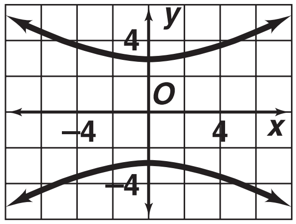
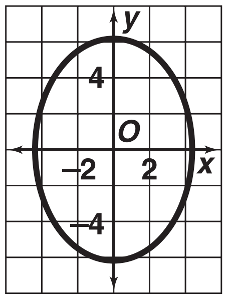
1.



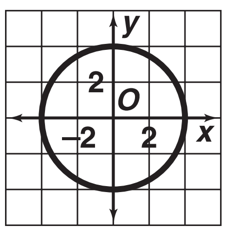
Hyperbola: center (0, 0), y-intercepts at $\pm\frac{5\sqrt{3}}{3}$, no x-intercepts, the lines of symmetry are the x- and y-axes; domain: all real numbers, range: $y \geq \frac{5\sqrt{3}}{3}$ or $y \leq -\frac{5\sqrt{3}}{3}$.

2.



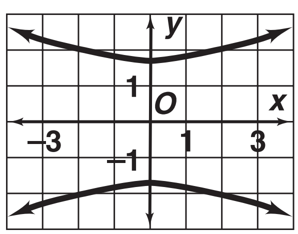
Ellipse: center (0, 0), x-intercepts at $\pm 3\sqrt{2}$, y-intercepts at ± 6, the lines of symmetry are the x- and y-axes; domain: $-3\sqrt{2} \leq x \leq 3\sqrt{2}$, range $-6 \leq y \leq 6$.

3.



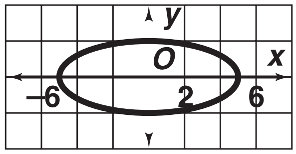
Circle: center (0, 0), radius 4, x-intercepts at ± 4, y-intercepts at ± 4, there are infinitely many lines of symmetry; domain: $-4 \leq x \leq 4$, range: $-4 \leq y \leq 4$.

4.



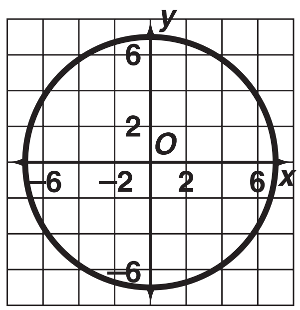
Hyperbola: center (0, 0), y-intercepts at $\pm\sqrt{3}$, no x-intercepts, the lines of symmetry are the x- and y-axes; domain: all real numbers, range: $y \leq -\sqrt{3}$ or $y \geq \sqrt{3}$.

5.



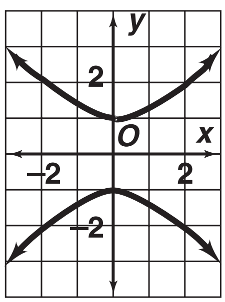
Ellipse: center (0, 0), y-intercepts at ± 2, x-intercepts at ± 5, the lines of symmetry are the x- and y-axes; domain: $-5 \leq x \leq 5$, range: $-2 \leq y \leq 2$.

6.



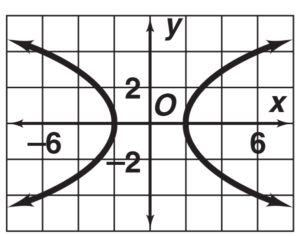
Circle: center (0, 0), radius 7, x- and y-intercepts at ± 7, there are infinitely many lines of symmetry; domain: $-7 \leq x \leq 7$, range: $-7 \leq y \leq 7$.

7.



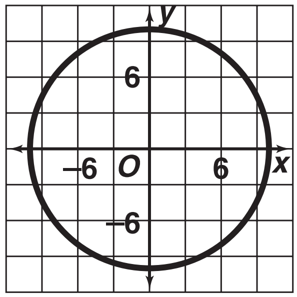
Hyperbola: center (0, 0), y-intercepts at ± 1, the lines of symmetry are the x- and y-axes; domain: all real numbers, range: $y \leq -1$ or $y \geq 1$.

