39. $\left\{\frac{\pi}{3}, \frac{5\pi}{3}\right\}$ **41.** $\left\{\frac{3\pi}{2}\right\}$ **43.** No solutions **45.** $\left[0, \frac{\pi}{6}\right) \cup \left(\frac{5\pi}{6}, \frac{7\pi}{6}\right) \cup \left(\frac{11\pi}{6}, 2\pi\right)$ **47.** $\left(\frac{\pi}{3}, \frac{5\pi}{3}\right)$

49. $y \approx 5\sin(3x + 0.9273)$ **51.** $C = 68°$; $b \approx 3.9$; $c \approx 6.6$ **53.** No triangle is formed **55.** $C = 72°$; $a \approx 2.9$; $b \approx 5.1$

57. $A \approx 44.4°$; $B \approx 78.5°$; $C \approx 57.1°$ **59.** ≈ 7.5 **61. (a)** $\approx 5.6 < b < 12$ **(b)** $b \approx 5.6$ or $b \geq 12$ **(c)** $b < 5.6$

63. ≈ 0.6 mi **65.** 1.25 rad **67. (a)** $\sin\theta + \frac{1}{2}\sin 2\theta$ **(b)** $\theta = \frac{\pi}{3}$; $\frac{3}{4}\sqrt{3} \approx 1.30$ square units

69. (a) $h = 4000 \sec\frac{\theta}{2} - 4000$ miles **(b)** $\approx 35.51°$ **71.** area of circle $= 256\pi$ cm^2, area outside hexagon $= 256\pi^2 - 384\sqrt{3}$ ≈ 139.140 cm^2 **73.** $\frac{405\pi}{24} \approx 53.01$ cm^3

75. (a) By the product-to-sum formula in 74c, $2\sin\frac{u+v}{2}\cos\frac{u-v}{2} = 2\cdot\frac{1}{2}\left(\sin\frac{u+v+u-v}{2} + \sin\frac{u+v-(u-v)}{2}\right) = \sin u + \sin v$

(b) By the product-to-sum formula in 74c, $2\sin\frac{u-v}{2}\cos\frac{u+v}{2} = 2\cdot\frac{1}{2}\left(\sin\frac{u-v+u+v}{2} + \sin\frac{u+v-(u+v)}{2}\right)$ $= \sin u + \sin(-v) = \sin u - \sin v$ **(c)** By the product-to-sum formula in 74b, $2\cos\frac{u+v}{2}\cos\frac{u-v}{2}$ $= 2\cdot\frac{1}{2}\left(\cos\frac{u+v-(u-v)}{2} + \cos\frac{u+v+u-v}{2}\right) = \cos v + \cos u = \cos u + \cos v$

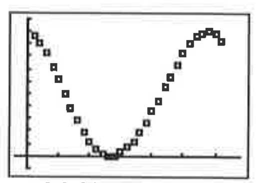
(d) By the product-to-sum formula in 74a, $-2\sin\frac{u+v}{2}\sin\frac{u-v}{2} = -2\cdot\frac{1}{2}\left(\cos\frac{u+v-(u-v)}{2} - \cos\frac{u+v+u-v}{2}\right)$ $= -(\cos v - \cos u) = \cos u - \cos v$

77. (a) Any inscribed angle that intercepts an arc of 180° is a right angle. **(b)** Two inscribed angles that intercept the same arc are congruent. **(c)** In right $\Delta A'BC$, $\sin A' = \frac{\text{opp}}{\text{hyp}} = \frac{a}{d}$. **(d)** Because $\angle A'$ and $\angle A$ are congruent, $\frac{\sin A}{a} = \frac{\sin A'}{a} = \frac{a/d}{a} = \frac{1}{d}$.

(e) Of course. They both equal $\frac{\sin A}{a}$ by the Law of Sines.

Chapter 5 Project

1.



[−2, 34] by [−0.1, 1.1]

5. One possible model is $y \approx 0.5\sin\left(\frac{2\pi}{30.5}(x - 21.375)\right) + 0.5$.

SECTION 6.1

Quick Review 6.1

1. $\frac{9\sqrt{3}}{2}$, 4.5 **3.** $-5.36, -4.50$ **5.** 33.85° **7.** 60.95° **9.** 248.20°

Exercises 6.1

5. $\langle 5, 2\rangle, \sqrt{29}$ **7.** $\langle -5, 1\rangle, \sqrt{26}$ **9.** $\langle -2, -24\rangle, 2\sqrt{145}$ **11.** $\langle -11, -7\rangle, \sqrt{170}$ **13.** $\langle 1, 7\rangle$ **15.** $\langle -3, 8\rangle$

17. $\langle 4, -9\rangle$ **19.** $\langle -4, -18\rangle$ **21.** $\approx -0.45\mathbf{i} + 0.89\mathbf{j}$ **23.** $\approx -0.45\mathbf{i} - 0.89\mathbf{j}$ **25. (a)** $\left\langle \frac{2}{\sqrt{5}}, \frac{1}{\sqrt{5}}\right\rangle$ **(b)** $\frac{2}{\sqrt{5}}\mathbf{i} + \frac{1}{\sqrt{5}}\mathbf{j}$

27. (a) $\left\langle -\frac{4}{\sqrt{41}}, -\frac{5}{\sqrt{41}}\right\rangle$ **(b)** $-\frac{4}{\sqrt{41}}\mathbf{i} - \frac{5}{\sqrt{41}}\mathbf{j}$ **29.** $\approx \langle 16.31, 7.61\rangle$ **31.** $\approx \langle -14.52, 44.70\rangle$ **33.** 5; $\approx 53.13°$

SECTION 6.2

Exploration 1

1. $\langle -2 - x, -y \rangle$, $\langle 2 - x, -y \rangle$. **3.** Answers will vary.

