.412	-0.201

x	0	0.2	0.4	0.6	0.8	1
y	0	0.201	0.412	0.644	0.927	1.571

(b)



(c)



They are the same.

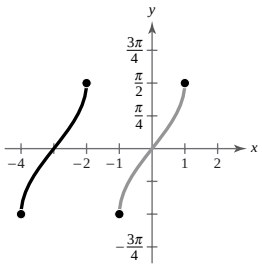
(d) Intercept: $(0, 0)$; symmetric about the origin

17. $\left(-\sqrt{3}, -\frac{\pi}{3}\right), \left(-\frac{\sqrt{3}}{3}, -\frac{\pi}{6}\right), \left(1, \frac{\pi}{4}\right)$

19. 0.47 **21.** 1.50 **23.** 0.72 **25.** -0.85

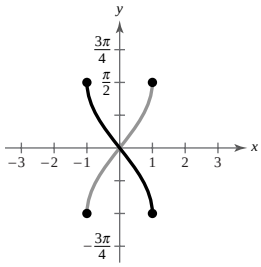
27. -1.41 **29.** 0.85 **31.** 1.29

33.



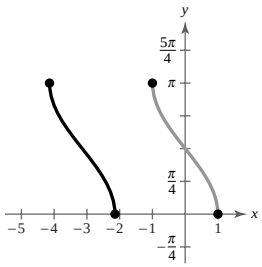
g is a horizontal shift of f three units to the left.

35.



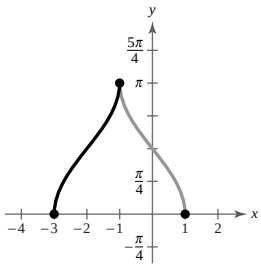
g is a reflection of f in the y-axis.

37.



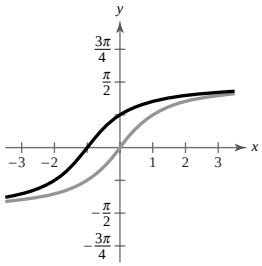
g is a horizontal shift of f π units to the left.

39.



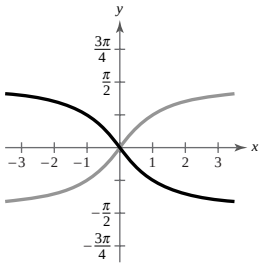
g is a reflection of f in the y-axis and a horizontal shift of f two units to the left.

41.



g is a horizontal shift of f one unit to the left.

43.



g is a reflection of f in the y-axis.

CHAPTER 4

45. $\theta = \arctan\frac{x}{8}$ **47.** $\theta = \arcsin\frac{x+2}{5}$

49. $\sqrt{4-x^2}$; $\theta = \arcsin\frac{x}{2}$, $\theta = \arccos\frac{\sqrt{4-x^2}}{2}$, $\theta = \arctan\frac{x}{\sqrt{4-x^2}}$

51. $\sqrt{x^2+2x+5}$; $\theta = \arcsin\frac{x+1}{\sqrt{x^2+2x+5}}$, $\theta = \arccos\frac{2}{\sqrt{x^2+2x+5}}$, $\theta = \arctan\frac{x+1}{2}$

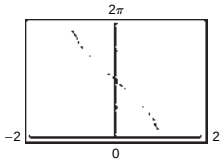
53. 0.7 **55.** -0.3 **57.** 0 **59.** $-\frac{\pi}{6}$ **61.** $\frac{\pi}{2}$

63. $\frac{\pi}{2}$ **65.** $\frac{4}{5}$ **67.** $\frac{7}{25}$ **69.** $\frac{\sqrt{34}}{5}$ **71.** $\frac{\sqrt{5}}{3}$

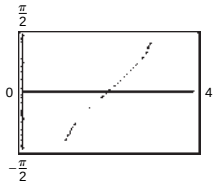
73. $\frac{1}{x}$ **75.** $\sqrt{-x^2-4x-3}$ **77.** $\frac{\sqrt{25-x^2}}{x}$

79. $\frac{\sqrt{x^2+7}}{x}$ **81.** $\frac{14}{\sqrt{x^2+196}}$ **83.** $\frac{|x-1|}{\sqrt{x^2-2x+10}}$

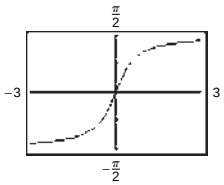
85.



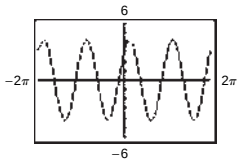
87.



89.



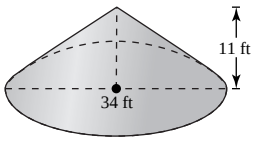
91. $3\sqrt{2}\sin\left(2t+\frac{\pi}{4}\right)$



The two forms are equivalent.

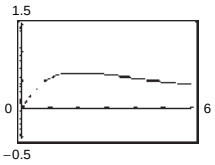
93. $\frac{\pi}{2}$ **95.** $\frac{\pi}{2}$ **97.** π

99. (a)



(b) 0.574 rad
(c) 12.94 ft

101. (a)

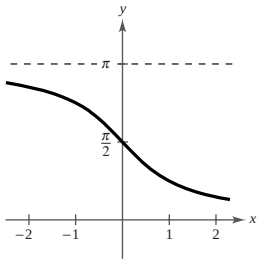


(b) 2 ft
(c) $\beta = 0$; As the camera moves farther from the picture, the angle subtended by the camera approaches zero.

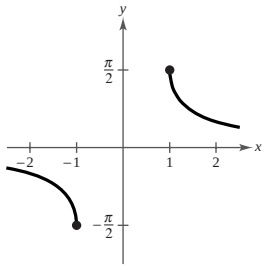
103. (a) $\theta = \arctan\frac{x}{20}$ (b) 0.245 rad, 0.540 rad

105. False. $\arctan 1 = \frac{\pi}{4}$

107.



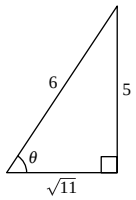
109.



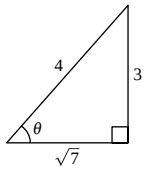
111. $\frac{\pi}{4}$ **113.** $\frac{5\pi}{6}$ **115 and 117.** Proofs

119. $\frac{\sqrt{2}}{2}$ **121.** $\frac{\sqrt{3}}{3}$

123. $\cos\theta = \frac{\sqrt{11}}{6}$
$\tan\theta = \frac{5\sqrt{11}}{11}$
$\csc\theta = \frac{6}{5}$
$\sec\theta = \frac{6\sqrt{11}}{11}$
$\cot\theta = \frac{\sqrt{11}}{5}$



125. $\cos\theta = \frac{\sqrt{7}}{4}$
$\tan\theta = \frac{3\sqrt{7}}{7}$
$\csc\theta = \frac{4}{3}$
$\sec\theta = \frac{4\sqrt{7}}{7}$
$\cot\theta = \frac{\sqrt{7}}{3}$



Section 4.8 (page 332)

1. harmonic motion **3.** No

5. $B = 60°$, $a \approx 5.77$, $c \approx 11.55$

7. $A = 19°$, $a \approx 4.82$, $c \approx 14.81$

9. $A \approx 26.57°$, $B \approx 63.43°$, $c \approx 13.42$

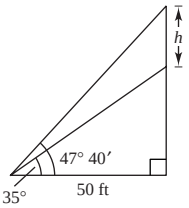
11. $A \approx 72.76°$, $B \approx 17.24°$, $a \approx 51.58$

13. $B = 77°45'$, $a \approx 91.34$, $b \approx 420.70$

15. 5.12 in. **17.** 8.21 ft **19.** 19.70 ft **21.** 109.63 ft

23. 2089.99 ft

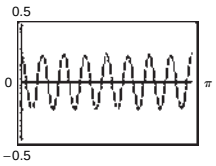
25. (a)



(b) $h = 50(\tan 47°40' - \tan 35°)$
(c) 19.87 ft

27. (a) $l = \sqrt{h^2 + 28h + 10{,}196}$ (b) $\theta = \arccos\frac{100}{l}$
(c) $h \approx 56$ ft

29. 70.35°

31. 75.97° **33.** 5098.78 ft **35.** 0.66 mi
37. 104.95 nm south, 58.18 nm west
39. (a) N 58° E (b) 68.82 m **41.** N 56.31° W
43. 1933.32 ft **45.** 3.23 mi
47. (a) 61.82°; 15.64° (b) 31.10 ft
49. 78.69° **51.** 35.26° **53.** $y = \sqrt{3}r$
55. $d = 8 \sin \pi t$ **57.** $d = 3 \cos \frac{4\pi t}{3}$
59. (a) 4 (b) 4 (c) 4 (d) $\frac{1}{16}$
61. (a) $\frac{1}{16}$ (b) 70 (c) 0 (d) $\frac{1}{140}$ **63.** $\omega = 528\pi$
65. (a) 

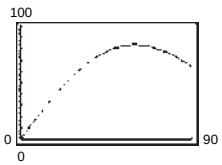
(b) $\frac{\pi}{8}$ sec (c) $\frac{\pi}{32}$ sec

67. (a)

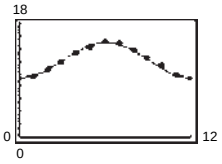
Base 1	Base 2	Altitude	Area
8	8 + 16 cos 10°	8 sin 10°	22.06
8	8 + 16 cos 20°	8 sin 20°	42.46
8	8 + 16 cos 30°	8 sin 30°	59.71
8	8 + 16 cos 40°	8 sin 40°	72.65
8	8 + 16 cos 50°	8 sin 50°	80.54
8	8 + 16 cos 60°	8 sin 60°	83.14
8	8 + 16 cos 70°	8 sin 70°	80.71

(b)

Base 1	Base 2	Altitude	Area
8	8 + 16 cos 56°	8 sin 56°	82.73
8	8 + 16 cos 58°	8 sin 58°	83.04
8	8 + 16 cos 59°	8 sin 59°	83.11
8	8 + 16 cos 60°	8 sin 60°	83.14
8	8 + 16 cos 61°	8 sin 61°	83.11
8	8 + 16 cos 62°	8 sin 62°	83.04

83.14 ft^2
(c) $A = 64(1 + \cos \theta)(\sin \theta)$
(d) 

83.14 ft^2; They are the same.

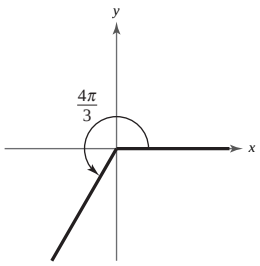
69. (a) 

(b) 12 mo; Yes, there are 12 months in a year.
(c) 2.77; The maximum change in the number of hours of daylight

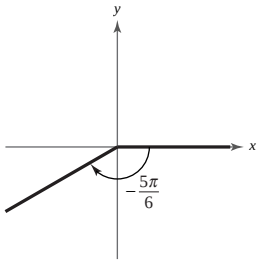
71. True. In $a \sin \omega t$ or $a \cos \omega t$, a is a real number.
73. False. The ampitude is equal to a.

75. Answers will vary. **77.** $4x - y + 6 = 0$
79. $4x + 5y - 22 = 0$ **81.** All real numbers x
83. All real numbers x

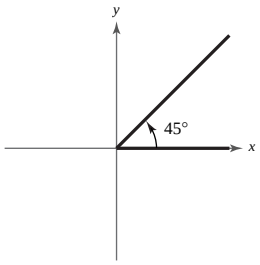
Review Exercises (page 340)

1. 1 rad
3. (a) 

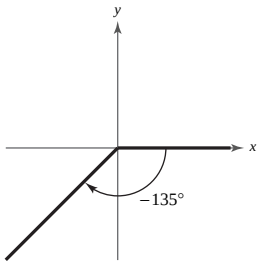
(b) Quadrant III
(c) $\frac{10\pi}{3}, -\frac{2\pi}{3}$

5. (a) 

(b) Quadrant III
(c) $\frac{7\pi}{6}, -\frac{17\pi}{6}$

7. (a) 

(b) Quadrant I
(c) 405°, −315°

9. (a) 

(b) Quadrant III
(c) 225°, −495°

11. 135.279° **13.** 6.572° **15.** 135° 17′ 24″
17. −85° 21′ 36″ **19.** 1.641 **21.** 7.243
23. 128.571° **25.** −200.535°
27. Complement: $\frac{3\pi}{8}$; supplement: $\frac{7\pi}{8}$
29. Complement: $\frac{\pi}{5}$; supplement: $\frac{7\pi}{10}$
31. Complement: 85°; supplement: 175°
33. Complement: none; supplement: 23°
35. $\frac{25}{12}$ rad **37.** $\frac{46\pi}{3}$ m **39.** 6000π cm/min
41. $\left(\frac{\sqrt{2}}{2}, -\frac{\sqrt{2}}{2}\right)$ **43.** $\left(-\frac{\sqrt{3}}{2}, \frac{1}{2}\right)$
45. $\left(-\frac{1}{2}, -\frac{\sqrt{3}}{2}\right)$ **47.** $\left(-\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$

CHAPTER 4

49. $\sin\frac{\pi}{4} = \frac{\sqrt{2}}{2}$
$\cos\frac{\pi}{4} = \frac{\sqrt{2}}{2}$
$\tan\frac{\pi}{4} = 1$
$\csc\frac{\pi}{4} = \sqrt{2}$
$\sec\frac{\pi}{4} = \sqrt{2}$
$\cot\frac{\pi}{4} = 1$

51. $\sin 2\pi = 0$
$\cos 2\pi = 1$
$\tan 2\pi = 0$
$\csc 2\pi$ is undefined.
$\sec 2\pi = 1$
$\cot 2\pi$ is undefined.

53. $\sin\left(-\frac{11\pi}{6}\right) = \frac{1}{2}$
$\cos\left(-\frac{11\pi}{6}\right) = \frac{\sqrt{3}}{2}$
$\tan\left(-\frac{11\pi}{6}\right) = \frac{\sqrt{3}}{3}$
$\csc\left(-\frac{11\pi}{6}\right) = 2$
$\sec\left(-\frac{11\pi}{6}\right) = \frac{2\sqrt{3}}{3}$
$\cot\left(-\frac{11\pi}{6}\right) = \sqrt{3}$

55. $\sin\left(-\frac{\pi}{2}\right) = -1$
$\cos\left(-\frac{\pi}{2}\right) = 0$
$\tan\left(-\frac{\pi}{2}\right)$ is undefined.
$\csc\left(-\frac{\pi}{2}\right) = -1$
$\sec\left(-\frac{\pi}{2}\right)$ is undefined.
$\cot\left(-\frac{\pi}{2}\right) = 0$

57. 1 **59.** $-\frac{1}{2}$ **61.** (a) $-\frac{3}{5}$ (b) $-\frac{5}{3}$
63. (a) $\frac{2}{3}$ (b) $\frac{3}{2}$ **65.** -0.8935 **67.** 0.5

69. $\sin\theta = \frac{\sqrt{65}}{9}$
$\cos\theta = \frac{4}{9}$
$\tan\theta = \frac{\sqrt{65}}{4}$
$\csc\theta = \frac{9\sqrt{65}}{65}$
$\sec\theta = \frac{9}{4}$
$\cot\theta = \frac{4\sqrt{65}}{65}$

71. $\sin\theta = \frac{5\sqrt{61}}{61}$
$\cos\theta = \frac{6\sqrt{61}}{61}$
$\tan\theta = \frac{5}{6}$
$\csc\theta = \frac{\sqrt{61}}{5}$
$\sec\theta = \frac{\sqrt{61}}{6}$
$\cot\theta = \frac{6}{5}$

73. $\sin\theta = \frac{7}{24}$
$\cos\theta = \frac{\sqrt{527}}{24}$
$\tan\theta = \frac{7\sqrt{527}}{527}$
$\csc\theta = \frac{24}{7}$
$\sec\theta = \frac{24\sqrt{527}}{527}$
$\cot\theta = \frac{\sqrt{527}}{7}$

75. $\sin\theta = \frac{\sqrt{17}}{17}$
$\cos\theta = \frac{4\sqrt{17}}{17}$
$\tan\theta = \frac{1}{4}$
$\csc\theta = \sqrt{17}$
$\sec\theta = \frac{\sqrt{17}}{4}$
$\cot\theta = 4$

77. (a) 0.1045 (b) 0.1045 **79.** (a) 0.7071 (b) 1.4142
81. Answers will vary. **83.** 235 ft

85. $\sin\theta = \frac{4}{5}$
$\cos\theta = \frac{3}{5}$
$\tan\theta = \frac{4}{3}$
$\csc\theta = \frac{5}{4}$
$\sec\theta = \frac{5}{3}$
$\cot\theta = \frac{3}{4}$

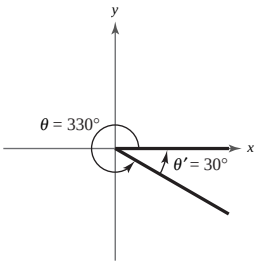
87. $\sin\theta = \frac{2\sqrt{53}}{53}$
$\cos\theta = -\frac{7\sqrt{53}}{53}$
$\tan\theta = -\frac{2}{7}$
$\csc\theta = \frac{\sqrt{53}}{2}$
$\sec\theta = -\frac{\sqrt{53}}{7}$
$\cot\theta = -\frac{7}{2}$

89. $\sin\theta = \frac{15\sqrt{481}}{481}$
$\cos\theta = \frac{16\sqrt{481}}{481}$
$\tan\theta = \frac{15}{16}$
$\csc\theta = \frac{\sqrt{481}}{15}$
$\sec\theta = \frac{\sqrt{481}}{16}$
$\cot\theta = \frac{16}{15}$

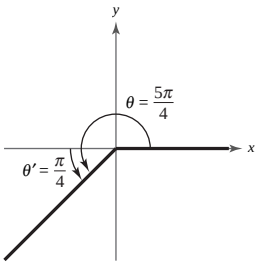
91. $\sin\theta = -\frac{\sqrt{11}}{6}$
$\cos\theta = \frac{5}{6}$
$\tan\theta = -\frac{\sqrt{11}}{5}$
$\csc\theta = -\frac{6\sqrt{11}}{11}$
$\cot\theta = -\frac{5\sqrt{11}}{11}$

93. $\cos\theta = -\frac{\sqrt{55}}{8}$ $\sec\theta = -\frac{8\sqrt{55}}{55}$
$\tan\theta = -\frac{3\sqrt{55}}{55}$ $\cot\theta = -\frac{\sqrt{55}}{3}$
$\csc\theta = \frac{8}{3}$

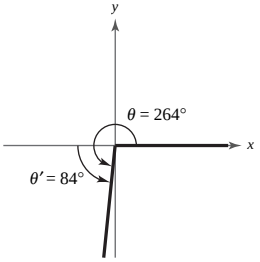
95. $\theta' = 30°$



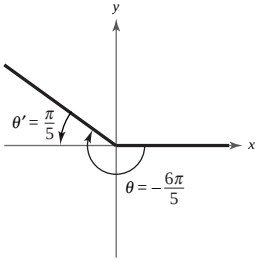
97. $\theta' = \frac{\pi}{4}$



99. $\theta' = 84°$



101. $\theta' = \frac{\pi}{5}$



103. $\sin 240° = -\frac{\sqrt{3}}{2}$
$\cos 240° = -\frac{1}{2}$
$\tan 240° = \sqrt{3}$

105. $\sin(-210°) = \frac{1}{2}$
$\cos(-210°) = -\frac{\sqrt{3}}{2}$
$\tan(-210°) = -\frac{\sqrt{3}}{3}$

107. $\sin\left(-\frac{9\pi}{4}\right) = -\frac{\sqrt{2}}{2}$

$\cos\left(-\frac{9\pi}{4}\right) = \frac{\sqrt{2}}{2}$

$\tan\left(-\frac{9\pi}{4}\right) = -1$

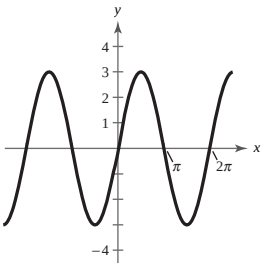
109. $\sin 4\pi = 0$

$\cos 4\pi = 1$

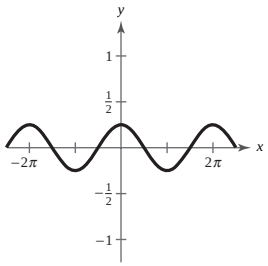
$\tan 4\pi = 0$

111. 0.6494 **113.** 3.2361

115.



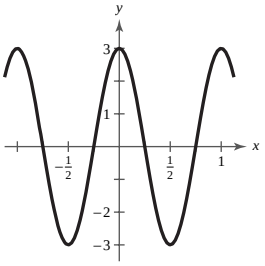
117.



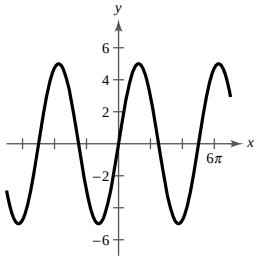
119. Period: 2; amplitude: 5

121. Period: π; amplitude: 3.4

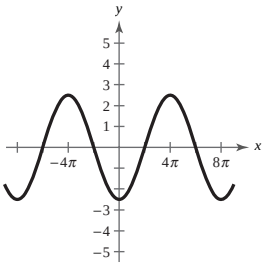
123.



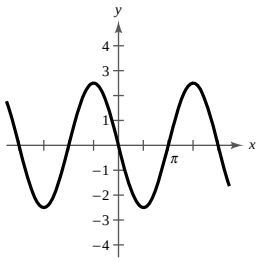
125.



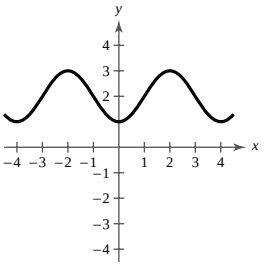
127.



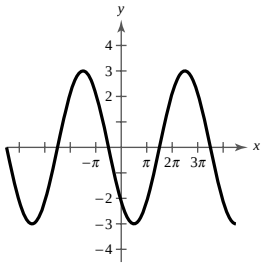
129.



131.



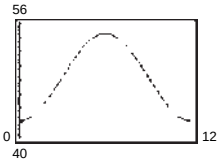
133.



135. $a = -2, b = 1, c = \frac{\pi}{4}$

137. $a = -4, b = 2, c = \frac{\pi}{2}$

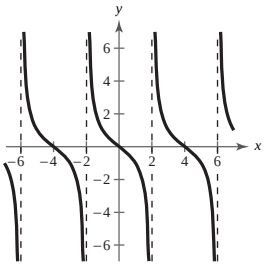
139.



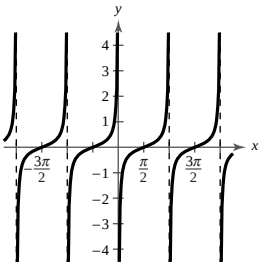
Maximum sales: June

Minimum sales: December

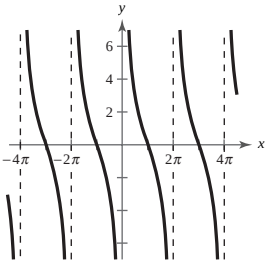
141.



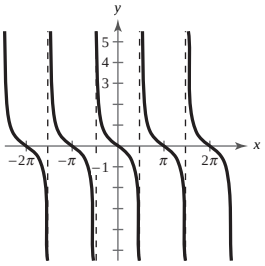
143.



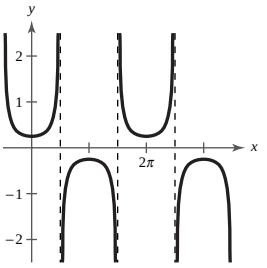
145.



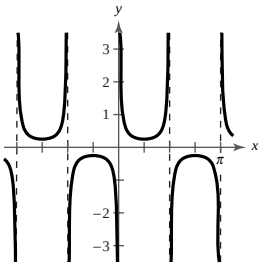
147.



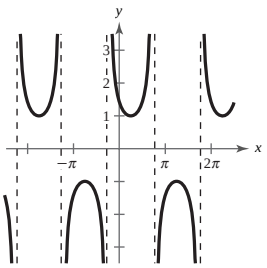
149.



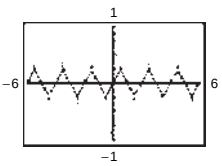
151.



153.

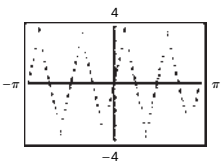


155.



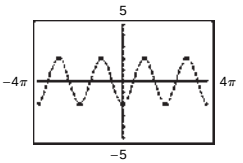
Answers will vary.

157.



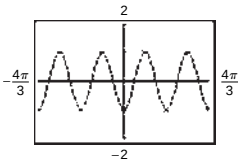
Answers will vary.

159.



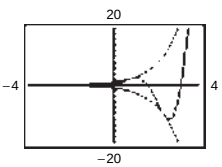
Answers will vary.

161.



Answers will vary.

163.

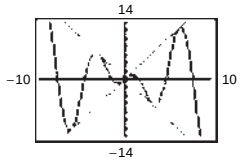


$-e^x \le e^x \sin 2x \le e^x$

Touches $y = \pm e^x$ at $x = \frac{\pi}{4} + \frac{n\pi}{2}$

Intercepts at $x = \frac{n\pi}{2}$

165.



$-2x \le 2x \cos x \le 2x$

Touches $y = \pm 2x$ at $x = n\pi$

Intercepts at $x = \frac{\pi}{2} + n\pi$

167. (a) $-\frac{\pi}{2}$ (b) 0 **169.** (a) $\frac{\pi}{4}$ (b) $\frac{5\pi}{6}$

171. 1.14 **173.** -1.22 **175.** -1.49 **177.** 0.68

179. $\theta = \arcsin\frac{x}{16}$ **181.** $\frac{1}{\sqrt{2x - x^2}}$ **183.** $\frac{2\sqrt{4 - 2x^2}}{4 - x^2}$

185. 0.071 km **187.** 9.47 mi **189.** $d = 3\cos\frac{2\pi t}{15}$

191. False. y is a function but is not one-to-one on $30° \le \theta \le 150°$.

193. False. Sine or cosine is used to model harmonic motion.

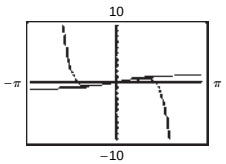
195. (a)

s	10	20	30
θ	0.0224	0.0894	0.1989

s	40	50	60
θ	0.3441	0.5105	0.6786

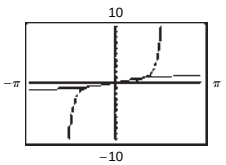
(b) θ is not a linear function of s.

197. (a)



The polynomial function is a good approximation for the arctangent function when x is close to 0.

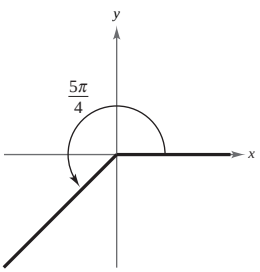
(b) $\arctan x \approx x - \frac{x^3}{3} + \frac{x^5}{5} - \frac{x^7}{7} + \frac{x^9}{9}$



The accuracy of the approximation increases as additional terms are added.

Chapter Test (page 345)

1. (a)



(b) Answers will vary. Sample answer: $\frac{13\pi}{4}, -\frac{3\pi}{4}$

(c) 225°

2. $44\frac{4}{9} \approx 44.44$ rad/sec

3. $\sin\theta = \frac{4\sqrt{17}}{17}$

$\cos\theta = -\frac{\sqrt{17}}{17}$

$\tan\theta = -4$

$\csc\theta = \frac{\sqrt{17}}{4}$

$\sec\theta = -\sqrt{17}$

$\cot\theta = -\frac{1}{4}$

4. $\sin\theta = \frac{7\sqrt{53}}{53}$

$\cos\theta = \frac{2\sqrt{53}}{53}$

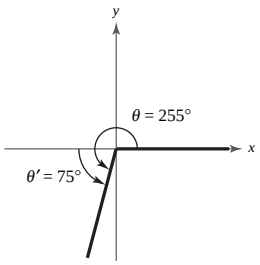
$\csc\theta = \frac{\sqrt{53}}{7}$

$\sec\theta = \frac{\sqrt{53}}{2}$

$\cot\theta = \frac{2}{7}$

5. $\theta' = 75°$

6. Quadrant II



7. 135°, 225° **8.** 1.33, 1.81

9. $\sin\theta = \frac{4}{5}$

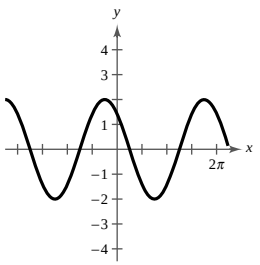
$\tan\theta = -\frac{4}{3}$

$\csc\theta = \frac{5}{4}$

$\sec\theta = -\frac{5}{3}$

$\cot\theta = -\frac{3}{4}$

10.



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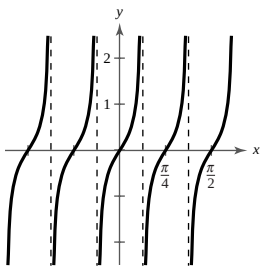

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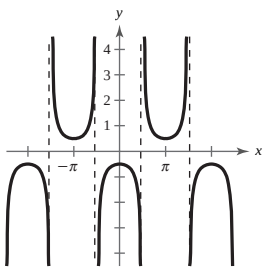
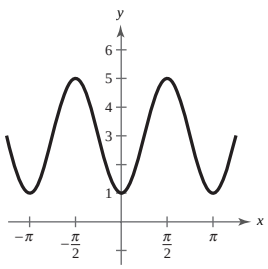


13.



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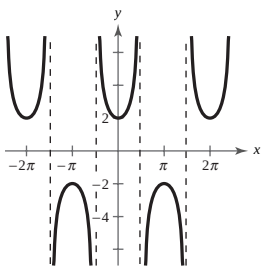
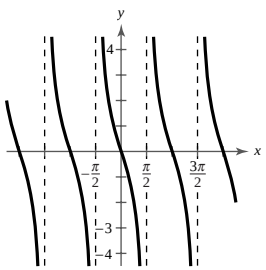
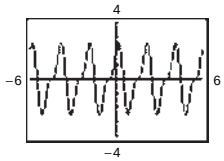
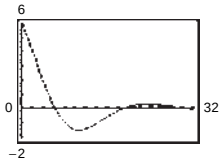


15.



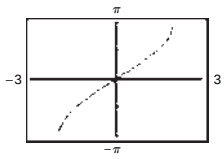
16. 

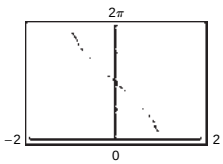
Period: 2

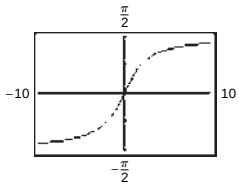
17. 

Not periodic

18. $a = -2, b = \frac{1}{2}, c = -\frac{\pi}{4}$ **19.** $\frac{\sqrt{5}}{2}$

20. 

21. 

22. 

23. 231.34°

Chapter 5

Section 5.1 (page 354)

1. (a) iii (b) i (c) ii **3.** $\sin u$ **5.** $\cos u$

7. $\tan x = \frac{\sqrt{3}}{3}$
$\csc x = 2$
$\sec x = \frac{2\sqrt{3}}{3}$
$\cot x = \sqrt{3}$

9. $\cos\theta = \frac{\sqrt{2}}{2}$
$\tan\theta = -1$
$\csc\theta = -\sqrt{2}$
$\cot\theta = -1$

11. $\sin x = -\frac{7}{25}$
$\cos x = -\frac{24}{25}$
$\csc x = -\frac{25}{7}$
$\cot x = \frac{24}{7}$

13. $\cos\phi = -\frac{15}{17}$
$\tan\phi = -\frac{8}{15}$
$\csc\phi = \frac{17}{8}$
$\cot\phi = -\frac{15}{8}$

15. $\sin x = \frac{2}{3}$
$\cos x = -\frac{\sqrt{5}}{3}$
$\csc x = \frac{3}{2}$
$\sec x = -\frac{3\sqrt{5}}{5}$
$\cot x = -\frac{\sqrt{5}}{2}$

17. $\sin\theta = -\frac{2\sqrt{5}}{5}$
$\cos\theta = -\frac{\sqrt{5}}{5}$
$\csc\theta = -\frac{\sqrt{5}}{2}$
$\sec\theta = -\sqrt{5}$
$\cot\theta = \frac{1}{2}$

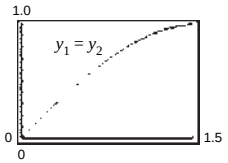
19. $\sin\theta = 0$ $\sec\theta = -1$
$\cos\theta = -1$ $\cot\theta$ is undefined.
$\tan\theta = 0$

21. d **22.** a **23.** b **24.** f **25.** e **26.** c
27. b **28.** c **29.** f **30.** a **31.** e **32.** d
33. $\cos x$ **35.** $\cos^2\phi$ **37.** $\sec x$ **39.** 1
41. $\cot x$ **43.** $1 + \sin y$ **45.** $\cos^2 x$ **47.** $\cos x + 2$
49. $\sec^4 x$ **51.** $\sin^2 x - \cos^2 x$ **53.** $(\csc x - 1)\cot^2 x$
55. $1 + 2\sin x\cos x$ **57.** $\cot^2 x$ **59.** $2\csc^2 x$
61. $-\cot x$ **63.** $\sec x$ **65.** $1 + \cos y$ **67.** $\cos x$
69. $3(\sec x + \tan x)$

71.

x	0.2	0.4	0.6	0.8
y_1	0.1987	0.3894	0.5646	0.7174
y_2	0.1987	0.3894	0.5646	0.7174

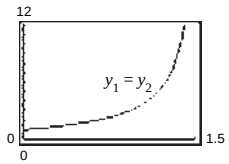
x	1.0	1.2	1.4
y_1	0.8415	0.9320	0.9854
y_2	0.8415	0.9320	0.9854

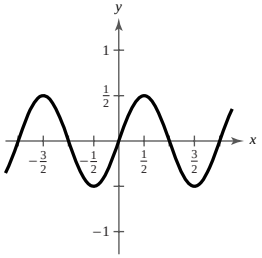


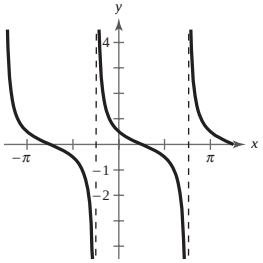
73.

x	0.2	0.4	0.6	0.8
y_1	1.2230	1.5085	1.8958	2.4650
y_2	1.2230	1.5085	1.8958	2.4650

x	1.0	1.2	1.4
y_1	3.4082	5.3319	11.6814
y_2	3.4082	5.3319	11.6814



75. $\csc x$ **77.** $\tan x$ **79.** $5\cos\theta$ **81.** $3\tan\theta$
83. $3\cos\theta$ **85.** $3\sec\theta$ **87.** $3\tan\theta$ **89.** $\sqrt{2}\cos\theta$
91. $0 \le \theta \le \pi$ **93.** $0 \le \theta < \frac{\pi}{2}, \frac{3\pi}{2} < \theta < 2\pi$
95. $\ln|\cot\theta|$ **97.** $\ln|(\cos x)(1 + \sin x)|$ **99.** $\ln|\tan x|$
101. The identity is not true when $\theta = \frac{7\pi}{6}$.
103. The identity is not true when $\theta = \frac{5\pi}{3}$.
105. The identity is not true when $\theta = \frac{7\pi}{4}$.
107. (a) and (b) Answers will vary.
109. (a) and (b) Answers will vary.
111. $\mu = \tan\theta$ **113.** Answers will vary.
115. False. $\cos 0 \cdot \sec\frac{\pi}{4} \neq 1$ **117.** 1, 1 **119.** ∞, 0
121. $\cos\theta = \pm\sqrt{1 - \sin^2\theta}$ $\sec\theta = \pm\frac{1}{\sqrt{1 - \sin^2\theta}}$
$\tan\theta = \pm\frac{\sin\theta}{\sqrt{1 - \sin^2\theta}}$ $\cot\theta = \pm\frac{\sqrt{1 - \sin^2\theta}}{\sin\theta}$
$\csc\theta = \frac{1}{\sin\theta}$
The sign depends on the choice of θ.
123. $\frac{x^2 + 6x - 8}{(x + 5)(x - 8)}$ **125.** $\frac{-5x^2 + 8x + 28}{(x^2 - 4)(x + 4)}$
127. 

129. 

CHAPTER 5

Section 5.2 (page 362)

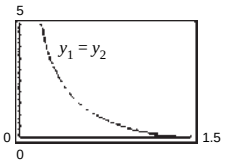
1. $\cot u$ **3.** $\tan u$ **5.** $\cos^2 u$ **7.** $-\sin u$ **9.** No

11–19. Answers will vary.

21.

x	0.2	0.4	0.6	0.8
y_1	4.8348	2.1785	1.2064	0.6767
y_2	4.8348	2.1785	1.2064	0.6767

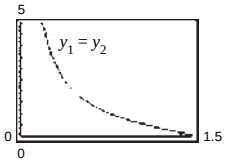
x	1.0	1.2	1.4
y_1	0.3469	0.1409	0.0293
y_2	0.3469	0.1409	0.0293



23.

x	0.2	0.4	0.6	0.8
y_1	4.8348	2.1785	1.2064	0.6767
y_2	4.8348	2.1785	1.2064	0.6767

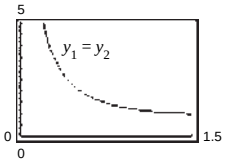
x	1.0	1.2	1.4
y_1	0.3469	0.1409	0.0293
y_2	0.3469	0.1409	0.0293



25.

x	0.2	0.4	0.6	0.8
y_1	5.0335	2.5679	1.7710	1.3940
y_2	5.0335	2.5679	1.7710	1.3940

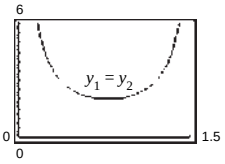
x	1.0	1.2	1.4
y_1	1.1884	1.0729	1.0148
y_2	1.1884	1.0729	1.0148



27.

x	0.2	0.4	0.6	0.8
y_1	5.1359	2.7880	2.1458	2.0009
y_2	5.1359	2.7880	2.1458	2.0009

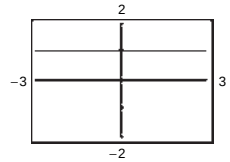
x	1.0	1.2	1.4
y_1	2.1995	2.9609	5.9704
y_2	2.1995	2.9609	5.9704



29. $\cot(-x) = -\cot(x)$ **31.** $(\tan^2 x)^2$

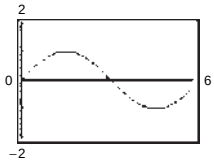
33–57. Answers will vary.

59.



$y = 1$

61.



$y = \sin x$

63. Answers will vary. **65.** 1 **67.** 2

69–75. Answers will vary.

77. (a) Answers will vary.

(b)

θ	15°	30°	45°	60°	75°	90°
s	18.66	8.66	5	2.88	1.34	0

(c) Maximum: 15° (d) Noon
Minimum: 90°

79. True. For instance, $(\sec^2\theta - 1)/\sec^2\theta = \sin^2\theta$ was verified two different ways on page 358.

81. False. $\sin^2\left(\frac{\pi}{4}\right) + \cos^2\left(\frac{\pi}{4}\right) \neq 1 + \tan^2\left(\frac{\pi}{4}\right)$

83. (a) Answers will vary. (b) No. Division by zero.

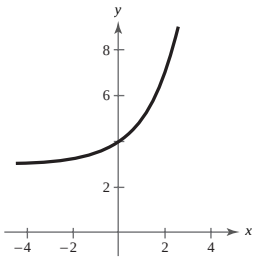
85. $a\cos\theta$ **87.** $a\sec\theta$

89. $\sqrt{\tan^2 x} = |\tan x|;\ \frac{3\pi}{4}$ **91.** $|\tan\theta| = \sqrt{\sec^2\theta - 1};\ \frac{3\pi}{4}$

93. Answers will vary.

95.

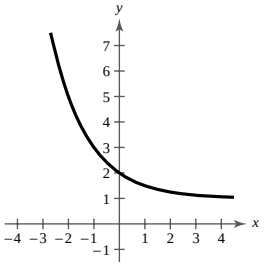
x	-4	-2	0	2	3
y	3.0625	3.25	4	7	11



Horizontal asymptote at $y = 3$

97.

x	-3	-2	0	2	4
y	9	5	2	1.25	1.0625



Horizontal asymptote at $y = 1$

Section 5.3 (page 373)

1. general **3.** No **5–9.** Answers will vary.

11. 30°, 150° **13.** 120°, 240° **15.** 45°, 225°

17. $\frac{5\pi}{6}, \frac{7\pi}{6}$ **19.** $\frac{3\pi}{4}, \frac{7\pi}{4}$ **21.** $\frac{5\pi}{6}, \frac{11\pi}{6}$ **23.** $\frac{7\pi}{6}, \frac{11\pi}{6}$

25. $\frac{\pi}{6}, \frac{7\pi}{6}$ **27.** $\frac{3\pi}{4}, \frac{7\pi}{4}$ **29.** $\frac{7\pi}{6} + 2n\pi, \frac{11\pi}{6} + 2n\pi$

31. $\frac{\pi}{6} + 2n\pi, \frac{11\pi}{6} + 2n\pi$ **33.** $\frac{\pi}{6} + n\pi, \frac{5\pi}{6} + n\pi$

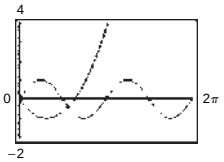
35. $\frac{\pi}{3} + n\pi, \frac{2\pi}{3} + n\pi$ **37.** $\frac{2\pi}{3}, \frac{5\pi}{3}$

39. $\frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}$ **41.** $0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}$

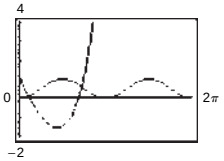
43. $\frac{\pi}{3}, \pi, \frac{5\pi}{3}$ **45.** No solution **47.** $\frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$

49. 3.6652, 4.7124, 5.7596 **51.** 0.8614, 5.4218

53. 1.5708 **55.** 0.5236, 2.6180

57. (a) 

(b) $\sin 2x = x^2 - 2x$
(c) $(0, 0), (1.7757, -0.3984)$

59. (a) 

(b) $\sin^2 x = e^x - 4x$
(c) $(0.3194, 0.0986)$, $(2.2680, 0.5878)$

61. $2\pi + 4n\pi$ **63.** $\frac{\pi}{8} + \frac{n\pi}{2}$ **65.** $\frac{2\pi}{3} + n\pi, \frac{5\pi}{6} + n\pi$

67. $\frac{\pi}{2} + 4n\pi, \frac{7\pi}{2} + 4n\pi$ **69.** $x = -1, 3$ **71.** $x = \pm 2$

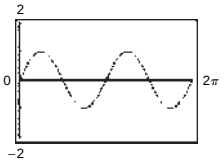
73. 1.1071, 4.2487 **75.** 0.8603, 3.4256

77. 0, 2.6779, 3.1416, 5.8195

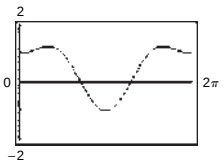
79. 0.3398, 0.8481, 2.2935, 2.8018

81. $\frac{\pi}{4}, \frac{5\pi}{4}$, arctan 5, arctan 5 + π

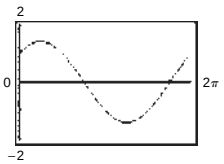
83. −1.154, 0.534 **85.** 1.110

87. (a) 

Maxima: $(0.7854, 1), (3.9270, 1)$
Minima: $(2.3562, -1), (5.4978, -1)$
(b) $\frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}$

89. (a) 

Maxima: $(1.0472, 1.25), (5.2360, 1.25)$
Minima: $(0, 1), (3.1416, -1), (6.2832, 1)$
(b) $0, \frac{\pi}{3}, \pi, \frac{5\pi}{3}, 2\pi$

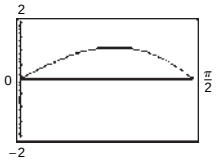
91. (a) 

Maximum: $(0.7854, 1.4142)$
Minimum: $(3.9270, -1.4142)$
(b) $\frac{\pi}{4}, \frac{5\pi}{4}$

93. 1 **95.** May, June, July

97. (a) All real numbers x except $x = 0$
(b) y-axis symmetry; horizontal asymptote: $y = 1$
(c) Oscillates
(d) Infinite number of solutions
(e) Yes. 0.6366

99. 0.04 sec, 0.43 sec, 0.83 sec **101.** 36.87°, 53.13°

103. (a) 

(b) $0.6100 < x < 1.0980$
$x \approx 0.86, A \approx 1.12$

105. 1 **107.** False. $\sin x - x = 0$ has one solution, $x = 0$.

109. False. The range of the sine function does not include 3.4.

111. Answers will vary. **113.** 2.164 rad

115. −0.007 rad **117.** Answers will vary.