8.



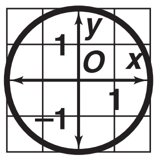
Hyperbola: center (0, 0), x-intercepts at ± 2, the lines of symmetry are the x- and y-axes; domain: $x \leq -2$ or $x \geq 2$, range: all real numbers.

9.



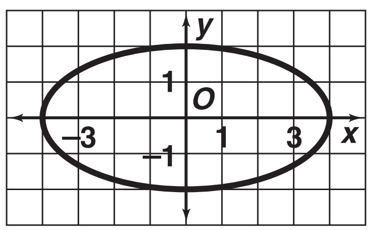
Circle: center (0, 0), radius 10, x- and y-intercepts at ± 10, there are infinitely many lines of symmetry; domain: $-10 \leq x \leq 10$, range: $-10 \leq y \leq 10$.

10.



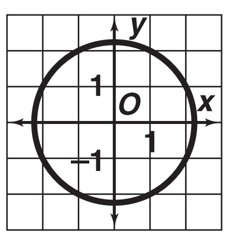
Circle: center (0, 0), radius 2, x- and y-intercepts at ± 2, there are infinitely many lines of symmetry; domain: $-2 \leq x \leq 2$, range: $-2 \leq y \leq 2$.

11.



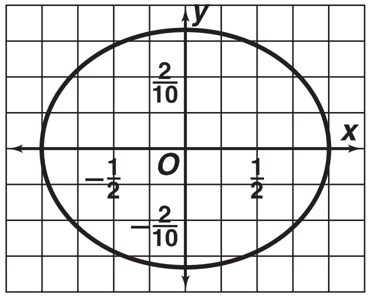
Ellipse: center (0, 0), x-intercepts at ± 4, y-intercepts at ± 2, the lines of symmetry are the x- and y-axes; domain: $-4 \leq x \leq 4$, range: $-2 \leq y \leq 2$.

12.



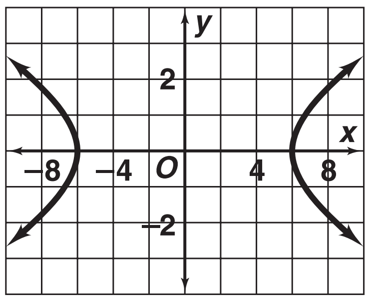
Circle: center (0, 0), radius $\sqrt{5}$, x- and y-intercepts at $\pm\sqrt{5}$, there are infinitely many lines of symmetry; domain: $-\sqrt{5} \leq x \leq \sqrt{5}$, range: $-\sqrt{5} \leq y \leq \sqrt{5}$.

13.



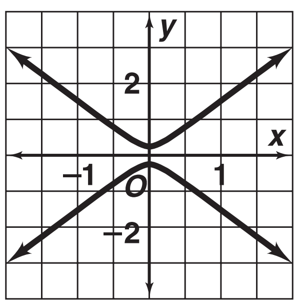
Ellipse: center (0, 0), x-intercepts at ± 1, y-intercepts at $\pm\frac{1}{3}$, the lines of symmetry are the x- and y-axes; domain: $-1 \leq x \leq 1$, range: $-\frac{1}{3} \leq y \leq \frac{1}{3}$.

14.



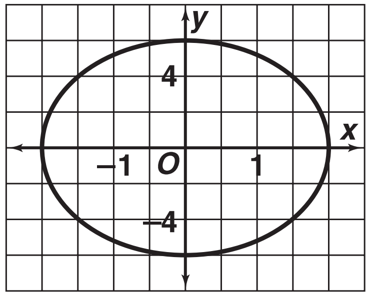
Hyperbola: center (0, 0), x-intercepts at ± 6, the lines of symmetry are the x- and y-axes; domain: $x \leq -6$ or $x \geq 6$, range: all real numbers.

15.



Hyperbola: center (0, 0), y-intercepts at $\pm\frac{1}{2}$, the lines of symmetry are the x- and y-axes; domain: all real numbers, range: $y \leq -\frac{1}{2}$ or $y \geq \frac{1}{2}$.