Quick Review 6.2

1. $\sqrt{13}$ **3.** 1 **5.** $\langle 3, \sqrt{3} \rangle$ **7.** $\langle -1, -\sqrt{3} \rangle$ **9.** $\left\langle \frac{4}{\sqrt{13}}, \frac{6}{\sqrt{13}} \right\rangle$

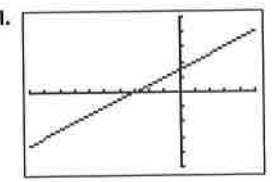
Exercises 6.2

1. 72 **3.** -47 **5.** 30 **7.** -14 **9.** 13 **11.** 4 **13.** $\approx 115.56°$ **15.** $\approx 64.65°$ **17.** $165°$ **19.** $135°$
21. $\approx 94.86°$ **25.** $-\frac{21}{10}\langle 3, 1 \rangle$; $-\frac{21}{10}\langle 3, 1 \rangle + \frac{17}{10}\langle -1, 3 \rangle$ **27.** $\frac{82}{85}\langle 9, 2 \rangle$; $\frac{82}{85}\langle 9, 2 \rangle + \frac{29}{85}\langle -2, 9 \rangle$ **29.** $47.73°, 74.74°, 57.53°$
31. ≈ -20.78 **33.** Parallel **35.** Neither **37.** Orthogonal **39.** **(a)** $(4, 0)$ and $(0, -3)$ **(b)** $(4.6, -0.8)$ or $(3.4, 0.8)$
41. **(a)** $(7, 0)$ and $(0, -3)$ **(b)** $\approx (7.39, -0.92)$ or $(6.61, 0.92)$ **43.** $\langle -1, 4 \rangle$ or $\left\langle \frac{5}{13}, \frac{8}{13} \right\rangle$ **45.** ≈ 138.56 pounds
47. **(a)** ≈ 415.82 pounds **(b)** ≈ 1956.30 pounds **49.** 14,300 foot-pounds **51.** ≈ 21.47 foot-pounds
53. ≈ 85.38 foot-pounds **55.** ≈ 624.5 foot-pounds
61. False. If one of **u** or **v** is the zero vector, then $\mathbf{u} \cdot \mathbf{v} = 0$ but **u** and **v** are not perpendicular.
63. (d) **65.** (a) **67.** **(a)** $2 \cdot 0 + 5 \cdot 2 = 10$ and $2 \cdot 5 + 5 \cdot 0 = 10$ **(b)** $\frac{5}{29}\langle 5, -2 \rangle$; $\frac{1}{29}\langle 62, 155 \rangle$ **(c)** $|\mathbf{w}_2| = \frac{31\sqrt{29}}{29}$
(d) $d = \frac{|2x_0 + 5y_0 - 10|}{\sqrt{29}}$ **(e)** $d = \frac{|ax_0 + by_0 - c|}{\sqrt{a^2 + b^2}}$

SECTION 6.3

Exploration 1

1.

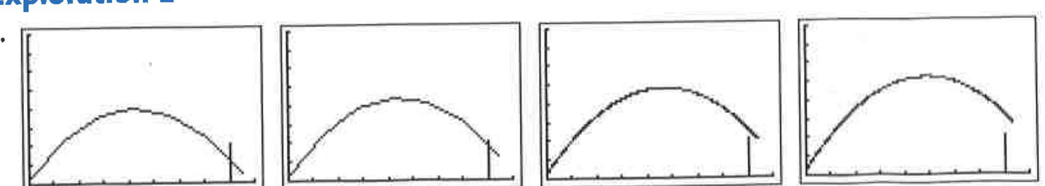


[−10, 5] by [−5, 5]

3. $t = 12$ **5.** Tmin ≤ -2 and Tmax ≥ 5.5

Exploration 2

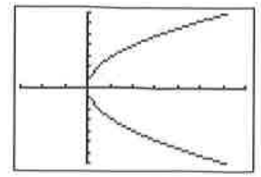
3.



[0, 450] by [0, 80] [0, 450] by [0, 80] [0, 450] by [0, 80] [0, 450] by [0, 80]

Quick Review 6.3

1. **(a)** $\langle -3, -2 \rangle$ **(b)** $\langle 4, 6 \rangle$ **(c)** $\langle 7, 8 \rangle$ **3.** $y + 2 = \frac{8}{7}(x + 3)$ or $y - 6 = \frac{8}{7}(x - 4)$

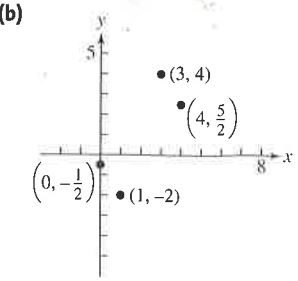
5. 

