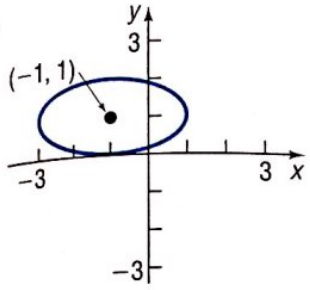
In Problems 19–28, find an equation for each ellipse. Graph the equation by hand.

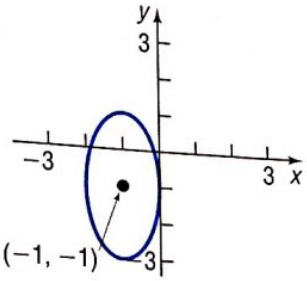
19. Center at $(0, 0)$; focus at $(3, 0)$; vertex at $(5, 0)$
20. Center at $(0, 0)$; focus at $(-1, 0)$; vertex at $(3, 0)$
21. Center at $(0, 0)$; focus at $(0, -4)$; vertex at $(0, 5)$
22. Center at $(0, 0)$; focus at $(0, 1)$; vertex at $(0, -2)$
23. Foci at $(\pm 2, 0)$; length of the major axis is 6
24. Focus at $(0, -4)$; vertices at $(0, \pm 8)$
25. Foci at $(0, \pm 3)$; x-intercepts are ± 2
26. Foci at $(0, \pm 2)$; length of the major axis is 8
27. Center at $(0, 0)$; vertex at $(0, 4)$; $b = 1$
28. Vertices at $(\pm 5, 0)$; $c = 2$

In Problems 29–32, write an equation for each ellipse.

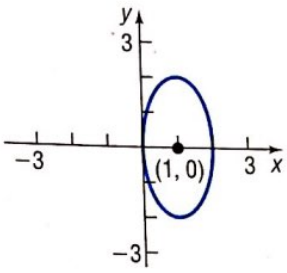
29.



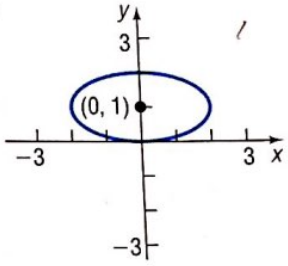
30.



31.



32.



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

33. $\dfrac{(x-3)^2}{4} + \dfrac{(y+1)^2}{9} = 1$
34. $\dfrac{(x+4)^2}{9} + \dfrac{(y+2)^2}{4} = 1$
35. $(x+5)^2 + 4(y-4)^2 = 16$
36. $9(x-3)^2 + (y+2)^2 = 18$
37. $x^2 + 4x + 4y^2 - 8y + 4 = 0$
38. $x^2 + 3y^2 - 12y + 9 = 0$
39. $2x^2 + 3y^2 - 8x + 6y + 5 = 0$
40. $4x^2 + 3y^2 + 8x - 6y = 5$
41. $9x^2 + 4y^2 - 18x + 16y - 11 = 0$
42. $x^2 + 9y^2 + 6x - 18y + 9 = 0$
43. $4x^2 + y^2 + 4y = 0$
44. $9x^2 + y^2 - 18x = 0$

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

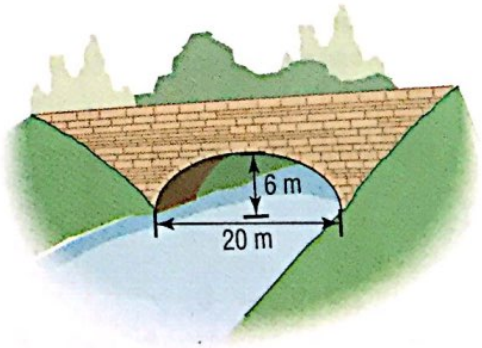
45. Center at $(2, -2)$; vertex at $(7, -2)$; focus at $(4, -2)$
46. Center at $(-3, 1)$; vertex at $(-3, 3)$; focus at $(-3, 0)$
47. Vertices at $(4, 3)$ and $(4, 9)$; focus at $(4, 8)$
48. Foci at $(1, 2)$ and $(-3, 2)$; vertex at $(-4, 2)$
49. Foci at $(5, 1)$ and $(-1, 1)$; length of the major axis is 8
50. Vertices at $(2, 5)$ and $(2, -1)$; $c = 2$
51. Center at $(1, 2)$; focus at $(4, 2)$; contains the point $(1, 3)$
52. Center at $(1, 2)$; focus at $(1, 4)$; contains the point $(2, 2)$
53. Center at $(1, 2)$; vertex at $(4, 2)$; contains the point $(1, 3)$
54. Center at $(1, 2)$; vertex at $(1, 4)$; contains the point $(2, 2)$