16.



Ellipse: center (0, 0), x-intercepts at ± 2, y-intercepts at ± 6, the lines of symmetry are the x- and y-axes; domain: $-2 \leq x \leq 2$, range: $-6 \leq y \leq 6$.

17. center (0, 0), x-intercepts at ± 3, y-intercepts at ± 2; domain: $-3 \leq x \leq 3$, range: $-2 \leq y \leq 2$

18. center (0, 0), no x-intercepts, y-intercepts at ± 2; domain: all real numbers, range: $y \leq -2$ or $y \geq 2$

19. center (0, 0), x-intercepts at ± 3, no y-intercepts; domain: $x \leq -3$ or $x \geq 3$, range: all real numbers

20. center (0, 0), x-intercepts at ± 8, y-intercepts at ± 4; domain: $-8 \leq x \leq 8$, range: $-4 \leq y \leq 4$

21. center (0, 0), x-intercepts at ± 3, y-intercepts at ± 5; domain: $-3 \leq x \leq 3$, range: $-5 \leq y \leq 5$

22. center (0, 0), no x-intercepts, y-intercepts at ± 3; domain: all real numbers; range: $y \leq -3$ or $y \geq 3$

23. 19

24. 17

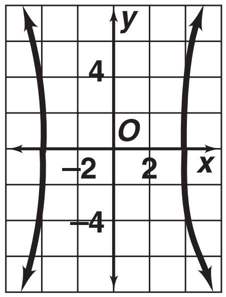
25. 18

26. 20

27. 21

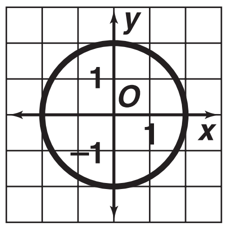
28. 22

29.



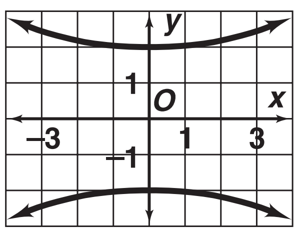
Hyperbola: center (0, 0), x-intercepts ± 4, the lines of symmetry are the x- and y-axes; domain: $x \leq -4$ or $x \geq 4$, range: all real numbers.

30.



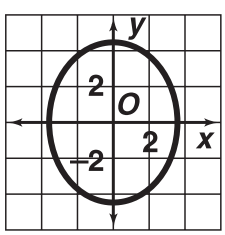
Circle: center (0, 0), radius 2, x- and y-intercepts at ± 2, there are infinitely many lines of symmetry; domain: $-2 \leq x \leq 2$, range: $-2 \leq y \leq 2$.

31.



Hyperbola: center (0, 0), y-intercepts at ± 2, the lines of symmetry are the x- and y-axes; domain: all real numbers, range: $y \leq -2$ or $y \geq 2$.

32.



Ellipse: center (0, 0), x-intercepts at $\pm\frac{8\sqrt{5}}{5}$, y-intercepts at $\pm 2\sqrt{5}$, the lines of symmetry are the x- and y-axes; domain: $-\frac{8\sqrt{5}}{5} \leq x \leq \frac{8\sqrt{5}}{5}$, range: $-2\sqrt{5} \leq y \leq 2\sqrt{5}$.

33. **a.** Let the lamp sit in a normal, upright position, but close enough to the wall for the bottom rim of the shade to almost touch the wall.

b. Hold the lamp so that the shade contacts the wall along a vertical line.

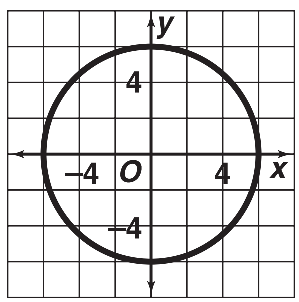
c. Hold the lamp at an angle so that the light from the top of the shade gives a closed, curved oblong area of light on the wall.

d. Hold the lamp so that the circular top rim of the shade is parallel to the wall.

34. **a.** All lines in the plane that pass through the center of a circle are axes of symmetry of the circle.

