

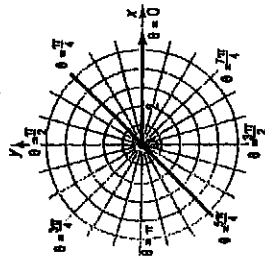
EXERCISES

Problems 1-16, identify each polar equation by transforming the equation to rectangular coordinates. Graph each polar equation by hand. Verify your results using a graphing utility.

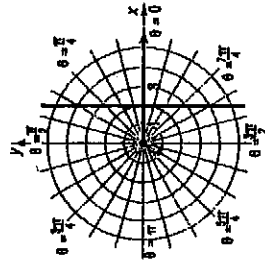
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|-------------------------|-------------------------|--------------------------|--------------------------|
| 1. $r = 4$ | 2. $r = 2$ | 3. $\theta = \pi/3$ | 4. $\theta = -\pi/4$ |
| 5. $r \sin \theta = 4$ | 6. $r \cos \theta = 4$ | 7. $r \cos \theta = -2$ | 8. $r \sin \theta = -2$ |
| 9. $r = 2 \cos \theta$ | 10. $r = 2 \sin \theta$ | 11. $r = -4 \sin \theta$ | 12. $r = -4 \cos \theta$ |
| 13. $r \sec \theta = 4$ | 14. $r \csc \theta = 8$ | 15. $r \csc \theta = -2$ | 16. $r \sec \theta = -4$ |

In Problems 17-24, match each of the graphs (A) through (H) to one of the following polar equations.

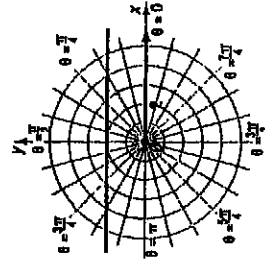
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|---------------------------|-------------------------|-------------------------|-------------------------|
| 17. $r = 2$ | 18. $\theta = \pi/4$ | 19. $r = 2 \cos \theta$ | 20. $r \cos \theta = 2$ |
| 21. $r = 1 + \cos \theta$ | 22. $r = 2 \sin \theta$ | 23. $\theta = 3\pi/4$ | 24. $r \sin \theta = 2$ |



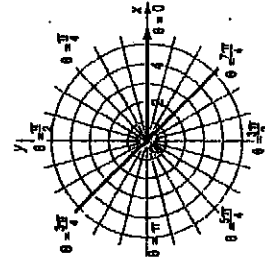
(A)



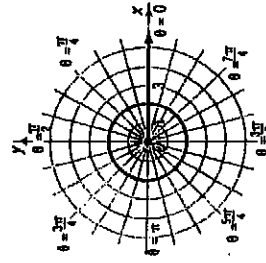
(B)



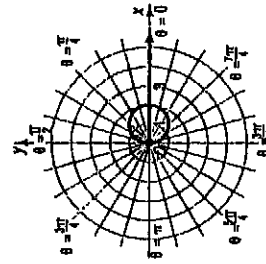
(C)



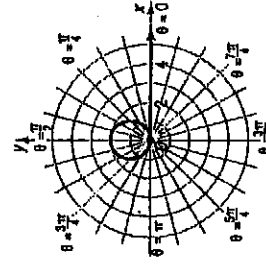
(D)



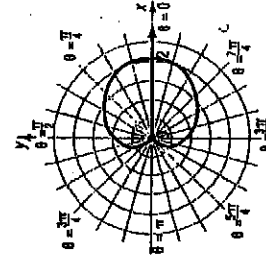
(E)



(F)



(G)



(H)

In Problems 25–30, match each of the graphs (A) through (F) to one of the following polar equations.

