9.3 Exercises

1–6 Plot the point given by the polar coordinates.

1. $\left(-1, \frac{5\pi}{4}\right)$
2. $\left(-5, \frac{3\pi}{2}\right)$
3. $\left(\frac{1}{4}, -\frac{7\pi}{6}\right)$
4. $\left(\sqrt{3}, -\frac{\pi}{3}\right)$
5. $\left(\frac{44}{9}, -\pi\right)$
6. $\left(\frac{7}{\sqrt{2}}, \frac{\pi}{2}\right)$

7–12 Convert the point from polar to Cartesian coordinates.

7. $\left(5, \frac{7\pi}{4}\right)$
8. $(0, 2\pi)$
9. $\left(6.25, -\frac{3\pi}{4}\right)$
10. $\left(-2.25, \frac{\pi}{4}\right)$
11. $\left(3, -\frac{5\pi}{6}\right)$
12. $\left(-11, \frac{5\pi}{6}\right)$

13–18 Convert the point from Cartesian to polar coordinates.

13. $(-3, 0)$
14. $\left(-6, \sqrt{3}\right)$
15. $(12, -1)$
16. $(8, 0)$
17. $\left(-\sqrt{3}, 9\right)$
18. $(-5, -5)$

19–30 Rewrite the rectangular equation in polar form.

19. $x^2 + y^2 = 25$
20. $x^2 + y^2 = 81$
21. $x = 12$
22. $y = 16$
23. $y = x$
24. $y = b$
25. $x = 16a$
26. $x^2 + y^2 = a$
27. $x^2 + y^2 = 4ax$
28. $x^2 + y^2 = 4ay$
29. $y^2 - 4 = 4x$
30. $x^2 + y^2 = 36a^2$

31–40 Rewrite the polar equation in rectangular form.

31. $r = 5\cos\theta$
32. $r = 8\sin\theta$
33. $r = 7$
34. $\theta = \frac{\pi}{6}$
35. $18r = 9\csc\theta$
36. $r = 2\sec\theta$
37. $r^2 = \sin 2\theta$
38. $r = \frac{2}{1 - \cos\theta}$
39. $r = \frac{12}{4\sin\theta + 7\cos\theta}$
40. $r = \frac{16}{4 + 4\sin\theta}$

41–46 Rewrite the polar equation in rectangular form; then sketch the graph.

41. $r = 2$
42. $r = 6$
43. $\theta = \frac{5\pi}{6}$
44. $\theta = \frac{\pi}{4}$
45. $r = 7\sec\theta$
46. $r = 2\csc\theta$

47–68 Sketch a graph of the given polar equation.

47. $r = 4$
48. $r = 5$
49. $\theta = \frac{4\pi}{3}$
50. $\theta = \frac{-\pi}{3}$
51. $r = 6\cos\theta$
52. $r = 2\sin\theta$
53. $r = 3 - 3\sin\theta$
54. $r = 6 + 5\cos\theta$
55. $r = 7(1 + \cos\theta)$
56. $r = 2(1 - 2\sin\theta)$
57. $r = 4 - 3\sin\theta$
58. $r = 3 + 4\sin\theta$
59. $r = 3\sin 3\theta$
60. $r = 5\sin 3\theta$
61. $r = 2\sin 2\theta$
62. $r = 4\sin 2\theta$
63. $r = 5\cos 5\theta$
64. $r = 4\cos 5\theta$
65. $r = 4\cos 4\theta$
66. $r = 3\cos 4\theta$
67. $r^2 = 16\sin\theta$
68. $r^2 = 9\cos 2\theta$

69–72 Find all points of intersection of the given polar curves.

69. $r = \sin\theta, \quad r = \cos\theta$
70. $r = \sin 2\theta, \quad r = \cos\theta$
71. $r = 1 - \cos\theta, \quad r = 1 + \sin\theta$
72. $r^2 = 4\sin\theta, \quad r = 1 - \sin\theta$

73. For a fixed $a \in \theta$, explain in geometric terms how the graphs of $f(\theta)$ and $f(\theta - a)$ are related. (**Hint:** For guidance, recall the rectangular analogue.)

74. **a.** Describe the graph of $r = \sec(\theta - \pi/4)$.

    b. How are the graphs of $r = k\sec(\theta - \pi/4)$ related as k ranges over nonzero values? (Do not use graphing technology.)

9.3 Technology Exercises

75–81 Use a graphing utility to sketch the given curve. Whenever applicable, explore how different values of the parameter(s) affect the shape of the graph. Experiment with both integer and noninteger parameters.

75. $r = \cos k\theta$

76. $r = 1 - k_1 \sin k_2\theta$

77. $r = \dfrac{1 + k\sin\theta}{1 - k\sin\theta}$

78. $r = \theta\cos\theta, \quad -2\pi \le \theta \le 2\pi$ (Garfield curve)

79. $r = 1 + 2\sin\dfrac{\theta}{2}$ (nephroid of Freeth)

80. $r = k_1 + k_2\theta$

81. $r = 1 - k_1\cos k_2\theta$