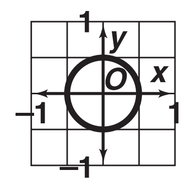
b. The axes of symmetry of an ellipse intersect at the center of the ellipse. The same is true for a hyperbola. This can be confirmed using, for example, $4x^2 + 9y^2 = 36$ and $4x^2 - 9y^2 = 36$.

35.



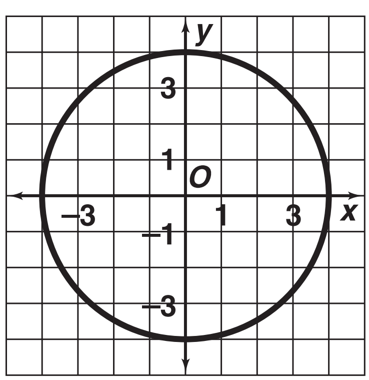
$x^2 + y^2 = 36$

36.



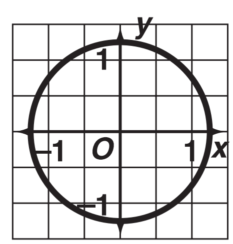
$x^2 + y^2 = \frac{1}{4}$

37.



$x^2 + y^2 = 16$

38.



$x^2 + y^2 = 1.5625$

39. D

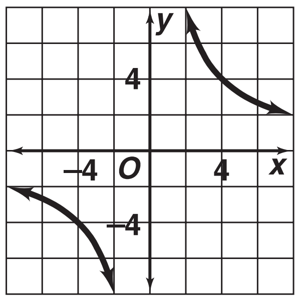
40–45. Answers may vary. Samples are given.

40. $(2, 4)$ **41.** $(\sqrt{2}, 1)$ **42.** $(-2, 2\sqrt{2})$

43. $(2, 0)$ **44.** $(-3, \sqrt{51})$ **45.** $(0, -\sqrt{7})$

46. Check students' work.

47. a.

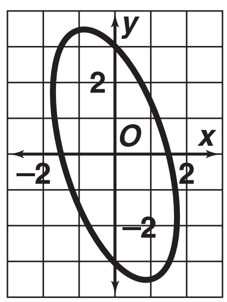


b. hyperbola

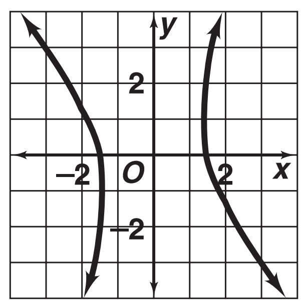
c. No intercepts, but $y = x$ and $y = -x$ are lines of symmetry.

d. yes; $f(x) = \frac{16}{x}$

48. a.



b.



49. one branch of a hyperbola

Answers for Lesson 10-2 Exercises

1. $y = \frac{1}{8}x^2$ **2.** $y = -\frac{1}{4}x^2$ **3.** $x = -\frac{1}{12}y^2$

4. $y = -\frac{1}{32}x^2$ **5.** $y = \frac{1}{8}x^2 + 2$ **6.** $x = \frac{1}{2}y^2$

7. $x = \frac{1}{24}y^2$ **8.** $y = -\frac{1}{16}x^2$ **9.** $y = \frac{1}{28}x^2$

10. $x = -\frac{1}{4}y^2$ **11.** $x = \frac{1}{8}y^2$ **12.** $y = -\frac{1}{20}x^2$

13. $y = \frac{1}{6}x^2$ **14.** $y = 2x^2$

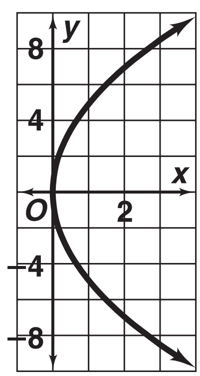
15. Answers may vary. Sample: $y = x^2$; The light produced by the bulb will reflect off the parabolic mirror in parallel rays.

