

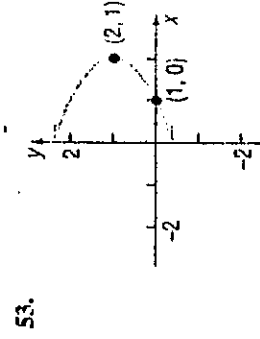
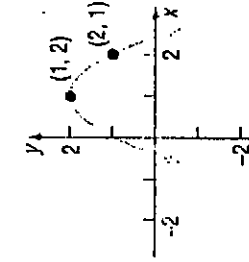
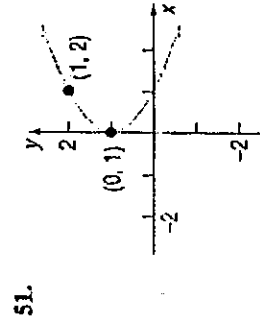
In Problems 17–22, find the equation of the parabola described. Find the two points that define the latus rectum, and graph the equation by hand.

17. Focus at $(4, 0)$; vertex at $(0, 0)$
 18. Focus at $(0, 2)$; vertex at $(0, 0)$
 19. Focus at $(0, -3)$; vertex at $(0, 0)$
 20. Focus at $(-4, 0)$; vertex at $(0, 0)$
 21. Focus at $(-2, 0)$; directrix the line $x = 2$
 22. Focus at $(0, -1)$; directrix the line $y = 1$
 23. Directrix the line $y = -\frac{1}{2}$; vertex at $(0, 0)$
 24. Directrix the line $x = -\frac{1}{2}$; vertex at $(0, 0)$
 25. Vertex at $(2, -3)$; focus at $(2, -5)$
 26. Vertex at $(4, -2)$; focus at $(6, -2)$
 27. Vertex at $(0, 0)$; axis of symmetry the y -axis; containing the point $(2, 3)$
 28. Vertex at $(0, 0)$; axis of symmetry the x -axis; containing the point $(2, 3)$
 29. Focus at $(-3, 4)$; directrix the line $y = 2$
 30. Focus at $(2, 4)$; directrix the line $x = -4$
 31. Focus at $(-3, -2)$; directrix the line $x = 1$
 32. Focus at $(-4, 4)$; directrix the line $y = -2$

In Problems 33–50, find the vertex, focus, and directrix of each parabola. Graph the equation using a graphing utility.

33. $x^2 = 4y$
 34. $y^2 = 8x$
 35. $y^2 = -16x$
 36. $x^2 = -4y$
 37. $(y - 2)^2 = 8(x + 1)$
 38. $(x + 4)^2 = 16(y + 2)$
 39. $(x - 5)^2 = -(y + 1)$
 40. $(y + 1)^2 = -4(x - 2)$
 41. $(y + 3)^2 = 8(x - 2)$
 42. $(x - 2)^2 = 4(y - 3)$
 43. $y^2 - 4y + 4x + 4 = 0$
 44. $x^2 + 6x - 4y + 1 = 0$
 45. $x^2 + 8x = 4y - 8$
 46. $y^2 - 2y = 8x - 1$
 47. $y^2 + 2y - x = 0$
 48. $x^2 - 4x = 2y$
 49. $x^2 - 4x = y + 4$
 50. $y^2 + 12y = -x + 1$

In Problems 51–58, write an equation for each parabola.



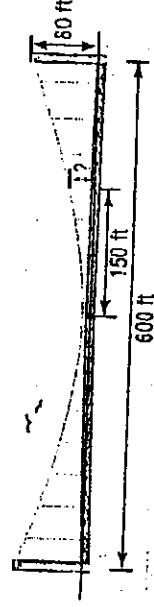
59. **Satellite Dish** A satellite dish is shaped like a paraboloid of revolution. The signals that emanate from a satellite strike the surface of the dish and are reflected to a single point, where the receiver is located. If the dish is 10 feet across at its opening and is 4 feet deep at its center, at what position should the receiver be placed?

60. **Constructing a TV Dish** A cable TV receiving dish is in the shape of a paraboloid of revolution. Find the location of the receiver, which is placed at the focus, if the dish is 6 feet across at its opening and 2 feet deep.

61. **Constructing a Flashlight** The reflector of a flashlight is in the shape of a paraboloid of revolution. Its diameter is 4 inches and its depth is 1 inch. How far from the vertex should the light bulb be placed so that the rays should be reflected parallel to the axis?