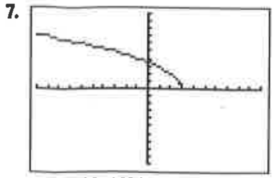
[−3, 7] by [−7, 7]

7. $x^2 + y^2 = 4$ **9.** 20π rad/sec

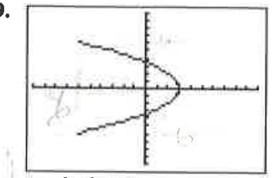
Exercises 6.3

1. (b) $[-5, 5]$ by $[-5, 5]$ **3. (a)** $[-5, 5]$ by $[-5, 5]$

5. (b) 

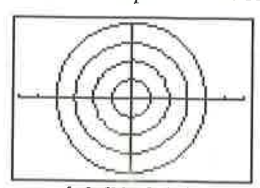
7. 

[−10, 10] by [−10, 10]

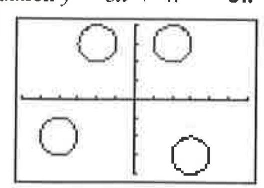
9. 

[−10, 10] by [−10, 10]

11. $y = x - 1$: line through $(0, -1)$ and $(1, 0)$ **13.** $y = -2x + 3$, $3 \le x \le 7$: line segment with endpoints $(3, -3)$ and $(7, -11)$
15. $x = (y - 1)^2$: parabola that opens to the right with vertex at $(0, 1)$ **17.** $y = x^3 - 2x + 3$: cubic polynomial
19. $x = 4 - y^2$: parabola that opens to left with vertex at $(4, 0)$
21. $t = x + 3$, so $y = \dfrac{2}{x + 3}$, on domain: $[-8, -3) \cup (-3, 2]$ **23.** $x^2 + y^2 = 25$: circle of radius 5 centered at $(0, 0)$
25. $x^2 + y^2 = 4$: three-fourths of a circle of radius 2 centered at $(0, 0)$ (not in Quadrant II) **27.** $x = 6t - 2$; $y = -3t + 5$
For Exercises #29–32, many answers are possible; one of the simplest is given.
29. $x = 3t + 3$, $y = 4 - 7t$, $0 \le t \le 1$ **31.** $x = 5 + 3\cos t$, $y = 2 + 3\sin t$, $0 \le t \le 2\pi$
33. $0.5 < t < 2$ **35.** $-3 \le t < -2$ **37. (b)** Ben is ahead by 2 ft.
39. (a) $y = -16t^2 + 1000$ **(c)** 744 ft **41.** Possible answers: **(a)** $0 < t < \dfrac{\pi}{2}$ (t in radians) **(b)** $0 < t < \pi$ **(c)** $\dfrac{\pi}{2} < t < \dfrac{3\pi}{2}$
43. (a) about 2.80 sec **(b)** ≈ 7.18 ft **45. (a)** Yes **(b)** 1.59 ft **47.** No
49. $v \approx -10.00$ ft/sec or 551.20 ft/sec **51.** $x = 35\cos\left(\dfrac{\pi}{6}t\right)$ and $y = 50 + 35\sin\left(\dfrac{\pi}{6}t\right)$
53. (a) When $t = \pi$ (or 3π, or 5π, etc.), $y = 2$. This corresponds to the highest points on the graph. **(b)** 2π units
59. True. Both correspond to the rectangular equation $y = 3x + 4$. **61.** (a) **63.** (d)

65. (a) 

[−6, 6] by [−4, 4]

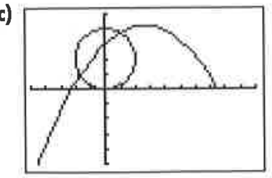
(b) a **(c)** 

[−6, 6] by [−4, 4]

(d) $(x - h)^2 + (y - k)^2 = a^2$; circle of radius a centered at (h, k)

67. (a) Jane is travelling in a circle of radius 20 feet and origin (0, 20), which yields $x_1 = 20\cos(nt)$ and $y_1 = 20 + 20\sin(nt)$. Since the Ferris wheel is making one revolution (2π) every 12 seconds, $2\pi = 12n$, so $n = \dfrac{2\pi}{12} = \dfrac{\pi}{6}$. Thus, $x_1 = 20\cos\left(\dfrac{\pi}{6}t\right)$ and $y_1 = 20 + 20\sin\left(\dfrac{\pi}{6}t\right)$, in radian mode.

(c)



[−50, 100] by [−50, 50]

Jane and the ball will be close to each other but not at the exact same point at $t = 2.2$ seconds.

(d) $d(t) = \sqrt{\left(20\cos\left(\frac{\pi}{6}t\right) + 30t - 75\right)^2 + \left(20 + 20\sin\left(\frac{\pi}{6}t\right) + 16t^2 - 30\sqrt{3}t\right)^2}$

(e) The minimum distance occurs at $t = 2.2$ seconds, when $d(t) = 1.64$ feet.