In Problems 55–58, graph each function by hand. Use a graphing utility to verify your results.

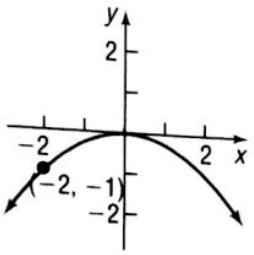
[**Hint:** Notice that each function is half an ellipse.]

55. $f(x) = \sqrt{16 - 4x^2}$
56. $f(x) = \sqrt{9 - 9x^2}$
57. $f(x) = -\sqrt{64 - 16x^2}$
58. $f(x) = -\sqrt{4 - 4x^2}$

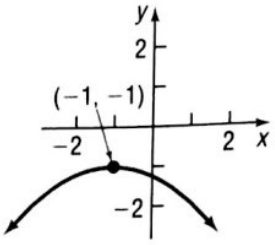
59. **Semielliptical Arch Bridge** An arch in the shape of the upper half of an ellipse is used to support a bridge that is to span a river 20 meters wide. The center of the arch is 6 meters above the center of the river (see the figure). Write an equation for the ellipse in which the x-axis coincides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



4.



5.



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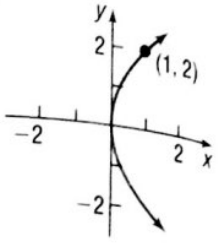

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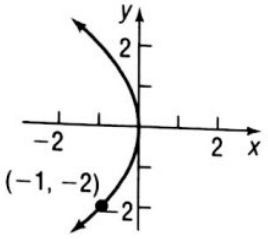

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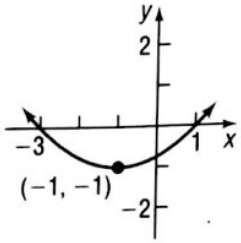


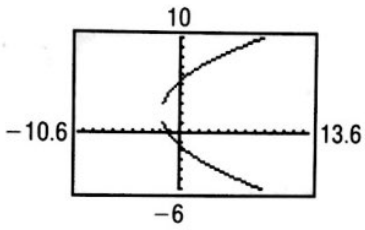
In Problems 9–16, the graph of a parabola is given. Match each graph to its equation.

A. $x^2 = 6y$ *B.* $x^2 = -6y$ *C.* $y^2 = 6x$

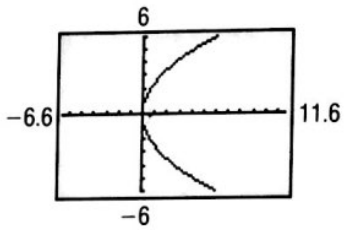
D. $y^2 = -6x$ *E.* $(y - 2)^2 = -6(x + 2)$ *F.* $(y - 2)^2 = 6(x + 2)$

G. $(x + 2)^2 = -6(y - 2)$ *H.* $(x + 2)^2 = 6(y - 2)$

9.



10.