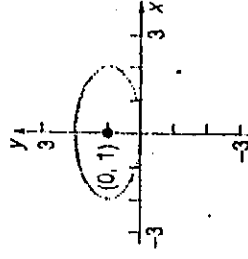
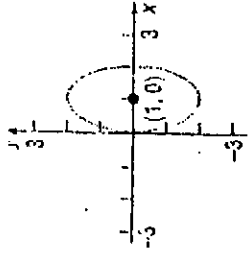
62. **Constructing a Headlight** A sealed-beam headlight is in the shape of a paraboloid of revolution. The bulb, which is placed at the focus, is 1 inch from the vertex. If the depth is to be 2 inches, what is the diameter of the headlight at its opening?

63. **Suspension Bridges** The cables of a suspension bridge are in the shape of a parabola, as shown in the figure. The towers supporting the cable are 600 feet apart and 80 feet high. If the cables touch the road surface midway between the towers, what is the height of the cable at a point 150 feet from the center of the bridge?



64. **Suspension Bridges** The cables of a suspension bridge are in the shape of a parabola. The towers supporting the cable are 400 feet apart and 100 feet high. If the cables are at a height of 10 feet midway between the towers, what is the height of the cable at a point 50 feet from the center of the bridge?

65. **Searchlights** A searchlight is shaped like a paraboloid of revolution. If the light source is located 2 feet from the base along the axis of symmetry and the opening is 5 feet across, how deep should the searchlight be?



In Problems 33–44, find the center, foci, and vertices of each ellipse. Graph each equation using a graphing utility.

33. $\frac{(x-3)^2}{4} + \frac{(y+1)^2}{9} = 1$

35. $(x+5)^2 + 4(y-4)^2 = 16$

37. $x^2 + 4x + 4y^2 - 8y + 4 = 0$

39. $2x^2 + 3y^2 - 8x + 6y + 5 = 0$

41. $9x^2 + 4y^2 - 18x + 16y - 11 = 0$

43. $4x^2 + y^2 + 4y = 0$

34. $\frac{(x+4)^2}{9} + \frac{(y+2)^2}{4} = 1$

36. $9(x-3)^2 + (y+2)^2 = 18$

38. $x^2 + 3y^2 - 12y + 9 = 0$

40. $4x^2 + 3y^2 + 8x - 6y = 5$

42. $x^2 + 9y^2 + 6x - 18y + 9 = 0$

44. $9x^2 + y^2 - 18x = 0$

In Problems 45–54, find an equation for each ellipse. Graph the equation by hand.

45. Center at (2, -2); vertex at (7, -2); focus at (4, -2)

47. Vertices at (4, 3) and (4, 9); focus at (4, 8)

49. Foci at (5, 1) and (-1, 1); length of the major axis is 8

51. Center at (1, 2); focus at (4, 2); contains the point (1, 3)

53. Center at (1, 2); vertex at (4, 2); contains the point (1, 3)

46. Center at (-3, 1); vertex at (-3, 3); focus at (-3, 0)

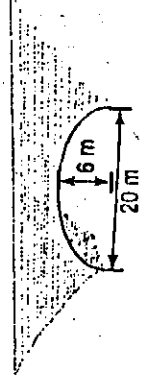
48. Foci at (1, 2) and (-3, 2); vertex at (-4, 2)

50. Vertices at (2, 5) and (2, -1); $c = 2$

52. Center at (1, 2); focus at (1, 4); contains the point (2, 2)

54. Center at (1, 2); vertex at (1, 4); contains the point (2, 2)

59. **Semielliptical Arch Bridge** An arch in the shape of the upper half of an ellipse is used to support a bridge that is to span a river 20 meters wide. The center of the arch is 6 meters above the center of the river (see the figure). Write an equation for the ellipse in which the x -axis coincides with the water level and the y -axis passes through the center of the arch.