Section 5.4 (page 381)

1. $\sin u \cos v - \cos u \sin v$ **3.** $\frac{\tan u + \tan v}{1 - \tan u \tan v}$

5. $\cos u \cos v + \sin u \sin v$

7. Sample answer: $\sin(45° + 60°)$

9. (a) $-\frac{1}{2}$ (b) $-\frac{3}{2}$ **11.** (a) $\frac{\sqrt{2} - \sqrt{6}}{4}$ (b) $\frac{1 + \sqrt{2}}{2}$

13. (a) $\frac{\sqrt{2} + \sqrt{6}}{4}$ (b) $\frac{\sqrt{2} - 1}{2}$

15. $\sin 105° = \frac{\sqrt{2} + \sqrt{6}}{4}$
$\cos 105° = \frac{\sqrt{2} - \sqrt{6}}{4}$
$\tan 105° = -2 - \sqrt{3}$

17. $\sin 195° = \frac{\sqrt{2} - \sqrt{6}}{4}$
$\cos 195° = -\frac{\sqrt{2} + \sqrt{6}}{4}$
$\tan 195° = 2 - \sqrt{3}$

19. $\sin \frac{11\pi}{12} = \frac{\sqrt{6} - \sqrt{2}}{4}$
$\cos \frac{11\pi}{12} = -\frac{\sqrt{2} + \sqrt{6}}{4}$
$\tan \frac{11\pi}{12} = -2 + \sqrt{3}$

21. $\sin\left(-\frac{\pi}{12}\right) = \frac{\sqrt{2} - \sqrt{6}}{4}$
$\cos\left(-\frac{\pi}{12}\right) = \frac{\sqrt{2} + \sqrt{6}}{4}$
$\tan\left(-\frac{\pi}{12}\right) = \sqrt{3} - 2$

23. $\sin 75° = \frac{\sqrt{2} + \sqrt{6}}{4}$
$\cos 75° = \frac{\sqrt{6} - \sqrt{2}}{4}$
$\tan 75° = 2 + \sqrt{3}$

25. $\sin(-285°) = \frac{\sqrt{6} + \sqrt{2}}{4}$
$\cos(-285°) = \frac{\sqrt{6} - \sqrt{2}}{4}$
$\tan(-285°) = \sqrt{3} + 2$

27. $\sin \frac{13\pi}{12} = \frac{\sqrt{2} - \sqrt{6}}{4}$
$\cos \frac{13\pi}{12} = -\frac{\sqrt{2} + \sqrt{6}}{4}$
$\tan \frac{13\pi}{12} = 2 - \sqrt{3}$

29. $\sin\left(-\frac{7\pi}{12}\right) = -\frac{\sqrt{2} + \sqrt{6}}{4}$
$\cos\left(-\frac{7\pi}{12}\right) = \frac{\sqrt{2} - \sqrt{6}}{4}$
$\tan\left(-\frac{7\pi}{12}\right) = 2 + \sqrt{3}$

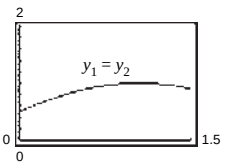
31. $\cos 70°$ **33.** $\tan 209°$ **35.** $\sin 2.3$

37. $\cos \frac{16\pi}{63}$ **39.** $\frac{\sqrt{3}}{2}$ **41.** $\frac{\sqrt{3}}{2}$ **43.** $-\sqrt{3}$

45.

x	0.2	0.4	0.6	0.8
y_1	0.6621	0.7978	0.9017	0.9696
y_2	0.6621	0.7978	0.9017	0.9696

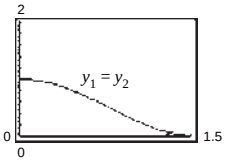
x	1.0	1.2	1.4
y_1	0.9989	0.9883	0.9384
y_2	0.9989	0.9883	0.9384



47.

x	0.2	0.4	0.6	0.8
y_1	0.9605	0.8484	0.6812	0.4854
y_2	0.9605	0.8484	0.6812	0.4854

x	1.0	1.2	1.4
y_1	0.2919	0.1313	0.0289
y_2	0.2919	0.1313	0.0289



49. $-\frac{56}{65}$ **51.** $-\frac{56}{33}$ **53.** $\frac{13}{85}$ **55.** $\frac{36}{85}$ **57.** 1

59. $\dfrac{2x^2 - \sqrt{1 - x^2}}{\sqrt{4x^2 + 1}}$ **61.** 0 **63.** 0 **65.** 1

67. -1 **69.** $\frac{33}{65}$ **71.** $\frac{24}{25}$ **73–79.** Answers will vary.

81. $\frac{\pi}{2}$ **83.** $0, \frac{\pi}{3}, \pi, \frac{5\pi}{3}$ **85.** 0.7854, 5.4978

87. $\frac{\pi}{2}, \pi, \frac{3\pi}{2}$ **89.** Answers will vary.

91. False. $\cos(u \pm v) = \cos u \cos v \mp \sin u \sin v$

93 and 95. Answers will vary.

97. (a) $\sqrt{2}\sin\left(\theta + \frac{\pi}{4}\right)$ (b) $\sqrt{2}\cos\left(\theta - \frac{\pi}{4}\right)$

99. (a) $13\sin(3\theta + 0.3948)$ (b) $13\cos(3\theta - 1.1760)$

101. $2\cos\theta$ **103.** Answers will vary.

105. $u + v = w$. Answers will vary.

107. $\cos(u + v + w) =$
$\cos u \cos v \cos w - \sin u \sin v \cos w$
$- \sin u \cos v \sin w - \cos u \sin v \sin w$

109. (0, 19), (38, 0) **111.** (0, 4), (2, 0), (7, 0)

Section 5.5 (page 390)

1. $\dfrac{1 + \cos 2u}{2}$ **3.** $-2\sin\left(\dfrac{u+v}{2}\right)\sin\left(\dfrac{u-v}{2}\right)$

5. $\tan\frac{u}{2}$ **7.** (a) ii (b) i (c) iii

9. (a) $\frac{3}{5}$ (b) $\frac{4}{5}$ (c) $\frac{3}{4}$ (d) $\frac{24}{25}$
(e) $\frac{7}{25}$ (f) $\frac{25}{7}$ (g) $\frac{25}{24}$ (h) $\frac{7}{24}$

11. 0, 1.0472, 3.1416, 5.2360; $0, \frac{\pi}{3}, \pi, \frac{5\pi}{3}$

13. 0.2618, 1.3090, 3.4034, 4.4506; $\frac{\pi}{12}, \frac{5\pi}{12}, \frac{13\pi}{12}, \frac{17\pi}{12}$

15. 0, 2.0944, 4.1888; $0, \frac{2\pi}{3}, \frac{4\pi}{3}$

17. 0, 1.5708, 3.1416, 4.7124; $0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}$

19. 1.5708, 3.6652, 5.7596; $\frac{\pi}{2}, \frac{7\pi}{6}, \frac{11\pi}{6}$

21. $\sin 2u = \frac{24}{25}$, $\cos 2u = \frac{7}{25}$, $\tan 2u = \frac{24}{7}$

23. $\sin 2u = \frac{4}{5}$, $\cos 2u = \frac{3}{5}$, $\tan 2u = \frac{4}{3}$

25. $\sin 2u = -\dfrac{\sqrt{3}}{2}$, $\cos 2u = -\dfrac{1}{2}$, $\tan 2u = \sqrt{3}$

27. $4\sin 2x$ **29.** $4\cos 2x$ **31.** $\frac{1}{8}(3 + 4\cos 2x + \cos 4x)$

33. $\frac{1}{8}(1 - \cos 4x)$ **35.** $\frac{1}{32}(2 + \cos 2x - 2\cos 4x - \cos 6x)$

37. $\frac{1}{2}(1 - \cos 4x)$ **39.** $\frac{1}{2}(1 + \cos x)$

41. $\dfrac{1 - \cos 4x}{1 + \cos 4x}$ **43.** $\frac{1}{8}(3 - 4\cos x + \cos 2x)$

45. (a) $\dfrac{4\sqrt{17}}{17}$ (b) $\dfrac{\sqrt{17}}{17}$ (c) $\frac{1}{4}$ (d) $\dfrac{\sqrt{17}}{4}$
(e) $\sqrt{17}$ (f) 4 (g) $\frac{8}{17}$ (h) $\dfrac{2\sqrt{17}}{17}$

47. $\sin 75° = \dfrac{\sqrt{2 + \sqrt{3}}}{2}$, $\cos 75° = \dfrac{\sqrt{2 - \sqrt{3}}}{2}$, $\tan 75° = \sqrt{3} + 2$

49. $\sin 67° 30' = \dfrac{\sqrt{2 + \sqrt{2}}}{2}$, $\cos 67° 30' = \dfrac{\sqrt{2 - \sqrt{2}}}{2}$, $\tan 67° 30' = 1 + \sqrt{2}$

51. $\sin\frac{\pi}{8} = \dfrac{\sqrt{2 - \sqrt{2}}}{2}$, $\cos\frac{\pi}{8} = \dfrac{\sqrt{2 + \sqrt{2}}}{2}$, $\tan\frac{\pi}{8} = \sqrt{2} - 1$

53. $\sin\frac{3\pi}{8} = \dfrac{\sqrt{2 + \sqrt{2}}}{2}$, $\cos\frac{3\pi}{8} = \dfrac{\sqrt{2 - \sqrt{2}}}{2}$, $\tan\frac{3\pi}{8} = \sqrt{2} + 1$

55. $\sin\frac{u}{2} = \dfrac{5\sqrt{26}}{26}$, $\cos\frac{u}{2} = \dfrac{\sqrt{26}}{26}$, $\tan\frac{u}{2} = 5$

57. $\sin\frac{u}{2} = \sqrt{\dfrac{89 - 5\sqrt{89}}{178}}$, $\cos\frac{u}{2} = -\sqrt{\dfrac{89 + 5\sqrt{89}}{178}}$, $\tan\frac{u}{2} = \dfrac{5 - \sqrt{89}}{8}$

59. $\sin\frac{u}{2} = \dfrac{3\sqrt{10}}{10}$, $\cos\frac{u}{2} = -\dfrac{\sqrt{10}}{10}$, $\tan\frac{u}{2} = -3$

61. $|\sin 3x|$ **63.** $-|\tan 4x|$ **65.** π

67. $\frac{\pi}{3}, \pi, \frac{5\pi}{3}$ **69.** $3\left(\sin\frac{2\pi}{3} + \sin 0\right)$

71. $\frac{1}{2}(\sin 8\theta + \sin 2\theta)$ **73.** $5(\cos 60° + \cos 90°)$

75. $\frac{1}{2}(\cos 2y - \cos 2x)$ **77.** $2\cos 3\theta \sin 2\theta$

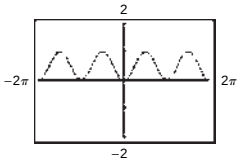
79. $2\cos 4x \cos 2x$ **81.** $2\cos\alpha\sin\beta$

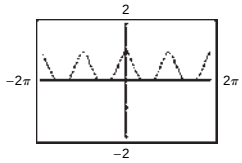
83. $-2\sin\theta\sin\frac{\pi}{2}$ **85.** $\dfrac{\sqrt{2}}{2}$ **87.** $\dfrac{\sqrt{6}}{2}$

89. $0, \frac{\pi}{4}, \frac{\pi}{2}, \frac{3\pi}{4}, \pi, \frac{5\pi}{4}, \frac{3\pi}{2}, \frac{7\pi}{4}$ **91.** $\frac{\pi}{6}, \frac{5\pi}{6}$

93. $\frac{25}{169}$ **95.** $\frac{4}{13}$ **97–109.** Answers will vary.

111. $\dfrac{1 - \cos 2x}{2}$ **113.** $\dfrac{3 + 4\cos 2x + \cos 4x}{8}$





115. $2x\sqrt{1 - x^2}$ **117.** $1 - 2x^2$ **119.** $\dfrac{1 - x^2}{1 + x^2}$

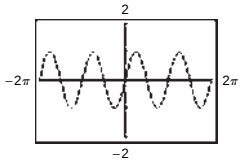
121. (a) $x = 0, \dfrac{\pi}{3}, \pi, \dfrac{5\pi}{3}, 2\pi$

(b) $x = \arccos\dfrac{1 \pm \sqrt{33}}{8}, 2\pi - \arccos\dfrac{1 \pm \sqrt{33}}{8}$

123. 23.85° **125.** $x = 2r(1 - \cos\theta)$

127. False. $\sin\dfrac{x}{2} = -\sqrt{\dfrac{1 - \cos x}{2}}$ for $\pi \le \dfrac{x}{2} \le 2\pi$.

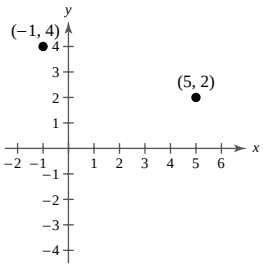
129. (a)



(b) $y = \sin 2x$

(c) Answers will vary.

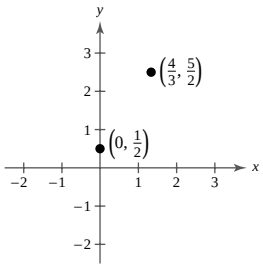
131. (a)



(b) $2\sqrt{10}$

(c) (2, 3)

133. (a)



(b) $\dfrac{2\sqrt{13}}{3}$ (c) $\left(\dfrac{2}{3}, \dfrac{3}{2}\right)$

135. (a) Complement: 35°; supplement: 125°

(b) Complement: none; supplement: 18°

137. (a) Complement: $\dfrac{4\pi}{9}$; supplement: $\dfrac{17\pi}{18}$

(b) Complement: $\dfrac{\pi}{20}$; supplement: $\dfrac{11\pi}{20}$

139. 0.4667 rad

Review Exercises (page 396)

1. $\sec x$ **3.** $\cos x$ **5.** $|\sin x|$

7. $\sec x$ **9.** $\sec x$

11. $\tan x = \dfrac{4}{3}$, $\csc x = \dfrac{5}{4}$, $\sec x = \dfrac{5}{3}$, $\cot x = \dfrac{3}{4}$

13. $\cos x = \dfrac{\sqrt{2}}{2}$, $\tan x = -1$, $\csc x = -\sqrt{2}$, $\sec x = \sqrt{2}$, $\cot x = -1$

15. $\cos^2 x$ **17.** $\csc\theta$ **19.** 1 **21.** $\csc x$

23. $1 + \cot\alpha$ **25–37.** Answers will vary.

39. $\dfrac{\pi}{6} + 2n\pi, \dfrac{5\pi}{6} + 2n\pi$ **41.** $\dfrac{\pi}{3} + 2n\pi, \dfrac{2\pi}{3} + 2n\pi$

43. $\dfrac{\pi}{6} + n\pi$ **45.** $\dfrac{\pi}{3} + n\pi, \dfrac{2\pi}{3} + n\pi$

47. $\dfrac{\pi}{6} + n\pi, \dfrac{5\pi}{6} + n\pi$ **49.** $n\pi$ **51.** $0, \dfrac{2\pi}{3}, \dfrac{4\pi}{3}$

53. $0, \dfrac{\pi}{2}, \pi$ **55.** $\dfrac{\pi}{8}, \dfrac{3\pi}{8}, \dfrac{9\pi}{8}, \dfrac{11\pi}{8}$

57. $0, \dfrac{\pi}{8}, \dfrac{3\pi}{8}, \dfrac{5\pi}{8}, \dfrac{7\pi}{8}, \dfrac{9\pi}{8}, \dfrac{11\pi}{8}, \dfrac{13\pi}{8}, \dfrac{15\pi}{8}$

59. $\dfrac{\pi}{12} + n\pi, \dfrac{5\pi}{12} + n\pi$ **61.** $\dfrac{\pi}{12} + \dfrac{n\pi}{6}$ **63.** $0, \pi$

65. $\arctan(-4) + \pi, \arctan 3, \arctan(-4) + 2\pi, \arctan 3 + \pi$

67. $\sin 285° = -\dfrac{\sqrt{2} + \sqrt{6}}{4}$, $\cos 285° = \dfrac{\sqrt{6} - \sqrt{2}}{4}$, $\tan 285° = -2 - \sqrt{3}$

69. $\sin\dfrac{31\pi}{12} = \dfrac{\sqrt{2} + \sqrt{6}}{4}$, $\cos\dfrac{31\pi}{12} = \dfrac{\sqrt{2} - \sqrt{6}}{4}$, $\tan\dfrac{31\pi}{12} = -2 - \sqrt{3}$

71. $\sin 180°$ **73.** $\tan 75°$ **75.** $-\frac{4}{5}$ **77.** $\frac{44}{117}$

79. $-\dfrac{3}{5}$ **81–85.** Answers will vary. **87.** $\dfrac{\pi}{4}, \dfrac{7\pi}{4}$

89. $\sin 2u = \dfrac{20\sqrt{6}}{49}$, $\cos 2u = -\dfrac{1}{49}$, $\tan 2u = -20\sqrt{6}$

91. $\sin 2u = -\dfrac{36}{85}$, $\cos 2u = \dfrac{77}{85}$, $\tan 2u = -\dfrac{36}{77}$

93 and 95. Answers will vary. **97.** 15°, 75°

99. $\frac{1}{32}(10 - 15\cos 2x + 6\cos 4x - \cos 6x)$

101. $\dfrac{1}{8}(3 + 4\cos 4x + \cos 8x)$ **103.** $\dfrac{1 - \cos 8x}{1 + \cos 8x}$

105. $\sin 15° = \dfrac{\sqrt{2 - \sqrt{3}}}{2}$, $\cos 15° = \dfrac{\sqrt{2 + \sqrt{3}}}{2}$, $\tan 15° = 2 - \sqrt{3}$

107. $\sin\dfrac{7\pi}{8} = \dfrac{\sqrt{2 - \sqrt{2}}}{2}$, $\cos\dfrac{7\pi}{8} = -\dfrac{\sqrt{2 + \sqrt{2}}}{2}$, $\tan\dfrac{7\pi}{8} = 1 - \sqrt{2}$

109. $\sin\dfrac{u}{2} = \dfrac{\sqrt{10}}{10}$, $\cos\dfrac{u}{2} = \dfrac{3\sqrt{10}}{10}$, $\tan\dfrac{u}{2} = \dfrac{1}{3}$

111. $\sin\dfrac{u}{2} = \dfrac{3\sqrt{14}}{14}$, $\cos\dfrac{u}{2} = \dfrac{\sqrt{70}}{14}$, $\tan\dfrac{u}{2} = \dfrac{3\sqrt{5}}{5}$

113. $-|\cos 4x|$ **115.** $\tan 5x$ **117.** $V = \sin\dfrac{\theta}{2}\cos\dfrac{\theta}{2}\,\text{m}^3$

119. $3\left(\sin\frac{\pi}{2}+\sin 0\right)$ **121.** $\frac{1}{2}(\cos\alpha-\cos 9\alpha)$

123. $2\cos\left(\frac{9\theta}{2}\right)\cos\left(\frac{\theta}{2}\right)$ **125.** $2\cos x\sin\frac{\pi}{4}$

127. $y=\frac{1}{2}\sqrt{10}\sin\left(8t-\arctan\frac{1}{3}\right)$

129. $\frac{\sqrt{10}}{2}$ ft **131.** False. $\cos\frac{\theta}{2}>0$

133. True. Answers will vary. **135.** Answers will vary.

137. No. $\sin\theta=\frac{1}{2}$ has an infinite number of solutions but is not an identity.

139. $y_3=y_2+1$

Chapter Test (page 399)

1. $\sin\theta=\frac{-3\sqrt{13}}{13}$ **2.** 1 **3.** 1

$\cos\theta=\frac{-2\sqrt{13}}{13}$

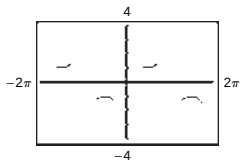
$\csc\theta=\frac{-\sqrt{13}}{3}$

$\sec\theta=\frac{-\sqrt{13}}{2}$

$\cot\theta=\frac{2}{3}$

4. $\csc\theta\sec\theta$ **5.** $0,\ \frac{\pi}{2}<\theta\le\pi,\ \frac{3\pi}{2}<\theta<2\pi$

6.



$y_1=y_2$

7–12. Answers will vary. **13.** $\sqrt{3}+2$

14. $\frac{1}{16}\left(\frac{10-15\cos 2x+6\cos 4x-\cos 6x}{1+\cos 2x}\right)$

15. $\tan 2\theta$ **16.** $2(\sin 6\theta+\sin 2\theta)$

17. $-2\cos\frac{7\theta}{2}\sin\frac{\theta}{2}$ **18.** $0,\ \frac{3\pi}{4},\ \pi,\ \frac{7\pi}{4}$

19. $\frac{\pi}{6},\ \frac{\pi}{2},\ \frac{5\pi}{6},\ \frac{3\pi}{2}$ **20.** $\frac{\pi}{6},\ \frac{5\pi}{6},\ \frac{7\pi}{6},\ \frac{11\pi}{6}$

21. $\frac{\pi}{6},\ \frac{5\pi}{6},\ \frac{3\pi}{2}$ **22.** $-2.938,\ -2.663,\ 1.170$

23. $\sin 2u=\frac{4}{5}$ **24.** 76.52°

$\cos 2u=-\frac{3}{5}$

$\tan 2u=-\frac{4}{3}$

Chapter 6

Section 6.1 (page 410)

1. oblique **3.** $\frac{1}{2}bc\sin A;\ \frac{1}{2}ab\sin C;\ \frac{1}{2}ac\sin B$

5. AAS (or ASA) and SSA

7. $C=95°,\ b\approx 24.59$ in., $c\approx 28.29$ in.

9. $A=40°,\ a\approx 15.69$ cm, $b\approx 6.32$ cm

11. $C=74°\ 15',\ a\approx 6.41$ km, $c\approx 6.26$ km

13. $B\approx 21.55°,\ C\approx 122.45°,\ c\approx 11.49$

15. $B=60.9°,\ b\approx 19.32,\ c\approx 6.36$

17. $B\approx 18°\ 13',\ C\approx 51°\ 32',\ c\approx 40.05$

19. $B\approx 48.74°,\ C\approx 21.26°,\ c\approx 48.23$

21. $A=48°,\ b\approx 2.29,\ c\approx 4.73$

23. $A=35°,\ a\approx 36.50,\ b\approx 11.05$

25. $A\approx 44°\ 14',\ B\approx 50°\ 26',\ b\approx 38.67$ **27.** No solution

29. Two solutions

$B\approx 72.21°,\ C\approx 49.79°,\ c\approx 10.27$

$B\approx 107.79°,\ C\approx 14.21°,\ c\approx 3.30$

31. Given: $A=36°,\ a=5$

(a) One solution if $b\le 5$ or $b=\frac{5}{\sin 36°}$.

(b) Two solutions if $5<b<\frac{5}{\sin 36°}$.

(c) No solution if $b>\frac{5}{\sin 36°}$.

33. Given: $A=10°,\ a=10.8$

(a) One solution if $b\le 10.8$ or $b=\frac{10.8}{\sin 10°}$.

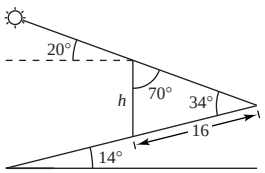
(b) Two solutions if $10.8<b<\frac{10.8}{\sin 10°}$.

(c) No solution if $b>\frac{10.8}{\sin 10°}$.

35. 28.19 square units **37.** 1782.32 square units

39. 2888.57 square units

41. (a)



(b) $\frac{16}{\sin 70°}=\frac{h}{\sin 34°}$

(c) 9.52 m

43. 240.03°

45. 15.53 km from Colt Station; 42.43 km from Pine Knob

47. $\theta\approx 16.08°$

49. (a) $\alpha\approx 5.36°$

(b) $\beta=\arcsin\left(\frac{d\sin\theta}{58.36}\right)$ (c) $d=\sin(84.64-\theta)\left[\frac{58.36}{\sin\theta}\right]$

(d)

θ	10°	20°	30°	40°	50°	60°
d	324.08	154.19	95.19	63.80	43.30	28.10

51. False. The triangle cannot be solved if only three angles are known.

53. False. AAS and ASA cases have unique solutions.

55. (a) Answers will vary; Sample answer: $b=4$

(b) Answers will vary; Sample answer: $b=7$

(c) Answers will vary; Sample answer: $b=10$

57. $\tan\theta=-\frac{12}{5};\ \csc\theta=-\frac{13}{12};\ \sec\theta=\frac{13}{5};\ \cot\theta=-\frac{5}{12}$

59. $3(\sin 11\theta+\sin 5\theta)$ **61.** $\frac{3}{2}\left(\sin\frac{11\pi}{6}+\sin\frac{3\pi}{2}\right)$

Section 6.2 (page 417)

1. $c^2=a^2+b^2-2ab\cos C$ **3.** No **5.** Yes

7. $A\approx 40.80°,\ B\approx 60.61°,\ C\approx 78.59°$

9. $A\approx 49.51°,\ B\approx 55.40°,\ C\approx 75.09°$

11. $A\approx 31.40°,\ C\approx 128.60°,\ b\approx 6.56$ mm

13. $A\approx 26.38°,\ B\approx 36.34°,\ C\approx 117.28°$

15. $B\approx 29.44°,\ C\approx 100.56°,\ a\approx 23.38$

17. $A \approx 36.87°$, $B \approx 53.13°$, $C = 90°$

19. $A \approx 103.52°$, $B \approx 38.24°$, $C \approx 38.24°$

21. $A \approx 154° 14'$, $C \approx 17° 31'$, $b \approx 8.58$

23. $A \approx 37° 6' 7''$, $C \approx 67° 33' 53''$, $b \approx 9.94$

	a	b	c	d	θ	ϕ
25.	4	8	11.64	4.96	30°	150°
27.	10	14	20	13.86	68.20°	111.80°
29.	15	16.96	25	20	77.22°	102.78°

31. Law of Cosines; $A \approx 102.44°$, $C \approx 37.56°$, $b \approx 5.26$

33. Law of Sines; no solution

35. Law of Sines; $C = 103°$, $a \approx 0.82$, $b \approx 0.71$ **37.** 104.57

39. 19.81 **41.** 0.27 ft^2 **43.** 15.52 **45.** 35.19

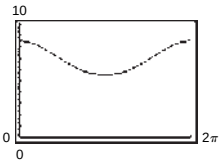
47. 483.40 m **49.** (a) N 59.7° E (b) N 72.8° E

51. 72.28° **53.** $PQ \approx 9.43$, $QS = 5$, $RS \approx 12.81$

55. 18,617.66 ft^2

57. (a) $49 = 2.25 + x^2 - 3x \cos\theta$

(b) $x = \frac{1}{2}\left(3\cos\theta + \sqrt{9\cos^2\theta + 187}\right)$

(c) 

(d) 6 in.

59. True **61.** Proof

63. To solve the triangle using the Law of Cosines, substitute values into $a^2 = b^2 + c^2 - 2bc\cos A$.

Simplify the equation so that you have a quadratic equation in terms of c. Then, find the two values of c, and find the two triangles that model the given information.

Using the Law of Sines will give the same result as using the Law of Cosines.

Sample answer: An advantage of using the Law of Cosines is that it is easier to choose the correct value to avoid the ambiguous case, but its disadvantage is that there are more computations. The opposite is true for the Law of Sines.

65. Proof **67.** $-\frac{\pi}{2}$ **69.** $\frac{\pi}{3}$

Section 6.3 (page 429)

1. directed line segment **3.** magnitude

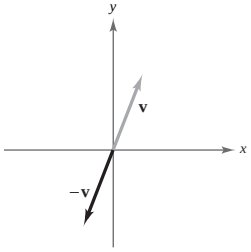
5. standard position **7.** resultant

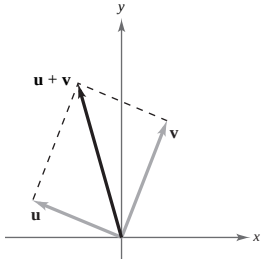
9. magnitude and direction **11.** Answers will vary.

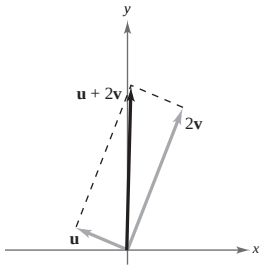
13. $\langle 1, 3\rangle$, $\|\mathbf{v}\| = \sqrt{10}$ **15.** $\langle -3, 2\rangle$, $\|\mathbf{v}\| = \sqrt{13}$

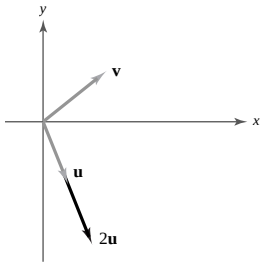
17. $\langle 0, 5\rangle$, $\|\mathbf{v}\| = 5$ **19.** $\langle 8, 6\rangle$, $\|\mathbf{v}\| = 10$

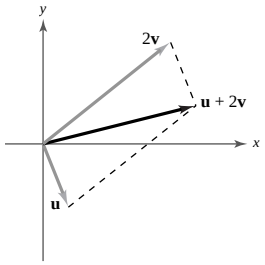
21. $\left\langle \frac{3}{5}, -\frac{3}{5}\right\rangle$, $\|\mathbf{v}\| = \frac{3\sqrt{2}}{5}$ **23.** $\left\langle \frac{7}{6}, \frac{9}{5}\right\rangle$, $\|\mathbf{v}\| = \frac{\sqrt{4141}}{30}$

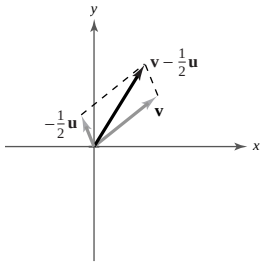
25. 

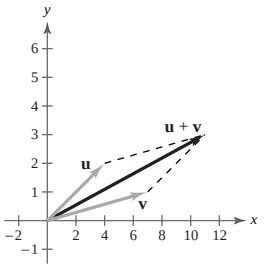
27. 

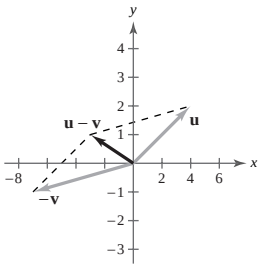
29. 

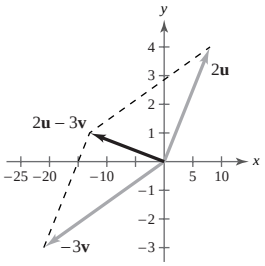
31. 

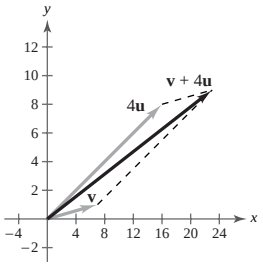
33. 

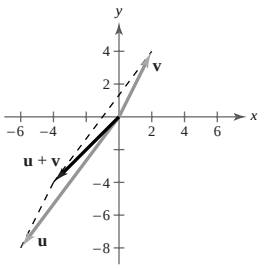
35. 

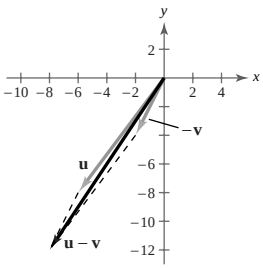
37. (a) $\langle 11, 3\rangle$ 

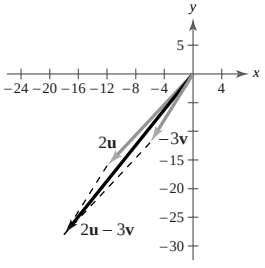
(b) $\langle -3, 1\rangle$ 

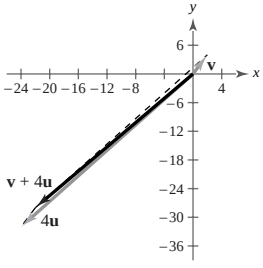
(c) $\langle -13, 1\rangle$ 

(d) $\langle 23, 9\rangle$ 

39. (a) $\langle -4, -4\rangle$ 

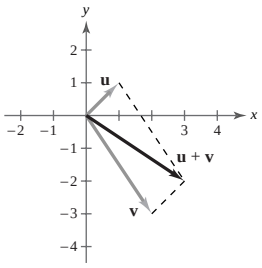
(b) $\langle -8, -12\rangle$ 

(c) $\langle -18, -28\rangle$ 

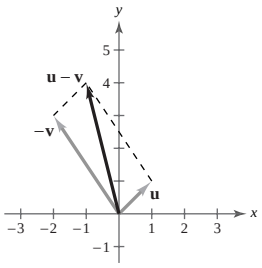
(d) $\langle -22, -28\rangle$ 

CHAPTER 6

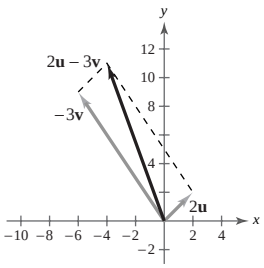
41. (a) $3\mathbf{i} - 2\mathbf{j}$



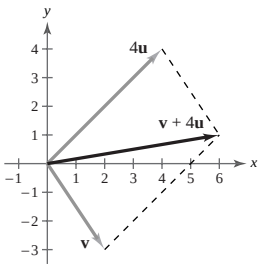
(b) $-\mathbf{i} + 4\mathbf{j}$



(c) $-4\mathbf{i} + 11\mathbf{j}$



(d) $6\mathbf{i} + \mathbf{j}$



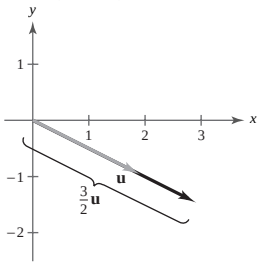
43. $\mathbf{u} + \mathbf{v}$ **45.** $\mathbf{w} - \mathbf{v}$ **47.** $\langle 1, 0 \rangle$

49. $\left\langle -\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2} \right\rangle$ **51.** $\left\langle -\frac{24}{25}, -\frac{7}{25} \right\rangle$ **53.** $\frac{4}{5}\mathbf{i} - \frac{3}{5}\mathbf{j}$

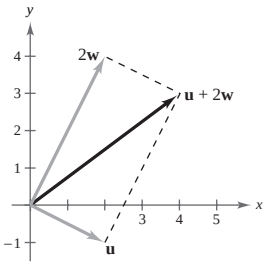
55. $\mathbf{j}$ **57.** $\frac{40\sqrt{61}}{61}\mathbf{i} + \frac{48\sqrt{61}}{61}\mathbf{j}$ **59.** $\frac{21}{5}\mathbf{i} + \frac{28}{5}\mathbf{j}$

61. $-8\mathbf{i}$ **63.** $7\mathbf{i} + 4\mathbf{j}$ **65.** $3\mathbf{i} + 8\mathbf{j}$

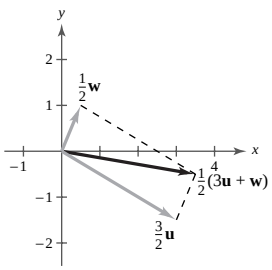
67. $\mathbf{v} = \left\langle 3, -\frac{3}{2} \right\rangle$



69. $\mathbf{v} = \langle 4, 3 \rangle$



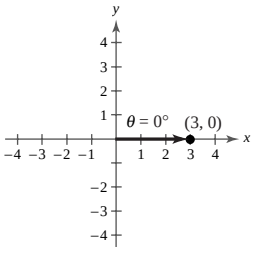
71. $\mathbf{v} = \left\langle \frac{7}{2}, -\frac{1}{2} \right\rangle$



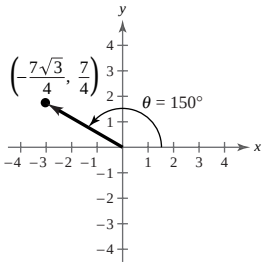
73. $\|\mathbf{v}\| = 5$, $\theta = 30°$

75. $\|\mathbf{v}\| = 6\sqrt{2}$, $\theta = 315°$ **77.** $\|\mathbf{v}\| = \sqrt{29}$, $\theta \approx 111.80°$

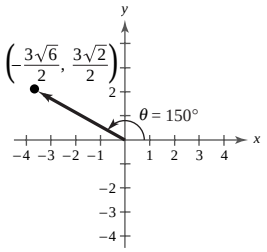
79. $\mathbf{v} = \langle 3, 0 \rangle$



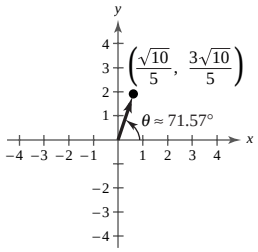
81. $\mathbf{v} = \left\langle -\frac{7\sqrt{3}}{4}, \frac{7}{4} \right\rangle$



83. $\mathbf{v} = \left\langle -\frac{3\sqrt{6}}{2}, \frac{3\sqrt{2}}{2} \right\rangle$



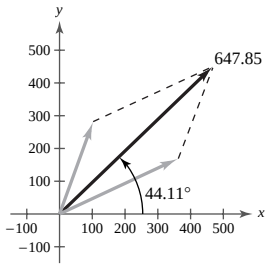
85. $\mathbf{v} = \left\langle \frac{\sqrt{10}}{5}, \frac{3\sqrt{10}}{5} \right\rangle$



87. $\left\langle \frac{5}{2}, \frac{10 + 5\sqrt{3}}{2} \right\rangle$

89. $\left\langle 10\sqrt{2} - 25\sqrt{3}, 25 + 10\sqrt{2} \right\rangle$ **91.** 90°

93.



95. 62.72°

$\|\mathbf{v}\| \approx 647.85$, $\theta \approx 44.11°$

97. Horizontal component: about 53.62 ft/sec
Vertical component: about 45.00 ft/sec

99. $T_{AC} \approx 3611.1$ lb, $T_{BC} \approx 2169.5$ lb

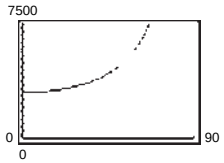
101. (a) $T = 3000 \sec \theta$; Domain: $0° \leq \theta < 90°$

(b)

θ	10°	20°	30°
T	3046.28	3192.53	3464.10

θ	40°	50°	60°
T	3916.22	4667.17	6000

(c)



(d) The component in the direction of the motion of the barge decreases.

103. (a) 12.10°, 357.85 N

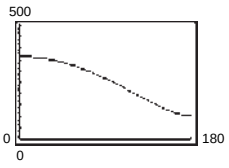
(b) $M = 10\sqrt{660 \cos \theta + 709}$

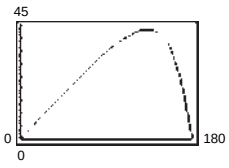
$\alpha = \arctan \dfrac{15 \sin \theta}{15 \cos \theta + 22}$

(c)

θ	0°	30°	60°	90°
M	370°	357.85°	322.34°	266.27°
α	0°	12.10°	23.77°	34.29°

θ	120°	150°	180°
M	194.68°	117.23°	70°
α	41.86°	39.78°	0°

(d) 



(e) For increasing θ, the two vectors tend to work against each other, resulting in a decrease in the magnitude of the resultant.

105. N 26.67° E, 130.35 km/h **107.** True by definition

109. True. $a = b = 0$

111. True. The magnitudes are equal and the directions are opposite.

113. True. $\mathbf{a} - \mathbf{b} = \mathbf{c}$ and $\mathbf{u} = -\mathbf{b}$

115. True. $\mathbf{a} = -\mathbf{d}$, $\mathbf{w} = -\mathbf{d}$

117. False. $\mathbf{u} - \mathbf{v} = -(\mathbf{b} + \mathbf{t})$

119. (a) 0°

(b) 180°

(c) No. The magnitude is equal to the sum when the angle between the vectors is 0°.

121. Proof **123.** Answers will vary.

125. $\langle 1, 3\rangle$ or $\langle -1, -3\rangle$ **127.** $12x^3y^7,\ x \neq 0,\ y \neq 0$

129. $48xy^2,\ x \neq 0$ **131.** 7.14×10^5

133. $\frac{\pi}{2} + n\pi,\ \pi + 2n\pi$ **135.** $\frac{\pi}{3} + 2n\pi, \frac{5\pi}{3} + 2n\pi$

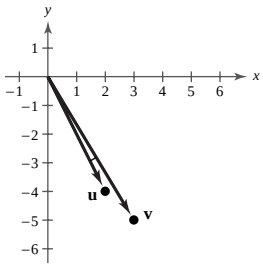
Section 6.4 (page 440)

1. Yes **3.** scalar **5.** $\left(\frac{\mathbf{u} \cdot \mathbf{v}}{\|\mathbf{v}\|^2}\right)\mathbf{v}$ **7.** 0 **9.** 14

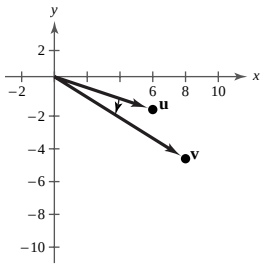
11. 8, scalar **13.** 4, scalar **15.** $\langle -114, -114\rangle$, vector

17. 13 **19.** $5\sqrt{41}$ **21.** 4 **23.** 90° **25.** 70.56°

27. 90° **29.** $\frac{5\pi}{12}$

31. 

$\theta \approx 4.40°$

33. 

$\theta \approx 13.57°$

35. 26.57°, 63.43°, 90° **37.** 41.63°, 53.13°, 85.24°

39. $-162\sqrt{2}$ **41.** -20 **43.** Orthogonal

45. Not orthogonal **47.** Neither **49.** Parallel

51. 3 **53.** 10 **55.** 0

57. $\frac{16}{17}\langle 4, 1\rangle$, $\mathbf{u} = \left\langle \frac{64}{17}, \frac{16}{17}\right\rangle + \left\langle -\frac{13}{17}, \frac{52}{17}\right\rangle$

59. $\frac{45}{229}\langle 2, 15\rangle$, $\mathbf{u} = \left\langle \frac{90}{229}, \frac{675}{229}\right\rangle + \left\langle -\frac{90}{229}, \frac{12}{229}\right\rangle$ **61.** **u** **63.** **0**

65. $\langle 3, -1\rangle, \langle -3, 1\rangle$ **67.** $-\frac{3}{4}\mathbf{i} - \frac{1}{2}\mathbf{j}, \frac{3}{4}\mathbf{i} + \frac{1}{2}\mathbf{j}$ **69.** 32

71. (a) 35,727.50; It is the total dollar amount paid to the employees.

(b) Multiply **v** by 1.02.

73. (a) Force $= 30{,}000 \sin d$

(b)

d	0°	1°	2°	3°	4°
Force	0	523.57	1046.98	1570.08	2092.69

d	5°	6°	7°	8°
Force	2614.67	3135.85	3656.08	4175.19

d	9°	10°
Force	4693.03	5209.45

(c) 29,885.84 lb

75. (a) Work $= 125\sqrt{3}d$

(b)

d	25	50	100
Work	5412.66	10,825.32	21,650.64

77. 10,282,651.78 N-m

79. True. The zero vector is orthogonal to every vector.

81. Orthogonal. $\mathbf{u} \cdot \mathbf{v} = 0$

83. 1. The angle between **u** and itself is 0. Then, using the equation

$$\cos\theta = \frac{\mathbf{u} \cdot \mathbf{u}}{\|\mathbf{u}\|\,\|\mathbf{u}\|}$$

and substituting 0 for θ, you see that $\cos 0 = 1$.

85. (a) **u** and **v** are parallel. (b) **u** and **v** are orthogonal.

87 and 89. Proofs

91. g is a horizontal shift of f four units to the right.

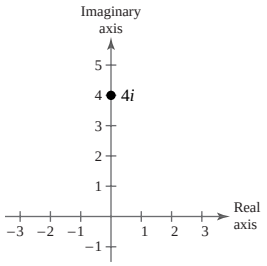
93. g is a vertical shift of f six units upward.

95. $15 + 12i$ **97.** 10 **99.** $\frac{47}{26} - \frac{27}{26}i$

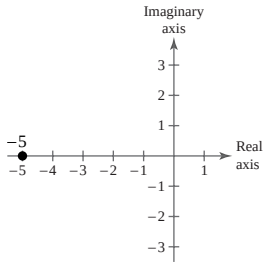
Section 6.5 (page 452)

1. absolute value **3.** nth root

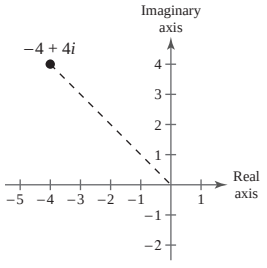
5. The distance from the origin to the point (a, b)

7. 

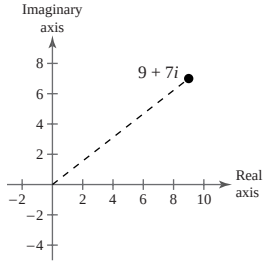
4

9. 

5

11. 

$4\sqrt{2}$

13. 

