

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. $(-6, \sqrt{3})$

15. $(12, -1)$

16. $(8, 0)$

17. $(-\sqrt{3}, 9)$

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

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

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

80. $r = k_1 + k_2\theta$

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