69. about 4.11 ft **73.** $t = \frac{1}{3}, \frac{2}{3}; t = \frac{1}{4}, \frac{1}{2}, \frac{3}{4}$

SECTION 6.4

Exploration 1

3. $\left(-2, \frac{\pi}{3}\right); \left(2, \frac{\pi}{2}\right); (3, 0); (1, \pi); \left(4, \frac{3\pi}{2}\right)$

Quick Review 6.4

1. **(a)** Quadrant II **(b)** Quadrant III **3.** Possible answers: $7\pi/4$, $-9\pi/4$ **5.** Possible answers: 520°, −200°

7. $(x - 3)^2 + y^2 = 4$ **9.** ≈ 11.14

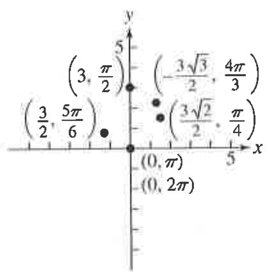
Exercises 6.4

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

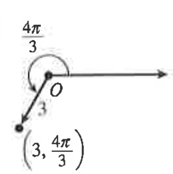
5. **(a)**

θ	$\frac{\pi}{4}$	$\frac{\pi}{2}$	$\frac{5\pi}{6}$	π	$\frac{4\pi}{3}$	2π
r	$\frac{3\sqrt{2}}{2}$	3	$\frac{3}{2}$	0	$-\frac{3\sqrt{3}}{2}$	0

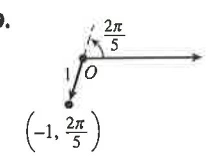
(b)



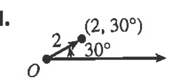
7.



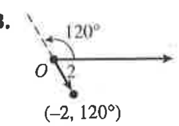
9.



11.



13.



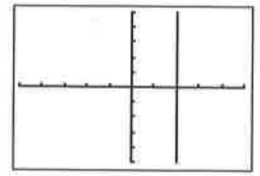
15. $\left(\frac{3}{4}, \frac{3}{4}\sqrt{3}\right)$

17. (−2.70, 1.30) **19.** (2, 0) **21.** (0, −2) **23.** $\left(2, \frac{\pi}{6} + 2n\pi\right)$ and $\left(-2, \frac{\pi}{6} + (2n + 1)\pi\right)$, n an integer

25. $(1.5, -20° + 360n°)$ and $(-1.5, 160° + 360n°)$, n an integer **27.** **(a)** $\left(\sqrt{2}, \frac{\pi}{4}\right)$ or $\left(-\sqrt{2}, \frac{5\pi}{4}\right)$ **(b)** $\left(\sqrt{2}, \frac{\pi}{4}\right)$ or $\left(-\sqrt{2}, -\frac{3\pi}{4}\right)$

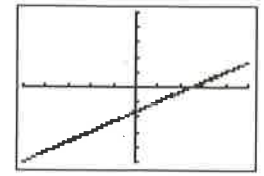
(c) The answers from (a), and also $\left(\sqrt{2}, \frac{9\pi}{4}\right)$ or $\left(-\sqrt{2}, \frac{13\pi}{4}\right)$ **29.** **(a)** $(\sqrt{29}, 1.95)$ or $(-\sqrt{29}, 5.09)$ **(b)** $(-\sqrt{29}, -1.19)$ or

43. $r = 2/\cos\theta = 2\sec\theta$



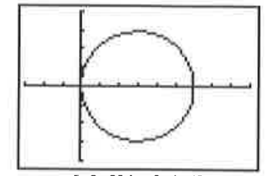
[−5, 5] by [−5, 5]

45. $r = \dfrac{5}{2\cos\theta - 3\sin\theta}$



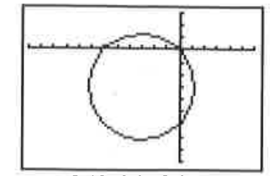
[−5, 5] by [−5, 5]

47. $r^2 - 6r\cos\theta = 0$, so $r = 6\cos\theta$



[−3, 9] by [−4, 4]

49. $r^2 + 6r\cos\theta + 6r\sin\theta = 0$, so $r = -6\cos\theta - 6\sin\theta$



[−12, 6] by [−9, 3]

51. $2\sqrt{3} \approx 3.46$ mi **53.** $\left(\frac{a}{\sqrt{2}}, \frac{\pi}{4}\right), \left(\frac{a}{\sqrt{2}}, \frac{3\pi}{4}\right), \left(\frac{a}{\sqrt{2}}, \frac{5\pi}{4}\right)$, and $\left(\frac{a}{\sqrt{2}}, \frac{7\pi}{4}\right)$

55. False. $(r, \theta) = (r, \theta + 2n\pi)$ for any integer n. These are all distinct polar coordinates. **57.** (c) **59.** (a)
61. (a) If $\theta_1 - \theta_2$ is an odd integer multiple of π, then the distance is $|r_1 + r_2|$. If $\theta_1 - \theta_2$ is an even integer multiple of π, then the distance is $|r_1 - r_2|$. **63.** ≈ 6.24 **65.** ≈ 7.43 **67.** $x = f(\theta)\cos(\theta)$, $y = f(\theta)\sin(\theta)$
69. $x = 5(\cos\theta)(\sin\theta)$, $y = 5\sin^2\theta$ **71.** $x = 4\cot\theta$, $y = 4$

SECTION 6.5

Quick Review 6.5

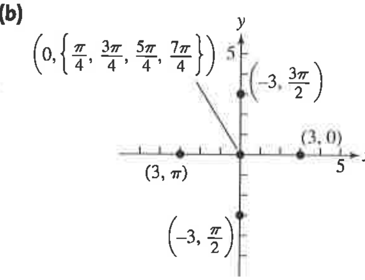
1. Minimum: -3 at $x = \left\{\frac{\pi}{2}, \frac{3\pi}{2}\right\}$; Maximum: 3 at $x = \{0, \pi, 2\pi\}$ **3.** Minimum: 0 at $x = \left\{\frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}\right\}$; Maximum: 2 at $x = \{0, \pi, 2\pi\}$ **5. (a)** No **(b)** No **(c)** Yes **7.** $\sin\theta$ **9.** $\cos^2\theta - \sin^2\theta$