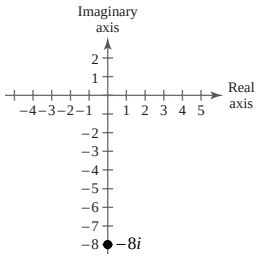
$\sqrt{130}$

CHAPTER 6

15. $2\left(\cos\frac{\pi}{2} + i\sin\frac{\pi}{2}\right)$ **17.** $4(\cos\pi + i\sin\pi)$

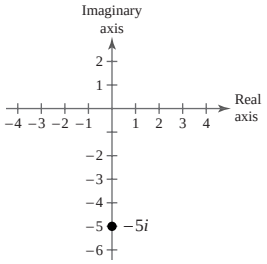
19. $3\sqrt{2}\left(\cos\frac{5\pi}{4} + i\sin\frac{5\pi}{4}\right)$ **21.** $2\left(\cos\frac{11\pi}{6} + i\sin\frac{11\pi}{6}\right)$

23.



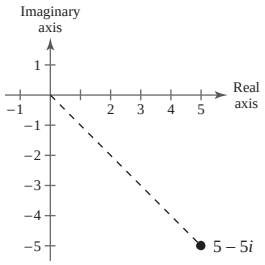
$8\left(\cos\frac{3\pi}{2} + i\sin\frac{3\pi}{2}\right)$

25.



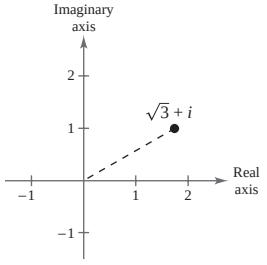
$5\left(\cos\frac{3\pi}{2} + i\sin\frac{3\pi}{2}\right)$

27.



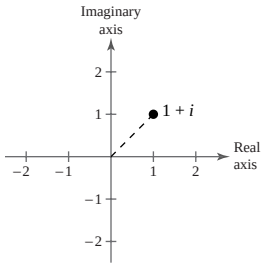
$5\sqrt{2}\left(\cos\frac{7\pi}{4} + i\sin\frac{7\pi}{4}\right)$

29.



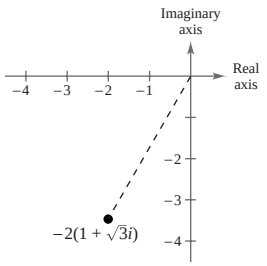
$2\left(\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}\right)$

31.



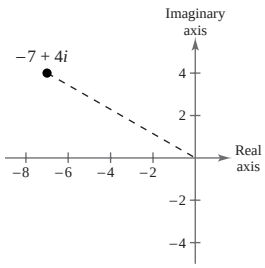
$\sqrt{2}\left(\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}\right)$

33.



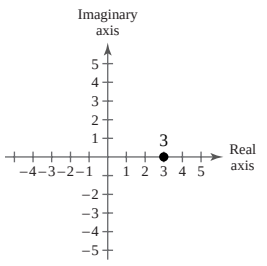
$4\left(\cos\frac{4\pi}{3} + i\sin\frac{4\pi}{3}\right)$

35.



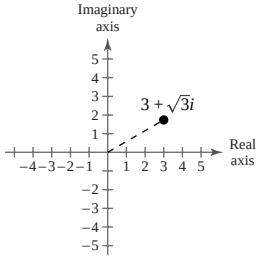
$\sqrt{65}(\cos 2.622 + i\sin 2.622)$

37.



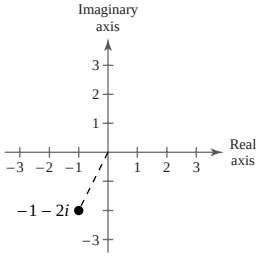
$3(\cos 0 + i\sin 0)$

39.



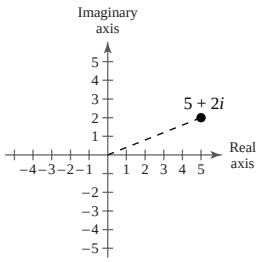
$2\sqrt{3}\left(\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}\right)$

41.



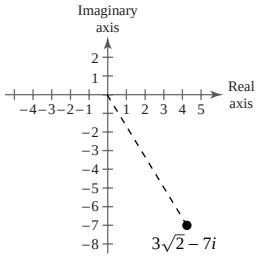
$\sqrt{5}(\cos 4.249 + i\sin 4.249)$

43.



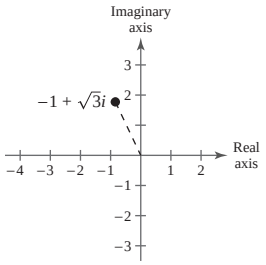
$\sqrt{29}(\cos 0.381 + i\sin 0.381)$

45.



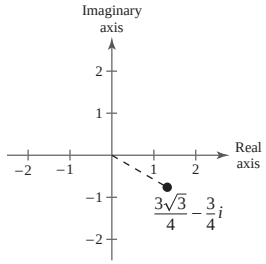
$\sqrt{67}(\cos 5.257 + i\sin 5.257)$

47.



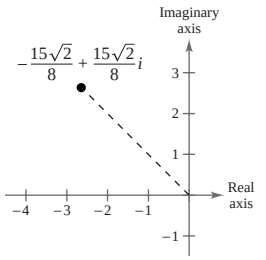
$-1 + \sqrt{3}i$

49.



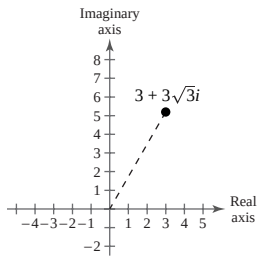
$\frac{3\sqrt{3}}{4} - \frac{3}{4}i$

51.



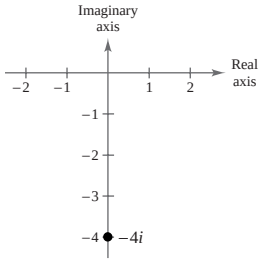
$-\frac{15\sqrt{2}}{8} + \frac{15\sqrt{2}}{8}i$

53.



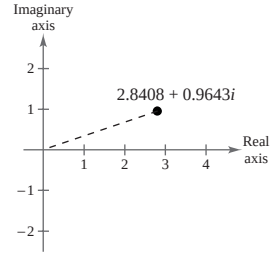
$3 + 3\sqrt{3}i$

55.



$-4i$

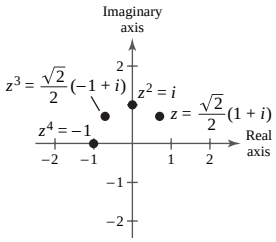
57.



$2.8408 + 0.9643i$

59. $4.6985 + 1.7101i$ **61.** $4.7693 + 7.6324i$

63.



65. $10(\cos 0 + i \sin 0)$

The absolute value of each is 1.

67. $6(\cos \pi + i \sin \pi)$ **69.** $\frac{10}{9}(\cos 200° + i \sin 200°)$

71. $\frac{11}{50}(\cos 130° + i \sin 130°)$ **73.** $\cos 30° + i \sin 30°$

75. $\frac{1}{2}(\cos 80° + i \sin 80°)$ **77.** $6(\cos 312° + i \sin 312°)$

79. (a) $2\sqrt{2}\left(\cos\frac{7\pi}{4} + i \sin\frac{7\pi}{4}\right)$ (b) and (c) $4\sqrt{2}\left(\cos\frac{\pi}{4} + i \sin\frac{\pi}{4}\right)$

81. (a) $2\sqrt{2}\left(\cos\frac{\pi}{4} + i \sin\frac{\pi}{4}\right)$ (b) and (c) $4\sqrt{2}\left(\cos\frac{7\pi}{4} + i \sin\frac{7\pi}{4}\right)$

83. (a) $2\left(\cos\frac{3\pi}{2} + i \sin\frac{3\pi}{2}\right)$ (b) and (c) $2 - 2i$ $\sqrt{2}\left(\cos\frac{\pi}{4} + i \sin\frac{\pi}{4}\right)$

85. (a) $2\left(\cos\frac{3\pi}{2} + i \sin\frac{3\pi}{2}\right)$ (b) and (c) $-2 - 2\sqrt{3}i$ $2\left(\cos\frac{11\pi}{6} + i \sin\frac{11\pi}{6}\right)$

87. (a) $2(\cos 0 + i \sin 0)$ (b) and (c) $2 - 2i$ $\sqrt{2}\left(\cos\frac{7\pi}{4} + i \sin\frac{7\pi}{4}\right)$

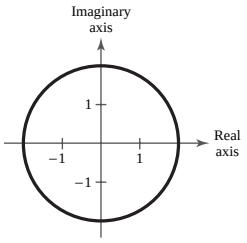
89. (a) $5(\cos 0.93 + i \sin 0.93)$ $2\left(\cos\frac{5\pi}{3} + i \sin\frac{5\pi}{3}\right)$

(b) and (c) $\left(\frac{3}{4} - \sqrt{3}\right) + \left(\frac{3\sqrt{3}}{4} + 1\right)i$

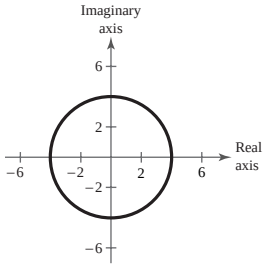
91. (a) $5(\cos 0 + i \sin 0)$ (b) and (c) $\frac{5}{4} - \frac{5}{4}i$ $2\sqrt{2}\left(\cos\frac{\pi}{4} + i \sin\frac{\pi}{4}\right)$

93. (a) $4\left(\cos\frac{\pi}{2} + i \sin\frac{\pi}{2}\right)$ (b) and (c) $2 - 2i$ $\sqrt{2}\left(\cos\frac{3\pi}{4} + i \sin\frac{3\pi}{4}\right)$

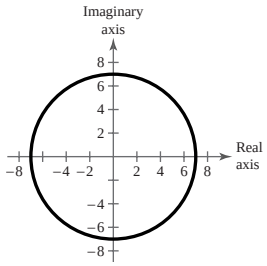
95.



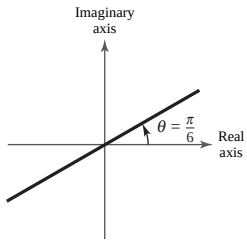
97.



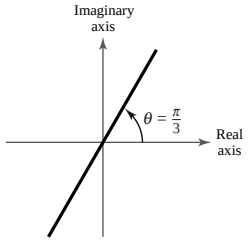
99.



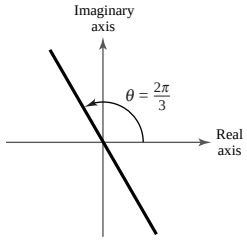
101.



103.



105.



107. $-2 + 2i$ **109.** $8i$ **111.** $-32\sqrt{3} + 32i$

113. $\frac{125}{2} + \frac{125\sqrt{3}}{2}i$ **115.** i **117.** $4.5386 - 15.3428i$

119. 256 **121.** $-597 - 122i$ **123.** $2048 + 2048\sqrt{3}i$

125. $\frac{9\sqrt{2}}{2} + \frac{9\sqrt{2}}{2}i$ **127.** Answers will vary.

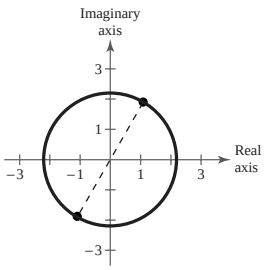
129. $1 + i, -1 - i$ **131.** $-\frac{\sqrt{6}}{2} + \frac{\sqrt{6}}{2}i, \frac{\sqrt{6}}{2} - \frac{\sqrt{6}}{2}i$

133. $-1.5538 + 0.6436i, 1.5538 - 0.6436i$

135. $\frac{\sqrt{6}}{2} + \frac{\sqrt{2}}{2}i, -\frac{\sqrt{6}}{2} - \frac{\sqrt{2}}{2}i$

137. (a) $\sqrt{5}(\cos 60° + i \sin 60°)$ $\sqrt{5}(\cos 240° + i \sin 240°)$

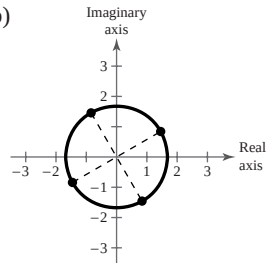
(b)



(c) $\frac{\sqrt{5}}{2} + \frac{\sqrt{15}}{2}i, -\frac{\sqrt{5}}{2} - \frac{\sqrt{15}}{2}i$

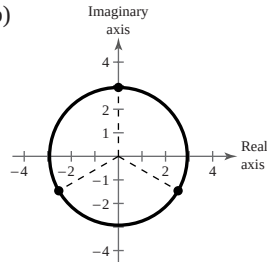
139. (a) $\sqrt[4]{8}\left(\cos\frac{\pi}{6} + i \sin\frac{\pi}{6}\right)$ $\sqrt[4]{8}\left(\cos\frac{2\pi}{3} + i \sin\frac{2\pi}{3}\right)$ $\sqrt[4]{8}\left(\cos\frac{7\pi}{6} + i \sin\frac{7\pi}{6}\right)$ $\sqrt[4]{8}\left(\cos\frac{5\pi}{3} + i \sin\frac{5\pi}{3}\right)$

(b)

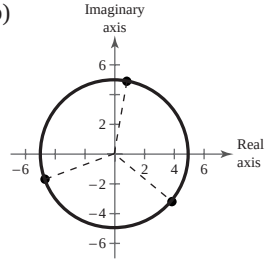


(c) $1.4565 + 0.8409i$ $-0.8409 + 1.4565i$ $-1.4565 - 0.8409i$ $0.8409 - 1.4565i$

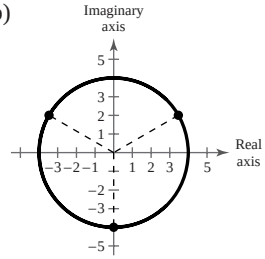
CHAPTER 6

141. (a) $\sqrt[3]{25}\left(\cos\frac{\pi}{2}+i\sin\frac{\pi}{2}\right)$
$\sqrt[3]{25}\left(\cos\frac{7\pi}{6}+i\sin\frac{7\pi}{6}\right)$
$\sqrt[3]{25}\left(\cos\frac{11\pi}{6}+i\sin\frac{11\pi}{6}\right)$
(b)


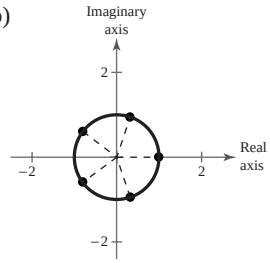
(c) $2.9240i$
$-2.5323 - 1.4620i$
$2.5323 - 1.4620i$

143. (a) $5\left(\cos\frac{4\pi}{9}+i\sin\frac{4\pi}{9}\right)$
$5\left(\cos\frac{10\pi}{9}+i\sin\frac{10\pi}{9}\right)$
$5\left(\cos\frac{16\pi}{9}+i\sin\frac{16\pi}{9}\right)$
(b)


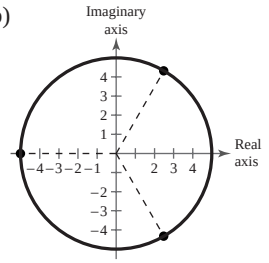
(c) $0.8682 + 4.9240i$,
$-4.6985 - 1.7101i$,
$3.8302 - 3.2139i$

145. (a) $4\left(\cos\frac{\pi}{6}+i\sin\frac{\pi}{6}\right)$
$4\left(\cos\frac{5\pi}{6}+i\sin\frac{5\pi}{6}\right)$
$4\left(\cos\frac{3\pi}{2}+i\sin\frac{3\pi}{2}\right)$
(b)


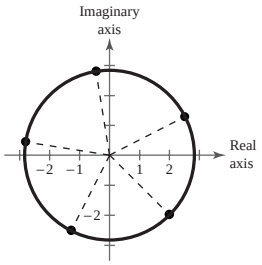
(c) $2\sqrt{3} + 2i$,
$-2\sqrt{3} + 2i$, $-4i$

147. (a) $\cos 0 + i\sin 0$
$\cos\frac{2\pi}{5}+i\sin\frac{2\pi}{5}$
$\cos\frac{4\pi}{5}+i\sin\frac{4\pi}{5}$
$\cos\frac{6\pi}{5}+i\sin\frac{6\pi}{5}$
$\cos\frac{8\pi}{5}+i\sin\frac{8\pi}{5}$
(b)


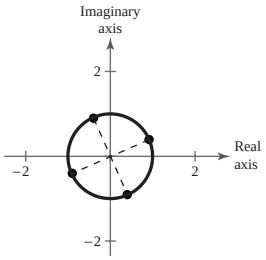
(c) 1, $0.3090 + 0.9511i$, $-0.8090 + 0.5878i$,
$-0.8090 - 0.5878i$, $0.3090 - 0.9511i$

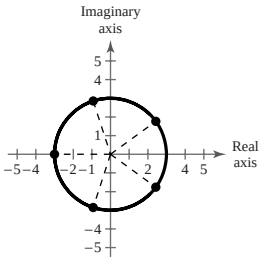
149. (a) $5\left(\cos\frac{\pi}{3}+i\sin\frac{\pi}{3}\right)$
$5(\cos\pi+i\sin\pi)$
$5\left(\cos\frac{5\pi}{3}+i\sin\frac{5\pi}{3}\right)$
(b)


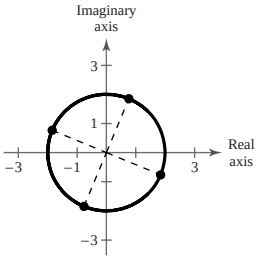
(c) $\frac{5}{2}+\frac{5\sqrt{3}}{2}i$, -5,
$\frac{5}{2}-\frac{5\sqrt{3}}{2}i$

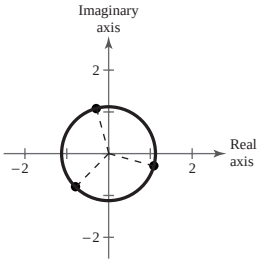
151. (a) $2\sqrt{2}\left(\cos\frac{3\pi}{20}+i\sin\frac{3\pi}{20}\right)$
$2\sqrt{2}\left(\cos\frac{11\pi}{20}+i\sin\frac{11\pi}{20}\right)$
$2\sqrt{2}\left(\cos\frac{19\pi}{20}+i\sin\frac{19\pi}{20}\right)$
$2\sqrt{2}\left(\cos\frac{27\pi}{20}+i\sin\frac{27\pi}{20}\right)$
$2\sqrt{2}\left(\cos\frac{7\pi}{4}+i\sin\frac{7\pi}{4}\right)$
(b)


(c) $2.5201 + 1.2841i$,
$-0.4425 + 2.7936i$,
$-2.7936 + 0.4425i$,
$-1.2841 - 2.5201i$,
$2 - 2i$

153. $\cos\frac{\pi}{8}+i\sin\frac{\pi}{8}$
$\cos\frac{5\pi}{8}+i\sin\frac{5\pi}{8}$
$\cos\frac{9\pi}{8}+i\sin\frac{9\pi}{8}$
$\cos\frac{13\pi}{8}+i\sin\frac{13\pi}{8}$


155. $3\left(\cos\frac{\pi}{5}+i\sin\frac{\pi}{5}\right)$
$3\left(\cos\frac{3\pi}{5}+i\sin\frac{3\pi}{5}\right)$
$3(\cos\pi+i\sin\pi)$
$3\left(\cos\frac{7\pi}{5}+i\sin\frac{7\pi}{5}\right)$
$3\left(\cos\frac{9\pi}{5}+i\sin\frac{9\pi}{5}\right)$


157. $2\left(\cos\frac{3\pi}{8}+i\sin\frac{3\pi}{8}\right)$
$2\left(\cos\frac{7\pi}{8}+i\sin\frac{7\pi}{8}\right)$
$2\left(\cos\frac{11\pi}{8}+i\sin\frac{11\pi}{8}\right)$
$2\left(\cos\frac{15\pi}{8}+i\sin\frac{15\pi}{8}\right)$


159. $\sqrt[6]{2}\left(\cos\frac{7\pi}{12}+i\sin\frac{7\pi}{12}\right)$
$\sqrt[6]{2}\left(\cos\frac{5\pi}{4}+i\sin\frac{5\pi}{4}\right)$
$\sqrt[6]{2}\left(\cos\frac{23\pi}{12}+i\sin\frac{23\pi}{12}\right)$


161. $E = 34 + 38i$ **163.** $Z = \frac{3}{2} - \frac{1}{2}i$ **165.** $I = \frac{39}{34} + \frac{3}{34}i$

167. True. $\left[\frac{1}{2}(1-\sqrt{3}i)\right]^9 = -1$

169. True. $z_1z_2 = r_1r_2[\cos(\theta_1+\theta_2)+i\sin(\theta_1+\theta_2)] = 0$ if and only if $r_1 = 0$ and/or $r_2 = 0$.

171. Answers will vary. **173.** (a) r^2 (b) $\cos 2\theta + i\sin 2\theta$

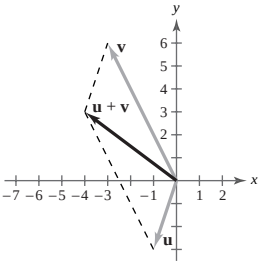
175. Answers will vary.

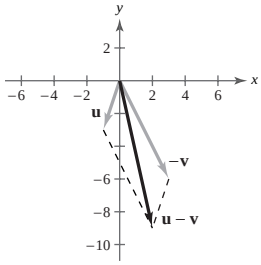
177. Maximum displacement: 16; $t = 2$

179. Maximum displacement: $\frac{1}{8}$; $t = \frac{1}{24}$

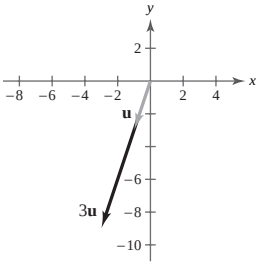
Review Exercises (page 458)

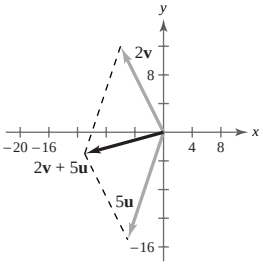
1. $C = 98°$, $b \approx 23.13$, $c \approx 29.90$
3. $A = 50°$, $a \approx 19.83$, $b \approx 10.94$
5. $C = 74° 15'$, $a \approx 5.84$, $c \approx 6.48$
7. No solution **9.** $A \approx 34.23°$, $C \approx 30.77°$, $c \approx 8.18$
11. 19.06 **13.** 221.34 **15.** 31.01 ft
17. $A \approx 27.81°$, $B \approx 54.75°$, $C \approx 97.44°$
19. $A \approx 15.29°$, $B \approx 20.59°$, $C \approx 144.11°$
21. $A \approx 13.19°$, $B \approx 20.98°$, $C \approx 145.83°$
23. $A \approx 86.38°$, $B \approx 28.62°$, $c \approx 22.70$
25. 4.29 ft, 12.63 ft **27.** 7.64 square units
29. 511.71 square units **31.** $\langle 7, -5\rangle$, $\|\mathbf{v}\| = \sqrt{74}$
33. $\langle 7, -7\rangle$, $\|\mathbf{v}\| = 7\sqrt{2}$
35. (a) $\langle -4, 3\rangle$ (b) $\langle 2, -9\rangle$



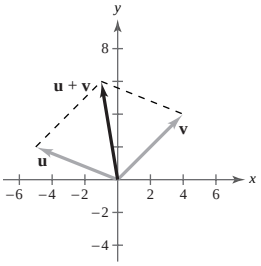


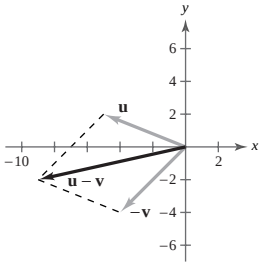
(c) $\langle -3, -9\rangle$ (d) $\langle -11, -3\rangle$



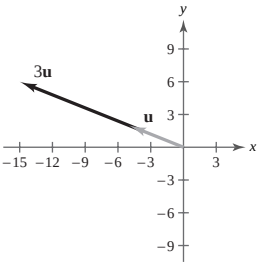


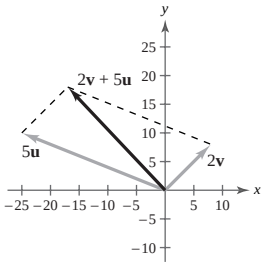
37. (a) $\langle -1, 6\rangle$ (b) $\langle -9, -2\rangle$



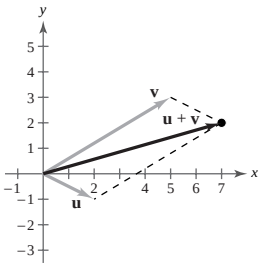


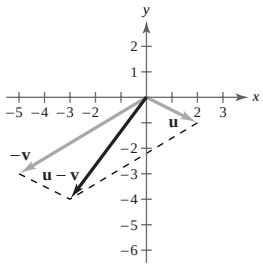
(c) $\langle -15, 6\rangle$ (d) $\langle -17, 18\rangle$



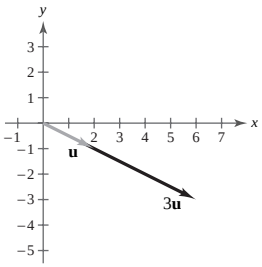


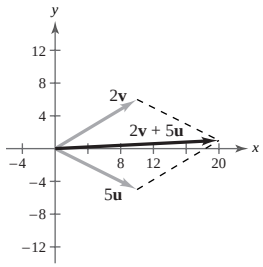
39. (a) $7\mathbf{i} + 2\mathbf{j}$ (b) $-3\mathbf{i} - 4\mathbf{j}$



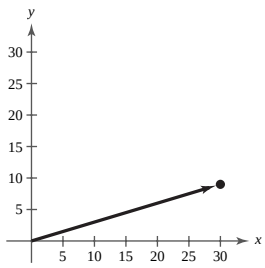


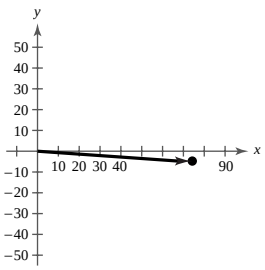
(c) $6\mathbf{i} - 3\mathbf{j}$ (d) $20\mathbf{i} + \mathbf{j}$



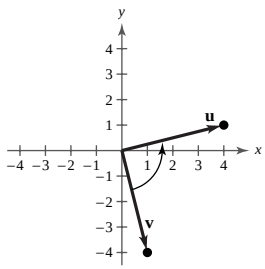


41. $\langle 30, 9\rangle$ **43.** $\langle 74, -5\rangle$



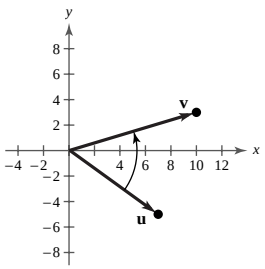


45. $\langle 0, -1\rangle$ **47.** $\frac{\sqrt{29}}{29}\langle 5, -2\rangle$ **49.** $9\mathbf{i} - 8\mathbf{j}$
51. $\|\mathbf{v}\| = 7$; $\theta = 60°$ **53.** $\|\mathbf{v}\| = \sqrt{41}$; $\theta = 38.7°$
55. $\|\mathbf{v}\| = 3\sqrt{2}$; $\theta = 225°$
57. 133.92 lb, 5.55° from the 85-lb force
59. 115.47 lb **61.** -20 **63.** 7 **65.** 25
67. -40 **69.** 2.802 **71.** $\frac{11\pi}{12}$
73.



90°

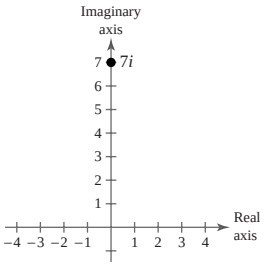
75.



52.2°

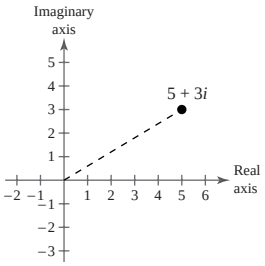
77. Parallel **79.** Neither **81.** $\frac{1}{2}$ **83.** -1
85. $\frac{13}{17}\langle -4, -1\rangle$, $\left\langle -\frac{52}{17}, -\frac{13}{17}\right\rangle + \left\langle -\frac{16}{17}, \frac{64}{17}\right\rangle$
87. $\frac{5}{2}\langle -1, 1\rangle$, $\left\langle -\frac{5}{2}, \frac{5}{2}\right\rangle + \left\langle \frac{9}{2}, \frac{9}{2}\right\rangle$ **89.** 72,000 ft-lb

91.



7

93.



$\sqrt{34}$

95. $2\sqrt{2}\left(\cos\frac{7\pi}{4} + i\sin\frac{7\pi}{4}\right)$ **97.** $2\left(\cos\frac{7\pi}{6} + i\sin\frac{7\pi}{6}\right)$

99. $10\left(\cos\frac{3\pi}{4} + i\sin\frac{3\pi}{4}\right)$ **101.** $4(\cos 240° + i\sin 240°)$

103. (a) $2\sqrt{2}\left(\cos\frac{7\pi}{4} + i\sin\frac{7\pi}{4}\right)$ (b) and (c) 12

$3\sqrt{2}\left(\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}\right)$

105. (a) $3\sqrt{2}\left(\cos\frac{7\pi}{4} + i\sin\frac{7\pi}{4}\right)$ (b) and (c) $-\frac{3}{2}i$

$2\sqrt{2}\left(\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}\right)$

107. $\frac{625}{2} + \frac{625\sqrt{3}}{2}i$ **109.** $2035 - 828i$

111. $\pm(0.3660 + 1.3660i)$ **113.** $-1 + i, 1 - i$

115. (a) $3\left(\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}\right)$

$3\left(\cos\frac{7\pi}{12} + i\sin\frac{7\pi}{12}\right)$

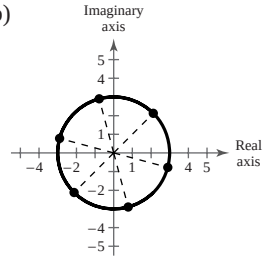
$3\left(\cos\frac{11\pi}{12} + i\sin\frac{11\pi}{12}\right)$

$3\left(\cos\frac{5\pi}{4} + i\sin\frac{5\pi}{4}\right)$

$3\left(\cos\frac{19\pi}{12} + i\sin\frac{19\pi}{12}\right)$

$3\left(\cos\frac{23\pi}{12} + i\sin\frac{23\pi}{12}\right)$

(b)



(c) $2.1213 + 2.1213i, -0.7765 + 2.8978i,$
$-2.8978 + 0.7765i, -2.1213 - 2.1213i,$
$0.7765 - 2.8978i, 2.8978 - 0.7765i$

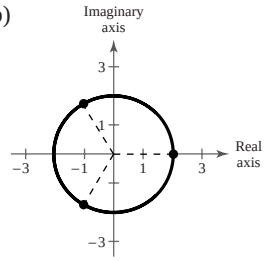
117. (a) $2(\cos 0 + i\sin 0)$

$2\left(\cos\frac{2\pi}{3} + i\sin\frac{2\pi}{3}\right)$

$2\left(\cos\frac{4\pi}{3} + i\sin\frac{4\pi}{3}\right)$

(c) $2, -1 + \sqrt{3}i,$
$-1 - \sqrt{3}i$

(b)

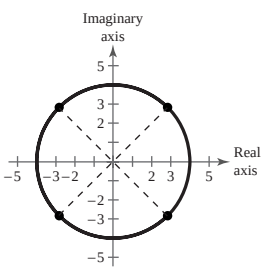


119. $4\left(\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}\right)$

$4\left(\cos\frac{3\pi}{4} + i\sin\frac{3\pi}{4}\right)$

$4\left(\cos\frac{5\pi}{4} + i\sin\frac{5\pi}{4}\right)$

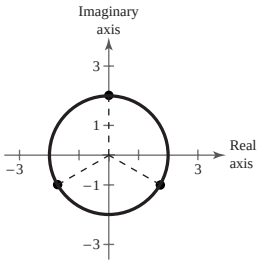
$4\left(\cos\frac{7\pi}{4} + i\sin\frac{7\pi}{4}\right)$



121. $2\left(\cos\frac{\pi}{2} + i\sin\frac{\pi}{2}\right)$

$2\left(\cos\frac{7\pi}{6} + i\sin\frac{7\pi}{6}\right)$

$2\left(\cos\frac{11\pi}{6} + i\sin\frac{11\pi}{6}\right)$



123. True. sin 90° is defined in the Law of Sines.

Chapter Test (page 461)

1. $C = 46°, a \approx 13.07, b \approx 22.03$

2. $A \approx 22.33°, B \approx 49.46°, C \approx 108.21°$

3. $B \approx 40.11°, C \approx 104.89°, a \approx 7.12$

4. Two solutions

$B \approx 41.10°, C \approx 113.90°, c \approx 38.94$

$B \approx 138.90°, C \approx 16.10°, c \approx 11.81$

5. No solution **6.** $B \approx 14.79°, C \approx 15.21°, c \approx 4.93$

7. 675 ft **8.** 2337 m^2 **9.** $\mathbf{w} = \langle 12, 13\rangle, \|\mathbf{w}\| \approx \sqrt{313}$

10. (a) $\langle 8, 8\rangle$ (b) $\langle -12, -22\rangle$ (c) $\langle -4, -26\rangle$

11. (a) $\langle -7, -18\rangle$ (b) $\langle -2, 32\rangle$ (c) $\langle -24, 20\rangle$

12. (a) $13\mathbf{i} + 17\mathbf{j}$ (b) $-17\mathbf{i} - 28\mathbf{j}$ (c) $-\mathbf{i} - 14\mathbf{j}$

13. (a) $-\mathbf{j}$ (b) $5\mathbf{i} + 9\mathbf{j}$ (c) $11\mathbf{i} + 17\mathbf{j}$

14. $\left\langle \frac{3\sqrt{13}}{13}, -\frac{2\sqrt{13}}{13} \right\rangle$ **15.** $\left\langle \frac{18\sqrt{34}}{17}, -\frac{30\sqrt{34}}{17} \right\rangle$

16. $\theta \approx 14.87°$, 250.15 lb **17.** -1 **18.** 105.95°

19. Yes. $\mathbf{u} \cdot \mathbf{v} = 0$ **20.** $\left\langle \frac{185}{26}, \frac{37}{26} \right\rangle, \mathbf{u} = \left\langle \frac{185}{26}, \frac{37}{26} \right\rangle + \left\langle -\frac{29}{26}, \frac{145}{26} \right\rangle$

21. $z = 6\sqrt{2}\left(\cos\frac{3\pi}{4} + i\sin\frac{3\pi}{4}\right)$ **22.** $-50 - 50\sqrt{3}i$

23. $-\frac{6561}{2} + \frac{6561\sqrt{3}}{2}i$ **24.** $5832i$

25. $4\left(\cos\frac{\pi}{12} + i\sin\frac{\pi}{12}\right)$

$4\left(\cos\frac{7\pi}{12} + i\sin\frac{7\pi}{12}\right)$

$4\left(\cos\frac{13\pi}{12} + i\sin\frac{13\pi}{12}\right)$

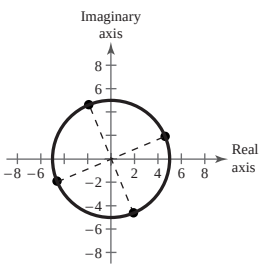
$4\left(\cos\frac{19\pi}{12} + i\sin\frac{19\pi}{12}\right)$

26. $5\left(\cos\frac{\pi}{8} + i\sin\frac{\pi}{8}\right)$

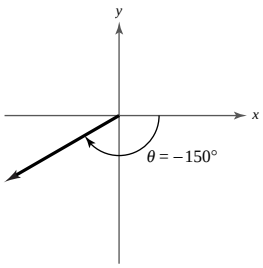
$5\left(\cos\frac{5\pi}{8} + i\sin\frac{5\pi}{8}\right)$

$5\left(\cos\frac{9\pi}{8} + i\sin\frac{9\pi}{8}\right)$

$5\left(\cos\frac{13\pi}{8} + i\sin\frac{13\pi}{8}\right)$



Cumulative Test for Chapters 4–6 (page 462)

1. (a) 

(b) 210°

(c) $-\frac{5\pi}{6}$

(d) 30°

(e) $\sin(-150°) = -\frac{1}{2}$

$\cos(-150°) = -\frac{\sqrt{3}}{2}$

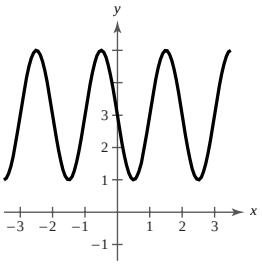
$\tan(-150°) = \frac{\sqrt{3}}{3}$

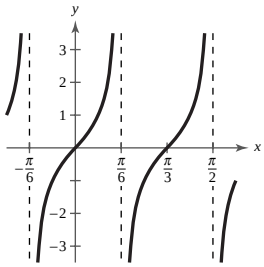
$\csc(-150°) = -2$

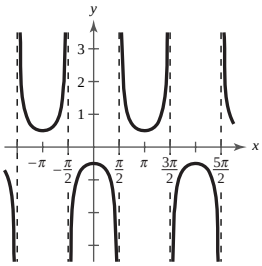
$\sec(-150°) = -\frac{2\sqrt{3}}{3}$

$\cot(-150°) = \sqrt{3}$

2. 146.1° **3.** $\cos\theta = -\frac{5}{13}$

4. 

5. 

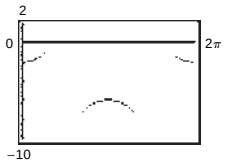
6. 

7. $a = 3, b = \pi, c = \pi$

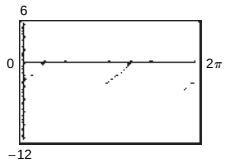
8. $\frac{3}{5}$ **9.** $-\frac{\sqrt{3}}{3}$ **10.** $\frac{2x}{\sqrt{4x^2+1}}$ **11.** $2\tan\theta$

12–14. Answers will vary. **15.** $\frac{3\pi}{2} + 2n\pi$

16. $\frac{\pi}{6} + n\pi, \frac{5\pi}{6} + n\pi$ **17.** 1.7646, 4.5186

18. 

$\frac{\pi}{3}, \frac{5\pi}{3}$

19. 

$\frac{\pi}{4}, \frac{5\pi}{4}$

20. $\frac{16}{63}$ **21.** $\frac{4}{3}$ **22.** $\frac{2\sqrt{5}}{5}$

23. $2\cos 6x \cos 2x$ **24–27.** Answers will vary.

28. $B \approx 14.89°$, $C \approx 119.11°$, $c \approx 17.00$

29. $B \approx 52.82°$, $C \approx 95.18°$, $a \approx 5.32$

30. $B = 55°$, $b \approx 20.14$, $c \approx 24.13$

31. $A \approx 26.07°$, $B \approx 33.33°$, $C \approx 120.60°$

32. 131.71 in.^{2} **33.** 94.10 in.^{2} **34.** $3\mathbf{i} + 5\mathbf{j}$

35. $\frac{\sqrt{5}}{5}\mathbf{i} - \frac{2\sqrt{5}}{5}\mathbf{j}$ **36.** -5 **37.** 1

38. $\left\langle -\frac{1}{13}, -\frac{5}{13}\right\rangle$; $\mathbf{u} = \left\langle \frac{105}{13}, -\frac{21}{13}\right\rangle + \left\langle -\frac{1}{13}, -\frac{5}{13}\right\rangle$

39. $3\sqrt{2}\left(\cos\frac{3\pi}{4} + i\sin\frac{3\pi}{4}\right)$ **40.** $-9 + 3\sqrt{3}i$

41. $-12\sqrt{3} + 12i$

42. $1.4553 + 0.3436i, -1.4553 - 0.3436i$

43. $1, -\frac{1}{2} + \frac{\sqrt{3}}{2}i, -\frac{1}{2} - \frac{\sqrt{3}}{2}i$

44. $5\left(\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}\right)$, $5\left(\cos\frac{3\pi}{4} + i\sin\frac{3\pi}{4}\right)$, $5\left(\cos\frac{5\pi}{4} + i\sin\frac{5\pi}{4}\right)$, $5\left(\cos\frac{7\pi}{4} + i\sin\frac{7\pi}{4}\right)$

45. 5 ft

46. $d = 7\sin\frac{\pi}{4}t$ **47.** 54.34°; 489.45 km/h **48.** 80.28°

Chapter 7

Section 7.1 (page 476)

1. system, equations **3.** substitution

5. Break-even point

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

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

11. (2, 2) **13.** (2, 6), (−1, 3)

15. $(0, 2), \left(\sqrt{3}, 2 - 3\sqrt{3}\right), \left(-\sqrt{3}, 2 + 3\sqrt{3}\right)$ **17.** (4, 4)

19. (5, 5) **21.** $\left(\frac{1}{2}, 3\right)$ **23.** (1, 1) **25.** $\left(\frac{20}{3}, \frac{40}{3}\right)$

27. No solution **29.** \$4000 at 4%, \$14,000 at 6%

31. \$3500 at 7.6%, \$14,500 at 8.8% **33.** (−2, 0), (3, 5)

35. No real solution **37.** (0, 0), (1, 1), (−1, −1)

39. (4, 3) **41.** $\left(\frac{5}{2}, \frac{3}{2}\right)$ **43.** No real solution

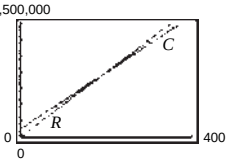
45. (3, 6), (−3, 0) **47.** (4, −0.5) **49.** (8, 3), (3, −2)

51. (±1.540, 2.372) **53.** (0, 1) **55.** (2.318, 2.841)

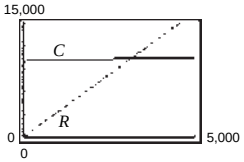
57. (2.25, 5.5) **59.** (0, −13), (±12, 5) **61.** (1, 2)

63. $(-2, 0), \left(\frac{29}{10}, \frac{21}{10}\right)$ **65.** No real solution **67.** (0.25, 1.5)

69. (0.287, 1.751) **71.** (0, 1), (1, 0) **73.** $\left(-4, -\frac{1}{4}\right), \left(\frac{1}{2}, 2\right)$

75. 

192 units; \$1,910,400

77. 

3133 units; \$10,308

79. 6 m × 9 m

CHAPTER 7

81. (a)

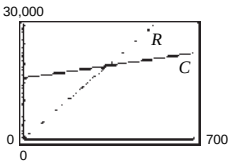
Week	Animated	Horror
1	336	42
2	312	60
3	288	78
4	264	96
5	240	114
6	216	132
7	192	150
8	168	168
9	144	186
10	120	204
11	96	222
12	72	240

(b) and (c) $x = 8$ (d) The answers are the same.

(e) During week 8 the same number of animated and horror films were rented.

83. (a) $C = 9.45x + 16{,}000$
$R = 55.95x$

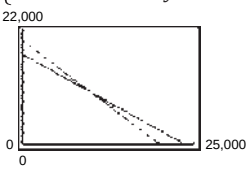
(b) 344 units



85. 8 mi × 12 mi

87. (a) $\begin{cases} x + y = 20{,}000 \\ 0.055x + 0.075y = 1300 \end{cases}$

(b)



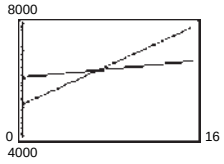
(c) \$10,000. The solution is (10,000, 10,000).

89. (a)

t	Year	Arizona	Indiana
0	2000	5118	6080
1	2001	5289.9	6115.7
2	2002	5461.8	6151.4
3	2003	5633.7	6187.1
4	2004	5805.6	6222.8
5	2005	5977.5	6258.5
6	2006	6149.4	6294.2
7	2007	6321.3	6329.9
8	2008	6493.2	6365.6

(b) 2008

(c)



(d) (7.06, 6332.15)

(7.06, 6332.15)

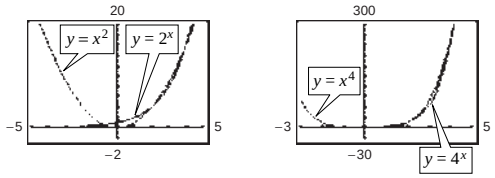
(e) At one point in 2007, the populations of Arizona and Indiana were equal.

91. False. You can solve for either variable before back-substituting.

93. For a linear system, the result will be a contradictory equation such as $0 = N$, where N is a nonzero real number. For a nonlinear system, there may be an equation with imaginary roots.

95. (a) $\begin{cases} 3x + y = 3 \\ 3x + y = 5 \end{cases}$ (b) $\begin{cases} 3x + y = 4 \\ 2x + y = 2 \end{cases}$ (c) $\begin{cases} 6x + 3y = 9 \\ 2x + y = 3 \end{cases}$

97. (a)



(b) There are three points of intersection when b is even.