16. $(0, 1), y = -1$ **17.** $\left(0, \frac{1}{4}\right), y = -\frac{1}{4}$ **18.** $(0, -2), y = 2$

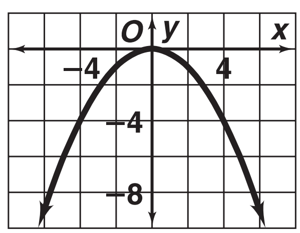
19. $\left(\frac{1}{2}, 0\right), x = -\frac{1}{2}$ **20.** $\left(0, \frac{1}{2}\right), y = -\frac{1}{2}$ **21.** $(9, 0), x = -9$

22. $\left(-\frac{9}{2}, 0\right), x = \frac{9}{2}$ **23.** $\left(0, -\frac{1}{8}\right), y = \frac{1}{8}$

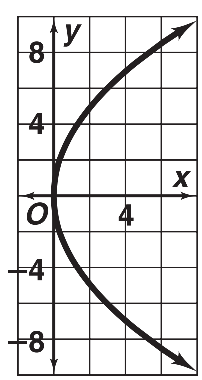
24. $(0, 0), (6, 0), x = -6$



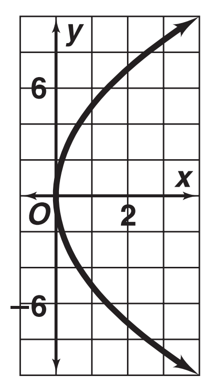
25. $(0, 0), (0, -1), y = 1$



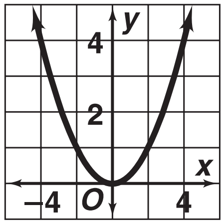
26. $(0, 0), (3, 0), x = -3$



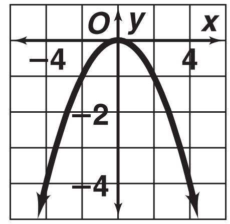
27. $(0, 0), \left(\frac{25}{4}, 0\right), x = -\frac{25}{4}$



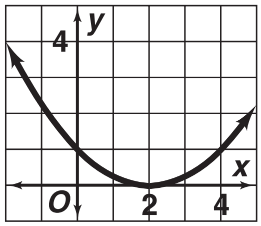
28. $(0, 0), (0, 1), y = -1$



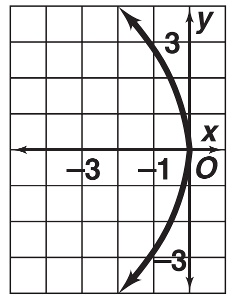
29. $(0, 0), (0, -1), y = 1$



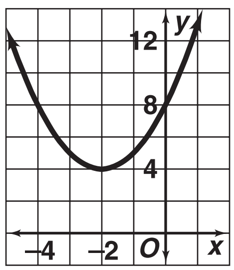
30. $(2, 0), (2, 1), y = -1$



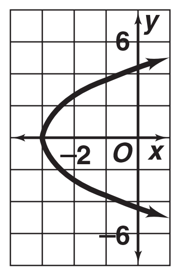
31. $(0, 0), (-2, 0), x = 2$



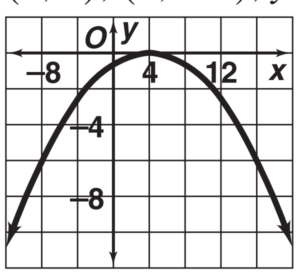
32. $(-2, 4), \left(-2, \frac{17}{4}\right), y = \frac{15}{4}$



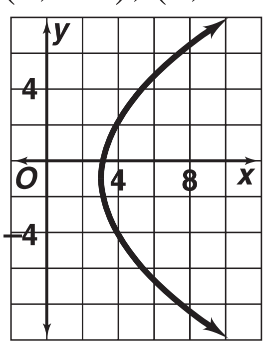
33. $(-3, 0), \left(-\frac{3}{2}, 0\right), x = -\frac{9}{2}$