Exercises 6.5

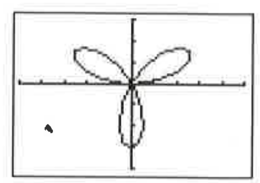
1. (a)

θ	0	$\frac{\pi}{4}$	$\frac{\pi}{2}$	$\frac{3\pi}{4}$	π	$\frac{5\pi}{4}$	$\frac{3\pi}{2}$	$\frac{7\pi}{4}$
r	3	0	−3	0	3	0	−3	0

(b)

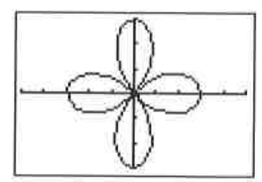


3. $k = \pi$



[−5, 5] by [−4, 3]

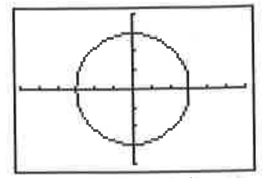
5. $k = 2\pi$



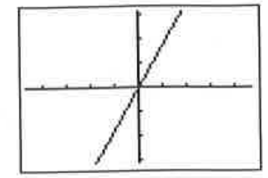
[−5, 5] by [−3, 3]

7. r_3 is graph (b). **9.** Graph (b) is $r = 2 - 2\cos\theta$. **11.** Graph (a) is $r = 2 - 2\sin\theta$.
13. Symmetric about the y-axis **15.** Symmetric about the x-axis **17.** All three symmetries
19. Symmetric about the y-axis **21.** Maximum r is 5 — when $\theta = 2n\pi$ for any integer n.
23. Maximum r is 3 (along with −3) — when $\theta = 2n\pi/3$ for any integer n.

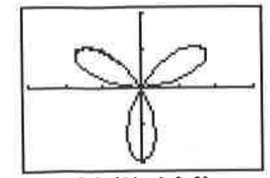
25. Domain: All reals
Range: $r = 3$
Continuous
Symmetric about the x-axis, y-axis, and origin
Bounded
Maximum r-value: 3
No asymptotes


[−6, 6] by [−4, 4]

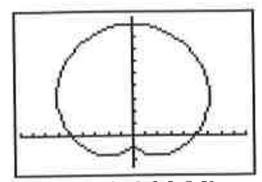
27. Domain: $\theta = \pi/3$
Range: $(-\infty, \infty)$
Continuous
Symmetric about the origin
Unbounded
Maximum r-value: none
No asymptotes


[−4.7, 4.7] by [−3.1, 3.1]

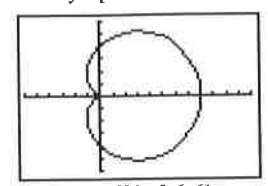
29. Domain: All reals
Range: $[-2, 2]$
Continuous
Symmetric about the y-axis
Bounded
Maximum r-value: 2
No asymptotes


[−3, 3] by [−2, 2]

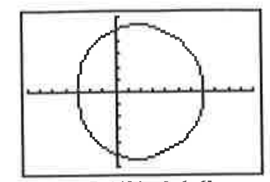
31. Domain: All reals
Range: $[1, 9]$
Continuous
Symmetric about the y-axis
Bounded
Maximum r-value: 9
No asymptotes


[−9, 9] by [−2.5, 9.5]

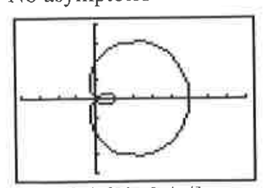
33. Domain: All reals
Range: $[0, 8]$
Continuous
Symmetric about the x-axis
Bounded
Maximum r-value: 8
No asymptotes


[−6, 12] by [−6, 6]

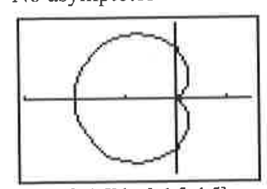
35. Domain: All reals
Range: $[3, 7]$
Continuous
Symmetric about the x-axis
Bounded
Maximum r-value: 7
No asymptotes


[−7, 11] by [−6, 6]

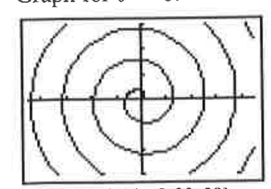
37. Domain: All reals
Range: $[-3, 7]$
Continuous
Symmetric about the x-axis
Bounded
Maximum r-value: 7
No asymptotes


[−4, 8] by [−4, 4]

39. Domain: All reals
Range: $[0, 2]$
Continuous
Symmetric about the x-axis
Bounded
Maximum r-value: 2
No asymptotes


[−3, 1.5] by [−1.5, 1.5]

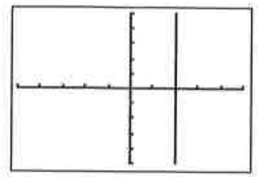
41. Domain: All reals
Range: $[0, \infty)$
Continuous
No symmetry
Unbounded
Maximum r-value: none
No asymptotes
Graph for $\theta \geq 0$:

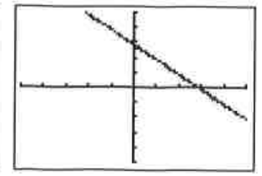

[−45, 45] by [−30, 30]

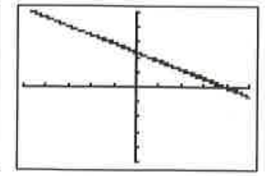
43.