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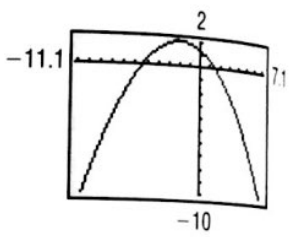

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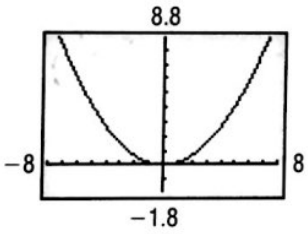

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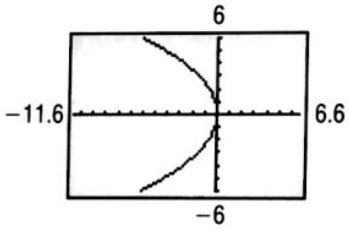

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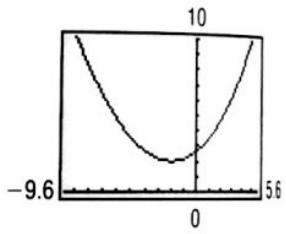

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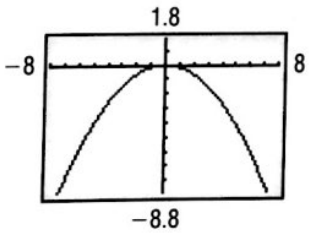
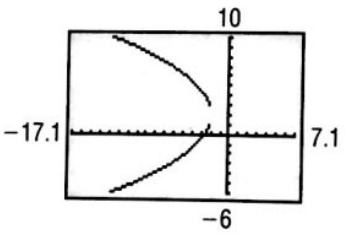


16.



In Problems 17–32, find the equation of the parabola described. Find the two points that define the latus rectum, and graph 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. $(x - 3)^2 = -(y + 1)$

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. $y^2 + 2y - x = 0$

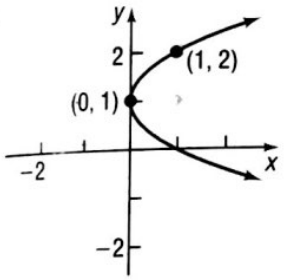
48. $x^2 - 4x = 2y$

49. $x^2 - 4x = y + 4$

50. $y^2 + 12y = -x + 1$

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

51.



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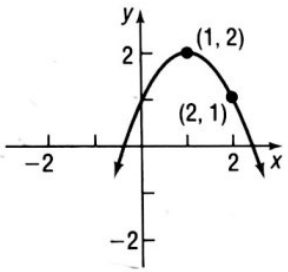

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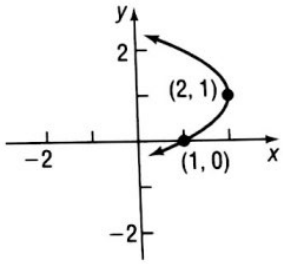
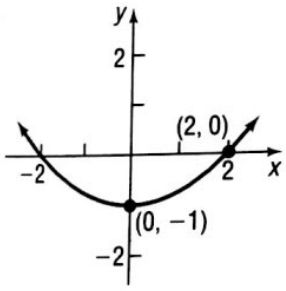
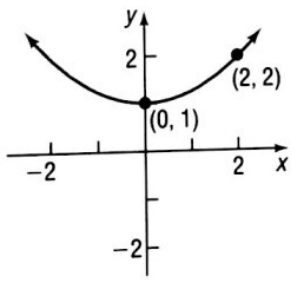


54.



55.



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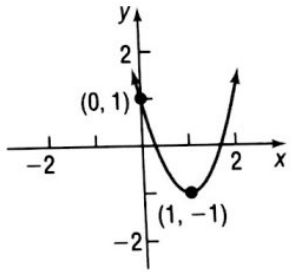

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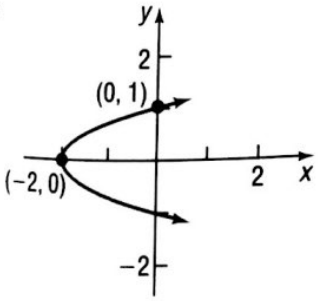
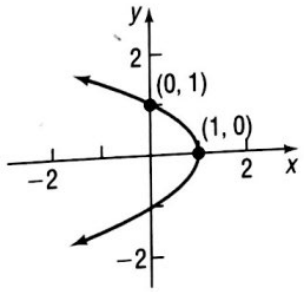


58.



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.