99. $y = -\frac{2}{7}x + \frac{45}{7}$ **101.** $y = 3$ **103.** $y = \frac{30}{17}x - \frac{18}{17}$

105. Domain: All real numbers x except $x = 6$
Asymptotes: $y = 0, x = 6$

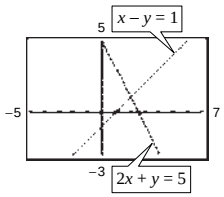
107. Domain: All real numbers x except $x = \pm 4$
Asymptotes: $y = 1, x = \pm 4$

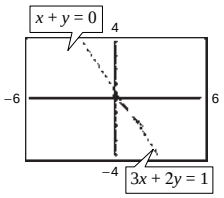
109. Domain: All real numbers x
Asymptote: $y = 0$

Section 7.2 (page 485)

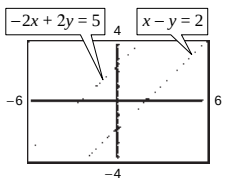
1. method, elimination **3.** Inconsistent **5.** Yes

7. (2, 1) **9.** (1, −1)





11. Inconsistent



13. $\left(2, \frac{1}{2}\right)$ **15.** (3, 4) **17.** (4, −1) **19.** $\left(\frac{12}{7}, \frac{18}{7}\right)$

21. Inconsistent **23.** b; One solution, consistent

24. a; Infinitely many solutions, consistent

25. c; One solution, consistent

26. d; No solutions, inconsistent **27.** $\left(\frac{3}{2}, -\frac{1}{2}\right)$

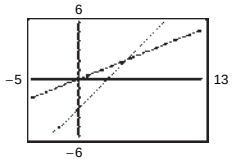
29. Inconsistent **31.** All points on $6x + 8y - 1 = 0$

33. (5, −2) **35.** All points on $-5x + 6y = -3$

37. All points on $5x - 6y - 3 = 0$ **39.** (101, 96)

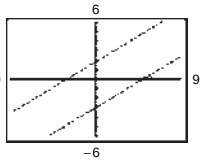
41. $\left(\frac{90}{31}, -\frac{67}{31}\right)$ **43.** (−1, 1) **45.** $\left(1, \frac{1}{2}\right)$

47.



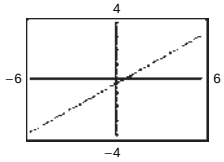
Consistent; (5, 2)

49.



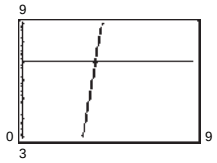
Inconsistent

51.



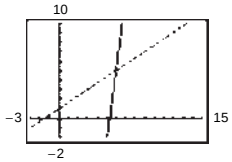
Consistent; all points on $8x - 14y = 5$

53.



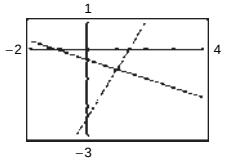
(3.833, 7)

55.



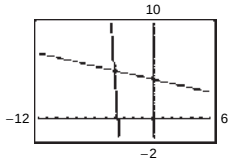
(6, 5)

57.



(1, −0.667)

59.



$(-4, 5)$

61. (4, 1) **63.** (2, −1) **65.** (6, −3) **67.** $\left(\frac{49}{4}, \frac{33}{4}\right)$

69. $\begin{cases} 3x + \frac{1}{2}y = 4 \\ x + 3y = 24 \end{cases}$ **71.** $\begin{cases} 2x + 2y = 11 \\ x - 4y = -7 \end{cases}$

73. (240, 404) **75.** (2,000,000, 100)

77. Plane: 550 mi/hr; wind: 50 mi/hr

79. (a) $\begin{cases} 5.00A + 3.50C = 5087.50 \\ A + C = 1175 \end{cases}$

(b) $A = 650$, $C = 525$; Answers will vary.

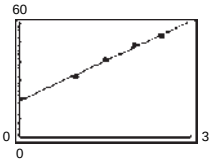
(c) $A = 650$, $C = 525$

81. 9 oranges, 7 grapefruit **83.** 185 movies, 125 video games

85. $y = 0.97x + 2.1$ **87.** $y = -2.5x + 5.54$

89. (a) and (b) $y = 14x + 19$

(c)



(d) 41.4 bushels per acre

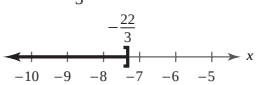
91. True. A linear system can have only one solution, no solution, or infinitely many solutions.

93. False. Sometimes you will be able to get only a close approximation.

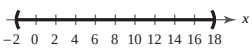
95. (a) $\begin{cases} x + y = 10 \\ x + y = 20 \end{cases}$ (b) $\begin{cases} x + y = 4 \\ 3x + 3y = 12 \end{cases}$

97. $u = 1$; $v = -\tan x$

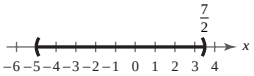
99. $x \le -\frac{22}{3}$



101. $-2 < x < 18$



103. $-5 < x < \frac{7}{2}$



105. $\ln 6x$

107. $\log_9 \frac{12}{x}$ **109.** $\ln \frac{x^2}{x+2}$ **111.** Answers will vary.

Section 7.3 (page 499)

1. row-echelon **3.** Gaussian **5.** three-dimensional

7. Independent **9.** (a) No (b) Yes (c) No (d) No

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

13. (2, −2, 2) **15.** (3, 10, 2) **17.** $\left(\frac{11}{4}, 7, 11\right)$

19. $\begin{cases} x - 2y + 3z = 5 \\ y - 2z = 9 \\ 2x - 3z = 0 \end{cases}$

It removed the x-term from Equation 2.

21. (1, 2, 3) **23.** (−4, 8, 5) **25.** (2, −3, −2)

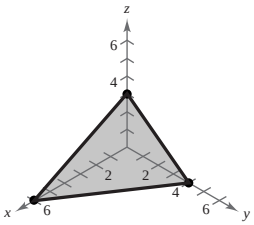
27. Inconsistent **29.** $\left(1, -\frac{3}{2}, \frac{1}{2}\right)$ **31.** $(-a + 3, a + 1, a)$

33. Inconsistent **35.** Inconsistent **37.** (−1, 1, 0)

39. $(2a, 21a - 1, 8a)$ **41.** $\left(-\frac{3}{2}a + \frac{1}{2}, -\frac{2}{3}a + 1, a\right)$

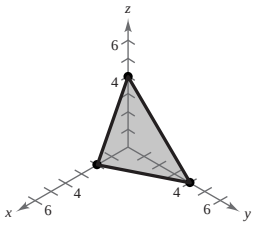
43. $\begin{cases} x + y + z = 1 \\ 2x + y + z = 4 \\ x + y - 3z = -7 \end{cases}$ **45.** $\begin{cases} x + y + 2z = -10 \\ -x + 12y + 8z = -14 \\ x + 14y - 4z = -6 \end{cases}$

47.



(6, 0, 0), (0, 4, 0), (0, 0, 3), (4, 0, 1)

49.



(2, 0, 0), (0, 4, 0), (0, 0, 4), (0, 2, 2)

51. $\frac{A}{x} + \frac{B}{x - 14}$ **53.** $\frac{A}{x} + \frac{B}{x^2} + \frac{C}{x - 10}$

55. $\frac{A}{x - 5} + \frac{B}{(x - 5)^2} + \frac{C}{(x - 5)^3}$ **57.** $\frac{1}{2}\left(\frac{1}{x - 1} - \frac{1}{x + 1}\right)$

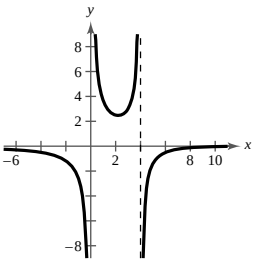
59. $\frac{1}{x} - \frac{1}{x + 1}$ **61.** $\frac{3}{2x - 1} - \frac{2}{x + 1}$

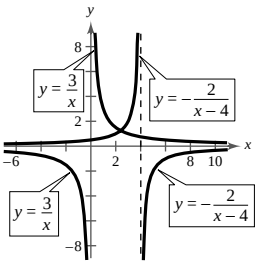
63. $-\frac{3}{x} - \frac{1}{x + 2} + \frac{5}{x - 2}$ **65.** $\frac{3}{x} - \frac{1}{x^2} + \frac{1}{x + 1}$

67. $2x - 7 + \frac{17}{x + 2} + \frac{1}{x + 1}$

69. $x + 3 + \frac{6}{x - 1} + \frac{4}{(x - 1)^2} + \frac{1}{(x - 1)^3}$

71. $\frac{3}{x} - \frac{2}{x - 4}$





The vertical asymptotes are the same.

CHAPTER 7

73. $s = -16t^2 + 144$ **75.** $s = -16t^2 - 32t + 400$

77. $y = \frac{1}{2}x^2 - 2x$ **79.** $y = x^2 - 6x + 8$

81. $x^2 + y^2 - 10x = 0$ **83.** $x^2 + y^2 + 6x - 8y = 0$

85. \$300,000 at 8%, \$400,000 at 9%, and \$75,000 at 10%

87. $187{,}500 + s$ in certificates of deposit
$187{,}500 - s$ in municipal bonds
$125{,}000 - s$ in blue-chip stocks
s in growth stocks

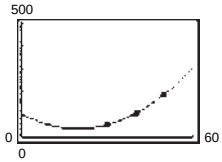
89. 13 two-point baskets, 6 three-point baskets, 9 free throws

91. $I_1 = 1, I_2 = 2, I_3 = 1$

93. $y = -\frac{5}{24}x^2 - \frac{3}{10}x + \frac{41}{6}$ **95.** $y = x^2 - x$

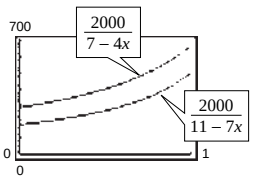
97. (a) $\begin{cases} 900a + 30b + c = 55 \\ 1600a + 40b + c = 105 \\ 2500a + 50b + c = 188 \end{cases}$

$y = 0.165x^2 - 6.55x + 103$

(b) 

(c) 453 ft

99. (a) $\frac{2000}{7 - 4x} - \frac{2000}{11 - 7x}$, $0 \le x \le 1$

(b) 

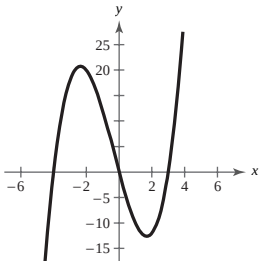
101. False. The leading coefficients are not all 1.

103. The student did not work the problem correctly. Because $\frac{x^2 + 1}{x(x - 1)}$ is an improper fraction, the student should have divided before decomposing.

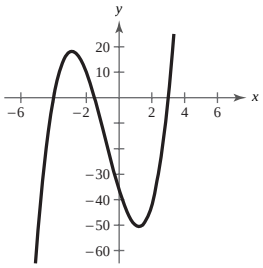
105. No. There are two arithmetic errors. The constant in the second equation should be -11 and the coefficient of z in the third equation should be 2.

107. $x = 5, y = 5, \lambda = -5$

109. (a) $-4, 0, 3$

(b) 

111. (a) $-4, -\frac{3}{2}, 3$

(b) 

113. $\frac{\pi}{6} + n\pi$ **115.** Answers will vary.

Section 7.4 (page 513)

1. matrix **3.** Gauss-Jordan elimination **5.** No

7. 1×2 **9.** 3×1 **11.** 2×2

13. $\left[\begin{array}{cc|c} 4 & -3 & -5 \\ -1 & 3 & 12 \end{array}\right]$ 2×3

15. $\left[\begin{array}{ccc|c} 1 & 10 & -2 & 2 \\ 5 & -3 & 4 & 0 \\ 2 & 1 & 0 & 6 \end{array}\right]$ 3×4

17. $\left[\begin{array}{ccc|c} 7 & -5 & 1 & 13 \\ 19 & 0 & -8 & 10 \end{array}\right]$ 2×4

19. $\begin{cases} 3x + 4y = 9 \\ x - y = -3 \end{cases}$

21. $\begin{cases} 9x + 12y + 3z = 0 \\ -2x + 18y + 5z = 10 \\ x + 7y - 8z = -4 \end{cases}$

23. Add -3 times R_2 to R_1. **25.** Interchange R_1 and R_2.

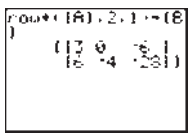
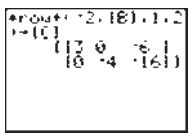
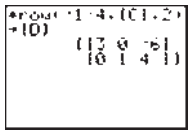
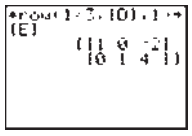
27. $\begin{bmatrix} 1 & 4 & 3 \\ 0 & 2 & -1 \end{bmatrix}$

29. $\begin{bmatrix} 1 & 1 & 4 & -1 \\ 0 & 5 & -2 & 6 \\ 0 & 3 & 20 & 4 \end{bmatrix}, \begin{bmatrix} 1 & 1 & 4 & -1 \\ 0 & 1 & -\frac{2}{5} & \frac{6}{5} \\ 0 & 3 & 20 & 4 \end{bmatrix}$

31. (a) i) $\left[\begin{array}{cc|c} 3 & 0 & -6 \\ 6 & -4 & -28 \end{array}\right]$ ii) $\left[\begin{array}{cc|c} 3 & 0 & -6 \\ 0 & -4 & -16 \end{array}\right]$

iii) $\left[\begin{array}{cc|c} 3 & 0 & -6 \\ 0 & 1 & 4 \end{array}\right]$ iv) $\left[\begin{array}{cc|c} 1 & 0 & -2 \\ 0 & 1 & 4 \end{array}\right]$

(b) $x = -2, y = 4$ (c) Answers will vary.

33. i) 
ii) 
iii) 
iv) 

35. Reduced row-echelon form **37.** Not in row-echelon form

39. Not in row-echelon form

41. $\begin{bmatrix} 1 & 3 & \frac{3}{2} & 5 \\ 0 & 1 & \frac{3}{14} & 0 \\ 0 & 0 & 1 & -\frac{35}{12} \end{bmatrix}$

43. $\begin{bmatrix} 1 & -1 & -1 & 1 \\ 0 & 1 & 6 & 3 \\ 0 & 0 & 0 & 0 \end{bmatrix}$

45. $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

47. $\begin{bmatrix} 1 & 0 & -\frac{3}{7} & -\frac{8}{7} \\ 0 & 1 & -\frac{12}{7} & \frac{10}{7} \end{bmatrix}$

49. $\begin{cases} x - 2y = 4 \\ y = -3 \end{cases}$
$(-2, -3)$

51. $\begin{cases} x - y + 2z = 4 \\ y - z = 2 \\ z = -2 \end{cases}$
$(8, 0, -2)$

53. $(7, -5)$ **55.** $(-4, -8, 2)$ **57.** $(3, 2)$

59. Inconsistent **61.** $(3, -2, 5, 0)$ **63.** $(4, -3, 2)$

65. $(2a + 1, 3a + 2, a)$ **67.** $(7, -3, 4)$

69. $(0, 2 - 4a, a)$ **71.** $(-5a, a, 3)$

73. Yes; $(-1, 1, -3)$ **75.** No **77.** $y = x^2 + 2x + 5$

79. $y = 2x^2 - x + 1$ **81.** $f(x) = -9x^2 - 5x + 11$

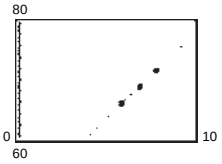
83. $f(x) = x^3 - 2x^2 - 4x + 1$ **85.** $I_1 = \frac{13}{10}, I_2 = \frac{11}{5}, I_3 = \frac{9}{10}$

87. $\begin{cases} x + 5y + 10z + 20w = 95 \\ x + y + z + w = 26 \\ y - 4z = 0 \\ x - 2y = -1 \end{cases}$

15 \$1 bills, 8 \$5 bills, 2 \$10 bills, 1 \$20 bill

89. $\dfrac{8x^2}{(x-1)^2(x+1)} = \dfrac{2}{x+1} + \dfrac{6}{x-1} + \dfrac{4}{(x-1)^2}$

91. (a) $y = -0.01t^2 + 3.08t + 47.7$

(b) 

(c) 2010: \$77.50, 2015: \$91.65, 2020: \$105.30

(d) Answers will vary.

93. (a) $x_1 = s, x_2 = t, x_3 = 600 - s, x_4 = s - t, x_5 = 500 - t, x_6 = s, x_7 = t$

(b) $x_1 = 0, x_2 = 0, x_3 = 600, x_4 = 0, x_5 = 500, x_6 = 0, x_7 = 0$

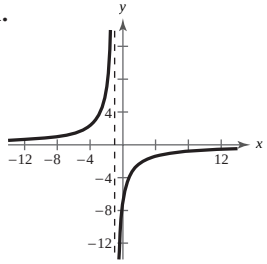
(c) $x_1 = 500, x_2 = 100, x_3 = 100, x_4 = 400, x_5 = 400, x_6 = 500, x_7 = 100$

95. True. See Example 7.

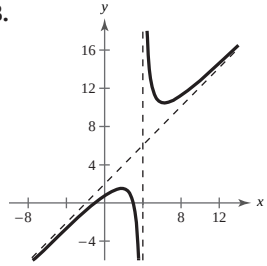
97. $\begin{cases} x + y + 7z = -1 \\ x + 2y + 11z = 0 \\ 2x + y + 10z = -3 \end{cases}$

(Answer is not unique.)

99. No; Answers will vary.

101. 

Asymptotes: $x = -1, y = 0$

103. 

Asymptotes: $x = 4, y = x + 2$

Section 7.5 (page 527)

1. equal **3.** zero, O

5. (a) iii (b) i (c) iv (d) v (e) ii

7. No, not in general. **9.** $x = 5, y = -8$

11. $x = -1, y = 4, z = 6$

13. (a) $\begin{bmatrix} 8 & -1 \\ 1 & 7 \end{bmatrix}$ (b) $\begin{bmatrix} 2 & -3 \\ 5 & -5 \end{bmatrix}$

(c) $\begin{bmatrix} 15 & -6 \\ 9 & 3 \end{bmatrix}$ (d) $\begin{bmatrix} 9 & -8 \\ 13 & -9 \end{bmatrix}$

15. (a) $\begin{bmatrix} 9 & 5 \\ 1 & -2 \\ -3 & 15 \end{bmatrix}$ (b) $\begin{bmatrix} 7 & -7 \\ 3 & 8 \\ -5 & -5 \end{bmatrix}$

(c) $\begin{bmatrix} 24 & -3 \\ 6 & 9 \\ -12 & 15 \end{bmatrix}$ (d) $\begin{bmatrix} 22 & -15 \\ 8 & 19 \\ -14 & -5 \end{bmatrix}$

17. (a) $\begin{bmatrix} 5 & 5 & -2 & 4 & 4 \\ -5 & 10 & 0 & -4 & -7 \end{bmatrix}$

(b) $\begin{bmatrix} 3 & 5 & 0 & 2 & 4 \\ 7 & -6 & -4 & 2 & 7 \end{bmatrix}$

(c) $\begin{bmatrix} 12 & 15 & -3 & 9 & 12 \\ 3 & 6 & -6 & -3 & 0 \end{bmatrix}$

(d) $\begin{bmatrix} 10 & 15 & -1 & 7 & 12 \\ 15 & -10 & -10 & 3 & 14 \end{bmatrix}$

19. (a) Not possible (b) Not possible

(c) $\begin{bmatrix} 18 & 0 & 9 \\ -3 & -12 & 0 \end{bmatrix}$ (d) Not possible

21. $\begin{bmatrix} -8 & -7 \\ 15 & -1 \end{bmatrix}$ **23.** $\begin{bmatrix} -24 & -4 & 12 \\ -12 & 32 & 12 \end{bmatrix}$

25. $\begin{bmatrix} -17.143 & 2.143 \\ 11.571 & 10.286 \end{bmatrix}$ **27.** $\begin{bmatrix} -4.841 & -3.739 \\ -4.252 & -13.249 \\ 9.713 & -0.362 \end{bmatrix}$

29. $\begin{bmatrix} -6 & -9 \\ -1 & 0 \\ 17 & -10 \end{bmatrix}$ **31.** $\begin{bmatrix} 3 & 3 \\ -\frac{1}{2} & 0 \\ -\frac{13}{2} & \frac{11}{2} \end{bmatrix}$ **33.** Not possible

35. $\begin{bmatrix} -2 & 51 \\ -8 & 33 \\ 0 & 27 \end{bmatrix}$ **37.** $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & \frac{7}{2} \end{bmatrix}$

39. $\begin{bmatrix} -15 & -5 & -25 & -45 \\ -18 & -6 & -30 & -54 \end{bmatrix}$

41. (a) $\begin{bmatrix} 0 & 15 \\ 6 & 12 \end{bmatrix}$ (b) $\begin{bmatrix} -2 & 2 \\ 31 & 14 \end{bmatrix}$ (c) $\begin{bmatrix} 9 & 6 \\ 12 & 12 \end{bmatrix}$

43. (a) $\begin{bmatrix} 0 & -10 \\ 10 & 0 \end{bmatrix}$ (b) $\begin{bmatrix} 0 & -10 \\ 10 & 0 \end{bmatrix}$ (c) $\begin{bmatrix} 8 & -6 \\ 6 & 8 \end{bmatrix}$

45. (a) $\begin{bmatrix} 7 & 7 & 14 \\ 8 & 8 & 16 \\ -1 & -1 & -2 \end{bmatrix}$ (b) $[13]$ (c) Not possible

47. $\begin{bmatrix} 70 & -17 & 73 \\ 32 & 11 & 6 \\ 16 & -38 & 70 \end{bmatrix}$ **49.** $\begin{bmatrix} 151 & 25 & 48 \\ 516 & 279 & 387 \\ 47 & -20 & 87 \end{bmatrix}$

51. $\begin{bmatrix} 5 & 8 \\ -4 & -16 \end{bmatrix}$ **53.** $\begin{bmatrix} -4 & 10 \\ 3 & 14 \end{bmatrix}$

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

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

59. (a) $\begin{bmatrix} -1 & 1 \\ -2 & 1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 4 \\ 0 \end{bmatrix}$ (b) $\begin{bmatrix} 4 \\ 8 \end{bmatrix}$

61. (a) $\begin{bmatrix} -2 & -3 \\ 6 & 1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} -4 \\ -36 \end{bmatrix}$ (b) $\begin{bmatrix} -7 \\ 6 \end{bmatrix}$

63. (a) $\begin{bmatrix} 1 & -2 & 3 \\ -1 & 3 & -1 \\ 2 & -5 & 5 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 9 \\ -6 \\ 17 \end{bmatrix}$ (b) $\begin{bmatrix} 1 \\ -1 \\ 2 \end{bmatrix}$

65. (a) $\begin{bmatrix} 1 & -5 & 2 \\ -3 & 1 & -1 \\ 0 & -2 & 5 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -20 \\ 8 \\ -16 \end{bmatrix}$ (b) $\begin{bmatrix} -1 \\ 3 \\ -2 \end{bmatrix}$

67. (a) $\begin{bmatrix} 7 & -2 & 5 \\ -6 & 13 & -8 \\ 16 & 11 & -3 \end{bmatrix}$ (b) $\begin{bmatrix} 7 & -2 & 5 \\ -6 & 13 & -8 \\ 16 & 11 & -3 \end{bmatrix}$

The answers are the same.

69. (a) $\begin{bmatrix} 26 & 11 & 0 \\ 11 & 20 & -3 \\ 11 & 14 & 0 \end{bmatrix}$ (b) $\begin{bmatrix} 26 & 11 & 0 \\ 11 & 20 & -3 \\ 11 & 14 & 0 \end{bmatrix}$

The answers are the same.

71. (a) $\begin{bmatrix} 25 & -34 & 28 \\ -53 & 34 & -7 \\ -76 & 30 & 21 \end{bmatrix}$ (b) $\begin{bmatrix} 25 & -34 & 28 \\ -53 & 34 & -7 \\ -76 & 30 & 21 \end{bmatrix}$

The answers are the same.

73. (a) and (b) $\begin{bmatrix} 3 & -6 & 0 \\ 3 & 3 & 0 \end{bmatrix}$ **75.** Not possible, undefined

77. Not possible, undefined

79. (a) and (b) $\begin{bmatrix} 6 & 12 & -12 \\ -6 & 6 & 0 \end{bmatrix}$ **81.** $\begin{bmatrix} -4 & 0 \\ 8 & 2 \end{bmatrix}$

83. $\begin{bmatrix} 84 & 60 & 30 \\ 42 & 120 & 84 \end{bmatrix}$ **85.** $\begin{bmatrix} 90 & 108 & 54 & 36 \\ 126 & 144 & 180 & 72 \end{bmatrix}$

87. [\$1037.50 \$1400.00 \$1012.50]
The entries represent the total profits made at the three outlets.

89. $\begin{bmatrix} \$23.20 & \$20.50 \\ \$38.20 & \$33.80 \\ \$76.90 & \$68.50 \end{bmatrix}$ The entries represent labor costs at the two plants for the three boat sizes.

91. $\begin{bmatrix} 0.40 & 0.15 & 0.15 \\ 0.28 & 0.53 & 0.17 \\ 0.32 & 0.32 & 0.68 \end{bmatrix}$ P^2 represents the proportion of changes in party affiliations after two elections.

93. True. To add two matrices, you add corresponding entries.

95. Not possible **97.** Not possible **99.** 2×2

101. 2×3 **103 and 105.** Answers will vary.

107. $AC = BC = \begin{bmatrix} 2 & 3 \\ 2 & 3 \end{bmatrix}, A \neq B$

109. (a) $A^2 = \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}, A^3 = \begin{bmatrix} -i & 0 \\ 0 & -i \end{bmatrix}, A^4 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

The entries on the main diagonal are i^2 in A^2, i^3 in A^3, and i^4 in A^4.

(b) $B^2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

B^2 is the identity matrix.

111. (a) $A = \begin{bmatrix} 0 & 2 \\ 0 & 0 \end{bmatrix}, B = \begin{bmatrix} 0 & 2 & 3 \\ 0 & 0 & 4 \\ 0 & 0 & 0 \end{bmatrix}$

(Answers are not unique.)

(b) A^2 and B^3 are zero matrices.

(c) $A = \begin{bmatrix} 0 & 2 & 3 & 4 \\ 0 & 0 & 5 & 6 \\ 0 & 0 & 0 & 7 \\ 0 & 0 & 0 & 0 \end{bmatrix}$

A^4 is the zero matrix.

(d) A^n is the zero matrix.

113. $\ln \dfrac{64}{\sqrt[3]{x^2 + 3}}$

Section 7.6 (page 538)

1. inverse **3.** No **5–9.** Answers will vary.

11. $\begin{bmatrix} \frac{1}{2} & 0 \\ 0 & \frac{1}{3} \end{bmatrix}$ **13.** $\begin{bmatrix} -3 & 2 \\ -2 & 1 \end{bmatrix}$ **15.** Does not exist

17. $\begin{bmatrix} 1 & 1 & -1 \\ -3 & 2 & -1 \\ 3 & -3 & 2 \end{bmatrix}$ **19.** $\begin{bmatrix} 1 & 0 & 0 \\ -\frac{3}{4} & \frac{1}{4} & 0 \\ \frac{7}{20} & -\frac{1}{4} & \frac{1}{5} \end{bmatrix}$

21. $\begin{bmatrix} -\frac{3}{2} & \frac{3}{2} & 1 \\ \frac{9}{2} & -\frac{7}{2} & -3 \\ -1 & 1 & 1 \end{bmatrix}$ **23.** $\begin{bmatrix} -12 & -5 & -9 \\ -4 & -2 & -4 \\ -8 & -4 & -6 \end{bmatrix}$

25. $\frac{5}{11}\begin{bmatrix} 0 & -4 & 2 \\ -22 & 11 & 11 \\ 22 & -6 & -8 \end{bmatrix}$ **27.** $\begin{bmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 \\ 2 & 0 & 1 & 0 \\ 0 & 1 & 0 & 2 \end{bmatrix}$

29. $\begin{bmatrix} \frac{1}{4} & \frac{1}{8} \\ -\frac{1}{4} & -\frac{5}{8} \end{bmatrix}$ **31.** $\frac{1}{59}\begin{bmatrix} 16 & 15 \\ -4 & 70 \end{bmatrix}$ **33.** $\begin{bmatrix} \frac{5}{13} & -\frac{3}{13} \\ \frac{1}{13} & \frac{2}{13} \end{bmatrix}$

35. $k = 0$ **37.** $(5, 0)$ **39.** $(-8, -6)$ **41.** $(3, 8, -11)$

43. $(2, 1, 0, 0)$ **45.** $(2, -2)$

47. Not possible, because A is not invertible. **49.** $(-4, -8)$

51. $(-1, 3, 2)$ **53.** $(0.3125t + 0.8125, 1.1875t + 0.6875, t)$

55. $(5, 0, -2, 3)$

57. \$7000 in AAA-rated bonds, \$1000 in A-rated bonds, and \$2000 in B-rated bonds

59. \$9000 in AAA-rated bonds, \$1000 in A-rated bonds, and \$2000 in B-rated bonds

61. $I_1 = \frac{1}{2}$ ampere, $I_2 = 3$ amperes, $I_3 = 3.5$ amperes

63. 100 bags for seedlings, 100 bags for general potting, 100 bags for hardwood plants

65. (a) $\begin{cases} 2.5r + 4l + 2i = 300 \\ -r + 2l + 2i = 0 \\ r + l + i = 120 \end{cases}$

(b) $\begin{bmatrix} 2.5 & 4 & 2 \\ -1 & 2 & 2 \\ 1 & 1 & 1 \end{bmatrix}\begin{bmatrix} r \\ l \\ i \end{bmatrix} = \begin{bmatrix} 300 \\ 0 \\ 120 \end{bmatrix}$

(c) 80 roses, 10 lilies, 30 irises

67. True, $AA^{-1} = I = A^{-1}A$. **69.** Answers will vary.

71. (a) Answers will vary.

(b) $A^{-1} = \begin{bmatrix} \frac{1}{a_{11}} & 0 & 0 & 0 & \dots & 0 \\ 0 & \frac{1}{a_{22}} & 0 & 0 & \dots & 0 \\ 0 & 0 & \frac{1}{a_{33}} & 0 & \dots & 0 \\ \vdots & \vdots & \vdots & \vdots & \dots & \vdots \\ 0 & 0 & 0 & 0 & \dots & \frac{1}{a_{nn}} \end{bmatrix}$

73. $\ln 3 \approx 1.099$ **75.** $\dfrac{e^{12/7}}{3} \approx 1.851$

77. Answers will vary.

Section 7.7 (page 545)

1. determinant **3.** -5 **5.** 4 **7.** 16

9. 28 **11.** -24 **13.** -0.002

15. (a) $M_{11} = -5, M_{12} = 2, M_{21} = 4, M_{22} = 3$

(b) $C_{11} = -5, C_{12} = -2, C_{21} = -4, C_{22} = 3$

17. (a) $M_{11} = 10, M_{12} = -43, M_{13} = 2, M_{21} = -30, M_{22} = 17, M_{23} = -6, M_{31} = 54, M_{32} = -53, M_{33} = -34$

(b) $C_{11} = 10, C_{12} = 43, C_{13} = 2, C_{21} = 30, C_{22} = 17, C_{23} = 6, C_{31} = 54, C_{32} = 53, C_{33} = -34$

19. (a) -75 (b) -75 **21.** (a) 170 (b) 170

23. -58 **25.** 0 **27.** -9 **29.** -168

31. 412 **33.** -336 **35.** 410

37. (a) -3 (b) -2

(c) $\begin{bmatrix} -2 & 0 \\ 0 & -3 \end{bmatrix}$ (d) 6; $|AB| = |A| \cdot |B|$

39. (a) 2 (b) -6

(c) $\begin{bmatrix} 1 & 4 & 3 \\ -1 & 0 & 3 \\ 0 & 2 & 0 \end{bmatrix}$ (d) -12; $|AB| = |A| \cdot |B|$

41. (a) -25 (b) -220

(c) $\begin{bmatrix} -7 & -16 & -1 & -28 \\ -4 & -14 & -11 & 8 \\ 13 & 4 & 4 & -4 \\ -2 & 3 & 2 & 2 \end{bmatrix}$ (d) 5500; $|AB| = |A| \cdot |B|$

43–47. Answers will vary. **49.** $x = \pm 2$ **51.** $x = \pm\frac{3}{2}$

53. $x = 1 \pm \sqrt{2}$ **55.** $x = -4, -1$ **57.** $x = 1, \frac{1}{2}$

59. $x = 3$ **61.** $8uv - 1$ **63.** e^{5x} **65.** $1 - \ln x$

67. True. Expansion by cofactors on a row of zeros is zero.

69. Answers will vary. Sample answer:

$A = \begin{bmatrix} 1 & 0 & -3 \\ 6 & -2 & 7 \\ 9 & 5 & -1 \end{bmatrix}$, $B = \begin{bmatrix} 3 & 1 & 5 \\ -8 & 1 & 0 \\ -7 & 6 & -2 \end{bmatrix}$

$|A + B| = -328$, $|A| + |B| = -404$

71. (a) 6 (b) $\begin{bmatrix} \frac{1}{3} & -\frac{1}{3} \\ \frac{1}{3} & \frac{1}{6} \end{bmatrix}$ (c) $\frac{1}{6}$ (d) They are reciprocals.

73. (a) 2 (b) $\begin{bmatrix} -4 & -5 & 1.5 \\ -1 & -1 & 0.5 \\ -1 & -1 & 0 \end{bmatrix}$

(c) $\frac{1}{2}$ (d) They are reciprocals.

75. (a) Columns 2 and 3 are interchanged.
(b) Rows 1 and 3 are interchanged.

77. (a) 3 is factored from the second row.
(b) 2 and 4 are factored from the first and second columns, respectively.

79. (a) 15 (b) -75 (c) -120
The determinant of a triangular matrix is the product of the numbers along the main diagonal.

81. Answers will vary. **83.** $(x - 2)(x - 1)$

85. $(2y - 3)^2$ **87.** $(2, -4)$

Section 7.8 (page 556)

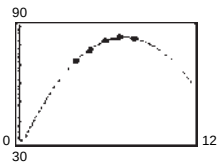
1. Cramer's Rule **3.** $-\frac{1}{2}$ **5.** $\frac{5}{2}$ **7.** $\frac{33}{8}$ **9.** 24

11. $x = 0, -\frac{16}{5}$ **13.** Collinear **15.** Not collinear

17. $x = 3$ **19.** $(-3, -2)$ **21.** Not possible

23. $(-1, 3, 2)$ **25.** (a) and (b) $\left(0, -\frac{1}{2}, \frac{1}{2}\right)$

27. (a) $y = -1.086t^2 + 15.949t + 25.326$

(b) 

The model fits the data well.

29. (a) [20 5 24], [20 0 13], [5 0 1], [20 0 23], [15 18 11]

(b) -119 28 67 -58 6 39 -1 -3 3 -118 26 69 -33 7 15

31. 1 -43 -108 49 91 91 1 -29 -73 33 42 15 7 14 14

33. HAPPY NEW YEAR

35. IF YOU CANT BE KIND BE VAGUE

37. True. Cramer's Rule divides by the determinant.

39. Answers will vary. **41.** $x + 4y - 19 = 0$

43. $2x - 7y - 27 = 0$

Review Exercises (page 560)

1. (1, 1) **3.** $\left(\frac{3}{2}, 5\right)$ **5.** (0.25, 0.625) **7.** (5, 4)

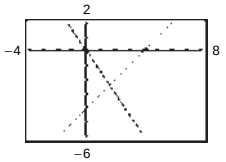
9. (0, 0), (2, 8), $(-2, 8)$ **11.** $(2, -0.5)$

13. (0, 0), $(4, -4)$ **15.** $(-1, 2)$, (0.67, 2.56) **17.** (4, 4)

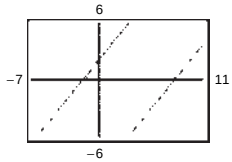
19. 800 plants **21.** 96 m × 144 m **23.** $\left(\frac{5}{2}, 3\right)$

25. $(-0.5, 0.8)$ **27.** $\left(-\frac{1}{2}, \frac{4}{5}\right)$ **29.** (0, 0)

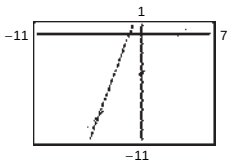
31. $\left(\frac{14}{5} + \frac{8}{5}a, a\right)$

33. 

Consistent; $(1.6, -2.4)$

35. 

Inconsistent

37. 

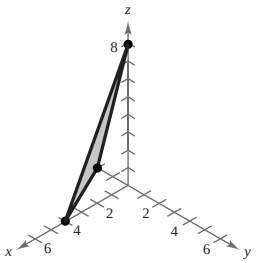
Consistent; $(-4.6, -8.6)$

39. $\left(\frac{500{,}000}{7}, \frac{159}{7}\right)$ **41.** 218.75 mi/h; 193.75 mi/h

43. $(2, -4, -5)$ **45.** $\left(\frac{38}{17}, \frac{40}{17}, -\frac{63}{17}\right)$

47. $(3a + 4, 2a + 5, a)$ **49.** $\left(-\frac{19}{6}, \frac{17}{12}, \frac{1}{3}\right)$

51. $(a - 4, a - 3, a)$

53. 

Sample answer: (0, 0, 8), (0, −2, 0), (4, 0, 0), (1, −1, 2)

55. $\frac{3}{x + 2} - \frac{4}{x + 4}$ **57.** $\frac{1}{2}\left(\frac{3}{x - 1} - \frac{x - 3}{x^2 + 1}\right)$

59. $\frac{2x - 1}{x^2 + 1} + \frac{-1}{x + 2}$ **61.** $y = 2x^2 + x - 5$

63. 4 par-3 holes, 10 par-4 holes, 4 par-5 holes

65. 3×1 **67.** 1×1

69. $\left[\begin{array}{cc|c} 6 & -7 & 11 \\ -2 & 5 & -1 \end{array}\right]$ **71.** $\left[\begin{array}{ccc|c} 8 & -7 & 4 & 12 \\ 3 & -5 & 2 & 20 \\ 5 & 3 & -3 & 26 \end{array}\right]$

73. $\begin{cases} 5x + y + 7z = -9 \\ 4x + 2y = 10 \\ 9x + 4y + 2z = 3 \end{cases}$ **75.** $\begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{bmatrix}$

77. $\begin{bmatrix} 1 & 0 & 3 & -2 \\ 0 & 1 & 4 & -3 \end{bmatrix}$ **79.** $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

81. $(10, -12)$ **83.** $(-0.2, 0.7)$ **85.** $\left(\frac{1}{2}, -\frac{1}{3}, 1\right)$

87. $(3a + 1, -a, a)$ **89.** $(2, -3, 3)$ **91.** $\left(1, 2, \frac{1}{2}\right)$

93. (1, 2, 2) **95.** (3, 0, −4) **97.** (2, 6, −10, −3)

99. $x = 12, y = -7$ **101.** $x = 1, y = 11$

103. (a) $\begin{bmatrix} 17 & -17 \\ 13 & 2 \end{bmatrix}$ (b) $\begin{bmatrix} -3 & 23 \\ -15 & 8 \end{bmatrix}$

(c) $\begin{bmatrix} 14 & 6 \\ -2 & 10 \end{bmatrix}$ (d) $\begin{bmatrix} 37 & -57 \\ 41 & -4 \end{bmatrix}$

105. (a) $\begin{bmatrix} 6 & 5 & 8 \\ 1 & 7 & 8 \\ 5 & 1 & 4 \end{bmatrix}$ (b) $\begin{bmatrix} 6 & -5 & 6 \\ 9 & -9 & -4 \\ 1 & 3 & 2 \end{bmatrix}$

(c) $\begin{bmatrix} 12 & 0 & 14 \\ 10 & -2 & 4 \\ 6 & 4 & 6 \end{bmatrix}$ (d) $\begin{bmatrix} 6 & 15 & 10 \\ -7 & 23 & 20 \\ 9 & -1 & 6 \end{bmatrix}$

107. $\begin{bmatrix} -13 & -8 & 18 \\ 0 & 11 & -19 \end{bmatrix}$ **109.** $\begin{bmatrix} 9 & -7 \\ -9 & 4 \end{bmatrix}$

111. $\begin{bmatrix} 48 & -18 & -3 \\ 15 & 51 & 33 \end{bmatrix}$ **113.** $\begin{bmatrix} -8 & -4 \\ 7 & -17 \\ -17 & -2 \end{bmatrix}$

115. $\frac{1}{3}\begin{bmatrix} 6 & 2 \\ -4 & 11 \\ 10 & 0 \end{bmatrix}$ **117.** $\begin{bmatrix} 14 & -2 & 8 \\ 14 & -10 & 40 \\ 36 & -12 & 48 \end{bmatrix}$

119. $[30]$ **121.** $\begin{bmatrix} 14 & -22 & 22 \\ 19 & -41 & 80 \\ 42 & -66 & 66 \end{bmatrix}$ **123.** $\begin{bmatrix} 1 & 17 \\ 12 & 36 \end{bmatrix}$

125. (a) $\begin{bmatrix} 525.88 & 47.40 \\ 734.94 & 66.20 \\ 861.76 & 77.20 \end{bmatrix}$

The entries represent the dairy mart's sales and profits on milk for Friday, Saturday, and Sunday.