Domain: $\left[0, \frac{\pi}{2}\right] \cup \left[\pi, \frac{3\pi}{2}\right]$
Range: $[0, 1]$
Continuous on each interval in domain

45. $\{6, 2, 6, 2\}$ **47.** $\{3, 5, 3, 5, 3, 5, 3, 5, 3, 5\}$ **49.** r_1 and r_2 **51.** r_2 and r_3 **53.** **(a)** A 4-petal rose curve with 2 short petals of length 1 and 2 long petals of length 3 **(b)** Symmetric about the origin **(c)** Maximum r-value: 3
55. **(a)** A 6-petal rose curve with 3 short petals of length 2 and 3 long petals of length 4 **(b)** Symmetric about the x-axis **(c)** Maximum r-value: 4 **61.** False. The spiral $r = \theta$ is unbounded. **63.** (d) **65.** (b) **67.** **(e)** Domain: All reals; Range: $[-|a|, |a|]$; Symmetric about the x-axis; Continuous; Bounded; Maximum r-value: $|a|$; No asymptotes
69. **(a)** r_1: $0 \le \theta \le 4\pi$ (or any interval that is 4π units long); r_2: same answer **(b)** r_1: 10 (overlapping) petals; r_2: 14 (overlapping) petals **71.** Starting with the graph of r_1, if we rotate counterclockwise (centered at the origin) by $\pi/4$ radians (45°), we get the graph of r_2; rotating r_1 counterclockwise by $\pi/3$ radians (60°) gives the graph of r_3.


[−5, 5] by [−5, 5]

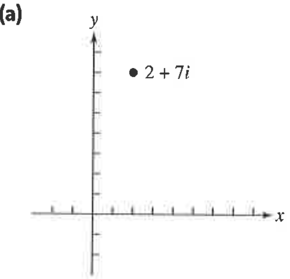

[−5, 5] by [−5, 5]


[−5, 5] by [−5, 5]

SECTION 6.6

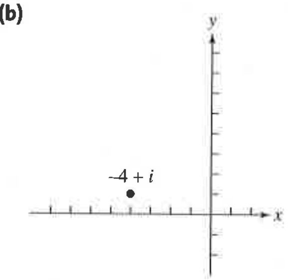
Quick Review 6.6

1. **(a)**



$\sqrt{53}$

(b)



$\sqrt{17}$

3. $-4 - 4i$ **5.** $\theta = \frac{5\pi}{6}$ **7.** $\theta = \frac{4\pi}{3}$ **9.** 1

Exercises 6.6

1. $3\left(\cos\frac{\pi}{2} + i\sin\frac{\pi}{2}\right)$ **3.** $2\sqrt{2}\left(\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}\right)$ **5.** $4\left(\cos\frac{2\pi}{3} + i\sin\frac{2\pi}{3}\right)$ **7.** $\cos\frac{5\pi}{3} + i\sin\frac{5\pi}{3}$

9. $\approx \sqrt{13}(\cos 0.59 + i\sin 0.59)$ **11.** $3\left(\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}\right)$ **13.** $\frac{3}{2}\sqrt{3} - \frac{3}{2}i$ **15.** $\frac{5}{2} - \frac{5}{2}\sqrt{3}\,i$ **17.** $\frac{\sqrt{6}}{2} - \frac{\sqrt{2}}{2}i$

19. $14(\cos 155° + i\sin 155°)$ **21.** $15\left(\cos\frac{23\pi}{12} + i\sin\frac{23\pi}{12}\right)$ **23.** $\frac{2}{3}(\cos 30° - i\sin 30°)$ **25.** $2(\cos\pi + i\sin\pi)$

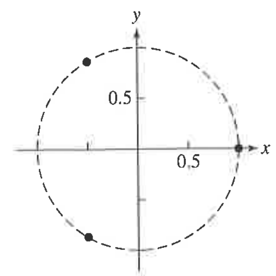
27. **(a)** $5 + i$; $\frac{1}{2} - \frac{5}{2}i$ **(b)** Same as (a) **29.** **(a)** $18 - 4i$; $\approx 0.35 + 0.41i$ **(b)** Same as (a) **31.** $-\frac{\sqrt{2}}{2} + i\frac{\sqrt{2}}{2}$

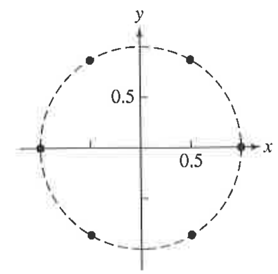
33. $4\sqrt{2} + 4\sqrt{2}\,i$ **35.** $-4 - 4i$ **37.** -8 **39.** $\frac{-1 + \sqrt{3}i}{\sqrt[3]{4}}$; $\frac{-1 - \sqrt{3}i}{\sqrt[3]{4}}$; $\sqrt[3]{2}$ **41.** $\sqrt[3]{3}\left(\cos\frac{4\pi}{9} + i\sin\frac{4\pi}{9}\right)$, $\sqrt[3]{3}\left(\cos\frac{10\pi}{9} + i\sin\frac{10\pi}{9}\right)$, $\sqrt[3]{3}\left(\cos\frac{16\pi}{9} + i\sin\frac{16\pi}{9}\right)$ **43.** $\approx \sqrt[3]{5}(\cos 1.79 + i\sin 1.79)$, $\approx \sqrt[3]{5}(\cos 3.88 + i\sin 3.88)$, $\approx \sqrt[3]{5}(\cos 5.97 + i\sin 5.97)$ **45.** $\cos\frac{\pi}{5} + i\sin\frac{\pi}{5}$, $\cos\frac{3\pi}{5} + i\sin\frac{3\pi}{5}$, -1, $\cos\frac{7\pi}{5} + i\sin\frac{7\pi}{5}$, $\cos\frac{9\pi}{5} + i\sin\frac{9\pi}{5}$