34. $(4, 0), (4, -6), y = 6$



35. $(3, -1), (6, -1), x = 0$



36. $x = \frac{1}{12}y^2$

37. $y = \frac{1}{400}x^2$

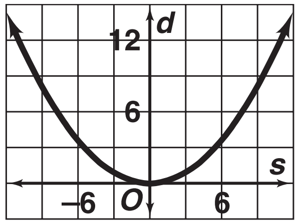
38. $y = -\frac{1}{20}x^2$

39. $x = -\frac{1}{28}y^2$

40. $x = -\frac{1}{36}y^2$

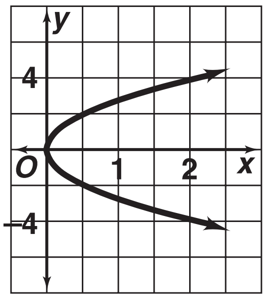
41. $y = -\frac{5}{56}x^2$

42.

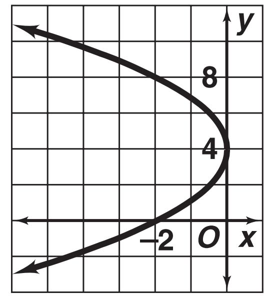


43. $x = -\frac{1}{8}y^2$ **44.** $y = \frac{1}{4}x^2$ **45.** $x = y^2$

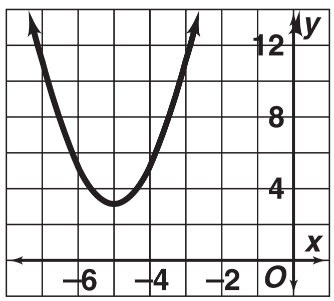
46.



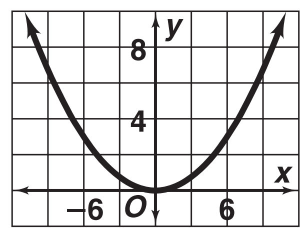
47.



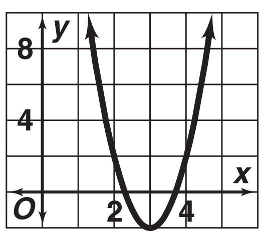
48.



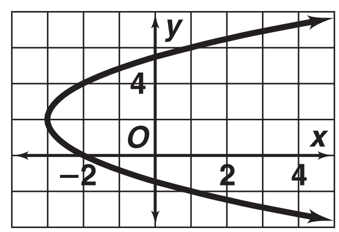
49.



50.



51.



52. $y = \frac{1}{6}(x - 1)^2 + 1$ **53.** $x = -\frac{1}{2}(y - 1)^2 + 1$

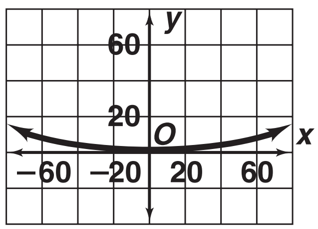
54. $y = -\frac{1}{4}(x - 1)^2 + 1$ **55.** Check students' work.

56. Answers may vary. Sample: Write the equation in the form $x = \frac{1}{4\left(\frac{1}{8}\right)}y^2$. The distance from the focus to the directrix is $2\left(\frac{1}{8}\right)$, or $\frac{1}{4}$.

57. B

58. The directrix will have equation $y = k - c$. A point (x, y) is on the parabola if and only if the distance from (x, y) to the directrix is equal to the distance from (x, y) to the focus. So (x, y) is on the parabola if and only if
$|y - (k - c)| = \sqrt{(x - h)^2 + (y - k - c)^2}$.
Square and simplify to get the equivalent equation
$4cy - 4kc = (x - h)^2$, or $(x - h)^2 = 4c(y - k)$.

59.



60. **a.** the bottom half of the parabola $y^2 = x$

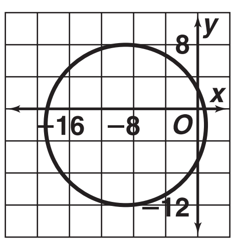
b. domain: all non-negative real numbers, range: all non-positive real numbers

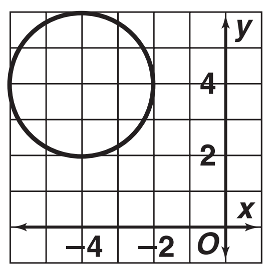
61. **a.** The vertex moves up, and the parabola widens.