(b) \$190.80

127. Answers will vary. **129.** $\begin{bmatrix} 4 & -5 \\ 5 & -6 \end{bmatrix}$

131. $\begin{bmatrix} \frac{1}{2} & -1 & -\frac{1}{2} \\ \frac{1}{2} & -\frac{2}{3} & -\frac{5}{6} \\ 0 & \frac{2}{3} & \frac{1}{3} \end{bmatrix}$ **133.** $\begin{bmatrix} \frac{1}{5} & \frac{1}{5} \\ \frac{1}{10} & -\frac{1}{15} \end{bmatrix}$

135. $\begin{bmatrix} 1 & 0 & 2 \\ 0 & 0 & -1 \\ 1 & 1 & 3 \end{bmatrix}$ **137.** $\begin{bmatrix} 1 & -1 \\ 4 & -\frac{7}{2} \end{bmatrix}$ **139.** $\begin{bmatrix} -\frac{1}{2} & \frac{1}{4} \\ \frac{1}{20} & \frac{1}{40} \end{bmatrix}$

141. (36, 11) **143.** (2, −1, −2) **145.** (1, −2, 1, 0)

147. (−3, 1) **149.** (1, 1, −2) **151.** −42 **153.** 550

155. (a) $M_{11} = 4, M_{12} = 7, M_{21} = -1, M_{22} = 2$

(b) $C_{11} = 4, C_{12} = -7, C_{21} = 1, C_{22} = 2$

157. (a) $M_{11} = 30, M_{12} = -12, M_{13} = -21, M_{21} = 20, M_{22} = 19, M_{23} = 22, M_{31} = 5, M_{32} = -2, M_{33} = 19$

(b) $C_{11} = 30, C_{12} = 12, C_{13} = -21, C_{21} = -20, C_{22} = 19, C_{23} = -22, C_{31} = 5, C_{32} = 2, C_{33} = 19$

159. 130 **161.** 6 **163.** −3 **165.** 279 **167.** 16

169. 1.75 **171.** $\frac{13}{2}$ **173.** 48 **175.** Collinear

177. (1, 2) **179.** (4, 7) **181.** (−1, 4, 5)

183. (0, −2.4, −2.6) **185.** (a) and (b) $\left(\frac{53}{33}, -\frac{17}{33}, \frac{61}{66}\right)$

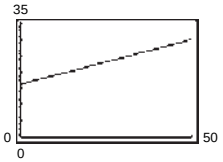
187. (a) [12 15 15], [11 0 15], [21 20 0], [2 5 12], [15 23 0]

(b) −21 6 0 −68 8 45 102 −42 −60 −53 20 21 99 −30 −69

189. I WILL BE BACK **191.** THAT IS MY FINAL ANSWER

193. (a) $y = 0.275t + 16.2$

(b)



(c) and (d) $t \approx 13.8$ or 2013

195. True. This is the correct sum of the two determinants.

197. An $n \times n$ matrix A has an inverse A^{-1} if $\det(A) \neq 0$.

Chapter Test (page 566)

1. (4, −2) **2.** (0, −1), (1, 0), (2, 1)

3. (8, 5), (2, −1) **4.** $\left(\frac{28}{9}, -\frac{31}{9}\right)$ **5.** $\left(-\frac{2}{3}, -\frac{1}{2}, 1\right)$

6. (1, 0, −2) **7.** $y = -\frac{1}{2}x^2 + x + 6$

8. $\frac{5}{x-1} + \frac{3}{(x-1)^2}$ **9.** $\frac{1}{x} + \frac{2}{x^2} - \frac{1}{x^2+1}$

10. $(-2a + 1.5, 2a + 1, a)$ **11.** (5, 2, −6)

12. (a) $\begin{bmatrix} 1 & 0 & 4 \\ -7 & -6 & -1 \\ 0 & 4 & 0 \end{bmatrix}$ (b) $\begin{bmatrix} 15 & 12 & 12 \\ -12 & -12 & 0 \\ 3 & 6 & 0 \end{bmatrix}$

(c) $\begin{bmatrix} 7 & 6 & 12 \\ -18 & -16 & -2 \\ 1 & 10 & 0 \end{bmatrix}$ (d) $\begin{bmatrix} 36 & 20 & 4 \\ -28 & -24 & -4 \\ 10 & 8 & 2 \end{bmatrix}$

13. $\begin{bmatrix} -\frac{4}{3} & -\frac{5}{3} & 1 \\ -\frac{4}{3} & -\frac{8}{3} & 1 \\ \frac{1}{3} & \frac{2}{3} & 0 \end{bmatrix}, (-2, 3, -1)$ **14.** 67 **15.** −2

16. 30 **17.** $\left(1, -\frac{1}{2}\right)$

18. $x_1 = 700 - s - t, x_2 = 300 - s - t, x_3 = s, x_4 = 100 - t, x_5 = t$

Chapter 8

Section 8.1 (page 577)

1. terms **3.** index, upper limit, lower limit

5. (a) Finite sequence (b) Infinite sequence

7. 7, 9, 11, 13, 15 **9.** 3, 9, 27, 81, 243

11. $-\frac{1}{2}, \frac{1}{4}, -\frac{1}{8}, \frac{1}{16}, -\frac{1}{32}$ **13.** $2, \frac{3}{2}, \frac{4}{3}, \frac{5}{4}, \frac{6}{5}$ **15.** $\frac{1}{2}, \frac{2}{5}, \frac{3}{10}, \frac{4}{17}, \frac{5}{26}$

17. (a) 0, 1, 0, 0.5, 0 (b) $0, 1, 0, \frac{1}{2}, 0$

19. (a) 0.5, 0.75, 0.875, 0.938, 0.969 (b) $\frac{1}{2}, \frac{3}{4}, \frac{7}{8}, \frac{15}{16}, \frac{31}{32}$

21. (a) 1, 0.354, 0.192, 0.125, 0.089 (b) $1, \frac{1}{2^{3/2}}, \frac{1}{3^{3/2}}, \frac{1}{8}, \frac{1}{5^{3/2}}$

23. (a) −1, 0.25, −0.111, 0.063, −0.04

(b) $-1, \frac{1}{4}, -\frac{1}{9}, \frac{1}{16}, -\frac{1}{25}$

25. (a) and (b) 3, 15, 35, 63, 99

27. 9, 15, 21, 27, 33, 39, 45, 51, 57, 63

29. $3, \frac{5}{2}, \frac{7}{3}, \frac{9}{4}, \frac{11}{5}, \frac{13}{6}, \frac{15}{7}, \frac{17}{8}, \frac{19}{9}, \frac{21}{10}$

31. 0, 2, 0, 2, 0, 2, 0, 2, 0, 2 **33.** $\frac{100}{101}$ **35.** −73

37. $\frac{64}{65}$ **39.** $a_n = 3n - 2$ **41.** $a_n = n^2 - 1$

43. $a_n = \frac{n+1}{n+2}$ **45.** $a_n = \frac{(-1)^{n+1}}{2^n}$ **47.** $a_n = 1 + \frac{1}{n}$

49. $a_n = \frac{1}{n!}$ **51.** $a_n = (-1)^n + 2(1)^n = (-1)^n + 2$

53. 28, 24, 20, 16, 12 **55.** 3, 4, 6, 10, 18

57. 1, 3, 4, 7, 11 **59.** 6, 8, 10, 12, 14; $a_n = 2n + 4$

61. 81, 27, 9, 3, 1; $a_n = \dfrac{243}{3^n}$

63. (a) 1, 1, 0.5, 0.167, 0.042 (b) 1, 1, $\frac{1}{2}$, $\frac{1}{6}$, $\frac{1}{24}$

65. (a) 1, 0.333, 0.4, 0.857, 2.667 (b) 1, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{6}{7}$, $\frac{8}{3}$

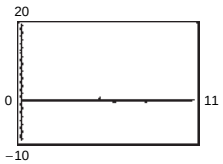
67. (a) 1, 0.5, 0.042, 0.001, 2.480×10^{-5}
(b) 1, $\frac{1}{2}$, $\frac{1}{24}$, $\frac{1}{720}$, $\frac{1}{40{,}320}$

69. $\dfrac{1}{12}$ **71.** 495 **73.** $n + 1$ **75.** $\dfrac{1}{2n(2n+1)}$

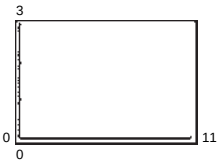
77. c **78.** b **79.** d **80.** a

81.

83.



85.



87. 35 **89.** 40 **91.** 30 **93.** $\frac{9}{5}$ **95.** 238

97. 30 **99.** 81 **101.** $\frac{47}{60}$

103. $\displaystyle\sum_{i=1}^{9} \frac{1}{3i} \approx 0.94299$ **105.** $\displaystyle\sum_{i=1}^{8} \left[2\left(\frac{i}{8}\right) + 3\right] = 33$

107. $\displaystyle\sum_{i=1}^{6} (-1)^{i+1} 3^i = -546$ **109.** $\displaystyle\sum_{i=1}^{20} \frac{(-1)^{i+1}}{i^2} \approx 0.821$

111. $\displaystyle\sum_{i=1}^{5} \frac{2^i - 1}{2^{i+1}} \approx 2.0156$ **113.** $\dfrac{75}{16}$ **115.** $-\dfrac{3}{2}$

117. (a) $\frac{3333}{5000}$ (b) $\frac{2}{3}$ **119.** (a) $\frac{1111}{10{,}000}$ (b) $\frac{1}{9}$

121. (a) $A_1 = \$5037.50$, $A_2 = \$5075.28$,
$A_3 = \$5113.35$, $A_4 = \$5151.70$,
$A_5 = \$5190.33$, $A_6 = \$5229.26$,
$A_7 = \$5268.48$, $A_8 = \$5307.99$
(b) \$6741.74

123. \$72,443 million **125.** True by the Properties of Sums

127. 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144;
1, 2, $\frac{3}{2}$, $\frac{5}{3}$, $\frac{8}{5}$, $\frac{13}{8}$, $\frac{21}{13}$, $\frac{34}{21}$, $\frac{55}{34}$, $\frac{89}{55}$

129. 1, 1, 2, 3, 5

131. $a_{n+1} = \dfrac{1}{2}a_n + \dfrac{(1+\sqrt{5})^n + (1-\sqrt{5})^n}{2^{n+1}}$

$a_{n+2} = \dfrac{3}{2}a_n + \dfrac{(1+\sqrt{5})^n + (1-\sqrt{5})^n}{2^{n+1}}$

133. $x, \dfrac{x^2}{2}, \dfrac{x^3}{6}, \dfrac{x^4}{24}, \dfrac{x^5}{120}$ **135.** $-\dfrac{x^3}{3}, \dfrac{x^5}{5}, -\dfrac{x^7}{7}, \dfrac{x^9}{9}, -\dfrac{x^{11}}{11}$

137. $-\dfrac{x^2}{2}, \dfrac{x^4}{24}, -\dfrac{x^6}{720}, \dfrac{x^8}{40{,}320}, -\dfrac{x^{10}}{3{,}628{,}800}$

139. $-x, \dfrac{x^2}{2}, -\dfrac{x^3}{6}, \dfrac{x^4}{24}, -\dfrac{x^5}{120}$

141. $x + 1, -\dfrac{(x+1)^2}{2}, \dfrac{(x+1)^3}{6}, -\dfrac{(x+1)^4}{24}, \dfrac{(x+1)^5}{120}$

143. $\dfrac{1}{4}, \dfrac{1}{12}, \dfrac{1}{24}, \dfrac{1}{40}, \dfrac{1}{60}, \dots; \dfrac{1}{2} - \dfrac{1}{2n+2}$

145. $\dfrac{1}{6}, \dfrac{1}{12}, \dfrac{1}{20}, \dfrac{1}{30}, \dfrac{1}{42}, \dots; \dfrac{1}{2} - \dfrac{1}{n+2}$

147. Yes, if there is a finite number of integer terms, you can always find a sum.

149. (a) $\begin{bmatrix} 8 & 1 \\ -3 & 7 \end{bmatrix}$ (b) $\begin{bmatrix} -22 & -7 \\ 3 & -18 \end{bmatrix}$
(c) $\begin{bmatrix} 18 & 9 \\ 18 & 0 \end{bmatrix}$ (d) $\begin{bmatrix} 0 & 6 \\ 27 & 18 \end{bmatrix}$

151. (a) $\begin{bmatrix} -3 & -7 & 4 \\ 4 & 4 & 1 \\ 1 & 4 & 3 \end{bmatrix}$ (b) $\begin{bmatrix} 8 & 17 & -14 \\ -12 & -13 & -9 \\ -3 & -15 & -10 \end{bmatrix}$
(c) $\begin{bmatrix} -2 & 7 & -16 \\ 4 & 42 & 45 \\ 1 & 23 & 48 \end{bmatrix}$ (d) $\begin{bmatrix} 16 & 31 & 42 \\ 10 & 47 & 31 \\ 13 & 22 & 25 \end{bmatrix}$

Section 8.2 (page 586)

1. $a_n = a_1 + (n-1)d$

3. A sequence is arithmetic when the differences between consecutive terms are the same.

5. Arithmetic sequence, $d = -2$

7. Arithmetic sequence, $d = -\frac{1}{2}$

9. Arithmetic sequence, $d = 0.6$

11. 21, 34, 47, 60, 73
Arithmetic sequence, $d = 13$

13. $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}, \frac{1}{6}$
Not an arithmetic sequence

15. 143, 136, 129, 122, 115
Arithmetic sequence, $d = -7$

17. 1, 5, 1, 5, 1
Not an arithmetic sequence

19. $-1, 1, -1, 1, -1$
Not an arithmetic sequence

21. $a_n = -2 + 3n$ **23.** $a_n = 108 - 8n$

25. $a_n = \frac{13}{2} - \frac{5}{2}n$ **27.** $a_n = \frac{10}{3}n + \frac{5}{3}$

29. $a_n = 103 - 3n$ **31.** 5, 11, 17, 23, 29

33. $-10, -22, -34, -46, -58$ **35.** $-2, 2, 6, 10, 14$

37. 22.45, 20.725, 19, 17.275, 15.55

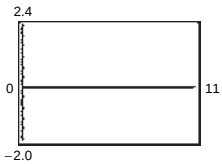
39. 15, 19, 23, 27, 31; $d = 4$; $a_n = 11 + 4n$

41. $\frac{3}{5}, \frac{1}{2}, \frac{2}{5}, \frac{3}{10}, \frac{1}{5}$; $d = -\frac{1}{10}$; $a_n = -\frac{1}{10}n + \frac{7}{10}$

43. 59 **45.** 18.6

47.

49.



51. $-1, 3, 7, 11, 15, 19, 23, 27, 31, 35$

53. 19.25, 18.5, 17.75, 17, 16.25, 15.5, 14.75, 14, 13.25, 12.5

55. 1.55, 1.6, 1.65, 1.7, 1.75, 1.8, 1.85, 1.9, 1.95, 2

57. 110 **59.** -25 **61.** 5050 **63.** -4585

65. 620 **67.** 41 **69.** 4000 **71.** 1275

73. 355 **75.** 129,250 **77.** 440 **79.** 2575

81. 14,268 **83.** 405 bricks **85.** \$200,000

87. (a) $a_n = 0.84n + 14.9$

CHAPTER 8

(b)

Year	2001	2002	2003	2004
Sales (in billions of dollars)	15.7	16.6	17.4	18.3

Year	2005	2006	2007	2008
Sales (in billions of dollars)	19.1	19.9	20.8	21.6

The model fits the data well.

(c) \$149.5 billion (d) \$203.2 billion; Answers will vary.

89. True. Use the recursion formula, $a_{n+1} = a_n + d$.

91. x, $3x$, $5x$, $7x$, $9x$, $11x$, $13x$, $15x$, $17x$, $19x$

93. 4 **95.** $S_n + 5n$

97. Answers will vary. Sample answer: Gauss saw that the sum of the first and last numbers was 101, the sum of the second and second-last numbers was 101, and so on. Seeing that there were 50 such pairs of numbers, Gauss simply multiplied 50 by 101 to get the summation 5050.

$a_n = (n+1)\left(\frac{n}{2}\right)$, where n is the total number of natural numbers.

99. 20,100 **101.** 2601

103. $(1, 5, -1)$ **105.** Answers will vary.

Section 8.3 (page 595)

1. geometric, common **3.** geometric series **5.** $|r| < 1$

7. Geometric sequence, $r = 3$ **9.** Not a geometric sequence

11. Geometric sequence, $r = -\frac{1}{2}$

13. Geometric sequence, $r = 2$

15. Not a geometric sequence **17.** 6, 18, 54, 162, 486

19. $1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}$ **21.** $5, -\frac{1}{2}, \frac{1}{20}, -\frac{1}{200}, \frac{1}{2000}$

23. $1, e, e^2, e^3, e^4$ **25.** $64, 32, 16, 8, 4$; $r = \frac{1}{2}$; $a_n = 64\left(\frac{1}{2}\right)^{n-1}$

27. 9, 18, 36, 72, 144; $r = 2$; $a_n = 9(2)^{n-1}$

29. $6, -9, \frac{27}{2}, -\frac{81}{4}, \frac{243}{8}$; $r = -\frac{3}{2}$; $a_n = 6\left(-\frac{3}{2}\right)^{n-1}$

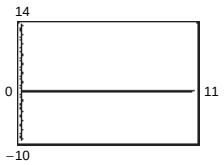
31. (a) 0.000034 (b) $\frac{2}{59{,}049}$ **33.** (a) 44.949 (b) $\frac{32{,}768}{729}$

35. (a) and (b) -243 **37.** (a) and (b) -646.803

39. $a_n = 7(3)^{n-1}$; 45,927 **41.** $a_n = 5(6)^{n-1}$; 50,388,480

43. $\frac{1}{128}$ **45.** $-\frac{2}{9}$

47.



49.

51. 8, 4, 6, 5, $\frac{11}{2}$ **53.**

n	S_n
1	16
2	24
3	28
4	30
5	31
6	31.5
7	31.75
8	31.875
9	31.9375
10	31.96875

55. 511 **57.** 43 **59.** 29,921.31 **61.** 6.4

63. 2092.60 **65.** $\sum_{n=1}^{7} 5(3)^{n-1}$ **67.** $\sum_{n=1}^{7} 2\left(-\frac{1}{4}\right)^{n-1}$

69. 50 **71.** $\frac{10}{3}$

73. Series does not have a finite sum because $\left|\frac{7}{3}\right| > 1$.

75. $\frac{1000}{89}$ **77.** $-\frac{30}{19}$ **79.** 27 **81.** $\frac{9}{4}$ **83.** $\frac{4}{11}$ **85.** $\frac{113}{90}$

87. Geometric; $r = 2$; 262,136 **89.** Geometric; $r = \frac{1}{3}$; 135

91. Arithmetic; $d = 6$; 720 **93.** Geometric; $r = 0.8$; 28.944

95. (a) \$1343.92 (b) \$1346.86 (c) \$1348.35
(d) \$1349.35 (e) \$1349.84

97. Answers will vary. **99.** (a) \$26,198.27 (b) \$26,263.88

101. (a) \$153,237.86 (b) \$153,657.02 **103.** 126 in.^{2}

105. (a) $T_n = 70(0.8)^n$ (b) 18.4°F; 4.8°F

(c)

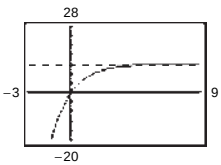
3.5 h

107. (a) $a_n = 1269.10(1.006)^n$
(b) The population is growing at a rate of 0.6% per year.
(c) 1388.2 million. This value is close to the prediction.
(d) 2010

109. 42 ft **111.** True. The terms all equal a_1.

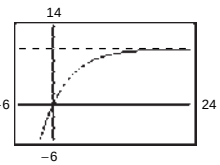
113. $3, \frac{3x}{2}, \frac{3x^2}{4}, \frac{3x^3}{8}, \frac{3x^4}{16}$ **115.** $100e^{8x}$

117. (a)



Horizontal asymptote: $y = 12$
Corresponds to the sum of the series

(b)



Horizontal asymptote: $y = 10$
Corresponds to the sum of the series.

119. Divide the second term by the first to obtain the common ratio. The nth term is the first term times the common ratio raised to the $(n-1)$th power.

121. 45.65 mi/h **123.** -102 **125.** Answers will vary.

Section 8.4 (page 604)

1. ${}_nC_r$ or $\binom{n}{r}$ **3.** Binomial Theorem, Pascal's Triangle

5. 21 **7.** 15,504 **9.** 14 **11.** 1 **13.** 210

15. 4950 **17.** 749,398 **19.** 1225 **21.** 31,125

23. $x^4 + 8x^3 + 24x^2 + 32x + 16$

25. $a^3 + 9a^2 + 27a + 27$ **27.** $y^3 - 12y^2 + 48y - 64$

29. $x^5 + 5x^4y + 10x^3y^2 + 10x^2y^3 + 5xy^4 + y^5$

31. $r^6 + 18r^5s + 135r^4s^2 + 540r^3s^3 + 1215r^2s^4 + 1458rs^5 + 729s^6$

33. $x^5 - 5x^4y + 10x^3y^2 - 10x^2y^3 + 5xy^4 - y^5$

35. $1 - 12x + 48x^2 - 64x^3$

37. $x^8 + 8x^6 + 24x^4 + 32x^2 + 16$

39. $x^{10} - 25x^8 + 250x^6 - 1250x^4 + 3125x^2 - 3125$

41. $x^8 + 4x^6y^2 + 6x^4y^4 + 4x^2y^6 + y^8$

43. $x^{18} - 6x^{15}y + 15x^{12}y^2 - 20x^9y^3 + 15x^6y^4 - 6x^3y^5 + y^6$

45. $\frac{1}{x^5} + \frac{5y}{x^4} + \frac{10y^2}{x^3} + \frac{10y^3}{x^2} + \frac{5y^4}{x} + y^5$

47. $\frac{16}{x^4} - \frac{32y}{x^3} + \frac{24y^2}{x^2} - \frac{8y^3}{x} + y^4$

49. $-512x^4 + 576x^3 - 240x^2 + 44x - 3$

51. $2x^4 - 24x^3 + 113x^2 - 246x + 207$

53. $-4x^6 - 24x^5 - 60x^4 - 83x^3 - 42x^2 - 60x + 20$

55. $61{,}440x^7$ **57.** $360x^3y^2$ **59.** $1{,}259{,}712x^2y^7$

61. $-4{,}330{,}260{,}000x^3y^9$ **63.** 1,737,104 **65.** 180

67. −489,888 **69.** 210 **71.** 35 **73.** 6

75. $81t^4 - 216t^3v + 216t^2v^2 - 96tv^3 + 16v^4$

77. $32x^5 - 240x^4y + 720x^3y^2 - 1080x^2y^3 + 810xy^4 - 243y^5$

79. $x^5 + 10x^4y + 40x^3y^2 + 80x^2y^3 + 80xy^4 + 32y^5$

81. $x^{3/2} + 15x + 75\sqrt{x} + 125$

83. $x^2 - 3x^{4/3}y^{1/3} + 3x^{2/3}y^{2/3} - y$

85. $3x^2 + 3xh + h^2,\ h \neq 0$

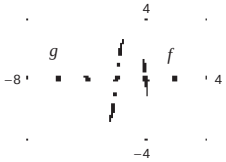
87. $6x^5 + 15x^4h + 20x^3h^2 + 15x^2h^3 + 6xh^4 + h^5,\ h \neq 0$

89. $\frac{\sqrt{x+h} - \sqrt{x}}{h} = \frac{1}{\sqrt{x+h} + \sqrt{x}},\ h \neq 0$

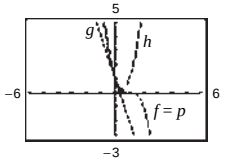
91. −4 **93.** $161 + 240i$ **95.** $2035 + 828i$

97. $-115 + 236i$ **99.** $-23 + 208\sqrt{3}i$ **101.** 1

103. $-\frac{1}{8}$ **105.** 1.172 **107.** 510,568.785

109. 

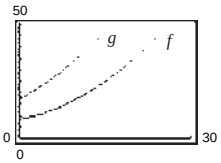
g is shifted four units to the left of f.
$g(x) = x^3 + 12x^2 + 44x + 48$

111. 

$p(x)$ is the expansion of $f(x)$.

113. 0.273 **115.** 0.171

117. (a) $g(t) = 0.044t^2 + 1.32t + 17.1$

(b) 

119. True. Pascal's Triangle is made up of binomial coefficients.

121. False. The correct term is $126{,}720x^4y^8$. **123.** $n + 1$ terms

125. (a) $5(2x)^4(-3y)^1 = -240x^4y$

(b) ${}_6C_3\left(\frac{1}{2}x\right)^3(7y)^3 = 857.5x^3y^3$

127 and 129. Answers will vary. **131.** $\begin{bmatrix} 1 & 2 \\ -0.5 & -0.5 \end{bmatrix}$

Section 8.5 (page 613)

1. Fundamental Counting Principle **3.** Permutation

5. 8 **7.** 6 **9.** 11 **11.** 10 **13.** 120

15. 1024 **17.** (a) 900 (b) 648 (c) 180

19. 16,000,000 **21.** (a) 35,152 (b) 3902

23. (a) 100,000 (b) 20,000 **25.** (a) 720 (b) 48

27. 24 **29.** 336 **31.** 120 **33.** 27,907,200

35. 197,149,680 **37.** 120 **39.** 362,880 **41.** 11,880

43. 50,653

45. ABCD, ABDC, ACBD, ACDB, ADBC, ADCB, BACD, BADC, CABD, CADB, DABC, DACB, BCAD, BDAC, CBAD, CDAB, DBAC, DCAB, BCDA, BDCA, CBDA, CDBA, DBCA, DCBA

47. 420 **49.** 2520 **51.** 10 **53.** 4 **55.** 1

57. 15,504 **59.** 850,668

61. AB, AC, AD, AE, AF, BC, BD, BE, BF, CD, CE, CF, DE, DF, EF

63. 2.53×10^{17} **65.** 195,249,054

67. (a) 17,550 (b) 1053 (c) 27,378 **69.** 24

71. 462,000 **73.** 5 **75.** 20 **77.** $n = 5$ or $n = 6$

79. $n = 10$ **81.** $n = 3$ **83.** $n = 2$

85. False. **87.** For some calculators the answer is too large.

89. ${}_nP_r$ represents the number of ways to choose and order r elements out of a collection of n elements.

91 and 93. Answers will vary. **95.** 35 **97.** $(-2, -8)$

Section 8.6 (page 622)

1. sample space **3.** mutually exclusive

5. $0 \leq P(E) \leq 1$ **7.** $P(E) = 1$

9. {(*H*, 1), (*H*, 2), (*H*, 3), (*H*, 4), (*H*, 5), (*H*, 6), (*T*, 1), (*T*, 2), (*T*, 3), (*T*, 4), (*T*, 5), (*T*, 6)}

11. {ABC, ACB, BAC, BCA, CAB, CBA} **13.** $\frac{3}{8}$ **15.** $\frac{7}{8}$

17. $\frac{3}{13}$ **19.** $\frac{3}{52}$ **21.** $\frac{5}{36}$ **23.** $\frac{11}{12}$ **25.** $\frac{3}{100}$ **27.** $\frac{9}{25}$

29. $\frac{1}{5}$ **31.** $\frac{2}{5}$ **33.** 0.25 **35.** $\frac{1}{3}$ **37.** 0.88 **39.** $\frac{7}{20}$

41. $\frac{4}{13}$ **43.** $\frac{4}{13}$ **45.** $\frac{9}{16}$ **47.** $\frac{3}{32}$ **49.** $\frac{1}{8}$ **51.** $\frac{2}{125}$

53. $P(\{\text{Taylor wins}\}) = \frac{1}{2}$
$P(\{\text{Moore wins}\}) = P(\{\text{Perez wins}\}) = \frac{1}{4}$

55. (a) 20.22 million (b) 0.294 (c) 0.866

57. (a) $\frac{1}{120}$ (b) $\frac{1}{24}$ **59.** (a) $\frac{14}{55}$ (b) $\frac{12}{55}$ (c) $\frac{54}{55}$

61. 0.1024 **63.** (a) $\frac{1}{15{,}625}$ (b) $\frac{4096}{15{,}625}$ (c) $\frac{11{,}529}{15{,}625}$

65. (a) $\frac{\pi}{4}$ (b) Answers will vary.

67. True. The sum of the probabilities of all outcomes must be 1.

69. (a) As you consider successive people with distinct birthdays, the probabilities must decrease to take into account the birth dates already used. Because the birth dates of people are independent events, multiply the respective probabilities of distinct birthdays.

(b) $\frac{365}{365} \cdot \frac{364}{365} \cdot \frac{363}{365} \cdot \frac{362}{365}$

(c) Answers will vary.

(d) Q_n is the probability that the birthdays are *not* distinct, which is equivalent to at least two people having the same birthday.

(e)

n	10	15	20	23	30	40	50
P_n	0.88	0.75	0.59	0.49	0.29	0.11	0.03
Q_n	0.12	0.25	0.41	0.51	0.71	0.89	0.97

(f) 23

71. (a) No. $P(A) + P(B) = 0.76 + 0.58 = 1.34 > 1$. The sum of the probabilities is greater than 1, so A and B cannot be mutually exclusive.

(b) Yes. $A' = 0.24$, $B' = 0.42$, and $A' + B' = 0.66 < 1$, so A' and B' can be mutually exclusive.

(c) $0.76 \leq P(A \cup B) \leq 1$

73. 15 **75.** 165

Review Exercises (page 628)

1. $\frac{2}{3}, \frac{4}{5}, \frac{8}{9}, \frac{16}{17}, \frac{32}{33}$ **3.** $a_n = 5n$ **5.** $a_n = \dfrac{2}{2n-1}$

7. 9, 5, 1, -3, -7 **9.** $\frac{1}{380}$ **11.** $(n+1)(n)$ **13.** 30

15. $\dfrac{205}{24}$ **17.** $\displaystyle\sum_{k=1}^{20} \frac{1}{2k} \approx 1.799$ **19.** $\displaystyle\sum_{k=1}^{9} \frac{k}{k+1} \approx 7.071$

21. (a) $\frac{1111}{2000}$ (b) $\frac{5}{9}$ **23.** (a) $\frac{15}{8}$ (b) 2

25. (a) 3015.00, 3030.08, 3045.23, 3060.45, 3075.75, 3091.13, 3106.59, 3122.12

(b) \$3662.38

27. Arithmetic sequence, $d = -2$

29. Arithmetic sequence, $d = \frac{1}{2}$

31. 3, 7, 11, 15, 19 **33.** 1, 4, 7, 10, 13

35. 35, 32, 29, 26, 23; $d = -3$; $a_n = 38 - 3n$

37. $a_n = 103 - 3n$; 1600 **39.** 80 **41.** 6375

43. (a) \$45,000 (b) \$202,500

45. Geometric sequence, $r = 2$

47. Geometric sequence, $r = -\frac{1}{3}$ **49.** $4, -1, \frac{1}{4}, -\frac{1}{16}, \frac{1}{64}$

51. 9, 6, 4, $\frac{8}{3}, \frac{16}{9}$ or 9, -6, 4, $-\frac{8}{3}, \frac{16}{9}$

53. 120, 40, $\frac{40}{3}, \frac{40}{9}, \frac{40}{27}$; $r = \frac{1}{3}$; $a_n = 120\left(\frac{1}{3}\right)^{n-1}$

55. (a) $-\frac{1}{2}$ (b) -0.5 **57.** 127 **59.** 3277 **61.** 32

63. 12 **65.** (a) $a_t = 130{,}000(0.7)^t$ (b) \$21,849.10

67. 45 **69.** 126 **71.** $x^4 + 20x^3 + 150x^2 + 500x + 625$

73. $a^5 - 20a^4b + 160a^3b^2 - 640a^2b^3 + 1280ab^4 - 1024b^5$

75. 20 **77.** 70 **79.** 10

81. (a) 216 (b) 108 (c) 36 **83.** 239,500,800

85. 5040 **87.** $n = 3$ **89.** 28 **91.** 479,001,600

93. $\frac{1}{9}$ **95.** (a) 0.416 (b) 0.8 (c) 0.074

97. True. $\dfrac{(n+2)!}{n!} = \dfrac{(n+2)(n+1)n!}{n!} = (n+2)(n+1)$

99. (a) Each term is obtained by adding the same constant (common difference) to the preceding term.

(b) Each term is obtained by multiplying the same constant (common ratio) by the preceding term.

Chapter Test (page 631)

1. 1, $-\frac{2}{3}, \frac{4}{9}, -\frac{8}{27}, \frac{16}{81}$ **2.** 12, 16, 20, 24, 28

3. $-x, \dfrac{x^2}{2}, -\dfrac{x^3}{3}, \dfrac{x^4}{4}, -\dfrac{x^5}{5}$

4. $-\dfrac{x^3}{6}, -\dfrac{x^5}{120}, -\dfrac{x^7}{5040}, -\dfrac{x^9}{362{,}880}, -\dfrac{x^{11}}{39{,}916{,}800}$ **5.** 7920

6. $\dfrac{1}{n+1}$ **7.** $2n$ **8.** $a_n = n^2 + 1$

9. $a_n = 5100 - 100n$ **10.** $a_n = 4\left(\frac{1}{2}\right)^{n-1}$

11. $\displaystyle\sum_{n=1}^{12} \frac{2}{3n+1}$ **12.** $\displaystyle\sum_{n=1}^{\infty} 2\left(\frac{1}{4}\right)^{n-1}$ **13.** 189 **14.** 28.80

15. $\frac{25}{7}$ **16.** $16a^4 - 160a^3b + 600a^2b^2 - 1000ab^3 + 625b^4$

17. 84 **18.** 1140 **19.** 72 **20.** 328,440

21. $n = 3$ **22.** 26,000 **23.** 12,650 **24.** $\frac{3}{26}$

25. $\frac{1}{462}$ **26.** (a) $\frac{1}{4}$ (b) $\frac{121}{3600}$ (c) $\frac{1}{60}$ **27.** 0.25

Chapter 9

Section 9.1 (page 643)

1. conic section **3.** circle, center

5. The standard form of the equation of a circle; (h, k) represents the center of the circle, r represents the radius of the circle.

7. $x^2 + y^2 = 16$ **9.** $(x-3)^2 + (y-7)^2 = 53$

11. $(x+3)^2 + (y+1)^2 = 7$

13. Center: $(0, 0)$
Radius: 7

15. Center: $(-2, 7)$
Radius: 4

17. Center: $(1, 0)$
Radius: $\sqrt{15}$

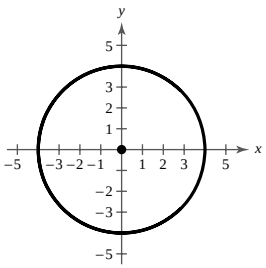
19. $x^2 + y^2 = 4$
Center: $(0, 0)$
Radius: 2

21. $x^2 + y^2 = \dfrac{3}{4}$
Center: $(0, 0)$
Radius: $\dfrac{\sqrt{3}}{2}$

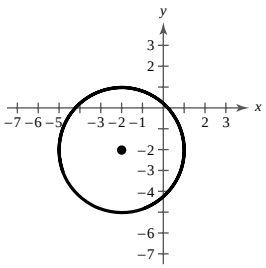
23. $(x-1)^2 + (y+3)^2 = 1$
Center: $(1, -3)$
Radius: 1

25. $\left(x + \frac{3}{2}\right)^2 + (y-3)^2 = 1$
Center: $\left(-\frac{3}{2}, 3\right)$
Radius: 1

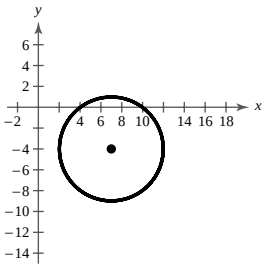
27. Center: $(0, 0)$
Radius: 4



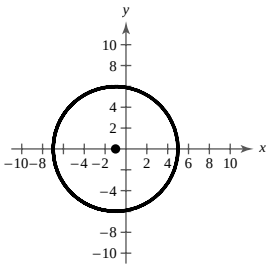
29. Center: $(-2, -2)$
Radius: 3



31. Center: $(7, -4)$
Radius: 5



33. Center: $(-1, 0)$
Radius: 6



35. x-intercept: $(2, 0)$
y-intercepts: $\left(0, -3 \pm \sqrt{5}\right)$

37. x-intercepts: $\left(1 \pm 2\sqrt{7}, 0\right)$
y-intercepts: $(0, 9)$, $(0, -3)$

39. x-intercepts: $\left(6 \pm \sqrt{7}, 0\right)$
y-intercept: none

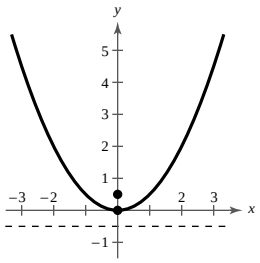
41. (a) $x^2 + y^2 = 2704$ (b) Yes (c) 2 mi

43. e **44.** b **45.** d **46.** f **47.** a **48.** c

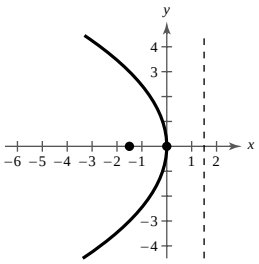
49. $x^2 = \frac{3}{2}y$ **51.** $x^2 = -6y$ **53.** $y^2 = -8x$

55. $x^2 = -4y$ **57.** $y^2 = -8x$ **59.** $y^2 = 9x$

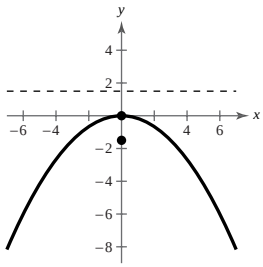
61. Vertex: $(0, 0)$
Focus: $\left(0, \frac{1}{2}\right)$
Directrix: $y = -\frac{1}{2}$



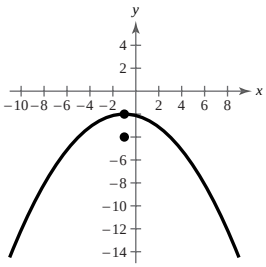
63. Vertex: $(0, 0)$
Focus: $\left(-\frac{3}{2}, 0\right)$
Directrix: $x = \frac{3}{2}$



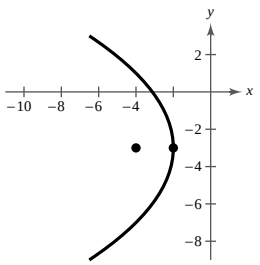
65. Vertex: $(0, 0)$
Focus: $\left(0, -\frac{3}{2}\right)$
Directrix: $y = \frac{3}{2}$



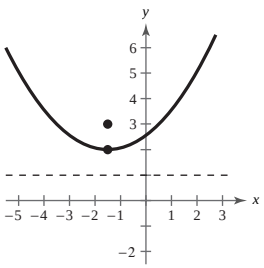
67. Vertex: $(-1, -2)$
Focus: $(-1, -4)$
Directrix: $y = 0$



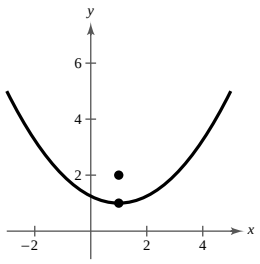
69. Vertex: $(-2, -3)$
Focus: $(-4, -3)$
Directrix: $x = 0$



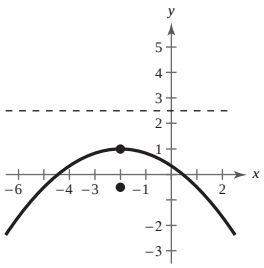
71. Vertex: $\left(-\frac{3}{2}, 2\right)$
Focus: $\left(-\frac{3}{2}, 3\right)$
Directrix: $y = 1$



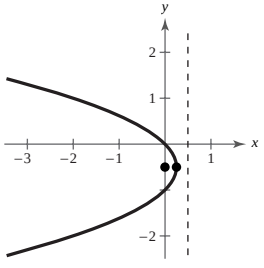
73. Vertex: $(1, 1)$
Focus: $(1, 2)$
Directrix: $y = 0$



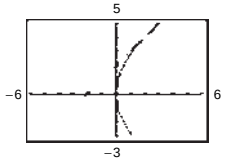
75. Vertex: $(-2, 1)$
Focus: $\left(-2, -\frac{1}{2}\right)$
Directrix: $y = \frac{5}{2}$



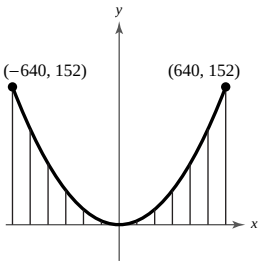
77. Vertex: $\left(\frac{1}{4}, -\frac{1}{2}\right)$
Focus: $\left(0, -\frac{1}{2}\right)$
Directrix: $x = \frac{1}{2}$



79. $(x - 3)^2 = -(y - 1)$ **81.** $y^2 = 4(x + 4)$
83. $y^2 = 2(x + 2)$ **85.** $(y - 2)^2 = -8(x - 5)$
87. $x^2 = 8(y - 4)$ **89.** $(y - 2)^2 = 8x$
91.



$(2, 4)$
93. $4x - y - 8 = 0$; $(2, 0)$ **95.** $4x - y + 2 = 0$; $\left(-\frac{1}{2}, 0\right)$
97. (a) $x^2 = 12{,}288y$ (in feet) (b) 22.6 ft
99. (a) $y^2 = 6x$ (b) 2.67 in.
101. (a)

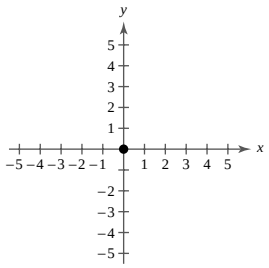


(b) $x^2 = \frac{51{,}200}{19}y$

(c)

x	0	200	400	500	600
y	0	14.844	59.375	92.773	133.59

103. $y^2 = 640x$ **105.** (a) $x^2 = -49(y - 100)$ (b) 70 ft
107. $y = \frac{3}{4}x - \frac{25}{4}$ **109.** $y = \frac{\sqrt{2}}{2}x - 3\sqrt{2}$
111. False. $x^2 + (y + 5)^2 = 25$ represents a circle with its center at $(0, -5)$ and a radius of 5.
113. False. A circle is a conic section.
115. True. The vertex is the closest point to the directrix or focus.
117. True. If the axis is horizontal, then the directrix must be vertical.
119.



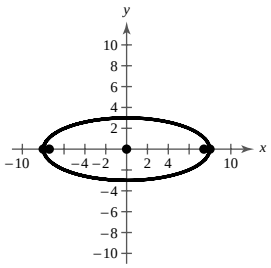
The intersection results in a point.
121. $y = -\sqrt{2(x - 2)} - 1$
123. Minimum: $(-0.75, -1.13)$
125. Minimum: $(0.88, -3.11)$; maximum: $(-0.88, 1.11)$

Section 9.2 (page 653)

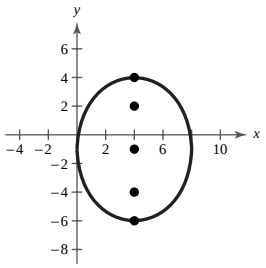
1. ellipse, foci **3.** minor axis **5.** Vertical **7.** 4
9. b **10.** c **11.** a **12.** d

CHAPTER 9

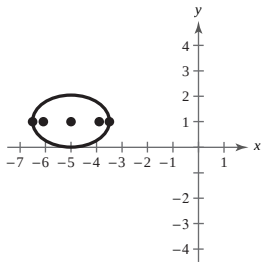
13. Center: $(0, 0)$
Vertices: $(\pm 8, 0)$
Foci: $\left(\pm\sqrt{55}, 0\right)$
Eccentricity: $\frac{\sqrt{55}}{8}$



15. Center: $(4, -1)$
Vertices: $(4, 4), (4, -6)$
Foci: $(4, 2), (4, -4)$
Eccentricity: $\frac{3}{5}$



17. Center: $(-5, 1)$
Vertices: $\left(-\frac{7}{2}, 1\right), \left(-\frac{13}{2}, 1\right)$
Foci: $\left(-5 \pm \frac{\sqrt{5}}{2}, 1\right)$
Eccentricity: $\frac{\sqrt{5}}{3}$



19. $\frac{x^2}{4} + \frac{y^2}{16} = 1$ **21.** $\frac{x^2}{9} + \frac{y^2}{5} = 1$ **23.** $\frac{x^2}{49} + \frac{y^2}{24} = 1$

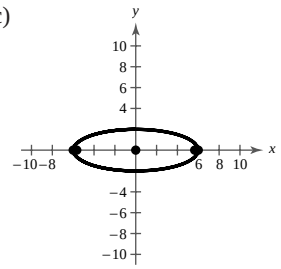
25. $\frac{x^2}{400/21} + \frac{y^2}{25} = 1$ **27.** $\frac{(x-2)^2}{1} + \frac{(y-3)^2}{9} = 1$

29. $\frac{(x-4)^2}{16} + \frac{(y-2)^2}{1} = 1$ **31.** $\frac{x^2}{308} + \frac{(y-4)^2}{324} = 1$

33. $\frac{(x-3)^2}{9} + \frac{(y-5)^2}{16} = 1$ **35.** $\frac{x^2}{16} + \frac{(y-4)^2}{12} = 1$

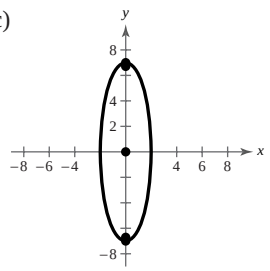
37. (a) $\frac{x^2}{36} + \frac{y^2}{4} = 1$ (c)

(b) Center: $(0, 0)$
Vertices: $(\pm 6, 0)$
Foci: $\left(\pm 4\sqrt{2}, 0\right)$
Eccentricity: $\frac{2\sqrt{2}}{3}$



39. (a) $\frac{x^2}{4} + \frac{y^2}{49} = 1$ (c)

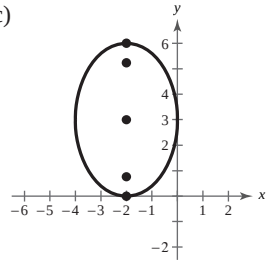
(b) Center: $(0, 0)$
Vertices: $(0, \pm 7)$
Foci: $\left(0, \pm 3\sqrt{5}\right)$
Eccentricity: $\frac{3\sqrt{5}}{7}$



41. (a) $\frac{(x+2)^2}{4} + \frac{(y-3)^2}{9} = 1$

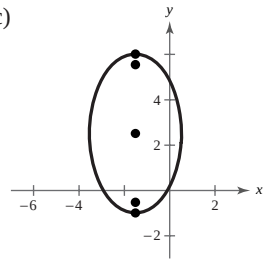
(b) Center: $(-2, 3)$
Vertices:
$(-2, 6), (-2, 0)$
Foci: $\left(-2, 3 \pm \sqrt{5}\right)$
Eccentricity: $\frac{\sqrt{5}}{3}$

(c)



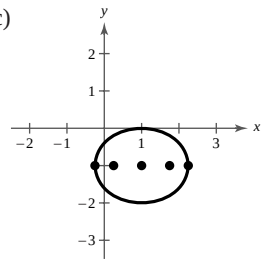
43. (a) $\frac{\left(x+\frac{3}{2}\right)^2}{4} + \frac{\left(y-\frac{5}{2}\right)^2}{12} = 1$ (c)

(b) Center: $\left(-\frac{3}{2}, \frac{5}{2}\right)$
Vertices: $\left(-\frac{3}{2}, \frac{5 \pm 4\sqrt{3}}{2}\right)$
Foci: $\left(-\frac{3}{2}, \frac{5}{2} \pm 2\sqrt{2}\right)$
Eccentricity: $\frac{\sqrt{6}}{3}$



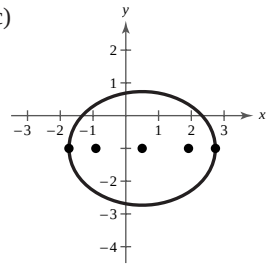
45. (a) $\frac{(x-1)^2}{25/16} + (y+1)^2 = 1$ (c)

(b) Center: $(1, -1)$
Vertices:
$\left(\frac{9}{4}, -1\right), \left(-\frac{1}{4}, -1\right)$
Foci: $\left(\frac{7}{4}, -1\right), \left(\frac{1}{4}, -1\right)$
Eccentricity: $\frac{3}{5}$



47. (a) $\frac{\left(x-\frac{1}{2}\right)^2}{5} + \frac{(y+1)^2}{3} = 1$ (c)

(b) Center: $\left(\frac{1}{2}, -1\right)$
Vertices: $\left(\frac{1}{2} \pm \sqrt{5}, -1\right)$
Foci: $\left(\frac{1}{2} \pm \sqrt{2}, -1\right)$
Eccentricity: $\frac{\sqrt{10}}{5}$

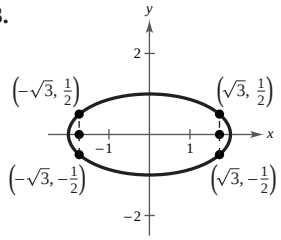


49. $\frac{\sqrt{5}}{3}$ **51.** $\frac{2\sqrt{2}}{3}$ **53.** $\frac{x^2}{25} + \frac{y^2}{16} = 1$

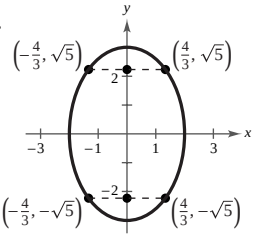
55. $\frac{x^2}{225/16} + \frac{y^2}{81/16} = 1$ **57.** $\left(\pm\sqrt{5}, 0\right)$; 6 ft

59. $\frac{x^2}{321.84} + \frac{y^2}{19.02} = 1$ **61.** $e = \frac{c}{a} \approx 0.052$

63.