25. $r = 4$

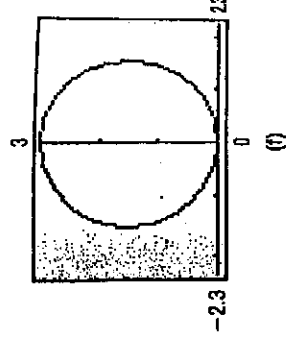
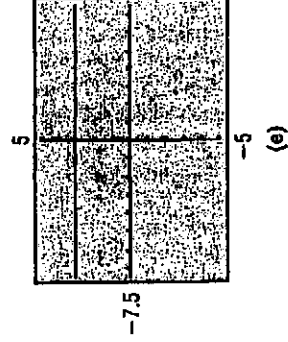
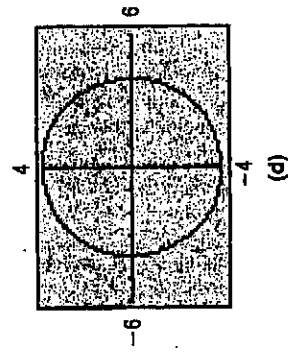
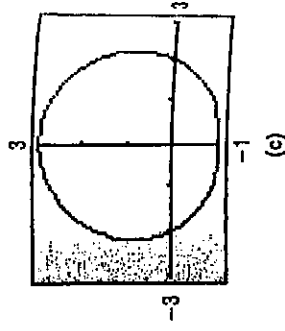
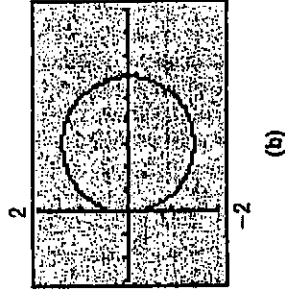
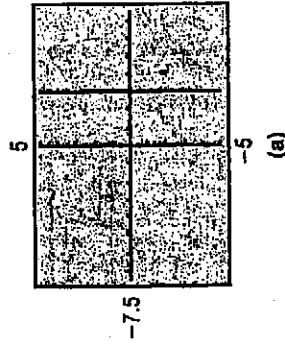
26. $r = 3 \cos \theta$

27. $r = 3 \sin \theta$

28. $r \sin \theta = 3$

29. $r \cos \theta = 3$

30. $r = 2 + \sin \theta$



In Problems 31–54, identify and graph each polar equation by hand. Be sure to test for symmetry. Verify your results using a graphing utility.

31. $r = 2 + 2 \cos \theta$

32. $r = 1 + \sin \theta$

33. $r = 3 - 3 \sin \theta$

34. $r = 2 - 2 \cos \theta$

35. $r = 2 + \sin \theta$

36. $r = 2 - \cos \theta$

37. $r = 4 - 2 \cos \theta$

38. $r = 4 + 2 \sin \theta$

39. $r = 1 + 2 \sin \theta$

40. $r = 1 - 2 \sin \theta$

41. $r = 2 - 3 \cos \theta$

42. $r = 2 + 4 \cos \theta$

43. $r = 3 \cos 2\theta$

44. $r = 2 \sin 2\theta$

45. $r = 4 \sin 3\theta$

46. $r = 3 \cos 4\theta$

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

48. $r^2 = \sin 2\theta$

49. $r = 2^\theta$

50. $r = 3^\theta$

51. $r = 1 - \cos \theta$

52. $r = 3 + \cos \theta$

53. $r = 1 - 3 \cos \theta$

54. $r = 4 \cos 3\theta$

In Problems 55–64, graph each polar equation by hand. Verify your results using a graphing utility.

55. $r = \frac{2}{1 - \cos \theta}$ (parabola)

56. $r = \frac{2}{1 - 2 \cos \theta}$ (hyperbola)

57. $r = \frac{1}{3 - 2 \cos \theta}$ (ellipse)

58. $r = \frac{1}{1 - \cos \theta}$ (parabola)

59. $r = \theta$, $\theta \geq 0$ (spiral of Archimedes)

60. $r = \frac{3}{\theta}$ (reciprocal spiral)

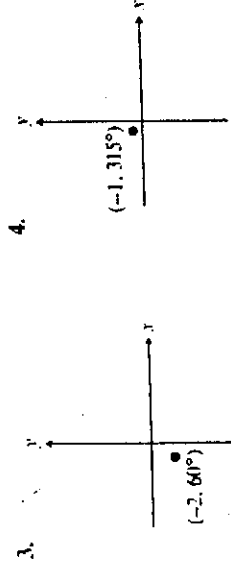
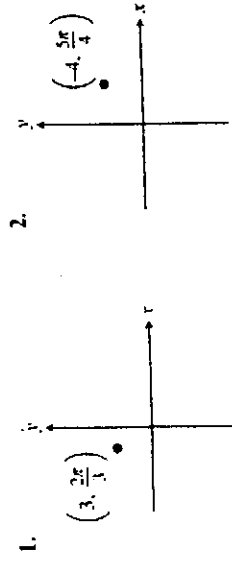
61. $r = \csc \theta - 2$, $0 < \theta < \pi$ (conchoid)

62. $r = \sin \theta \tan \theta$ (cissoid)

63. $r = \tan \theta$ (kappa curve)

64. $r = \cos \frac{\theta}{2}$

In Exercises 1–4, the polar coordinates of a point are given. Find its rectangular coordinates.