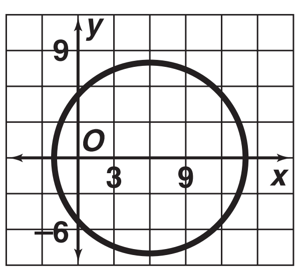
b. The vertex moves down, and the parabola narrows.

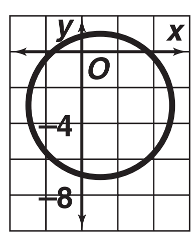
c. The parabola would degenerate into the ray with endpoint $(0, -2)$ that passes through the origin.

Answers for Lesson 10-3 Exercises

1. $x^2 + y^2 = 100$
2. $(x + 4)^2 + (y + 6)^2 = 49$
3. $(x - 2)^2 + (y - 3)^2 = 20.25$
4. $(x + 6)^2 + (y - 10)^2 = 1$
5. $(x - 1)^2 + (y + 3)^2 = 100$
6. $(x + 5)^2 + (y + 1)^2 = 36$
7. $(x + 3)^2 + y^2 = 64$
8. $(x + 1.5)^2 + (y + 3)^2 = 4$
9. $x^2 + (y + 1)^2 = 9$
10. $(x + 1)^2 + y^2 = 1$
11. $(x - 2)^2 + (y + 4)^2 = 25$
12. $(x + 1)^2 + (y - 3)^2 = 81$
13. $x^2 + (y + 5)^2 = 100$
14. $(x - 3)^2 + (y - 2)^2 = 49$
15. $(x + 6)^2 + (y - 1)^2 = 20$
16. $(x - 5)^2 + y^2 = 50$
17. $(x + 3)^2 + (y - 4)^2 = 9$
18. $(x - 2)^2 + (y + 6)^2 = 16$
19. $(1, 1), 1$
20. $(-2, 10), 2$
21. $(3, -1), 6$
22. $(-3, 5), 9$
23. $(0, -3), 5$
24. $(-6, 0), 11$
25. $(-2, -4), 16$
26. $(3, 7), 4\sqrt{6}$
27. 

28. 

29. 

30. 

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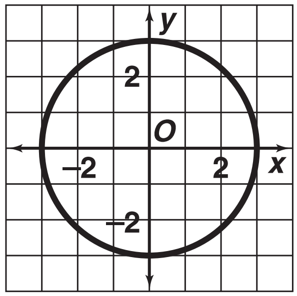

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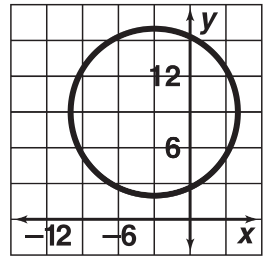

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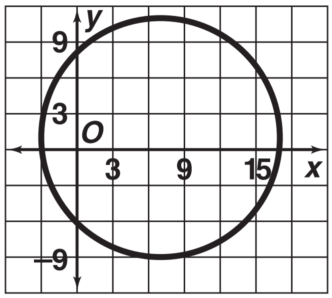

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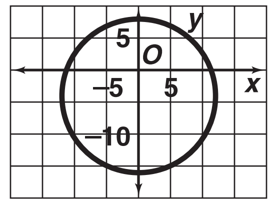