65.



67. True. The ellipse is more elongated when e is close to 1.

69. Nearly circular because its eccentricity is about 0.055, which is close to zero.

71. (a) $2a$

(b) The sum of the distances from the two fixed points is constant.

73. $\dfrac{(x-6)^2}{324}+\dfrac{(y-2)^2}{308}=1$ **75.** Arithmetic

77. Geometric **79.** 1093

Section 9.3 (page 665)

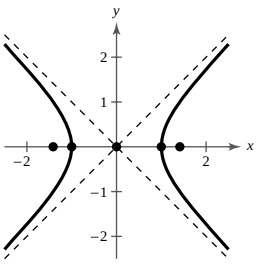
1. hyperbola

3. $Ax^2+Bxy+Cy^2+Dx+Ey+F=0$

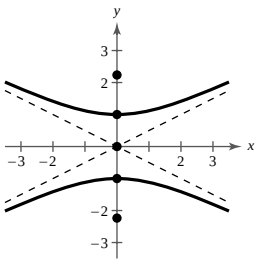
5. Horizontal: a, d; vertical: b, c

7. b **8.** c **9.** a **10.** d

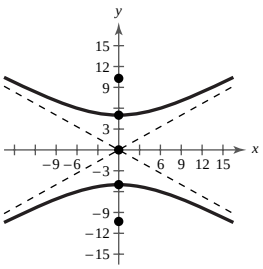
11. Center: $(0, 0)$
Vertices: $(\pm 1, 0)$
Foci: $\left(\pm\sqrt{2}, 0\right)$
Asymptotes: $y=\pm x$



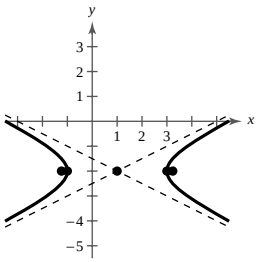
13. Center: $(0, 0)$
Vertices: $(0, \pm 1)$
Foci: $\left(0, \pm\sqrt{5}\right)$
Asymptotes: $y=\pm\frac{1}{2}x$



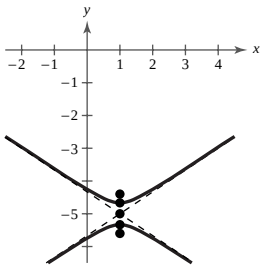
15. Center: $(0, 0)$
Vertices: $(0, \pm 5)$
Foci: $\left(0, \pm\sqrt{106}\right)$
Asymptotes: $y=\pm\frac{5}{9}x$



17. Center: $(1, -2)$
Vertices:
$(3, -2), (-1, -2)$
Foci: $\left(1 \pm \sqrt{5}, -2\right)$
Asymptotes:
$y=-2\pm\frac{1}{2}(x-1)$



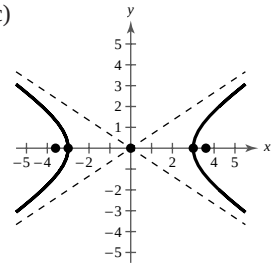
19. Center: $(1, -5)$
Vertices: $\left(1, -5 \pm \dfrac{1}{3}\right)$
Foci: $\left(1, -5 \pm \dfrac{\sqrt{13}}{6}\right)$
Asymptotes:
$y=-5\pm\dfrac{2}{3}(x-1)$



21. (a) $\dfrac{x^2}{9}-\dfrac{y^2}{4}=1$

(b) Center: $(0, 0)$
Vertices: $(\pm 3, 0)$
Foci: $\left(\pm\sqrt{13}, 0\right)$
Asymptotes: $y=\pm\dfrac{2}{3}x$

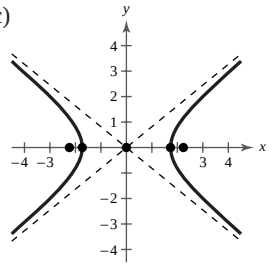
(c)



23. (a) $\dfrac{x^2}{3}-\dfrac{y^2}{2}=1$

(b) Center: $(0, 0)$
Vertices: $\left(\pm\sqrt{3}, 0\right)$
Foci: $\left(\pm\sqrt{5}, 0\right)$
Asymptotes: $y=\pm\dfrac{\sqrt{6}}{3}x$

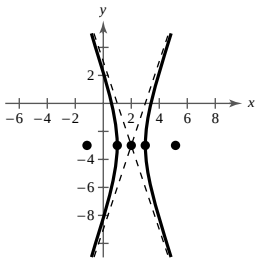
(c)



25. (a) $(x-2)^2-\dfrac{(y+3)^2}{9}=1$

(b) Center: $(2, -3)$
Vertices:
$(3, -3), (1, -3)$
Foci: $\left(2 \pm \sqrt{10}, -3\right)$
Asymptotes:
$y=-3\pm 3(x-2)$

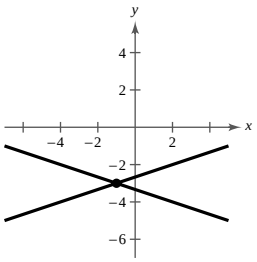
(c)



27. (a) $(x+1)^2-9(y+3)^2=0$

(b) It is a degenerate conic. The graph of this equation is two lines intersecting at $(-1, -3)$.

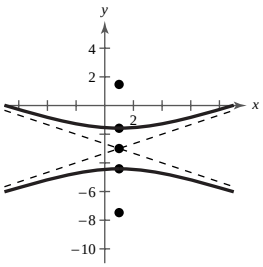
(c)



29. (a) $\dfrac{(y+3)^2}{2}-\dfrac{(x-1)^2}{18}=1$

(b) Center: $(1, -3)$
Vertices: $\left(1, -3 \pm \sqrt{2}\right)$
Foci: $\left(1, -3 \pm 2\sqrt{5}\right)$
Asymptotes: $y=-3\pm\dfrac{1}{3}(x-1)$

(c)



CHAPTER 9

31. $\frac{y^2}{4} - \frac{x^2}{12} = 1$ **33.** $\frac{x^2}{1} - \frac{y^2}{25} = 1$

35. $\frac{17y^2}{1024} - \frac{17x^2}{64} = 1$ **37.** $\frac{(x-4)^2}{4} - \frac{y^2}{12} = 1$

39. $\frac{(y-5)^2}{16} - \frac{(x-4)^2}{9} = 1$ **41.** $\frac{y^2}{9} - \frac{4(x-2)^2}{9} = 1$

43. $\frac{(y-2)^2}{4} - \frac{x^2}{4} = 1$ **45.** $\frac{(x-2)^2}{1} - \frac{(y-2)^2}{1} = 1$

47. $\frac{(x-3)^2}{9} - \frac{(y-2)^2}{4} = 1$

49. $\frac{x^2}{98{,}010{,}000} - \frac{y^2}{13{,}503{,}600} = 1$

51. (a) $x^2 - \frac{y^2}{27} = 1$ (b) 1.89 ft = 22.68 in.

53. $\left(12\sqrt{5} - 12, 0\right) \approx (14.83, 0)$

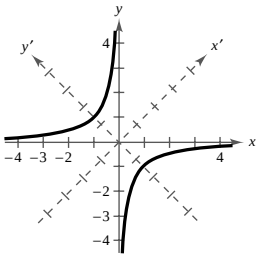
55. Ellipse **57.** Hyperbola **59.** Parabola

61. Circle **63.** Parabola

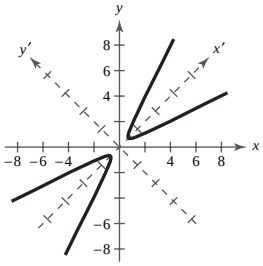
65. e **66.** b **67.** f **68.** a **69.** d **70.** c

71. (3, 0)

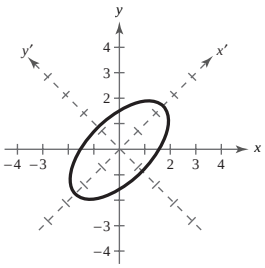
73. $\frac{(y')^2}{2} - \frac{(x')^2}{2} = 1$



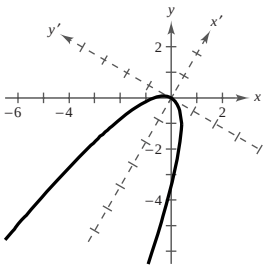
75. $(x')^2 - \frac{(y')^2}{1/3} = 1$



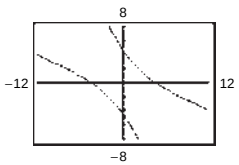
77. $\frac{(x')^2}{6} + \frac{(y')^2}{3/2} = 1$



79. $x' = -(y')^2$

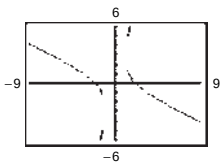


81.



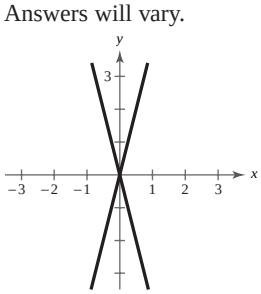
$\theta = 45°$;
Answers will vary.

83.

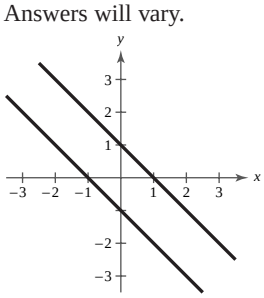


$\theta \approx 26.57°$;
Answers will vary.

85.



87.



89. True. For a hyperbola, $c^2 = a^2 + b^2$. The larger the ratio of b to a, the larger the eccentricity of the hyperbola, $e = c/a$.

91. False. If $D = E$ or $D = -E$, the graph is two intersecting lines. For example, the graph of $x^2 - y^2 - 2x + 2y = 0$ is two intersecting lines.

93. False. The constant term F remains the same.

95. The asymptotes pass through the corners of the rectangle.

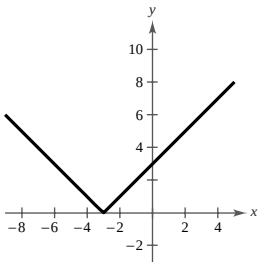
97. $\frac{(x-6)^2}{9} - \frac{(y-2)^2}{7} = 1$ **99.** Proof

101. $x^3 + x^2 + 2x - 6$ **103.** $x^2 - 2x + 1 + \frac{2}{x+2}$

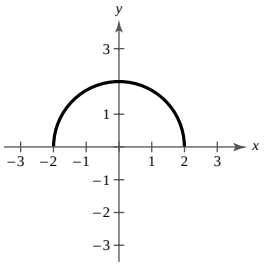
105. $x(x+4)(x-4)$ **107.** $2x(x-6)^2$

109. $2(2x+3)(4x^2 - 6x + 9)$

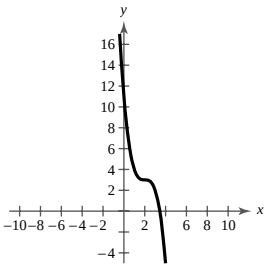
111.



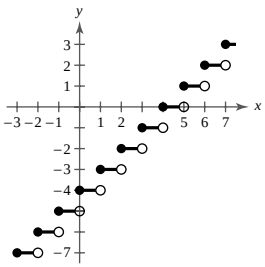
113.



115.



117.



Section 9.4 (page 674)

1. plane curve, parametric equations, parameter

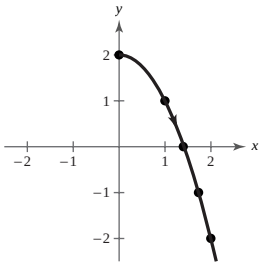
3. Eliminate the parameter.

5. c **6.** d **7.** b **8.** a

9. (a)

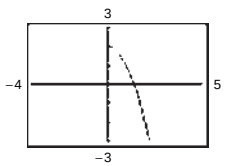
t	0	1	2	3	4
x	0	1	$\sqrt{2}$	$\sqrt{3}$	2
y	2	1	0	-1	-2

(b)

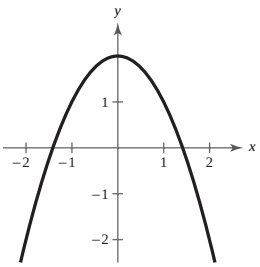


The curve starts at $(0, 2)$ and moves along the right half of the parabola.

(c)



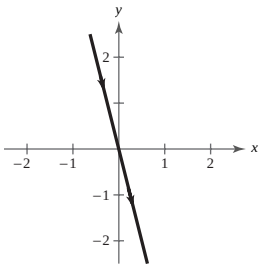
(d) $y = 2 - x^2$



The graph is an entire parabola rather than just the right half.

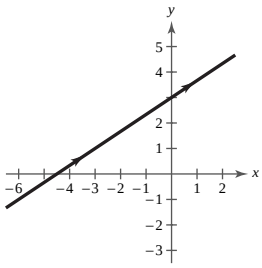
11. b

13.



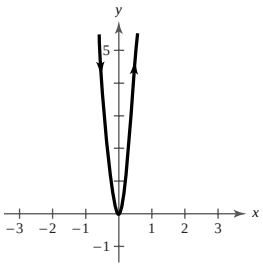
$y = -4x$

15.



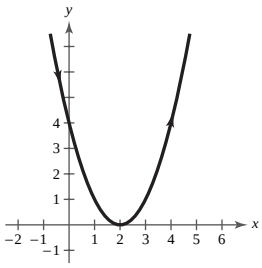
$y = \frac{2}{3}x + 3$

17.



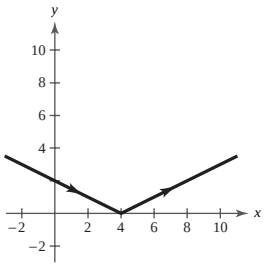
$y = 16x^2$

19.



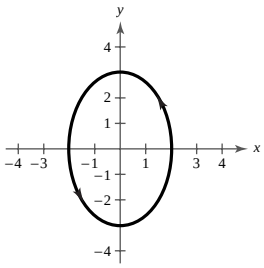
$y = (x - 2)^2$

21.



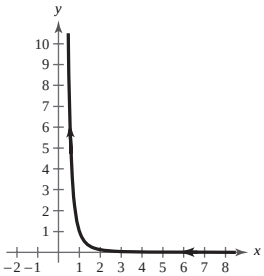
$y = \frac{1}{2}|x - 4|$

23.



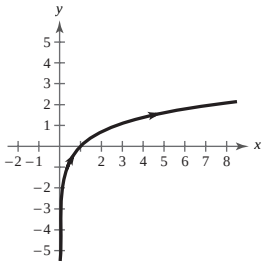
$\frac{x^2}{4} + \frac{y^2}{9} = 1$

25.



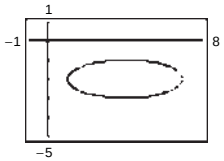
$y = x^{-3},\ x > 0$

27.

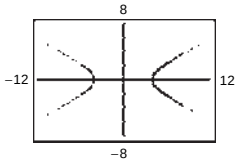


$y = \ln x$

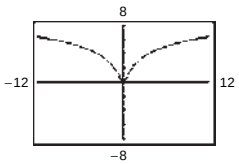
29.



31.



33.



35. Each curve represents a portion of the line $y = 2x + 1$.

	Domain	*Orientation*
(a)	$(-\infty, \infty)$	Left to right
(b)	$[-1, 1]$	Depends on θ
(c)	$(0, \infty)$	Right to left
(d)	$(0, \infty)$	Left to right

37. $y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$ **39.** $\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1$

41. $x = 3 - 5t, y = 1 + 5t$ **43.** $x = 5\cos\theta, y = 4\sin\theta$

45. (a) $x = t, y = 5t - 3$ (b) $x = 2 - t, y = -5t + 7$

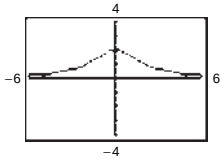
47. (a) $x = t, y = \frac{1}{t}$ (b) $x = 2 - t, y = \frac{1}{2 - t}$

49. (a) $x = t, y = 6t^2 - 5$

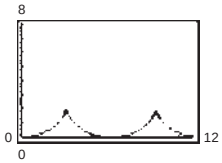
(b) $x = 2 - t, y = 6t^2 - 24t + 19$

51. (a) $x = t, y = e^t$ (b) $x = 2 - t, y = e^{2-t}$

53.



55.

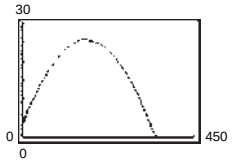


57. b **58.** c **59.** d **60.** a

61. (a) $x = (146.67\cos\theta)t$

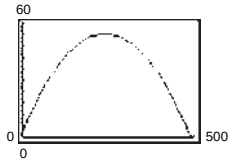
$y = 3 + (146.67\sin\theta)t - 16t^2$

(b)



No

(c)



Yes

(d) About 19.4°

63. True. Both sets of parametric equations correspond to $y = x^2 + 1$.

65. False. The set $x = t^2$, $y = t$ does not correspond to y as a function of x.

67. Yes, the orientation would be reversed.

69. Even **71.** Neither

Section 9.5 (page 681)

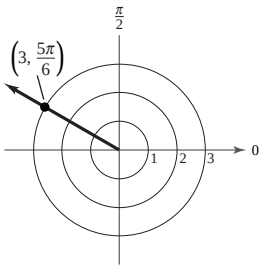
1. pole

3. $x = r\cos\theta, y = r\sin\theta$ and $\tan\theta = \frac{y}{x}, r^2 = x^2 + y^2$

5. $(0, 4)$ **7.** $\left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$

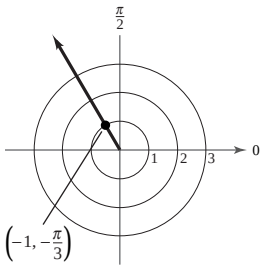
CHAPTER 9

9.



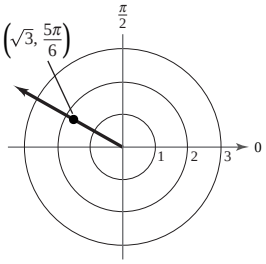
$\left(3, -\frac{7\pi}{6}\right), \left(-3, \frac{11\pi}{6}\right), \left(-3, -\frac{\pi}{6}\right)$

11.



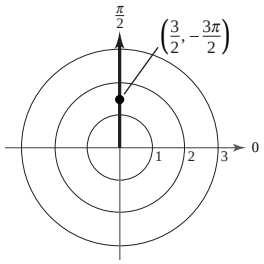
$\left(-1, \frac{5\pi}{3}\right), \left(1, \frac{2\pi}{3}\right), \left(1, -\frac{4\pi}{3}\right)$

13.



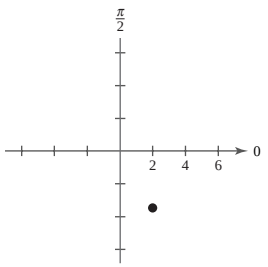
$\left(-\sqrt{3}, \frac{11\pi}{6}\right), \left(\sqrt{3}, -\frac{7\pi}{6}\right), \left(-\sqrt{3}, -\frac{\pi}{6}\right)$

15.



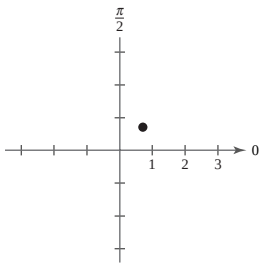
$\left(\frac{3}{2}, \frac{\pi}{2}\right), \left(-\frac{3}{2}, \frac{3\pi}{2}\right), \left(-\frac{3}{2}, -\frac{\pi}{2}\right)$

17.



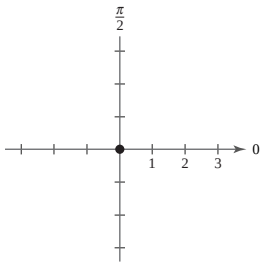
$\left(2, -2\sqrt{3}\right)$

19.



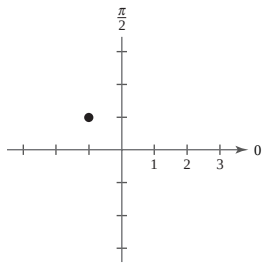
$\left(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}\right)$

21.



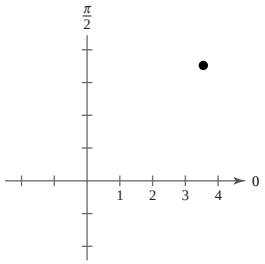
(0, 0)

23.



(−1.004, 0.996)

25.

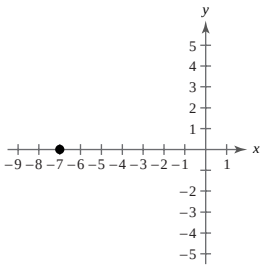


(3.549, 3.522)

27. (1.53, 1.29) **29.** (−1.20, −4.34)

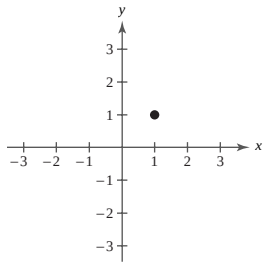
31. (−0.02, 2.50) **33.** (−3.60, 1.97)

35.



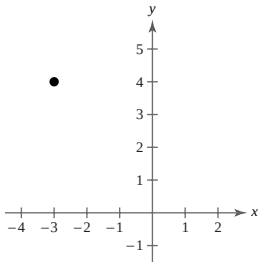
(7, π), (−7, 0)

37.



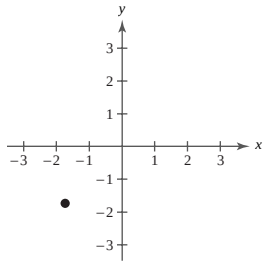
$\left(\sqrt{2}, \frac{\pi}{4}\right), \left(-\sqrt{2}, \frac{5\pi}{4}\right)$

39.



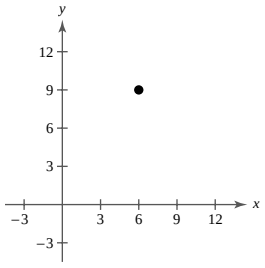
(5, 2.214), (−5, 5.356)

41.



$\left(\sqrt{6}, \frac{5\pi}{4}\right), \left(-\sqrt{6}, \frac{\pi}{4}\right)$

43.



(10.82, 0.98), (−10.82, 4.12)

45. (3.61, −0.59) **47.** (2.65, 0.86) **49.** (2.83, 0.49)

51. $r = 3$ **53.** $r = 4 \csc \theta$ **55.** $r = 8 \sec \theta$

57. $r = -\dfrac{2}{3 \cos \theta - \sin \theta}$ **59.** $r^2 = 8 \csc 2\theta$

61. $r^2 = 9 \cos 2\theta$ **63.** $r = 6 \cos \theta$ **65.** $r = 2a \cos \theta$

67. $r = \tan^2 \theta \sec \theta$ **69.** $x^2 + y^2 - 4y = 0$

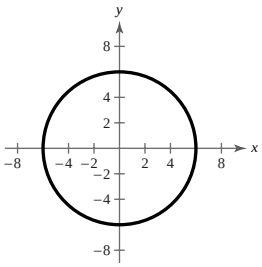
71. $y = -\sqrt{3}x$ **73.** $y = -\frac{\sqrt{3}}{3}x$ **75.** $x = 0$

77. $x^2 + y^2 = 16$ **79.** $y = -3$ **81.** $(x^2 + y^2)^3 = x^2$

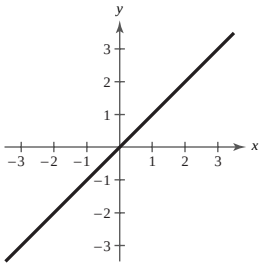
83. $(x^2 + y^2)^2 = 6x^2y - 2y^3$ **85.** $y^2 = 2x + 1$

87. $4x^2 - 5y^2 = 36y + 36$

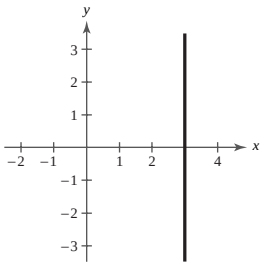
89. The graph is a circle centered at the origin with a radius of 6; $x^2 + y^2 = 36$.



91. The graph consists of all points on the line that makes an angle of $\pi/4$ with the positive x-axis; $x - y = 0$.



93. The graph is a vertical line through (3, 0); $x - 3 = 0$.



95. True. Because r is a directed distance, (r, θ) can be represented by $(-r, \theta \pm (2n + 1)\pi)$, so $|r| = |-r|$.

97. (a) Answers will vary.

(b) The points lie on a line passing through the pole.
$d = \sqrt{r_1^2 + r_2^2 - 2r_1r_2} = |r_1 - r_2|$

(c) $d = \sqrt{r_1^2 + r_2^2}$ (Pythagorean Theorem)
Answers will vary.

(d) Answers will vary. The Distance Formula should give the same result in both cases.

99. $\left(x - \frac{1}{2}\right)^2 + \left(y - \frac{3}{2}\right)^2 = \frac{5}{2}$; A circle centered at $\left(\frac{1}{2}, \frac{3}{2}\right)$ with a radius of $\frac{\sqrt{10}}{2}$.

101. $A \approx 30.68°$
$B \approx 48.23°$
$C \approx 101.09°$

103. $a \approx 16.16$
$b \approx 19.44$
$B \approx 86°$

Section 9.6 (page 689)

1. convex limaçon **3.** lemniscate

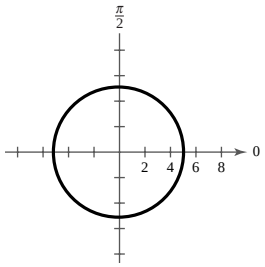
5. When (r, θ) can be replaced with $(r, \pi - \theta)$ or $(-r, -\theta)$ and yield an equivalent equation

7. Rose curve **9.** Lemniscate **11.** Rose curve **13.** a

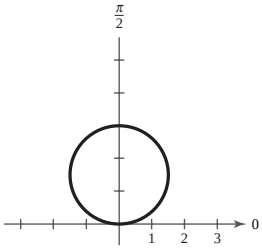
15. c **17.** Polar axis **19.** $\theta = \frac{\pi}{2}$ **21.** $\theta = \frac{\pi}{2}$

23. Pole

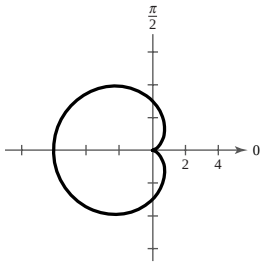
25.



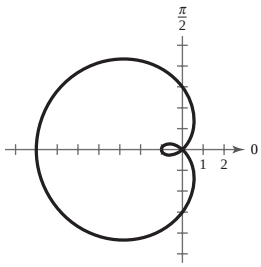
27.



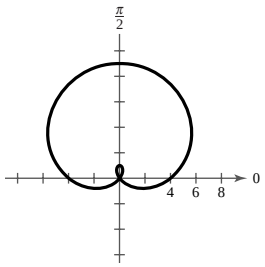
29.



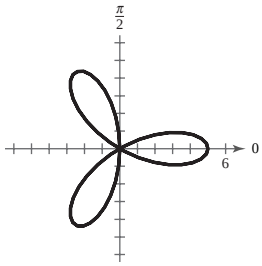
31.



33.



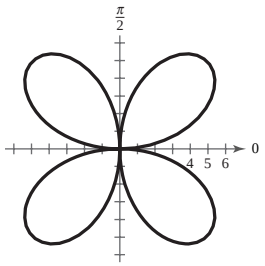
35.



Symmetry: polar axis

Zeros: $\frac{\pi}{6}, \frac{\pi}{2}, \frac{5\pi}{6}$

37.

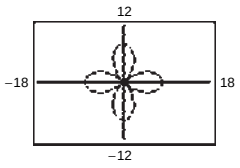


Symmetry:

$\theta = \frac{\pi}{2}$, polar axis, pole

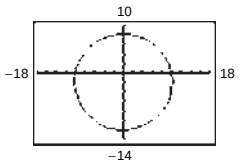
Zeros: $0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}, 2\pi$

39.



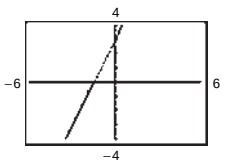
Answers will vary.

41.



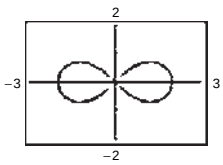
Answers will vary.

43.



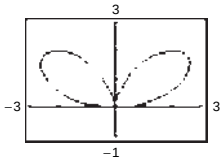
Answers will vary.

45.

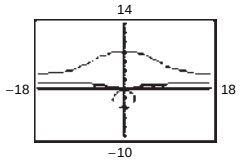


Answers will vary.

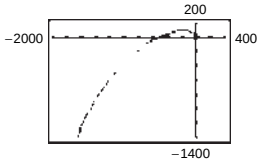
CHAPTER 9

47. 

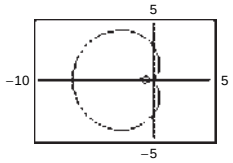
Answers will vary.

49. 

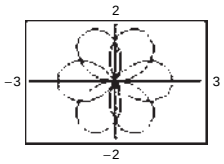
Answers will vary.

51. 

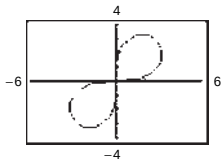
Answers will vary.

53. 

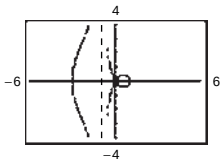
$0 \le \theta < 2\pi$

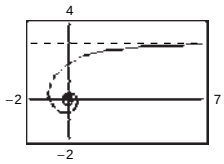
55. 

$0 \le \theta < 4\pi$

57. 

$0 \le \theta < \dfrac{\pi}{2}$

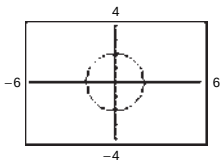
59. 

61. 

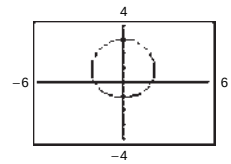
63. True. $n = 5$ **65.** Answers will vary.

67. (a) $r = 2 - \sin\left(\theta - \dfrac{\pi}{4}\right)$ (b) $r = 2 + \cos\theta$

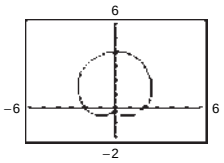
(c) $r = 2 + \sin\theta$ (d) $r = 2 - \cos\theta$

69. 

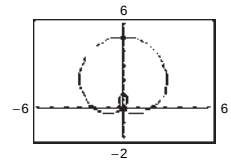
$k = 0$; circle



$k = 1$; convex limaçon



$k = 2$; cardioid

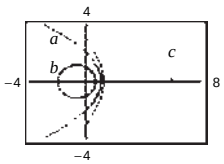


$k = 3$; limaçon with inner loop

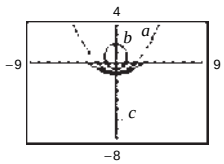
71. $x = -3, 3$ **73.** $x = \frac{13}{5}$

Section 9.7 (page 695)

1. conic **3.** vertical

5. 

(a) Parabola
(b) Ellipse
(c) Hyperbola

7. 

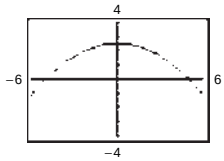
(a) Parabola
(b) Ellipse
(c) Hyperbola

9. b **10.** c **11.** f **12.** e **13.** d **14.** a

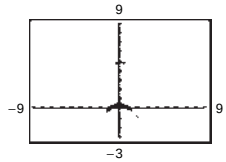
15. Parabola **17.** Ellipse **19.** Ellipse

21. Ellipse **23.** Hyperbola

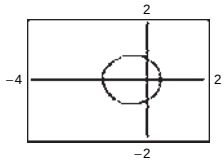
25. Parabola



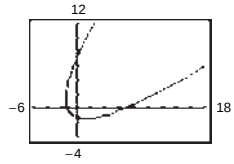
27. Hyperbola



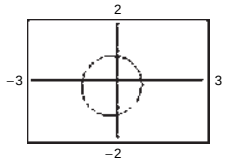
29. Ellipse



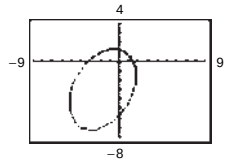
31.



33.



35.



37. $r = \dfrac{1}{1 - \cos\theta}$ **39.** $r = \dfrac{1}{2 + \sin\theta}$

41. $r = \dfrac{2}{1 + 2\cos\theta}$ **43.** $r = \dfrac{2}{1 - \sin\theta}$

45. $r = \dfrac{10}{1 - \cos\theta}$ **47.** $r = \dfrac{10}{3 + 2\cos\theta}$

49. $r = \dfrac{20}{3 - 2\cos\theta}$ **51.** $r = \dfrac{16}{3 + 5\cos\theta}$

53. Answers will vary.

55. $r = \dfrac{9.2930 \times 10^7}{1 - 0.0167\cos\theta}$

Perihelion: 9.1404×10^7 mi

Aphelion: 9.4508×10^7 mi

57. $r = \dfrac{6.7280 \times 10^7}{1 - 0.0068\cos\theta}$

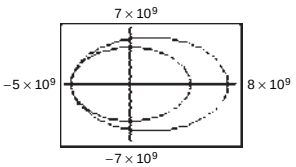
Perihelion: 6.6781×10^7 mi

Aphelion: 6.7695×10^7 mi

59. (a) $r_{\text{Neptune}} = \dfrac{4.4977 \times 10^9}{1 - 0.0086\cos\theta}$

$r_{\text{Pluto}} = \dfrac{5.5404 \times 10^9}{1 - 0.2488\cos\theta}$

(b) Neptune: Perihelion: 4.4593×10^9 km
Aphelion: 4.5367×10^9 km
Pluto: Perihelion: 4.4366×10^9 km
Aphelion: 7.3754×10^9 km

(c) 

(d) Yes; because on average, Pluto is farther from the sun than Neptune.

(e) Using a graphing utility, it would appear that the orbits intersect. No, Pluto and Neptune will never collide because the orbits do not intersect in three-dimensional space.

61. False. The equation can be rewritten as $r = \dfrac{-4/3}{1 + \sin\theta}$.

Because ep is negative, p must be negative, and because p represents the distance between the pole and the directrix, the directrix has to be below the pole.

63. True. The graphs represent the same hyperbola.

65. Answers will vary.

67. $r^2 = \dfrac{24{,}336}{169 - 25\cos^2\theta}$ **69.** $r^2 = \dfrac{400}{25 - 9\cos^2\theta}$

71. $r^2 = \dfrac{144}{25\sin^2\theta - 16}$

73. (a) Ellipse

(b) $r = \dfrac{4}{1 + 0.4\cos\theta}$ is reflected about the line $\theta = \dfrac{\pi}{2}$.

$r = \dfrac{4}{1 - 0.4\sin\theta}$ is rotated 90° counterclockwise.

75. Circle **77.** $\dfrac{\sqrt{2}}{10}$ **79.** $\dfrac{\sqrt{2}}{10}$

Review Exercises (page 700)

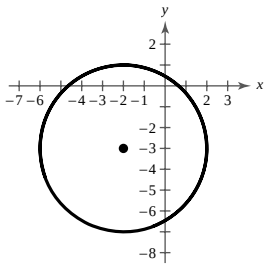
1. Hyperbola **3.** $x^2 + y^2 = 25$

5. $(x - 2)^2 + (y - 4)^2 = 13$

7. $x^2 + y^2 = 36$
Center: $(0, 0)$
Radius: 6

9. $\left(x - \frac{1}{2}\right)^2 + \left(y + \frac{3}{4}\right)^2 = 1$
Center: $\left(\frac{1}{2}, -\frac{3}{4}\right)$
Radius: 1

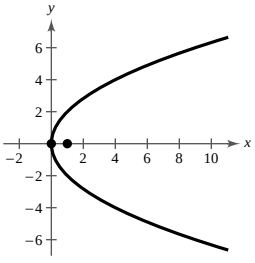
11.



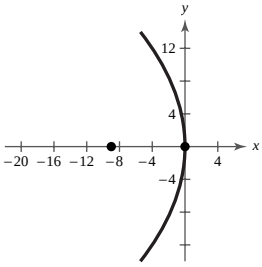
Center: $(-2, -3)$
Radius: 4

13. $\left(3 \pm \sqrt{6}, 0\right)$

15. Vertex: $(0, 0)$
Focus: $(1, 0)$
Directrix: $x = -1$



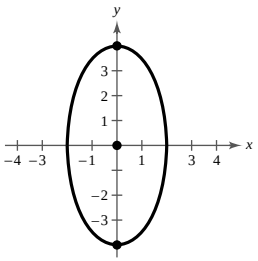
17. Vertex: $(0, 0)$
Focus: $(-9, 0)$
Directrix: $x = 9$



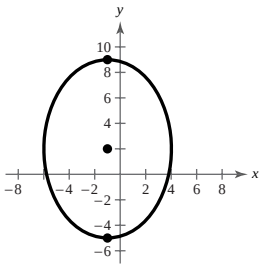
19. $y^2 = 16x$ **21.** $(x + 6)^2 = -9(y - 4)$

23. $2x + y - 2 = 0$; $(1, 0)$ **25.** $8\sqrt{6}$ m

27. Center: $(0, 0)$
Vertices: $(0, \pm 4)$
Foci: $\left(0, \pm 2\sqrt{3}\right)$
Eccentricity: $\dfrac{\sqrt{3}}{2}$



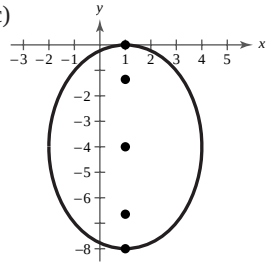
29. Center: $(-1, 2)$
Vertices: $(-1, 9), (-1, -5)$
Foci: $\left(-1, 2 \pm 2\sqrt{6}\right)$
Eccentricity: $\dfrac{2\sqrt{6}}{7}$



31. (a) $\dfrac{(x - 1)^2}{9} + \dfrac{(y + 4)^2}{16} = 1$

(b) Center: $(1, -4)$
Vertices: $(1, 0), (1, -8)$
Foci: $\left(1, -4 \pm \sqrt{7}\right)$
Eccentricity: $\dfrac{\sqrt{7}}{4}$

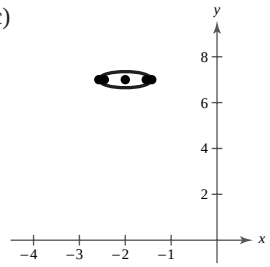
(c)



33. (a) $\dfrac{(x + 2)^2}{1/3} + \dfrac{(y - 7)^2}{1/8} = 1$

(b) Center: $(-2, 7)$
Vertices: $\left(-2 \pm \dfrac{\sqrt{3}}{3}, 7\right)$
Foci: $\left(-2 \pm \dfrac{\sqrt{30}}{12}, 7\right)$
Eccentricity: $\dfrac{\sqrt{10}}{4}$

(c)



35. $\dfrac{x^2}{25} + \dfrac{y^2}{9} = 1$ **37.** $\dfrac{(x - 2)^2}{25} + \dfrac{y^2}{21} = 1$

39. The foci should be placed 3 feet on either side of the center at the same height as the pillars.

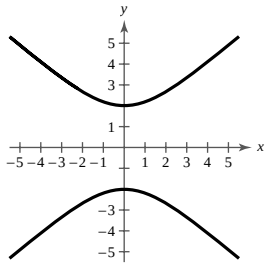
41. $e \approx 0.0543$ **43.** $\dfrac{x^2}{16} - \dfrac{y^2}{20} = 1$

45. $\dfrac{(x - 4)^2}{16/5} - \dfrac{y^2}{64/5} = 1$

47. (a) $\dfrac{y^2}{4} - \dfrac{x^2}{5} = 1$

(b) Center: $(0, 0)$
Vertices: $(0, \pm 2)$
Foci: $(0, \pm 3)$
Eccentricity: $\dfrac{3}{2}$

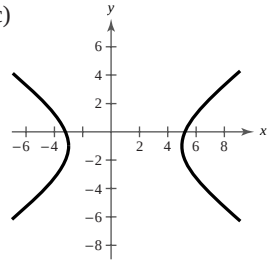
(c)



49. (a) $\dfrac{(x-1)^2}{16} - \dfrac{(y+1)^2}{9} = 1$

(b) Center: $(1, -1)$
Vertices: $(5, -1), (-3, -1)$
Foci: $(6, -1), (-4, -1)$
Eccentricity: $\dfrac{5}{4}$

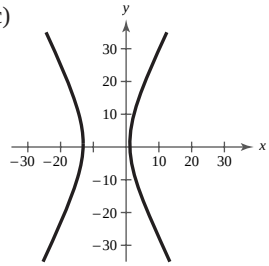
(c)



51. (a) $\dfrac{(x+6)^2}{101/2} - \dfrac{(y-1)^2}{202} = 1$

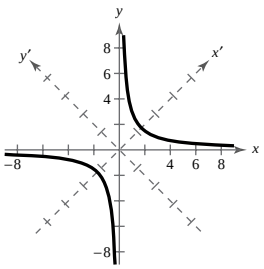
(b) Center: $(-6, 1)$
Vertices: $\left(-6 \pm \dfrac{\sqrt{202}}{2}, 1\right)$
Foci: $\left(-6 \pm \dfrac{\sqrt{1010}}{2}, 1\right)$
Eccentricity: $\sqrt{5}$

(c)

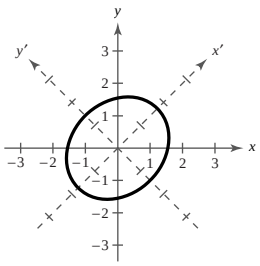


53. About 72 mi **55.** Ellipse **57.** Hyperbola

59. $\dfrac{(x')^2}{6} - \dfrac{(y')^2}{6} = 1$

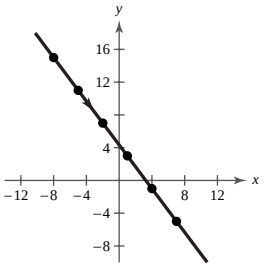


61. $\dfrac{(x')^2}{3} + \dfrac{(y')^2}{2} = 1$

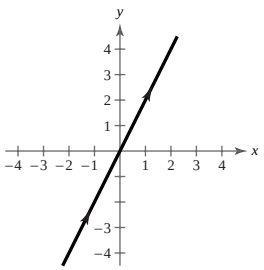


63.

t	-2	-1	0	1	2	3
x	-8	-5	-2	1	4	7
y	15	11	7	3	-1	-5

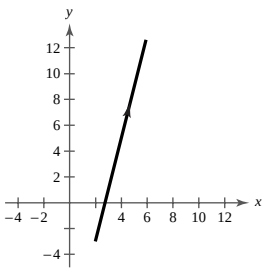


65.



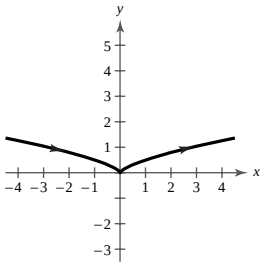
$y = 2x$

67.



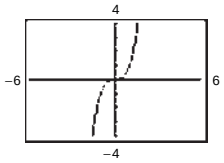
$y = 4x - 11,\ x \geq 2$

69.

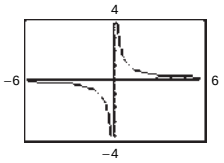


$y = \frac{1}{2}x^{2/3}$

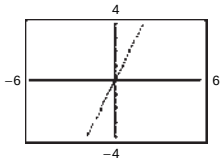
71.



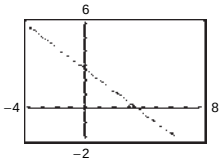
73.



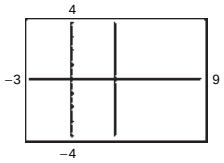
75.