In Exercises 5 and 6, (a) complete the table for the polar equation and (b) plot the corresponding points.

5. $r = 3 \sin \theta$

θ	$\pi/4$	$\pi/2$	$5\pi/6$	π	$4\pi/3$	2
r						

6. $r = 2 \csc \theta$

θ	$\pi/4$	$\pi/2$	$5\pi/6$	π	$4\pi/3$	2
r						

In Exercises 7–14, plot the point with the given polar coordinates.

7. $(3, 4\pi/3)$ 8. $(2, 5\pi/6)$
 9. $(-1, 2\pi/5)$ 10. $(-3, 17\pi/10)$

11. $(2, 30^\circ)$ 12. $(3, 210^\circ)$
 13. $(-2, 120^\circ)$ 14. $(-3, 135^\circ)$

In Exercises 15–22, find the rectangular coordinates of the point with given polar coordinates.

15. $(1.5, 7\pi/3)$ 16. $(2.5, 17\pi/4)$
 17. $(-3, -29\pi/7)$ 18. $(-2, -14\pi/5)$
 19. $(-2, \pi)$ 20. $(1, \pi/2)$
 21. $(2, 270^\circ)$ 22. $(-3, 360^\circ)$

In Exercises 23–26, polar coordinates of point P are given. Find all of its polar coordinates.

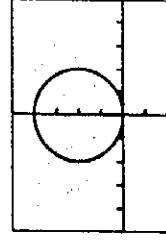
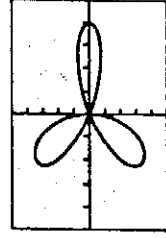
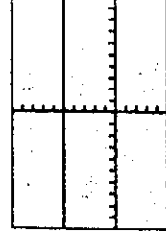
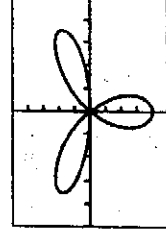
23. $P = (2, \pi/6)$ 24. $P = (1, -\pi/4)$
 25. $P = (1.5, -20^\circ)$ 26. $P = (-2.5, 50^\circ)$

In Exercises 27–30, rectangular coordinates of point P are given. Find all polar coordinates of P that satisfy

- (a) $0 \leq \theta \leq 2\pi$ (b) $-\pi \leq \theta \leq \pi$ (c) $0 \leq \theta \leq 4\pi$
 27. $P = (1, 1)$ 28. $P = (1, 3)$
 29. $P = (-2, 5)$ 30. $P = (-1, -2)$

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In Exercises 31–34, use your grapher to match the polar equation with its graph.



31. $r = 5 \csc \theta$ 32. $r = 4 \sin \theta$
 33. $r = 4 \cos 3\theta$ 34. $r = 4 \sin 3\theta$

In Exercises 35–42, convert the polar equation to rectangular form and identify the graph. Support your answer by graphing the polar equation.

35. $r = 3 \sec \theta$ 36. $r = -2 \csc \theta$
 37. $r = -3 \sin \theta$ 38. $r = -4 \cos \theta$
 39. $r \csc \theta = 1$ 40. $r \sec \theta = 3$
 41. $r = 2 \sin \theta - 4 \cos \theta$ 42. $r = 4 \cos \theta - 4 \sin \theta$

In Exercises 43–50, convert the rectangular equation to polar form. Graph the polar equation.

43. $x = 2$ 44. $x = 5$
 45. $2x - 3y = 5$ 46. $3x + 4y = 2$
 47. $(x - 3)^2 + y^2 = 9$ 48. $x^2 + (y - 1)^2 = 1$
 49. $(x + 3)^2 + (y + 3)^2 = 18$ 50. $(x - 1)^2 + (y + 4)^2 = 17$