10.3 EXERCISES

PRACTICE

Plot the point given by the polar coordinates. See Example 1.

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.** $\left(\frac{7}{\sqrt{2}}, \frac{\pi}{2}\right)$

Convert the point from polar to Cartesian coordinates. See Example 2.

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.** $\left(-11, \frac{5\pi}{6}\right)$

Convert the point from Cartesian to polar coordinates. See Example 3.

13. $(-3, 0)$ **14.** $\left(-6, \sqrt{3}\right)$ **15.** $(12, -1)$

16. $(8, 0)$ **17.** $\left(-\sqrt{3}, 9\right)$ **18.** $(-5, -5)$

Rewrite the rectangular equation in polar form. See Example 4.

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.** $x^2 + y^2 = 36a^2$

Rewrite the polar equation in rectangular form. See Example 5.

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.** $r = \frac{16}{4 + 4\sin\theta}$

Rewrite the polar equation in rectangular form; then sketch the graph. See Examples 6 and 7.

41. $r = 2$ **42.** $r = 6$ **43.** $\theta = \frac{5\pi}{6}$

44. $\theta = \frac{\pi}{4}$ **45.** $r = 7\sec\theta$ **46.** $r = 2\csc\theta$

Sketch a graph of the given polar equation. See Examples 8 and 9.

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.** $r^2 = 16\sin 2\theta$

68. $r^2 = 9\cos 2\theta$

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.** $r^2 = 4\sin\theta, \quad r = 1 - \sin\theta$

WRITING & THINKING

73. For a fixed real number a, 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 $r = \sec\left(\theta - \frac{\pi}{4}\right)$.

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

TECHNOLOGY

Use a graphing utility to sketch each of the given curves. 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. $r = 1 + 2\sin\left(\dfrac{\theta}{2}\right)$ (nephroid of Freeth)

80. $r = k_1 + k_2\theta$

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