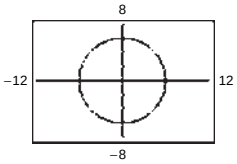
77.



79.



81.



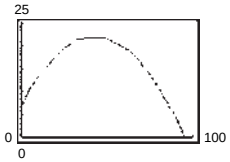
83. (a) $x = t, y = 6t + 2$ (b) $x = 1 - t, y = 8 - 6t$

85. (a) $x = t, y = t^2 + 2$ (b) $x = 1 - t, y = t^2 - 2t + 3$

87. $x = t, y = 5$ **89.** $x = -1 + 11t, y = 6 - 6t$

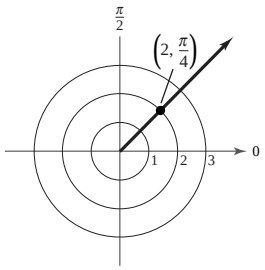
91. 54.22 ft/sec

93.



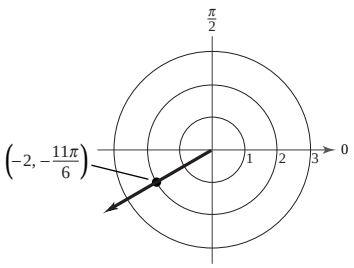
21.93 ft

95.



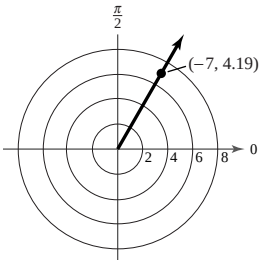
$\left(2, -\dfrac{7\pi}{4}\right), \left(-2, \dfrac{5\pi}{4}\right), \left(-2, -\dfrac{3\pi}{4}\right)$

97.



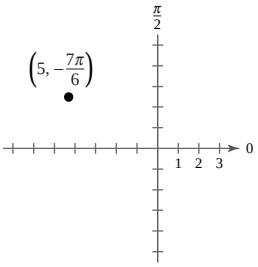
$\left(-2, \dfrac{\pi}{6}\right), \left(2, \dfrac{7\pi}{6}\right), \left(2, -\dfrac{5\pi}{6}\right)$

99.



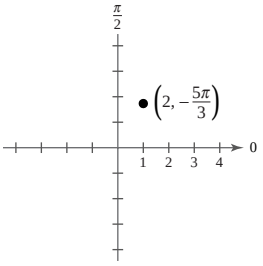
$(-7, -2.09), (7, -5.23), (7, 1.05)$

101.



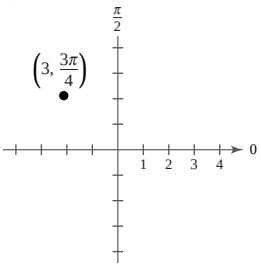
$\left(-\frac{5\sqrt{3}}{2}, \frac{5}{2}\right)$

103.



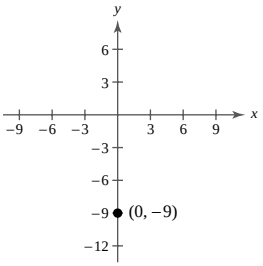
$\left(1, \sqrt{3}\right)$

105.



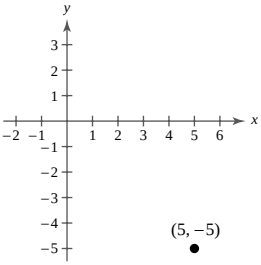
$\left(-\frac{3\sqrt{2}}{2}, \frac{3\sqrt{2}}{2}\right)$

107.



$\left(-9, \frac{\pi}{2}\right), \left(9, \frac{3\pi}{2}\right)$

109.



$\left(-5\sqrt{2}, \frac{3\pi}{4}\right), \left(5\sqrt{2}, \frac{7\pi}{4}\right)$

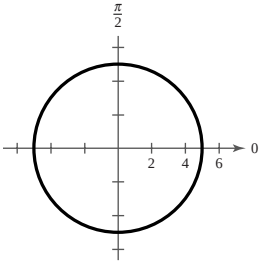
111. $r = 9$ **113.** $r = 4\cos\theta$ **115.** $r^2 = 5\sec\theta\csc\theta$

117. $r^2 = \dfrac{1}{1 + 3\cos^2\theta}$ **119.** $x^2 + y^2 = 25$

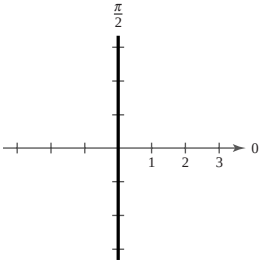
121. $x^2 + y^2 = 3x$ **123.** $(x^2 + y^2)^2 - x^2 + y^2 = 0$

125. $y = -\dfrac{\sqrt{3}}{3}x$

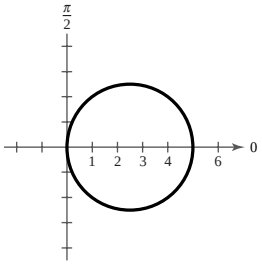
127.



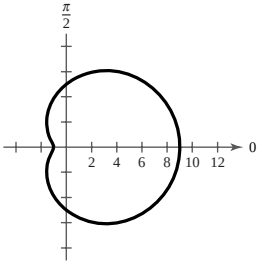
129.



131.



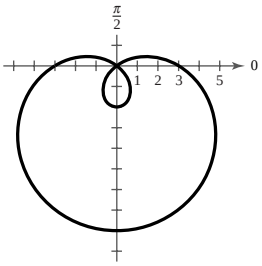
133. Dimpled limaçon



Symmetry: Polar axis

Zeros of r: None

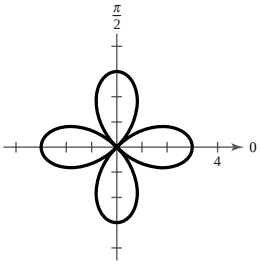
135. Limaçon with inner loop



Symmetry: $\theta = \dfrac{\pi}{2}$

Zeros of r: $\theta \approx 0.64, 2.50$

137. Rose curve

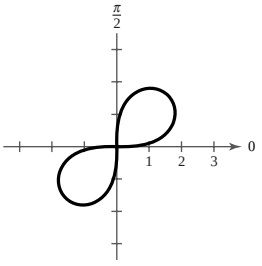


Symmetry:

Pole, polar axis, $\theta = \dfrac{\pi}{2}$

Zeros of r: $\theta = \dfrac{\pi}{4}, \dfrac{3\pi}{4}, \dfrac{5\pi}{4}, \dfrac{7\pi}{4}$

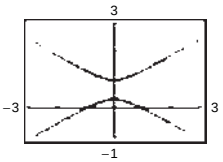
139. Lemniscate



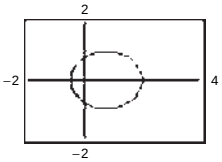
Symmetry: Pole

Zeros of r: $\theta = 0, \dfrac{\pi}{2}$

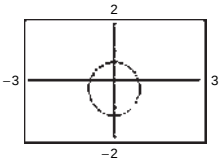
141. Hyperbola



143. Ellipse



145. Ellipse



147. $r = \dfrac{4}{1 - \cos\theta}$ **149.** $r = \dfrac{5}{3 - 2\cos\theta}$

151. $r = \dfrac{1.512}{1 - 0.093\cos\theta}$

Perihelion: 1.383 astronomical units

Aphelion: 1.667 astronomical units

153. False. The equation of a hyperbola is a second-degree equation.

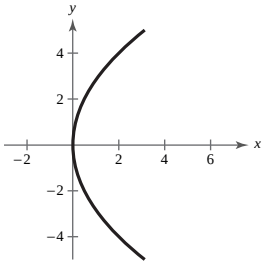
CHAPTER 9

155. (a) Vertical translation (b) Horizontal translation
(c) Reflection in the y-axis (d) Vertical shrink

157. The orientation would be reversed.

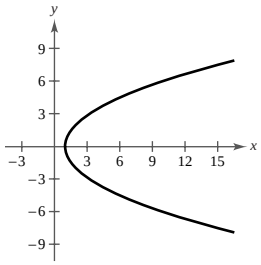
Chapter Test (page 704)

1.



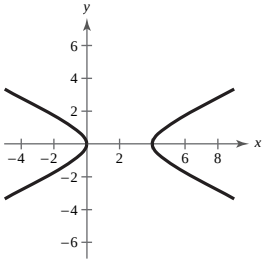
Vertex: $(0, 0)$
Focus: $(2, 0)$

2.



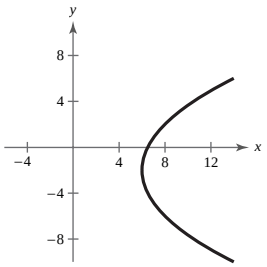
Vertex: $(1, 0)$
Focus: $(2, 0)$

3.



Vertices: $(0, 0), (4, 0)$
Foci: $\left(2 \pm \sqrt{5}, 0\right)$

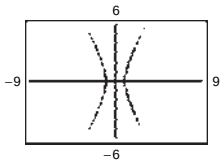
4. $(y + 2)^2 = 8(x - 6)$



5. $\dfrac{(x + 6)^2}{16} + \dfrac{(y - 3)^2}{49} = 1$

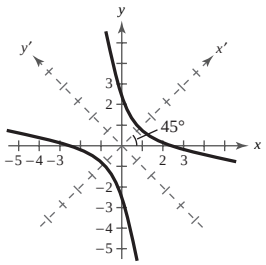
6. $\dfrac{y^2}{9} - \dfrac{x^2}{4} = 1$

7.

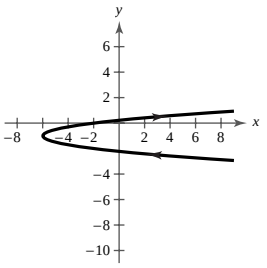


Answers will vary.

8. (a) $45°$
(b)

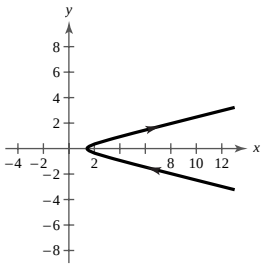


9.



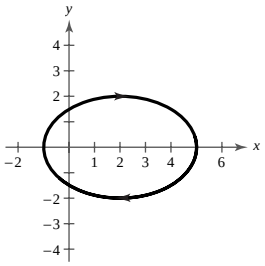
$(y + 1)^2 = \frac{1}{4}(x + 6)$

10.



$\dfrac{x^2}{2} - \dfrac{y^2}{1/8} = 1,\ x \geq \sqrt{2}$

11.



$\dfrac{(x - 2)^2}{9} + \dfrac{y^2}{4} = 1$

12. (a) $x = t, y = 7 - 4t$ (b) $x = 2 - t, y = 4t - 1$

13. (a) $x = t, y = \dfrac{3}{t}$ (b) $x = 2 - t, y = \dfrac{3}{2 - t}$

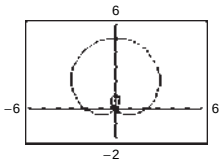
14. (a) $x = t, y = t^2 + 10$ (b) $x = t - 2, y = t^2 - 4t + 14$

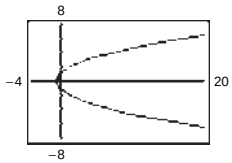
15. $\left(\sqrt{3}, -1\right)$

16. Sample answer: $\left(2\sqrt{2}, \dfrac{7\pi}{4}\right); \left(2\sqrt{2}, -\dfrac{\pi}{4}\right), \left(-2\sqrt{2}, \dfrac{3\pi}{4}\right)$

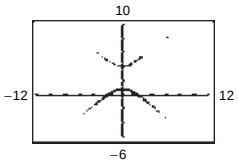
17. $r = 3 \cos \theta$ **18.** $x^2 + (y - 1)^2 = 1$

19. Limaçon with inner loop **20.** Parabola





21. Hyperbola



22. $r = \dfrac{4}{4 + \sin \theta}$ **23.** $r = \dfrac{10}{4 + 5 \sin \theta}$

24. Maximum: $|r| = 8$

Zeros of r: $\theta = \dfrac{\pi}{6}, \dfrac{\pi}{2}, \dfrac{5\pi}{6}$

Cumulative Test for Chapters 7–9 (page 705)

1. $(4, -3)$ **2.** $(8, 4), (2, -2)$

3. $\left(\frac{3}{5}, -4, -\frac{1}{5}\right)$ **4.** $(1, -4, -4)$

5. $\begin{bmatrix} -7 & -10 & -16 \\ -6 & 18 & 9 \\ -12 & 16 & 7 \end{bmatrix}$ **6.** $\begin{bmatrix} -18 & 15 & -14 \\ 28 & 11 & 34 \\ -20 & 52 & -1 \end{bmatrix}$

7. $\begin{bmatrix} 3 & -31 & 2 \\ 22 & 18 & 6 \\ 52 & -40 & 14 \end{bmatrix}$ **8.** $\begin{bmatrix} 5 & 36 & 31 \\ -36 & 12 & -36 \\ 16 & 0 & 18 \end{bmatrix}$

9. (a) $\begin{bmatrix} -175 & 37 & -13 \\ 95 & -20 & 7 \\ 14 & -3 & 1 \end{bmatrix}$ (b) 1

10. 22 **11.** (a) $\frac{1}{5}, -\frac{1}{7}, \frac{1}{9}, -\frac{1}{11}, \frac{1}{13}$ (b) 3, 6, 12, 24, 48

12. 135 **13.** $\frac{47}{52}$ **14.** 34.48 **15.** 66.67 **16.** $\frac{15}{8}$

17. $-\frac{5}{51}$ **18.** $\frac{8}{3}$ **19.** (a) 190 (b) 190

20. $x^4 + 12x^3 + 54x^2 + 108x + 81$

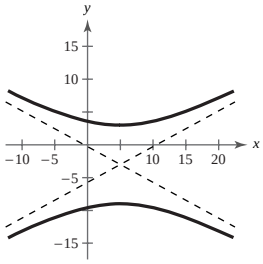
21. $32x^5 + 80x^4y^2 + 80x^3y^4 + 40x^2y^6 + 10xy^8 + y^{10}$

22. $x^6 - 12x^5y + 60x^4y^2 - 160x^3y^3 + 240x^2y^4 - 192xy^5 + 64y^6$

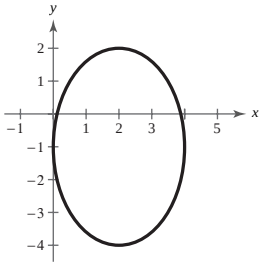
23. $6561a^8 - 69{,}984a^7b + 326{,}592a^6b^2 - 870{,}912a^5b^3 + 1{,}451{,}520a^4b^4 - 1{,}548{,}288a^3b^5 + 1{,}032{,}192a^2b^6 - 393{,}216ab^7 + 65{,}536b^8$

24. 120 **25.** 420 **26.** 302,400 **27.** 15,120

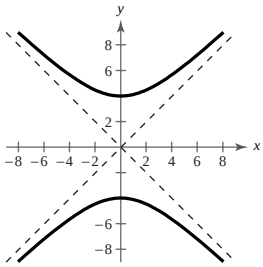
28. Hyperbola



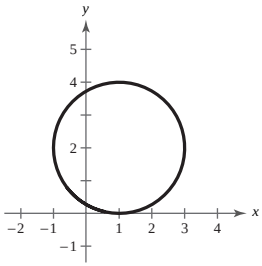
29. Ellipse



30. Hyperbola



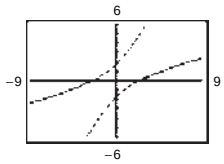
31. Circle



32. $(x - 2)^2 = -\frac{4}{3}(y - 3)$

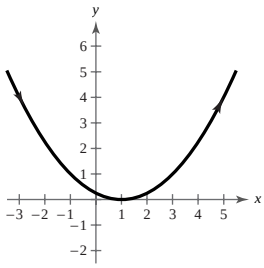
33. $\dfrac{(x-1)^2}{25} + \dfrac{(y-4)^2}{4} = 1$ **34.** $\dfrac{(y+4)^2}{4} - \dfrac{x^2}{16/3} = 1$

35.



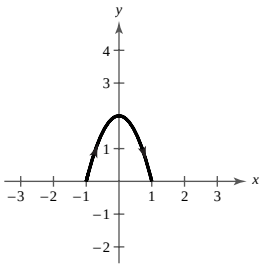
$\theta \approx 37.98°$

36. (a) and (b)



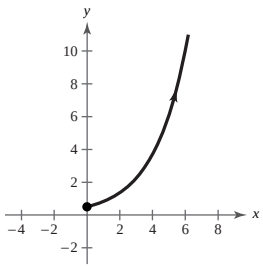
(c) $y = \dfrac{x^2 - 2x + 1}{4}$

37. (a) and (b)



(c) $y = 2 - 2x^2$, $-1 \le x \le 1$

38. (a) and (b)



(c) $y = 0.5e^{0.5x}$, $x \ge 0$

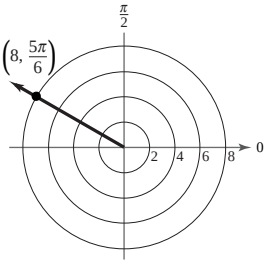
39. (a) $x = t, y = 3t - 2$ (b) $x = 2t, y = 6t - 2$

40. (a) $x = t, y = t^2 - 16$ (b) $x = 2t, y = 4t^2 - 16$

41. (a) $x = t, y = \dfrac{2}{t}$ (b) $x = 2t, y = \dfrac{1}{t}$

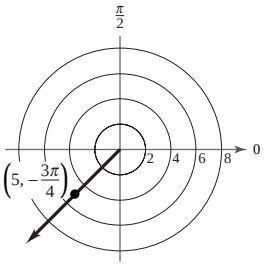
42. (a) $x = t, y = \dfrac{e^{2t}}{e^{2t} + 1}$ (b) $x = 2t, y = \dfrac{e^{4t}}{e^{4t} + 1}$

43.



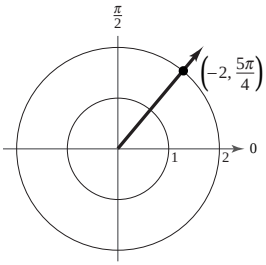
$\left(8, -\frac{7\pi}{6}\right), \left(-8, -\frac{\pi}{6}\right), \left(-8, \frac{11\pi}{6}\right)$

44.



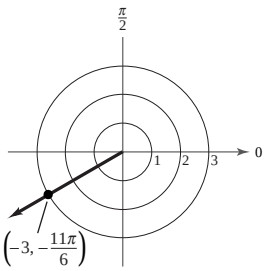
$\left(5, \frac{5\pi}{4}\right), \left(-5, -\frac{7\pi}{4}\right), \left(-5, \frac{\pi}{4}\right)$

45.



$\left(-2, -\frac{3\pi}{4}\right), \left(2, -\frac{7\pi}{4}\right), \left(2, \frac{\pi}{4}\right)$

46.

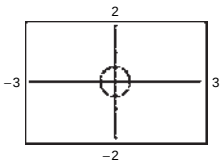


$\left(-3, \frac{\pi}{6}\right), \left(3, -\frac{5\pi}{6}\right), \left(3, \frac{7\pi}{6}\right)$

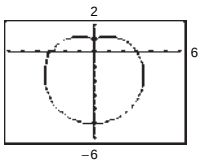
47. $r = -\dfrac{1}{4\sin\theta + 4\cos\theta}$ **48.** $(x - 2)^2 + y^2 = 4$

49. $\dfrac{\left(x + \frac{10}{9}\right)^2}{\frac{64}{81}} - \dfrac{y^2}{\frac{4}{9}} = 1$

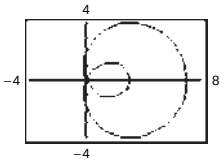
50. Circle



51. Dimpled limaçon



52. Limaçon with inner loop



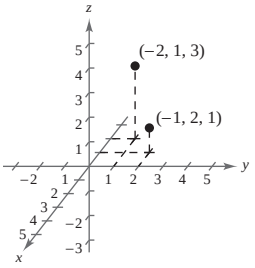
53. \$701,303.32 **54.** $\frac{1}{4}$

55. $24\sqrt{2}$ m

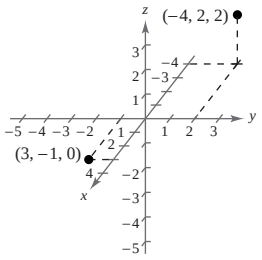
Chapter 10

Section 10.1 (page 716)

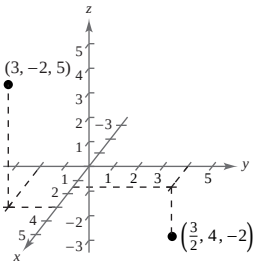
1. three-dimensional **3.** Distance Formula
5. surface, space
7. A sphere with center (h, k, j) and radius r
9. $A(-1, 4, 3)$, $B(1, 3, -2)$, $C(-3, 0, -2)$
11. $A(-2, -1, 4)$, $B(3, -2, 0)$, $C(-2, 2, -3)$
13.



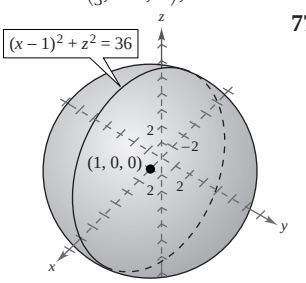
15.



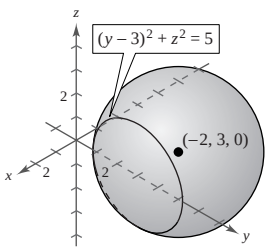
17.



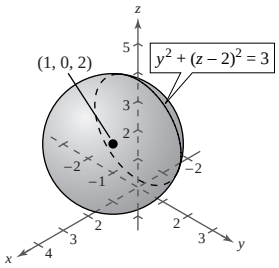
19. $(-3, 3, 5)$ **21.** $(11, 0, 0)$ **23.** Octant V
25. Octants I, II, III, and IV **27.** Octants II, IV, VI, and VIII
29. $3\sqrt{21}$ units **31.** $\sqrt{65}$ units
33. $\sqrt{114}$ units **35.** $\sqrt{105}$ units **37.** $2\sqrt{5}$, 3, $\sqrt{29}$
39. 3, 6, $3\sqrt{5}$ **41.** 6, 6, $2\sqrt{10}$; isosceles triangle
43. 6, 6, $2\sqrt{10}$; isosceles triangle
45. $(0, -1, 7)$ **47.** $(1, 0, 6)$ **49.** $\left(\frac{5}{2}, 2, 6\right)$
51. $(x - 3)^2 + (y - 2)^2 + (z - 4)^2 = 16$
53. $(x + 1)^2 + (y - 2)^2 + z^2 = 3$
55. $x^2 + (y - 4)^2 + (z - 3)^2 = 16$
57. $(x + 3)^2 + (y - 7)^2 + (z - 5)^2 = 25$
59. $\left(x - \frac{3}{2}\right)^2 + y^2 + (z - 3)^2 = \frac{45}{4}$
61. Center: $(3, 0, 0)$; radius: 3
63. Center: $(2, -1, 0)$; radius: $\sqrt{5}$
65. Center: $(2, -1, 3)$; radius: 2
67. Center: $(-2, 0, 4)$; radius: 1
69. Center: $\left(1, \frac{1}{3}, 4\right)$; radius: 3
71. Center: $(1, -2, 0)$; radius: $\frac{\sqrt{21}}{2}$
73. Center: $\left(\frac{1}{3}, -1, 0\right)$; radius: 1
75.



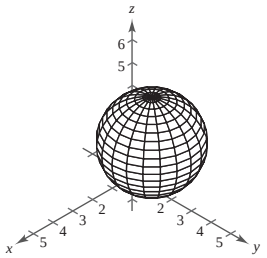
77.



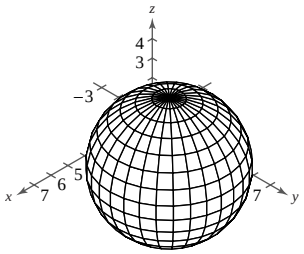
79.



81.



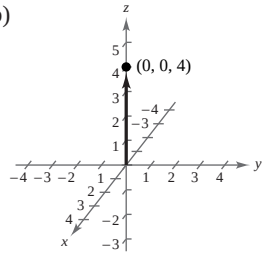
83.



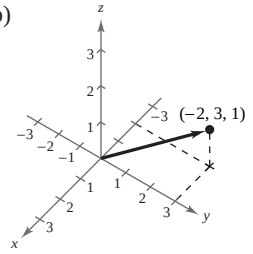
85. $(3, 3, 3)$ **87.** $x^2 + y^2 + z^2 = \frac{205^2}{4}$
89. False. z is the directed distance from the xy-plane to P.
91. 0; 0; 0 **93.** $(x_2, y_2, z_2) = (2x_m - x_1, 2y_m - y_1, 2z_m - z_1)$
95. $v = -\frac{3 \pm \sqrt{17}}{2}$ **97.** $x = \frac{5 \pm \sqrt{5}}{2}$ **99.** $y = -\frac{1 \pm \sqrt{10}}{2}$

Section 10.2 (page 724)

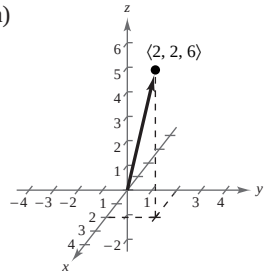
1. zero **3.** parallel **5.** $\|\mathbf{v}\| = \sqrt{v_1^2 + v_2^2 + v_3^2}$
7. (a) $\langle 0, 0, 4 \rangle$ (b)



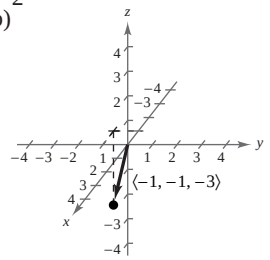
9. (a) $\langle -2, 3, 1 \rangle$ (b)



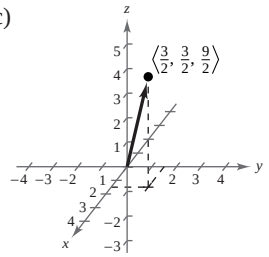
11. (a) $\langle 7, -5, 5 \rangle$ (b) $3\sqrt{11}$ (c) $\frac{\sqrt{11}}{33}\langle 7, -5, 5 \rangle$
13. (a) $\langle 2, 2, 0 \rangle$ (b) $2\sqrt{2}$ (c) $\frac{\sqrt{2}}{2}\langle 1, 1, 0 \rangle$
15. (a)



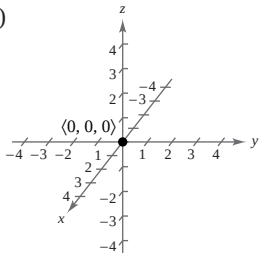
(b)

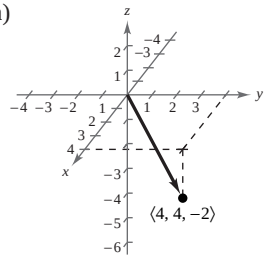


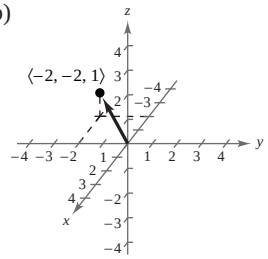
(c)

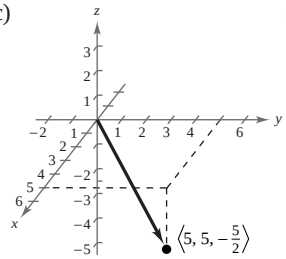


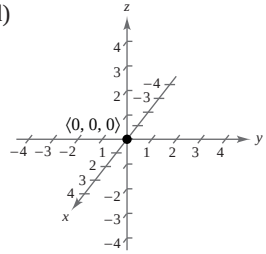
(d)



17. (a) 

(b) 

(c) 

(d) 

19. $\mathbf{z} = \langle -3, 7, 6 \rangle$ **21.** $\mathbf{z} = \left\langle \frac{1}{2}, 6, \frac{3}{2} \right\rangle$
23. $\mathbf{z} = \left\langle -\frac{5}{2}, 12, \frac{15}{2} \right\rangle$ **25.** $9\sqrt{2}$ **27.** $\sqrt{21}$
29. $\sqrt{21}$ **31.** $\sqrt{34}$
33. (a) $\frac{1}{13}(5\mathbf{i} - 12\mathbf{k})$ (b) $-\frac{1}{13}(5\mathbf{i} - 12\mathbf{k})$
35. (a) $\frac{\sqrt{74}}{74}(8\mathbf{i} + 3\mathbf{j} - \mathbf{k})$ (b) $-\frac{\sqrt{74}}{74}(8\mathbf{i} + 3\mathbf{j} - \mathbf{k})$
37. $\langle -26, 0, 48 \rangle$ **39.** 8.73 **41.** -4 **43.** 0
45. 124.45° **47.** 109.92° **49.** Parallel **51.** Neither
53. Orthogonal **55.** Not collinear **57.** Collinear
59. Right triangle. Answers will vary.
61. Acute triangle. Answers will vary.
63. (3, 1, 7) **65.** $\left(6, \frac{5}{2}, -\frac{7}{4}\right)$ **67.** $\pm\frac{3\sqrt{14}}{14}$
69. $\left\langle 0, 2\sqrt{2}, 2\sqrt{2} \right\rangle$ or $\left\langle 0, 2\sqrt{2}, -2\sqrt{2} \right\rangle$
71. 3.64 lb **73.** True. $\cos^{-1} 0 = 90°$
75. Sphere of radius 4 centered at (x_1, y_1, z_1)

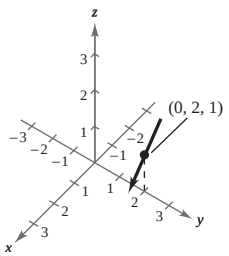
Section 10.3 (page 731)

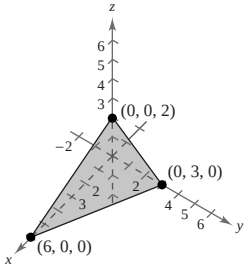
1. cross product **3.** $\|\mathbf{u}\| \|\mathbf{v}\| \sin\theta$ **5.** $\langle -1, 0, 2 \rangle$
7. $\langle 1, 1, 1 \rangle$ **9.** $\langle 3, -3, -3 \rangle$ **11.** $\langle 0, 42, 0 \rangle$
13. $-7\mathbf{i} + 13\mathbf{j} + 16\mathbf{k}$ **15.** $-17\mathbf{i} + \mathbf{j} + 10\mathbf{k}$
17. $-\frac{7}{6}\mathbf{i} - \frac{7}{8}\mathbf{j}$ **19.** $-18\mathbf{i} - 6\mathbf{j}$ **21.** $-\mathbf{i} - 2\mathbf{j} - \mathbf{k}$
23. $\langle 10, -2, -4 \rangle$ **25.** $-6\mathbf{i} - 15\mathbf{j} - 6\mathbf{k}$
27. $-\frac{1}{4}\mathbf{i} - \frac{7}{10}\mathbf{j} - 2\mathbf{k}$ **29.** $\frac{1}{3}\mathbf{i} - \frac{2}{3}\mathbf{j} - \frac{2}{3}\mathbf{k}$
31. $\frac{\sqrt{19}}{19}(\mathbf{i} - 3\mathbf{j} + 3\mathbf{k})$ **33.** $\frac{\sqrt{7602}}{7602}(-71\mathbf{i} - 44\mathbf{j} + 25\mathbf{k})$
35. $\frac{\sqrt{2}}{2}(\mathbf{i} - \mathbf{j})$ **37.** 1 **39.** $\sqrt{806}$ **41.** 56
43. (a) Answers will vary. (b) $6\sqrt{10}$
(c) The parallelogram is not a rectangle.
45. $\frac{3\sqrt{13}}{2}$ **47.** $\frac{1}{2}\sqrt{4290}$ **49.** -16
51. 2 **53.** 2 **55.** 12 **57.** 84
59. (a) $T(p) = \frac{p}{2}\cos 40°$
(b)

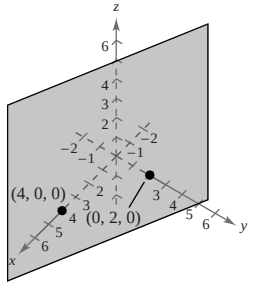
p	15	20	25	30	35	40	45
T	5.75	7.66	9.58	11.49	13.41	15.32	17.24

61. True. The cross product is defined only for three-dimensional vectors.
63. Proof **65.** Proof **67.** $-\frac{1}{2}$

Section 10.4 (page 740)

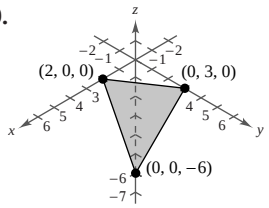
1. direction **3.** perpendicular **5.** yz-plane
7. (a) $x = t,\ y = 2t,\ z = 3t$ (b) $x = \frac{y}{2} = \frac{z}{3}$
9. (a) $x = -4 + 3t,\ y = 1 + 8t,\ z = -6t$
(b) $\frac{x+4}{3} = \frac{y-1}{8} = \frac{z}{-6}$
11. (a) $x = 2 + 2t,\ y = -3 - 3t,\ z = 5 + t$
(b) $\frac{x-2}{2} = \frac{y+3}{-3} = z - 5$
13. (a) $x = 2 - t,\ y = 4t,\ z = 2 - 5t$
(b) $\frac{x-2}{-1} = \frac{y}{4} = \frac{z-2}{-5}$
15. (a) $x = -3 + 4t,\ y = 8 - 10t,\ z = 15 + t$
(b) $\frac{x+3}{4} = \frac{y-8}{-10} = z - 15$
17. (a) $x = 3 - 4t, y = 1, z = 2 + 3t$ (b) Not possible
19. (a) $x = -\frac{1}{2} + 3t, y = 2 - 5t, z = \frac{1}{2} - t$
(b) $\frac{x+\frac{1}{2}}{3} = \frac{y-2}{-5} = \frac{z-\frac{1}{2}}{-1}$
21. 

23. $x - 2 = 0$ **25.** $-2x + y - 2z + 10 = 0$
27. $-x - 2y + z + 2 = 0$ **29.** $-3x - 9y + 7z = 0$
31. $6x - 2y - z - 8 = 0$ **33.** $y - 5 = 0$
35. $y - z + 2 = 0$ **37.** $7x + y - 11z - 5 = 0$
39. $x = 2, y = 3, z = 4 + t$
41. $x = 2 + 3t, y = 3 + 2t, z = 4 - t$
43. $x = 5 + 2t, y = -3 - t, z = -4 + 3t$
45. $x = 2 - t, y = 1 + t, z = 2 + t$
47. Orthogonal **49.** Orthogonal
51. (a) 60.67° (b) $x = 2 - t,\ y = 8t,\ z = 7t$
53. (a) 77.83° (b) $x = 1 + 6t,\ y = t,\ z = 1 + 7t$
55. 

57. 

CHAPTER 10

59.



61. $\frac{8}{9}$ **63.** $\frac{2\sqrt{6}}{3}$ **65.** 88.45°

67. False. Lines that do not intersect and are not in the same plane may not be parallel.

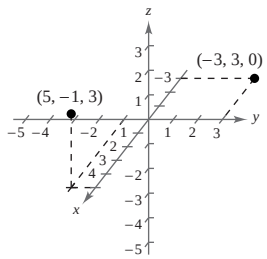
69. The point and the vector are reversed. The correct answer should be:

$$\frac{x-1}{3} = \frac{y-2}{5} = \frac{z-6}{4}$$

71. Parallel. $\langle 10, -18, 20\rangle$ is a scalar multiple of $\langle -15, 27, -30\rangle$.

Review Exercises (page 744)

1.



3. $(-5, 3, 0)$ **5.** $\sqrt{30}$ **7.** $\sqrt{29}, \sqrt{38}, \sqrt{67}$

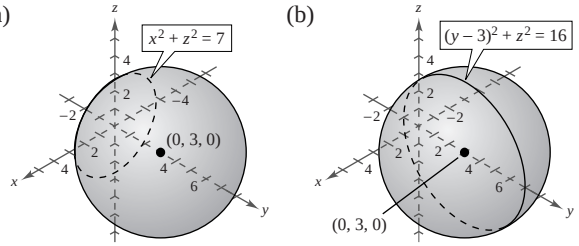
9. $(0, -1, -1)$ **11.** $(1, 1, -9)$

13. $(x-2)^2 + (y-3)^2 + (z-5)^2 = 1$

15. $(x-1)^2 + (y-5)^2 + (z-2)^2 = 36$

17. Center: $(2, 3, 0)$; radius: 3

19. (a) (b)



21. (a) $\langle 1, 4, -3\rangle$ (b) $\sqrt{26}$ (c) $\frac{\sqrt{26}}{26}\langle 1, 4, -3\rangle$

23. (a) $\langle -10, 6, 7\rangle$ (b) $\sqrt{185}$ (c) $\frac{\sqrt{185}}{185}\langle -10, 6, 7\rangle$

25. -9 **27.** 1 **29.** 90° **31.** 90° **33.** Orthogonal

35. Orthogonal **37.** Not collinear **39.** Collinear

41. *A*: 159.10 lb of tension
B: 115.58 lb of tension
C: 115.58 lb of tension

43. $\langle -10, 0, -10\rangle$

45. $\frac{\sqrt{7602}}{7602}(-71\mathbf{i} - 44\mathbf{j} + 25\mathbf{k})$

47. (a) Answers will vary. (b) $2\sqrt{43}$
(c) The parallelogram is not a rectangle.

49. 75

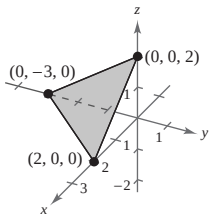
51. (a) $x = 3 + 6t, y = 11t, z = 2 + 4t$
(b) $\frac{x-3}{6} = \frac{y}{11} = \frac{z-2}{4}$

53. (a) $x = -1 + 4t, y = 3 + 3t, z = 5 - 6t$
(b) $\frac{x+1}{4} = \frac{y-3}{3} = \frac{z-5}{-6}$

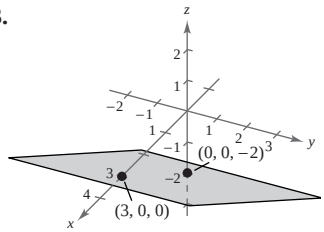
55. (a) $x = -2t, y = \frac{5}{2}t, z = t$ (b) $\frac{x}{-2} = \frac{y}{5/2} = z$

57. $-2x - 12y + 5z = 0$ **59.** $z - 2 = 0$

61.



63.



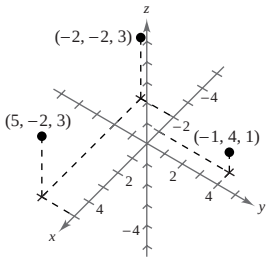
65. $\frac{\sqrt{110}}{110}$ **67.** $\frac{\sqrt{110}}{55}$

69. False. $\mathbf{u} \times \mathbf{v} = -(\mathbf{v} \times \mathbf{u})$ **71 and 73.** Answers will vary.

75. $\mathbf{u} \times \mathbf{v} = (u_2v_3 - u_3v_2)\mathbf{i} - (u_1v_3 - u_3v_1)\mathbf{j} + (u_1v_2 - u_2v_1)\mathbf{k}$

Chapter Test (page 746)

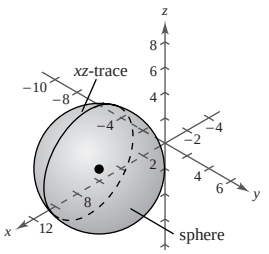
1.



2. No. Answers will vary.

3. (7, 1, 2)

4. $(x-7)^2 + (y-1)^2 + (z-2)^2 = 19$



5. $\langle 2, 5, -10\rangle$; $\sqrt{129}$ **6.** $\langle -3, -5, 8\rangle$; $7\sqrt{2}$

7. $\mathbf{u} = \langle -2, 6, -6\rangle$, $\mathbf{v} = \langle -12, 5, -5\rangle$

8. (a) $\sqrt{194}$ (b) 84 (c) $\langle 0, 62, 62\rangle$ **9.** 46.23°

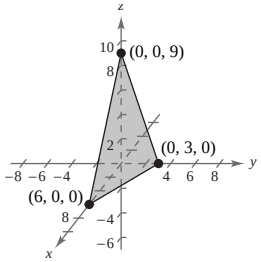
10. Answers will vary. Sample answer:
(a) $x = 8 - 2t, y = -2 + 6t, z = 5 - 6t$
(b) $\frac{x-8}{-2} = \frac{y+2}{6} = \frac{z-5}{-6}$

11. Neither **12.** Orthogonal

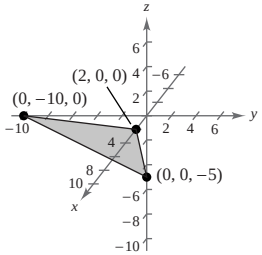
13. Answers will vary; $2\sqrt{230}$

14. $27x + 4y + 32z + 33 = 0$ **15.** 200

16.



17.



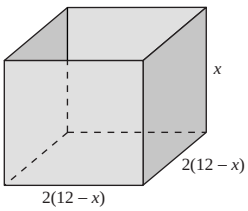
18. $\frac{4\sqrt{14}}{7}$

Chapter 11

Section 11.1 (page 757)

1. limit **3.** 3

5. (a)



(b) Answers will vary.

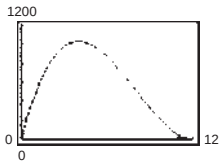
(c)

x	3	3.5	3.9	4
V	972	1011.5	1023.5	1024

x	4.1	4.5	5
V	1023.5	1012.5	980

$\lim_{x \to 4} V = 1024$

(d)



7.

x	1.9	1.99	1.999	2
$f(x)$	13.5	13.95	13.995	14

x	2.001	2.01	2.1
$f(x)$	14.005	14.05	14.5

14; Yes

9.

x	-1.1	-1.01	-1.001	-1
$f(x)$	-0.3226	-0.3322	-0.3332	Error

x	-0.999	-0.99	-0.9
$f(x)$	-0.3334	-0.3344	-0.3448

-0.3333; No

11.

x	-0.1	-0.01	-0.001	0
$f(x)$	0.5017	0.50002	0.5000002	Error

x	0.001	0.01	0.1
$f(x)$	0.5000002	0.50002	0.5017

0.5; No

13.

x	-1.1	-1.01	-1.001	-1
$f(x)$	-2.1	-2.01	-2.001	Error

x	-0.999	-0.99	-0.9
$f(x)$	-1.999	-1.99	-1.9

-2

15.

x	0.9	0.99	0.999	1
$f(x)$	0.2564	0.2506	0.2501	Error

x	1.001	1.01	1.1
$f(x)$	0.2499	0.2494	0.2439

0.25

17.

x	-0.1	-0.01	-0.001	0
$f(x)$	0.2247	0.2237	0.2236	Error

x	0.001	0.01	0.1
$f(x)$	0.2236	0.2235	0.2225

0.2236

19.

x	-4.1	-4.01	-4.001	-4
$f(x)$	0.4762	0.4975	0.4998	Error

x	-3.999	-3.99	-3.9
$f(x)$	0.5003	0.5025	0.5263

0.5

21.

x	-0.1	-0.01	-0.001	0
$f(x)$	0.9983	0.99998	0.9999998	Error

x	0.001	0.01	0.1
$f(x)$	0.9999998	0.99998	0.9983

1

23.

x	-0.1	-0.01	-0.001	0
$f(x)$	-0.0997	-0.0100	-0.0010	Error

x	0.001	0.01	0.1
$f(x)$	0.0010	0.0100	0.0997

0

25.

x	-0.1	-0.01	-0.001	0
$f(x)$	0.9063	0.9901	0.9990	Error

x	0.001	0.01	0.1
$f(x)$	1.0010	1.0101	1.1070

1

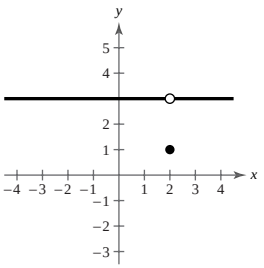
27.

x	1.9	1.99	1.999	2
$f(x)$	2.2314	2.0203	2.002	Error

x	2.001	2.01	2.1
$f(x)$	1.998	1.9803	1.8232

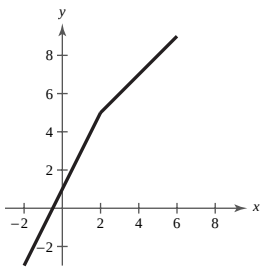
2

29.



$\lim_{x\to 2} f(x) = 3$

31.



$\lim_{x\to 2} f(x) = 5$

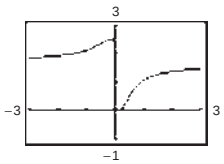
33. 2

35. Limit does not exist; One-sided limits do not agree.

37. Limit does not exist; One-sided limits do not agree.

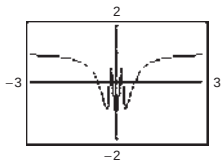
39. Limit does not exist; Function oscillates between -2 and 2.