51. $\sqrt[8]{2}\left(\cos\frac{\pi}{16} + i\sin\frac{\pi}{16}\right)$, $\sqrt[8]{2}\left(\cos\frac{9\pi}{16} + i\sin\frac{9\pi}{16}\right)$, $\sqrt[8]{2}\left(\cos\frac{17\pi}{16} + i\sin\frac{17\pi}{16}\right)$, $\sqrt[8]{2}\left(\cos\frac{25\pi}{16} + i\sin\frac{25\pi}{16}\right)$

53. $\sqrt{2}\left(\cos\frac{\pi}{12} + i\sin\frac{\pi}{12}\right)$, $-1 + i$, $\sqrt{2}\left(\cos\frac{17\pi}{12} + i\sin\frac{17\pi}{12}\right)$ **55.** $\frac{1+i}{\sqrt[6]{4}}$, $\sqrt[6]{2}\left(\cos\frac{7\pi}{12} + i\sin\frac{7\pi}{12}\right)$, $\sqrt[6]{2}\left(\cos\frac{11\pi}{12} + i\sin\frac{11\pi}{12}\right)$, $\sqrt[6]{2}\left(\cos\frac{5\pi}{4} + i\sin\frac{5\pi}{4}\right)$, $\sqrt[6]{2}\left(\cos\frac{19\pi}{12} + i\sin\frac{19\pi}{12}\right)$, $\sqrt[6]{2}\left(\cos\frac{23\pi}{12} + i\sin\frac{23\pi}{12}\right)$

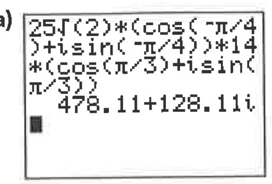
57. $1, -\frac{1}{2} \pm \frac{\sqrt{3}}{2}i$ **59.** $\pm 1, \frac{1}{2} \pm \frac{\sqrt{3}}{2}i, -\frac{1}{2} \pm \frac{\sqrt{3}}{2}i$ **61.** -8; -2 and $1 \pm \sqrt{3}i$



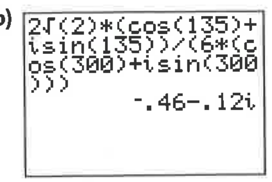


65. False. For example, the complex number $1 + i$ has infinitely many trigonometric forms. Here are two: $\sqrt{2}\left(\cos\frac{\pi}{4} + i\sin\frac{\pi}{4}\right)$, $\sqrt{2}\left(\cos\frac{9\pi}{4} + i\sin\frac{9\pi}{4}\right)$. **67.** (b) **69.** (a) **71.** **(b)** r^2 **(c)** $\cos(2\theta) + i\sin(2\theta)$

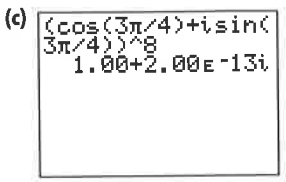
73. **(a)**



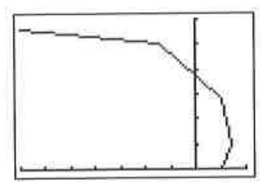
(b)



(c)



75. $x(t) = (\sqrt{3})^t\cos(0.62t)$, $y(t) = (\sqrt{3})^t\sin(0.62t)$ **79.** $1, -\frac{1}{2} + \frac{\sqrt{3}}{2}i, -\frac{1}{2} - \frac{\sqrt{3}}{2}i$ **81.** $-1, \frac{1}{2} + \frac{\sqrt{3}}{2}i, \frac{1}{2} - \frac{\sqrt{3}}{2}i$



[−7, 2] by [0, 6]

83. -1, $\approx 0.81 + 0.59i$, $0.81 - 0.59i$, $-0.31 + 0.95i$, $-0.31 - 0.95i$

CHAPTER 6 REVIEW EXERCISES

1. $\langle -2, -3\rangle$ **3.** $\sqrt{37}$ **5.** 6 **7.** $\langle 3, 6\rangle$; $3\sqrt{5}$ **9.** $\langle -8, -3\rangle$; $\sqrt{73}$ **11.** **(a)** $\left\langle \frac{-2}{\sqrt{5}}, \frac{1}{\sqrt{5}}\right\rangle$ **(b)** $\left\langle \frac{6}{\sqrt{5}}, \frac{-3}{\sqrt{5}}\right\rangle$

13. **(a)** $\tan^{-1}\left(\frac{3}{4}\right) \approx 0.64$, $\tan^{-1}\left(\frac{5}{2}\right) \approx 1.19$ **(b)** ≈ 0.55 **15.** $\approx (-2.27, -1.06)$ **17.** $(\sqrt{2}, -\sqrt{2})$