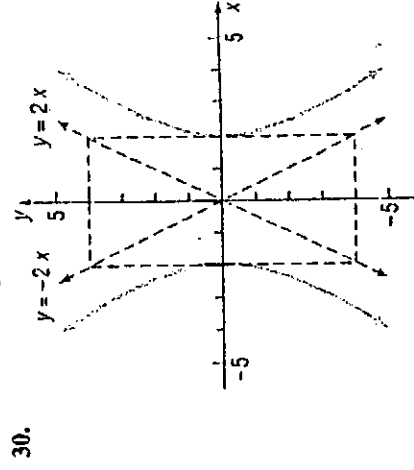
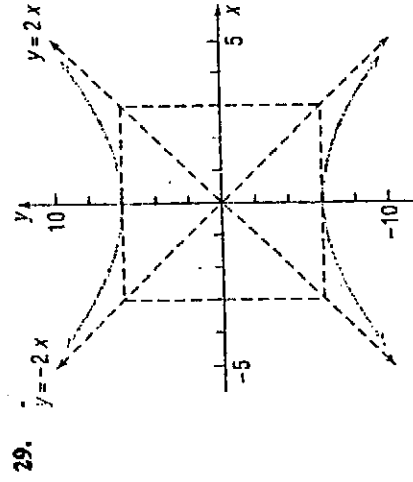
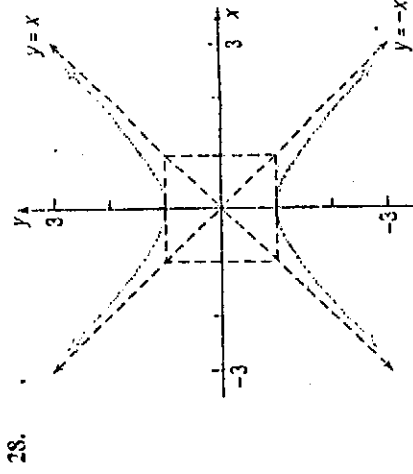
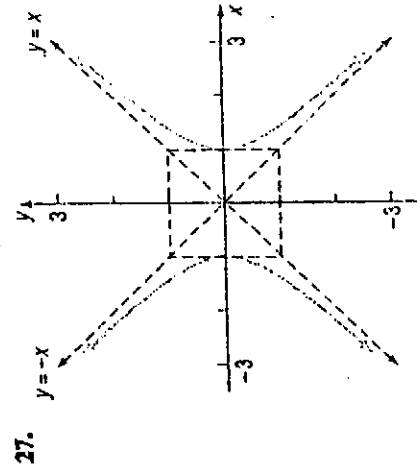
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62. **Whispering Galleries** Jim, standing at one focus of a whispering gallery, is 6 feet from the nearest wall. His friend is standing at the other focus, 100 feet away. What is the length of this whispering gallery? How high is its elliptical ceiling at the center?

63. **Semielliptical Arch Bridge** A bridge is built in the shape of a semielliptical arch. The bridge has a span of 120 feet and a maximum height of 25 feet. Choose a suitable rectangular coordinate system and find the height of the arch at distances of 10, 30, and 50 feet from the center.

64. **Semielliptical Arch Bridge** A bridge is built in the shape of a semielliptical arch and is to have a span of 100 feet. The height of the arch, at a distance of 40 feet from the center, is to be 10 feet. Find the height of the arch at its center.

In Problems 27-30, write an equation for each hyperbola.



In Problems 31-38, find an equation for the hyperbola described. Graph the equation by hand.

31. Center at (4, -1); focus at (7, -1); vertex at (6, -1)
32. Center at (-3, 1); focus at (-3, 6); vertex at (-3, 4)
33. Center at (-3, -4); focus at (-3, -8); vertex at (-3, -2)
34. Center at (1, 4); focus at (-2, 4); vertex at (0, 4)
35. Foci at (3, 7) and (7, 7); vertex at (6, 7)
36. Focus at (-4, 0); vertices at (-4, 4) and (-4, 2)
37. Vertices at (-1, -1) and (3, -1); asymptote the line $(x - 1)/2 = (y + 1)/3$
38. Vertices at (1, -3) and (1, 1); asymptote the line $(x - 1)/2 = (y + 1)/3$

In Problems 39-52, find the center, transverse axis, vertices, foci, and asymptotes. Graph each equation using a graphing utility.

39. $\frac{(x-2)^2}{4} - \frac{(y+3)^2}{9} = 1$ 40. $\frac{(y+3)^2}{4} - \frac{(x-2)^2}{9} = 1$
41. $(y-2)^2 - 4(x+2)^2 = 4$ 42. $(x+4)^2 - 9(y-3)^2 = 9$ 43. $(x+1)^2 - (y+2)^2 = 4$
44. $(y-3)^2 - (x+2)^2 = 4$ 45. $x^2 - y^2 - 2x - 2y - 1 = 0$ 46. $y^2 - x^2 - 4y + 4x - 1 = 0$
47. $y^2 - 4x^2 - 4y - 8x - 4 = 0$ 48. $2y^2 - y^2 + 4x + 4y - 4 = 0$ 49. $4x^2 - y^2 - 24x - 4y + 16 = 0$
50. $2y^2 - x^2 + 2x + 8y + 3 = 0$ 51. $y^2 - 4x^2 - 16x - 2y - 19 = 0$ 52. $x^2 - 3y^2 + 8x - 6y + 4 = 0$