41.



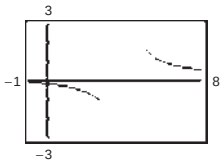
No

43.



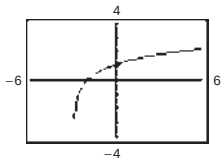
No

45.



No

47.



Yes

49. (a) -16 (b) 12 (c) $\frac{1}{2}$ (d) 2

51. (a) 8 (b) $\frac{3}{8}$ (c) 3 (d) $-\frac{61}{8}$

53. -15 **55.** 7 **57.** $-\frac{9}{10}$ **59.** $\frac{7}{13}$ **61.** 1

63. e^3 **65.** 0 **67.** $\frac{\pi}{6}$

69. True. See Condition 1 on page 754.

71. (a) and (b) Answers will vary.

73. (a) No. The function may approach different values from the right and left of 4.

(b) No. The function may approach 4 as x approaches 2, but the function could be undefined at $x = 2$.

75. $-\frac{1}{3}$, $x \neq 5$

77. $\frac{5x+4}{5x+2}$, $x \neq \frac{1}{3}$ **79.** $\frac{x^2-3x+9}{x-2}$, $x \neq -3$

Section 11.2 (page 767)

1. dividing out technique **3.** Rationalizing technique

5. (a) 1 (b) 3 (c) 5

$g_2(x) = -2x + 1$

7. (a) 2 (b) 0 (c) 0

$g_2(x) = x(x + 1)$

9. $\frac{1}{12}$ **11.** 3 **13.** 4 **15.** 12 **17.** 80 **19.** $\frac{7}{2}$

21. $\frac{1}{3}$ **23.** $\frac{\sqrt{5}}{10}$ **25.** $\frac{1}{4}$ **27.** -1 **29.** $-\frac{1}{16}$

31. 0 **33.** 0 **35.** 0

37.

x	-0.1	-0.01	-0.001	0
$f(x)$	1.813	1.980	1.998	Error

x	0.001	0.01	0.1
$f(x)$	2.002	2.020	2.214

2.000

39.

x	-0.1	-0.01	-0.001	0
$f(x)$	1.056	1.005	1.001	Error

x	0.001	0.01	0.1
$f(x)$	0.9995	0.995	0.954

1.000

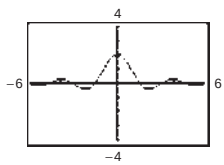
41.

x	-0.1	-0.01	-0.001	0
$f(x)$	0.149	0.137	0.135	Error

x	0.001	0.01	0.1
$f(x)$	0.135	0.134	0.122

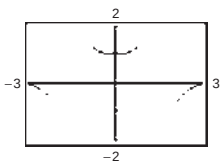
0.135

43.



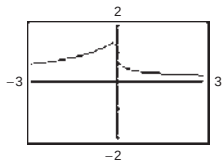
2.000

45.



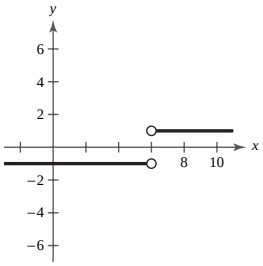
1.000

47.



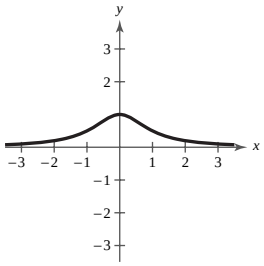
0.333

49.



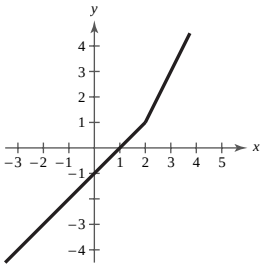
Limit does not exist.

51.



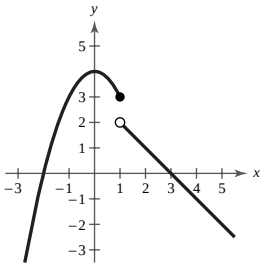
$\lim_{x\to 1} f(x) = \frac{1}{2}$

53.



$\lim_{x\to 2} f(x) = 1$

55.

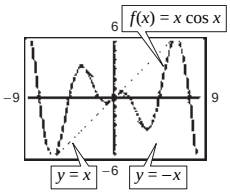


Limit does not exist.

57. (a) and (b) 0.50 (c) $\frac{1}{2}$

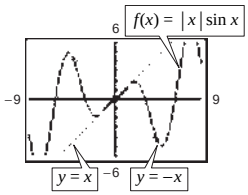
59. (a) and (b) -0.13 (c) $-\frac{1}{8}$

61.



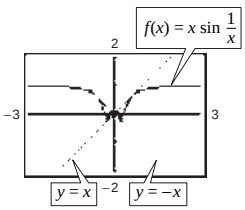
$\lim_{x\to 0} f(x) = 0$

63.



$\lim_{x\to 0} f(x) = 0$

65.

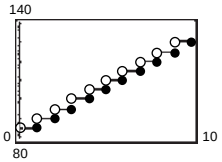


$\lim_{x\to 0} f(x) = 0$

67. (a) Direct substitution; 0 (b) 1

69. -32 ft/sec **71.** Answers will vary.

73. (a)



(b)

x	5	5.3	5.4	5.5	5.6	5.7	6
$C(x)$	105	110	110	110	110	110	110

$\lim_{x\to 5.5} C(x) = 110$

(c)

x	4	4.5	4.9	5	5.1	5.5	6
$C(x)$	100	105	105	105	110	110	110

The limit does not exist.

75. 3 **77.** $\frac{1}{2\sqrt{x}}$ **79.** $2x - 3$ **81.** $-\frac{1}{(x+2)^2}$

83. True. See page 761. **85–87.** Answers will vary.

89. Parabola **91.** Hyperbola

93. Orthogonal **95.** Neither

Section 11.3 (page 777)

1. Calculus **3.** secant line

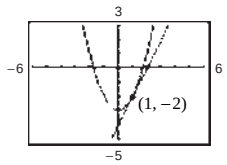
5. 2 **7.** 0 **9.** $\frac{1}{2}$ **11.** 2 **13.** -2

15. -1 **17.** $\frac{1}{6}$ **19.** $m = -2x$; (a) 0 (b) 4

21. $m = -\frac{1}{(x+4)^2}$; (a) $-\frac{1}{16}$ (b) $-\frac{1}{4}$

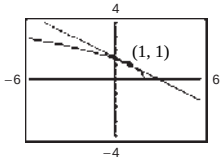
23. $m = \frac{1}{2\sqrt{x-1}}$; (a) $\frac{1}{2}$ (b) $\frac{1}{6}$

25.



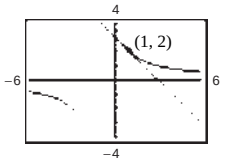
2

27.



$-\frac{1}{2}$

29.



-1

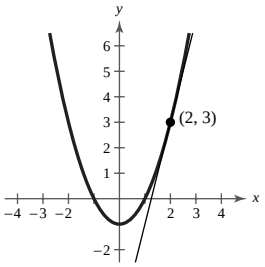
31. $-6x$ **33.** 0 **35.** $-\frac{1}{3}$

37. $-\frac{2}{x^3}$ **39.** $\frac{1}{2\sqrt{x-4}}$ **41.** $-\frac{1}{2(x-9)^{3/2}}$

43. (a) 4

(b) $y = 4x - 5$

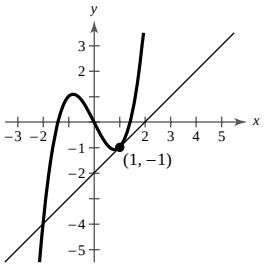
(c)



45. (a) 1

(b) $y = x - 2$

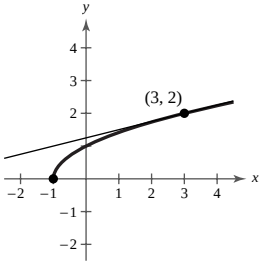
(c)



47. (a) $\frac{1}{4}$

(b) $y = \frac{1}{4}x + \frac{5}{4}$

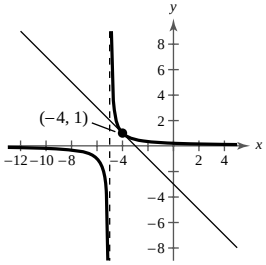
(c)



49. (a) -1

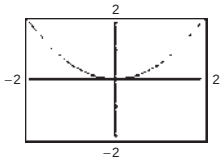
(b) $y = -x - 3$

(c)



CHAPTER 11

51.

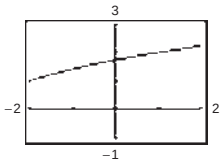


x	-2	-1.5	-1	-0.5	0
$f(x)$	2	1.125	0.5	0.125	0
$f'(x)$	-2	-1.5	-1	-0.5	0

x	0.5	1	1.5	2
$f(x)$	0.125	0.5	1.125	2
$f'(x)$	0.5	1	1.5	2

They appear to be the same.

53.



x	-2	-1.5	-1	-0.5	0
$f(x)$	1	1.225	1.414	1.581	1.732
$f'(x)$	0.5	0.408	0.354	0.316	0.289

x	0.5	1	1.5	2
$f(x)$	1.871	2	2.121	2.236
$f'(x)$	0.267	0.25	0.236	0.224

They appear to be the same.

55. $f'(x) = 2x - 4$; $(2, -1)$

57. $f'(x) = 9x^2 - 9$; $(-1, 6)$, $(1, -6)$

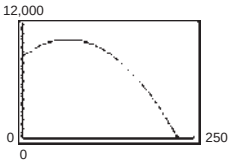
59. $(-1, -1)$, $(0, 0)$, $(1, -1)$

61. $\left(\frac{\pi}{6}, \sqrt{3} + \frac{\pi}{6}\right), \left(\frac{5\pi}{6}, \frac{5\pi}{6} - \sqrt{3}\right)$

63. $(0, 0)$, $(-2, 4e^{-2})$ **65.** $(e^{-1}, -e^{-1})$

67. (a) $y = -0.41t^2 + 54.7t + 8529$

(b)



38; The population is increasing by approximately 38,000 people per year in 2020.

(c) $y' = -0.82t + 54.7$; 38.3

(d) Answers will vary.

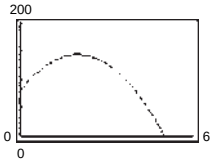
69. (a) $V'(r) = 4\pi r^2$ (b) About 201.06

(c) Cubic inches per inch; The derivative is a formula for rate of change.

71. (a) $s'(t) = -32t + 64$ (b) 16 ft/sec

(c) $t = 2$ sec; Answers will vary. (d) -96 ft/sec

(e)



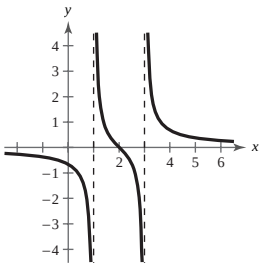
73. True. The graph of the derivative is a line, which is a one-to-one function.

75. b **76.** a **77.** d **78.** c

79. Answers will vary. Sample answer: A sketch of any linear function with positive slope

81. Answers will vary. Sample answer: A sketch of any quadratic function of the form $y = a(x - 1)^2 + k$, where $a > 0$

83.



Section 11.4 (page 786)

1. 5 **3.** converge **5.** c **6.** a **7.** d **8.** b

9. f **10.** g **11.** h **12.** e **13.** 0 **15.** -1

17. $\frac{5}{6}$ **19.** -4 **21.** Limit does not exist. **23.** $\frac{4}{3}$

25. 2 **27.** -1 **29.** -4 **31.** -5

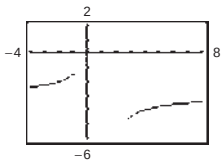
33. (a)

x	10^0	10^1	10^2	10^3
$f(x)$	Error	-3.33	-3.03	-3.003

x	10^4	10^5	10^6
$f(x)$	-3.0003	-3.00003	-3.000003

-3

(b)



(c) $\lim_{x \to \infty} f(x) = -3$

-3

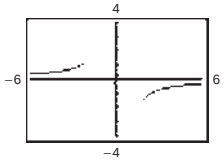
35. (a)

x	10^0	10^1	10^2	10^3
$f(x)$	Error	-0.202	-0.0200	-0.002

x	10^4	10^5	10^6
$f(x)$	-0.0002	-0.00002	-0.000002

0

(b)



(c) $\lim_{x \to \infty} f(x) = 0$

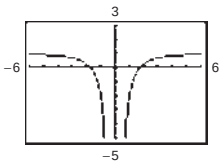
0

37. (a)

x	10^0	10^1	10^2	10^3
$f(x)$	-2	0.97	0.9997	0.999997

x	10^4	10^5	10^6
$f(x)$	0.99999997	0.9999999997	1

1

(b) 

(c) $\lim_{x\to\infty} f(x) = 1$

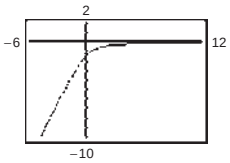
1

39. (a)

x	10^0	10^1	10^2	10^3
$f(x)$	-0.7321	-0.0995	-0.0100	-0.0010

x	10^4	10^5	10^6
$f(x)$	-1.0×10^{-4}	-1.0×10^{-5}	-1.0×10^{-6}

0

(b) 

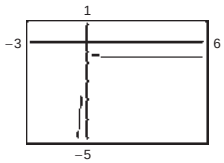
0

41. (a)

x	10^0	10^1	10^2	10^3
$f(x)$	-0.7082	-0.7454	-0.7495	-0.74995

x	10^4	10^5	10^6
$f(x)$	-0.749995	-0.7499995	-0.7500

-0.75

(b) 

-0.75

43. $1, \frac{3}{5}, \frac{2}{5}, \frac{5}{17}, \frac{3}{13}$
Limit: 0

45. $\frac{1}{3}, \frac{2}{5}, \frac{3}{7}, \frac{4}{9}, \frac{5}{11}$
Limit: $\frac{1}{2}$

47. $\frac{1}{5}, \frac{1}{2}, \frac{9}{11}, \frac{8}{7}, \frac{25}{17}$
Limit does not exist.

49. 2, 3, 4, 5, 6
Limit does not exist.

51. $-1, \frac{1}{2}, -\frac{1}{3}, \frac{1}{4}, -\frac{1}{5}$
Limit: 0

53.

n	10^0	10^1	10^2	10^3
a_n	2	1.55	1.505	1.5005

1.5

$\lim_{n\to\infty} a_n = \frac{3}{2}$

55.

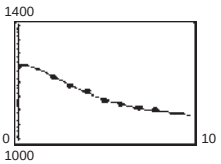
n	10^0	10^1	10^2	10^3
a_n	13.33	5.683	5.06683	5.0066683

5

$\lim_{n\to\infty} a_n = 5$

57. (a) $\overline{C} = \dfrac{13.50x + 45{,}750}{x}$ (b) \$471; \$59.25

(c) \$13.50; As the number of PDAs produced gets very large, the average cost approaches \$13.50.

59. (a) 

The model fits the data well.

(b) 2009: 1,092,000
2010: 1,086,000

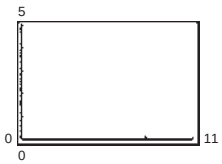
(c) 1,056,000; As time passes, the number of United States military reserve personnel approaches 1,056,000.

(d) Answers will vary.

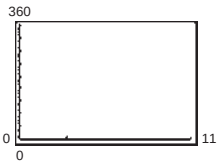
61. False. $y = \dfrac{x^2}{x+1}$ does not have a horizontal asymptote.

63. True. See page 784.

65. Answers will vary. Sample answer: Let $f(x) = x^2$ and $g(x) = x^2$. Then $\lim_{x\to\infty} x^2 = \infty$ and $\lim_{x\to\infty} [f(x) - g(x)] = 0$.

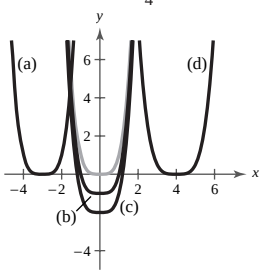
67. 

Converges to 0

69. 

Diverges

71. The limit is $-\frac{1}{4}$.

73. 

75. 60 **77.** 150

Section 11.5 (page 794)

1. $\dfrac{n(n+1)}{2}$ **3.** 100 rectangles **5.** 420 **7.** 44,100

9. 44,140 **11.** 5850

CHAPTER 11

13. (a) $S(n) = \dfrac{n^2 + 2n + 1}{4n^2}$

(b)

n	10^0	10^1	10^2	10^3	10^4
$S(n)$	1	0.3025	0.2550	0.2505	0.2501

(c) $\lim_{n\to\infty} S(n) = \dfrac{1}{4}$

15. (a) $S(n) = \dfrac{2n^2 + 3n + 7}{2n^2}$

(b)

n	10^0	10^1	10^2	10^3	10^4
$S(n)$	6	1.185	1.0154	1.0015	1.0002

(c) $\lim_{n\to\infty} S(n) = 1$

17. (a) $S(n) = \dfrac{14n^2 + 3n + 1}{6n^3}$

(b)

n	10^0	10^1	10^2	10^3	10^4
$S(n)$	3	0.2385	0.0234	0.0023	0.0002

(c) $\lim_{n\to\infty} S(n) = 0$

19. 14.25 **21.** 1.27

23.

n	4	8	20	50
Approximate area	18	21	22.8	23.52

25.

n	4	8	20	50
Approximate area	3.5156	2.8477	2.4806	2.3409

27.

n	4	8	20	50	100	∞
Area	40	38	36.8	36.32	36.16	36

29.

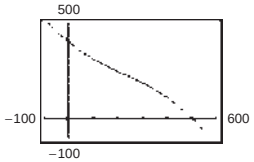
n	4	8	20	50	100	∞
Area	14.25	14.81	15.13	15.25	15.29	$\frac{46}{3}$

31.

n	4	8	20	50	100	∞
Area	19	18.5	18.2	18.08	18.04	18

33. 3 **35.** $\frac{15}{2}$ **37.** $\frac{128}{3}$ **39.** $\frac{3}{4}$ **41.** $\frac{3}{4}$ **43.** 144

45.



105,208.33 ft²

47. True. See Formula 2 on page 789. **49.** c

Review Exercises (page 798)

1.

x	2.9	2.99	2.999	3
$f(x)$	16.4	16.94	16.994	17

x	3.001	3.01	3.1
$f(x)$	17.006	17.06	17.6

17; Yes

3.

x	-0.1	-0.01	-0.001	0
$f(x)$	1.0517	1.0050	1.0005	Error

x	0.001	0.01	0.1
$f(x)$	0.9995	0.9950	0.9516

1; No

5. 2 **7.** Limit does not exist.

9. (a) 8 (b) 1 (c) 10 (d) $\frac{2}{5}$

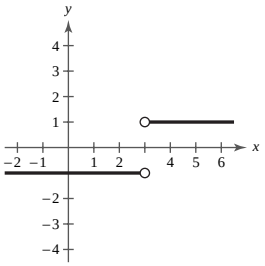
11. 5 **13.** $\frac{10}{3}$ **15.** -2 **17.** 0 **19.** e

21. $-\dfrac{\pi}{6}$ **23.** $-\dfrac{1}{4}$ **25.** $\dfrac{1}{15}$ **27.** -9 **29.** -1

31. $\frac{1}{4}$ **33.** (a) and (b) 0.17 **35.** Limit does not exist.

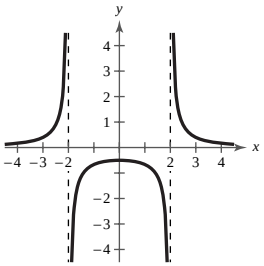
37. (a) and (b) 2 **39.** (a) and (b) 0.577

41.



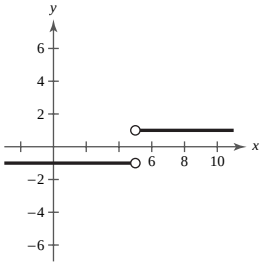
Limit does not exist.

43.



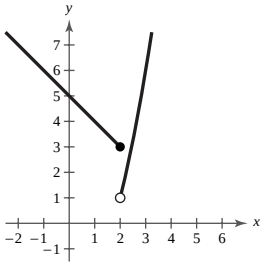
Limit does not exist.

45.



Limit does not exist.

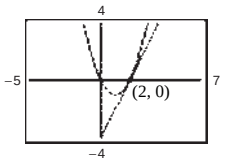
47.



Limit does not exist.

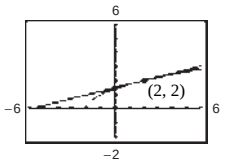
49. $3 - 2x$ **51.** 2

53.



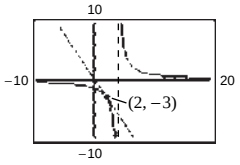
2

55.



$\frac{1}{4}$

57.



$-\frac{3}{2}$

59. $m = 2x - 4$; (a) -4 (b) 6

61. $m = -\dfrac{4}{(x-6)^2}$; (a) -4 (b) -1

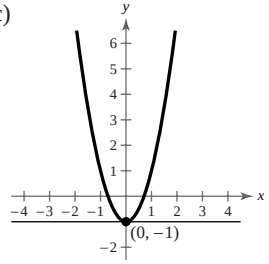
63. $f'(x) = 0$ **65.** $h'(x) = -\frac{1}{2}$ **67.** $g'(x) = 4x$

69. $f'(t) = \dfrac{1}{2\sqrt{t+5}}$ **71.** $g'(s) = -\dfrac{4}{(s+5)^2}$

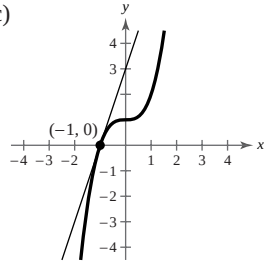
73. $g'(x) = -\dfrac{1}{2(x+4)^{3/2}}$

75. (a) 0 (b) $y = -1$ **77.** (a) 3 (b) $y = 3x + 3$

(c)



(c)



79. 2 **81.** 0 **83.** Limit does not exist. **85.** 3

87. $-\frac{1}{9}, \frac{1}{14}, \frac{3}{19}, \frac{5}{24}, \frac{7}{29}$ Limit: $\frac{2}{5}$

89. $-1, \frac{1}{8}, -\frac{1}{27}, \frac{1}{64}, -\frac{1}{125}$ Limit: 0

91. $-\frac{1}{2}, -\frac{9}{8}, -\frac{7}{6}, -\frac{37}{32}, -\frac{57}{50}$ Limit: -1

93. (a) $S(n) = \dfrac{5n^2 + 9n + 4}{6n^2}$

(b)

n	10^0	10^1	10^2	10^3	10^4
$S(n)$	3	0.99	0.8484	0.8348	0.8335

(c) $\dfrac{5}{6}$

95. 6.75

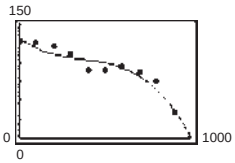
97.

n	4	8	20	50
Approximate area	7.5	6.375	5.74	5.4944

99. 50 **101.** 21 **103.** 68

105. (a) $y = (-3.376 \times 10^{-7})x^3 + (3.753 \times 10^{-4})x^2 - 0.168x + 132$

(b)

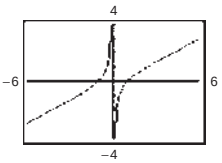


(c) 88,700 ft^2

107. True. See page 775.

Chapter Test (page 801)

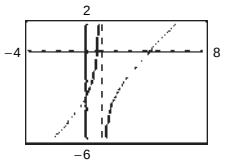
1.



-0.75

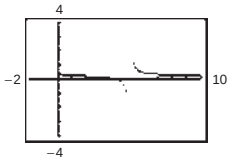
$\lim_{x \to -2} f(x) = -\frac{3}{4}$

2.



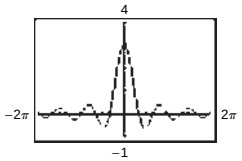
Limit does not exist.

3.



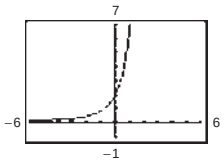
Limit does not exist.

4.



3.0000

5.



2.0000

6. (a) $m = 6x - 5$; 7 (b) $m = 6x^2 + 6$; 12

7. $f'(x) = -\frac{2}{5}$ **8.** $f'(x) = 4x + 4$

9. $f'(x) = -\dfrac{1}{(x+1)^2}$ **10.** 0 **11.** -3

12. Limit does not exist.

13. $0, \frac{3}{4}, \frac{14}{19}, \frac{12}{17}, \frac{36}{53}$ Limit: $\frac{1}{2}$

14. $0, 1, 0, \frac{1}{2}, 0$ Limit: 0

15. 12.5 **16.** 8 **17.** $\frac{34}{3}$

18. (a) $y = 8.79x^2 - 6.2x - 0.4$ (b) 81.7 ft/sec

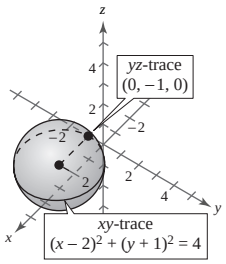
Cumulative Test for Chapters 10 and 11 (page 802)

1. $(-6, 1, 2)$ **2.** $(0, -5, 0)$ **3.** $\sqrt{149}$

4. 3, 4, 5 **5.** $\left(-1, 2, \frac{1}{2}\right)$

6. $(x-2)^2 + (y-2)^2 + (z-4)^2 = 24$

7.



8. $\mathbf{u} \cdot \mathbf{v} = -38$
$\mathbf{u} \times \mathbf{v} = \langle -18, -6, -14 \rangle$

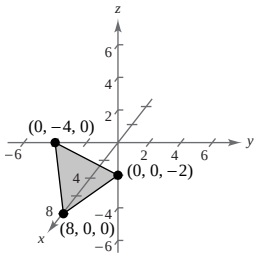
9. Neither **10.** Orthogonal **11.** Parallel **12.** 12

13. (a) $x = -2 + 7t, y = 3 + 5t, z = 25t$

(b) $\dfrac{x+2}{7} = \dfrac{y-3}{5} = \dfrac{z}{25}$

14. $x = -1 + 2t, y = 2 - 4t, z = t$ **15.** $75x + 50y - 31z = 0$

16.



17. $\dfrac{\sqrt{30}}{2}$ **18.** 84.26°

19. 4 **20.** $-\frac{1}{3}$ **21.** $\frac{1}{14}$

22. $\frac{1}{4}$ **23.** -1

24. Limit does not exist.

25. $-\frac{1}{9}$ **26.** $\frac{1}{8}$ **27.** $\frac{1}{4}$

28. $m = -2x$; 4

29. $m = \frac{1}{2}(x+3)^{-1/2}; \frac{1}{2}$

30. $m = -(x+3)^{-2}; -\frac{1}{16}$ **31.** $m = 2x - 1$; 1

32. Limit does not exist. **33.** -7 **34.** 3 **35.** 0

36. 0 **37.** Limit does not exist. **38.** $-42{,}875$

39. 8190 **40.** 672,880 **41.** 10.5 **42.** 8.13

43. 2.69 **44.** 1.57 **45.** $\frac{5}{2}$ **46.** $\frac{76}{3}$ **47.** $\frac{16}{3}$ **48.** $\frac{3}{4}$

CHAPTER 11

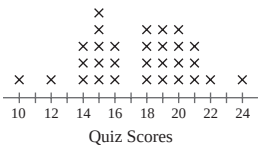
Appendices

Appendix B.1 (page A31)

1. Line plots **3.** frequency distribution **5.** scatter plot

7. (a) 2.979 (b) 0.19

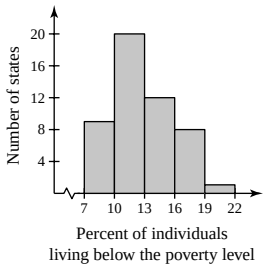
9.



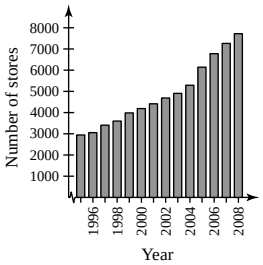
15

11. Sample answer:

Interval	Tally
[7, 10)	𝍸 ||||
[10, 13)	𝍸 𝍸 𝍸 𝍸
[13, 16)	𝍸 𝍸 ||
[16, 19)	𝍸 |||
[19, 22)	|

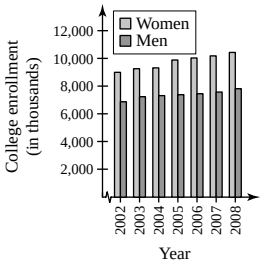


13.

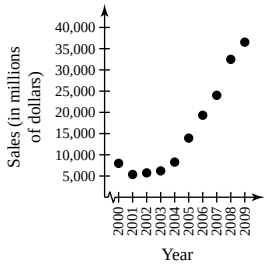


Answers will vary. Sample answer: As time progresses from 1995 to 2008, the number of Wal-Mart stores increases at a fairly constant rate.

15.



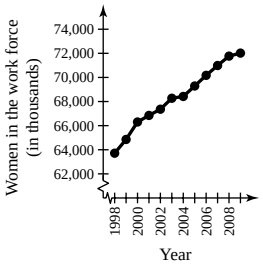
17.



19. The price decreased slightly from 2000 to 2002.

21. From 2001 to 2002 **23.** About 40%

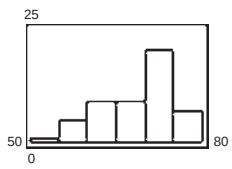
25.



Answers will vary. Sample answer: As time progresses from 1998 to 2009, the number of women in the work force increases at a fairly constant rate.

27. 65 **29.** Yes

31. Answers will vary. Sample answer: A histogram is best because the data are percents within a year that do not relate to increasing or decreasing behavior.



33. A bar graph is similar to a histogram, except that the bars can be either horizontal or vertical and the labels of the bars are not necessarily numbers. Another difference between a bar graph and a histogram is that the bars in a bar graph are usually separated by spaces.

35. Line plots are useful for ordering small sets. Histograms or bar graphs can be used to organize larger sets. Line graphs are used to show trends over periods of time.

Appendix B.2 (page A41)

1. measure, central tendency

3. variance, standard deviation

5. Mean: About 8.86; median: 8; mode: 7

7. Mean: About 10.29; median: 8; mode: 7

9. Mean: 9; median: 8; mode: 7

11. (a) The mean; Answers will vary.
(b) Mean: About 14.86; median: 14; mode: 13
Each is increased by 6.
(c) Each will increase by k.

13. Mean: 320; median: 320; mode: 320

15. (a) Jay: 199.67; Hank: 199.67; Buck: 229.33
(b) 209.56 (c) 202

17. Answers will vary. Sample answer: $\{4, 4, 10\}$

19. The median

21. (a) $\bar{x} = 12;\ \sigma \approx 2.83$ (b) $\bar{x} = 20;\ \sigma \approx 2.83$
(c) $\bar{x} = 12;\ \sigma \approx 1.41$ (d) $\bar{x} = 9;\ \sigma \approx 1.41$

23. $\bar{x} = 6,\ v = 10,\ \sigma \approx 3.16$

25. $\bar{x} = 2,\ v = \frac{4}{3},\ \sigma \approx 1.15$ **27.** $\bar{x} = 4,\ v = 4,\ \sigma = 2$

29. $\bar{x} = 47,\ v = 226,\ \sigma \approx 15.03$

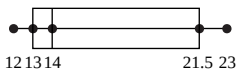
31. 3.42 **33.** 1.65

35. $\bar{x} = 12$ and $|x_i - 12| = 8$ for all x_i.

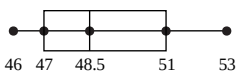
37. The mean will increase by 5, but the standard deviation will not change.

39. [179, 291]; [151, 319]
[203, 267]; [187, 283]

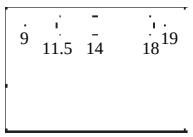
41. (a) Upper quartile: 21.5
Lower quartile: 13
(b)



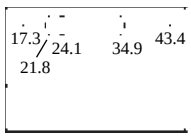
43. (a) Upper quartile: 51
Lower quartile: 47
(b)



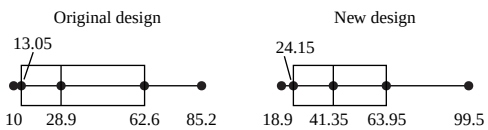
45.



47.



49.



From the plots, you can see that the lifetimes of the sample units made by the new design are greater than the lifetimes of the sample units made by the original design. (The median lifetime increased by more than 12 months.)

Appendix B.3 (page A45)

1. $y = 1.6x + 7.5$ **3.** $y = 0.262x + 1.93$

Index of Selected Applications

Go to this textbook's *Companion Website* for a complete list of applications.

Geometry

Interest Rate

Miscellaneous

Time and Distance

U.S. Demographics

Index

F

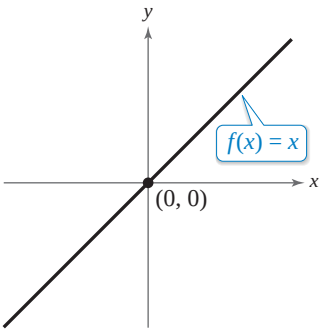
O

P

Library of Parent Functions Summary

Linear Function *(p. 6)*

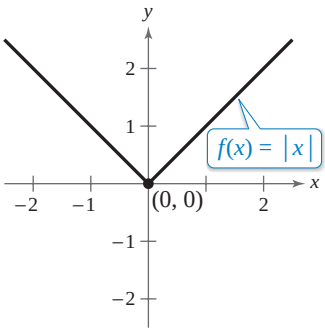
$f(x) = x$



Domain: $(-\infty, \infty)$
Range: $(-\infty, \infty)$
Intercept: $(0, 0)$
Increasing

Absolute Value Function *(p. 19)*

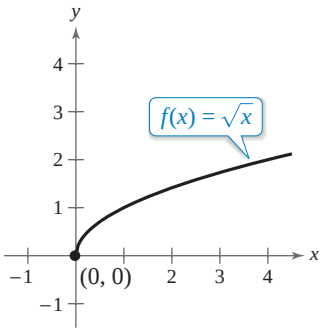
$$f(x) = |x| = \begin{cases} x, & x \geq 0 \\ -x, & x < 0 \end{cases}$$



Domain: $(-\infty, \infty)$
Range: $[0, \infty)$
Intercept: $(0, 0)$
Decreasing on $(-\infty, 0)$
Increasing on $(0, \infty)$
Even function
y-axis symmetry

Square Root Function *(p. 20)*

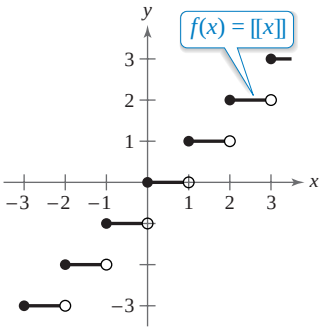
$f(x) = \sqrt{x}$



Domain: $[0, \infty)$
Range: $[0, \infty)$
Intercept: $(0, 0)$
Increasing on $(0, \infty)$

Greatest Integer Function *(p. 34)*

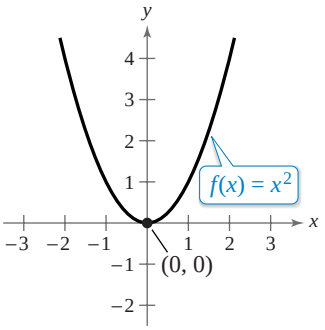
$f(x) = [\![x]\!]$



Domain: $(-\infty, \infty)$
Range: the set of integers
x-intercepts: in the interval $[0, 1)$
y-intercept: $(0, 0)$
Constant between each pair of consecutive integers
Jumps vertically one unit at each integer value

Quadratic Function *(p. 92)*

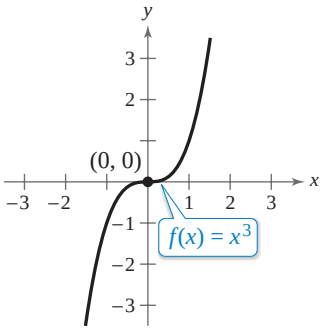
$f(x) = ax^2$



Domain: $(-\infty, \infty)$
Range: $[0, \infty)$
Intercept: $(0, 0)$
Decreasing on $(-\infty, 0)$
Increasing on $(0, \infty)$
Even function
Axis of symmetry: $x = 0$
Relative minimum or vertex: $(0, 0)$

Cubic Function *(p. 101)*

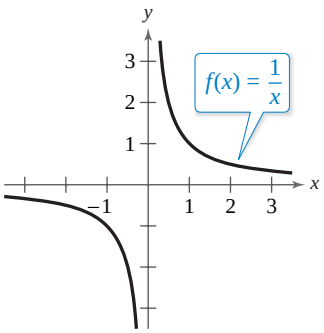
$f(x) = x^3$



Domain: $(-\infty, \infty)$
Range: $(-\infty, \infty)$
Intercept: $(0, 0)$
Increasing on $(-\infty, \infty)$
Odd function
Origin symmetry

Rational Function *(p. 152)*

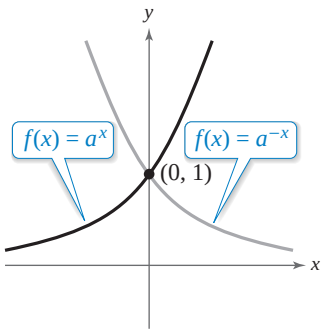
$f(x) = \dfrac{1}{x}$



Domain: $(-\infty, 0) \cup (0, \infty)$
Range: $(-\infty, 0) \cup (0, \infty)$
No intercepts
Decreasing on $(-\infty, 0)$ and $(0, \infty)$
Odd function
Origin symmetry
Vertical asymptote: y-axis
Horizontal asymptote: x-axis

Exponential Function *(p. 182)*

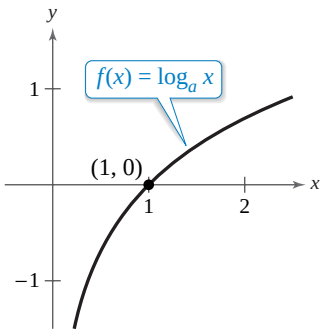
$f(x) = a^x,\ a > 0,\ a \neq 1$



Domain: $(-\infty, \infty)$
Range: $(0, \infty)$
Intercept: $(0, 1)$
Increasing on $(-\infty, \infty)$
for $f(x) = a^x$
Decreasing on $(-\infty, \infty)$
for $f(x) = a^{-x}$
x-axis is a horizontal asymptote
Continuous

Logarithmic Function *(p. 195)*

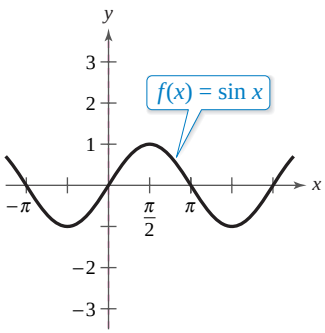
$f(x) = \log_a x,\ a > 0,\ a \neq 1$



Domain: $(0, \infty)$
Range: $(-\infty, \infty)$
Intercept: $(1, 0)$
Increasing on $(0, \infty)$
y-axis is a vertical asymptote
Continuous
Reflection of graph of $f(x) = a^x$
in the line $y = x$

Sine Function *(p. 293)*

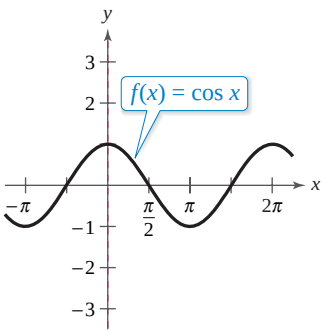
$f(x) = \sin x$



Domain: $(-\infty, \infty)$
Range: $[-1, 1]$
Period: 2π
x-intercepts: $(n\pi, 0)$
y-intercept: $(0, 0)$
Odd function
Origin symmetry

Cosine Function *(p. 293)*

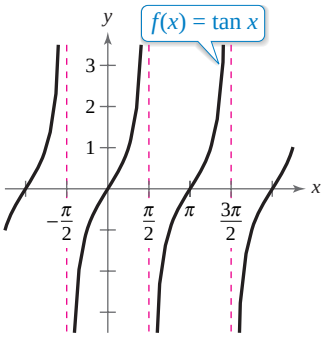
$f(x) = \cos x$



Domain: $(-\infty, \infty)$
Range: $[-1, 1]$
Period: 2π
x-intercepts: $\left(\dfrac{\pi}{2} + n\pi, 0\right)$
y-intercept: $(0, 1)$
Even function
y-axis symmetry

Tangent Function *(p. 304)*

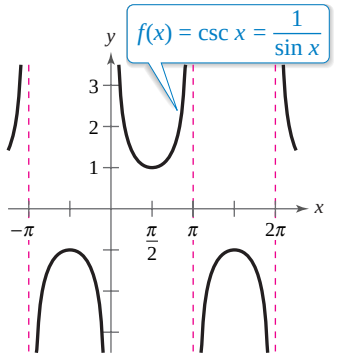
$f(x) = \tan x$



Domain: $x \neq \dfrac{\pi}{2} + n\pi$
Range: $(-\infty, \infty)$
Period: π
x-intercepts: $(n\pi, 0)$
y-intercept: $(0, 0)$
Vertical asymptotes: $x = \dfrac{\pi}{2} + n\pi$
Odd function
Origin symmetry

Cosecant Function *(p. 307)*

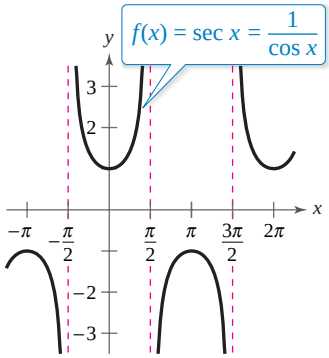
$f(x) = \csc x$



Domain: $x \neq n\pi$
Range: $(-\infty, -1] \cup [1, \infty)$
Period: 2π
No intercepts
Vertical asymptotes: $x = n\pi$
Odd function
Origin symmetry

Secant Function *(p. 307)*

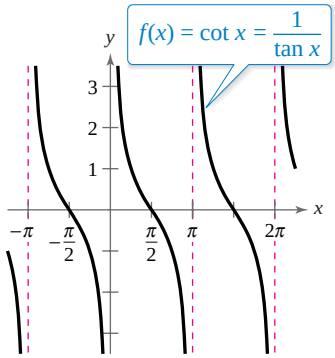
$f(x) = \sec x$



Domain: $x \neq \frac{\pi}{2} + n\pi$
Range: $(-\infty, -1] \cup [1, \infty)$
Period: 2π
y-intercept: $(0, 1)$
Vertical asymptotes:
$x = \frac{\pi}{2} + n\pi$
Even function
y-axis symmetry

Cotangent Function *(p. 306)*

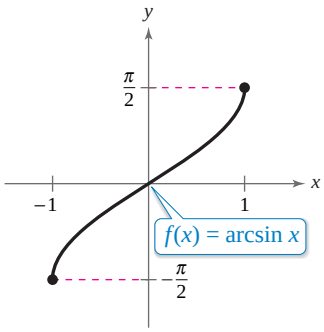
$f(x) = \cot x$



Domain: $x \neq n\pi$
Range: $(-\infty, \infty)$
Period: π
x-intercepts: $\left(\frac{\pi}{2} + n\pi, 0\right)$
Vertical asymptotes: $x = n\pi$
Odd function
Origin symmetry

Inverse Sine Function *(p. 319)*

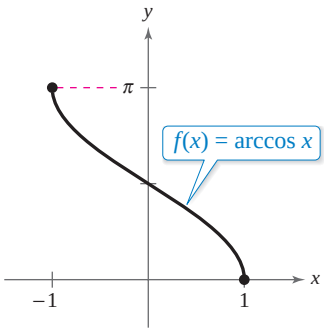
$f(x) = \arcsin x$



Domain: $[-1, 1]$
Range: $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$
Intercept: $(0, 0)$
Odd function
Origin symmetry

Inverse Cosine Function *(p. 319)*

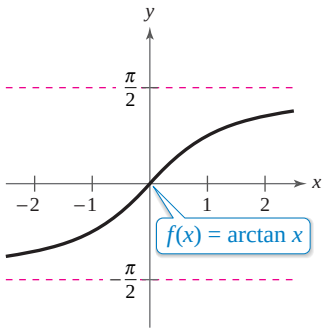
$f(x) = \arccos x$



Domain: $[-1, 1]$
Range: $[0, \pi]$
y-intercept: $\left(0, \frac{\pi}{2}\right)$

Inverse Tangent Function *(p. 319)*

$f(x) = \arctan x$



Domain: $(-\infty, \infty)$
Range: $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$
Intercept: $(0, 0)$
Horizontal asymptotes: $y = \pm\frac{\pi}{2}$
Odd function
Origin symmetry