19. $\left(1, -\frac{2\pi}{3} + (2n+1)\pi\right)$ and $\left(-1, -\frac{2\pi}{3} + 2n\pi\right)$, n an integer **21.** **(a)** $\left(-\sqrt{13}, \pi + \tan^{-1}\left(-\frac{3}{2}\right)\right) \approx (-\sqrt{13}, 2.16)$ or

23. **(a)** $(5, 0)$ or $(-5, \pi)$ or $(5, 2\pi)$ **(b)** $(-5, -\pi)$ or $(5, 0)$ or $(-5, \pi)$ **(c)** The answers from (a), and also $(-5, 3\pi)$ or $(5, 4\pi)$

25. $y = -\frac{3}{5}x + \frac{29}{5}$: line through $\left(0, \frac{29}{5}\right)$ with slope $m = -\frac{3}{5}$ **27.** $x = 2(y + 1)^2 + 3$: parabola that opens to right with vertex at $(3, 1)$

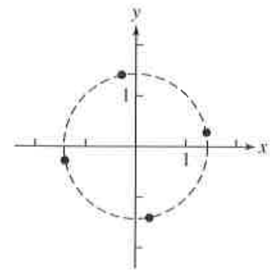
29. $y = \sqrt{x + 1}$: square root function starting at $(-1, 0)$ **31.** $x = 2t + 3, y = 3t + 4$ **33.** $a = -3, b = 4, |z_1| = 5$

35. $3\sqrt{3} + 3i$ **37.** $-1.25 - 1.25\sqrt{3}i$ **39.** $3\sqrt{2}\left(\cos\frac{7\pi}{4} + i\sin\frac{7\pi}{4}\right)$; Other representations would use angles $\frac{7\pi}{4} + 2n\pi$, n an integer. **41.** $\approx \sqrt{34}[\cos(5.25) + i\sin(5.25)]$ Other representations would use angles $\approx 5.25 + 2n\pi$, n an integer.

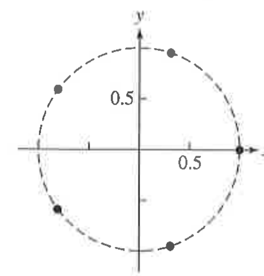
43. $12(\cos 90° + i\sin 90°)$; $\frac{3}{4}(\cos 330° + i\sin 330°)$ **45.** **(a)** $243\left(\cos\frac{5\pi}{4} + i\sin\frac{5\pi}{4}\right)$ **(b)** $-\frac{243\sqrt{2}}{2} - \frac{243\sqrt{2}}{2}i$

47. **(a)** $125(\cos\pi + i\sin\pi)$ **(b)** -125

49. $\sqrt[8]{18}\left(\cos\frac{\pi}{16} + i\sin\frac{\pi}{16}\right)$, $\sqrt[8]{18}\left(\cos\frac{9\pi}{16} + i\sin\frac{9\pi}{16}\right)$, $\sqrt[8]{18}\left(\cos\frac{17\pi}{16} + i\sin\frac{17\pi}{16}\right)$, $\sqrt[8]{18}\left(\cos\frac{25\pi}{16} + i\sin\frac{25\pi}{16}\right)$



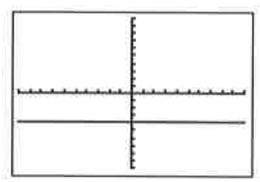
51. $1, \cos\frac{2\pi}{5} + i\sin\frac{2\pi}{5}$, $\cos\frac{4\pi}{5} + i\sin\frac{4\pi}{5}$, $\cos\frac{6\pi}{5} + i\sin\frac{6\pi}{5}$, $\cos\frac{8\pi}{5} + i\sin\frac{8\pi}{5}$



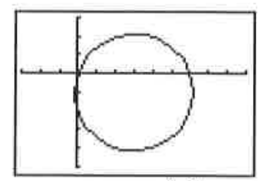
53. (b) **55.** (a) **57.** Not shown **59.** (c) **61.** $x^2 + y^2 = 4$ — a circle with center $(0, 0)$ and radius 2

63. $\left(x + \frac{3}{2}\right)^2 + (y + 1)^2 = \frac{13}{4}$ — a circle of radius $\frac{\sqrt{13}}{2}$ with center $\left(-\frac{3}{2}, -1\right)$

65. $r = -\frac{4}{\sin\theta} = -4\csc\theta$ **67.** $r = 6\cos\theta - 2\sin\theta$

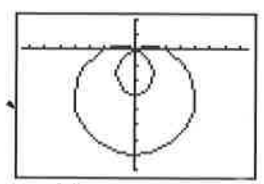


$[-10, 10]$ by $[-10, 10]$



$[-3, 9]$ by $[-5, 3]$

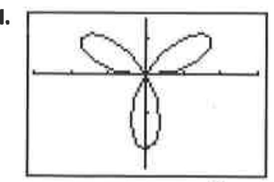
69.



$[-7.5, 7.5]$ by $[-8, 2]$

Domain: All reals
Range: $[-3, 7]$
Symmetric about the y-axis
Continuous

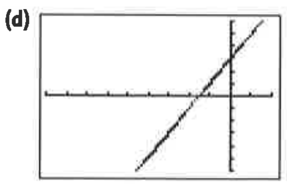
71.



$[-3, 3]$ by $[-2.5, 1.5]$

Domain: All reals
Range: $[-2, 2]$
Symmetric about the y-axis
Continuous

73. **(d)**



$[-9, 2]$ by $[-6, 6]$