35. $x^2 + y^2 = 16$

36. $x^2 + y^2 = 9$

37. $x^2 + y^2 = 25$

38. $x^2 + y^2 = 3$

39. $x^2 + y^2 = 25$

40. $x^2 + y^2 = 169$

41. $x^2 + y^2 = 169$

42. $x^2 + y^2 = 13$

43. $x^2 + y^2 = 26$

44. $x^2 + y^2 = 52$

45. $(x + 6)^2 + (y - 13)^2 = 49$

46. $(x - 5)^2 + (y + 3)^2 = 25$

47. $(x + 2)^2 + (y - 7.5)^2 = 2.25$

48. $(x - 1)^2 + (y + 2)^2 = 10$

49. $(x - 2)^2 + (y - 1)^2 = 25$

50. $(x - 6)^2 + (y - 4)^2 = 25$

51. $(x + 1)^2 + (y + 7)^2 = 36$

52. A

53. Check students' work.

54. Replacing x with $x + 7$ and y with $y - 7$ has the effect of translating the circle 7 units left and 7 units up.

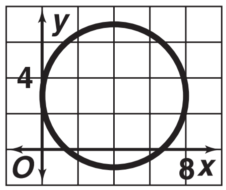
55. $(0, 0), \sqrt{2}$ **56.** $(0, -1), \sqrt{5}$ **57.** $(0, 0), \sqrt{14}$

58. $(0, 4), \sqrt{11}$ **59.** $(-5, 0), 3\sqrt{2}$ **60.** $(-2, -4), 5\sqrt{2}$

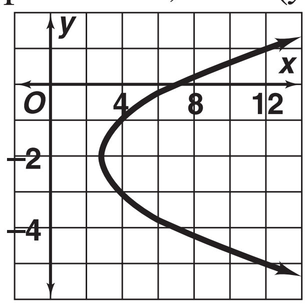
61. $(-3, 5), \sqrt{38}$ **62.** $(-1, 0), 2$ **63.** $(3, 1), \sqrt{6}$

64. $(0, 2), 2\sqrt{5}$

65. circle; $(x - 4)^2 + (y - 3)^2 = 16$;



66. parabola; $x = (y + 2)^2 + 3$;

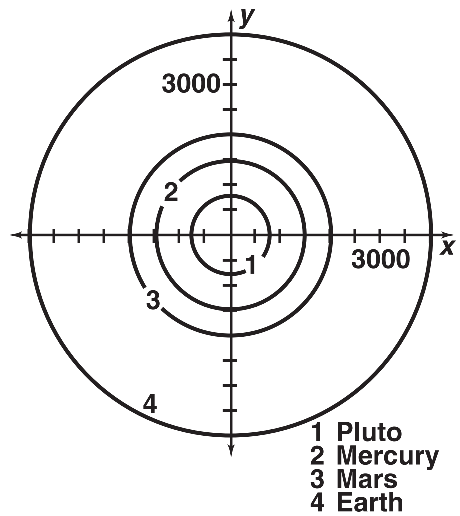


67. Let $P(x, y)$ be any point on the circle centered at the origin and having radius r. If $P(x, y)$ is one of the points $(r, 0)$, $(-r, 0)$, $(0, r)$, or $(0, -r)$, substitution shows that $x^2 + y^2 = r^2$. If $P(x, y)$ is any other point on the circle, drop a perpendicular $\overline{PK}$ from P to the x-axis (K on the x-axis). ΔOPK is a right triangle with legs of lengths $|x|$ and $|y|$ and with hypotenuse of length r. By the Pythagorean Theorem, $|x|^2 + |y|^2 = r^2$. But $|x|^2 = x^2$ and $|y|^2 = y^2$. So $x^2 + y^2 = r^2$.

68. **a.** The radius would have length 0.

b. point $(0, 0)$

69. a.



b. Earth: $x^2 + y^2 = 15{,}705{,}369$
Mars: $x^2 + y^2 = 4{,}456{,}321$
Mercury: $x^2 + y^2 = 2{,}296{,}740$
Pluto: $x^2 + y^2 = 511{,}225$

70. a. $(x - 3)^2 + (y - 4)^2 = 25$

b. $y = -\frac{1}{3}x^2 + \frac{10}{3}x$

Answers for Lesson 10-4 Exercises

1. $\frac{x^2}{16} + \frac{y^2}{9} = 1$

2. $\frac{x^2}{4} + y^2 = 1$

3. $\frac{x^2}{9} + y^2 = 1$

4. $x^2 + \frac{y^2}{36} = 1$

5. $\frac{x^2}{16} + \frac{y^2}{49} = 1$

6. $\frac{x^2}{36} + \frac{y^2}{25} = 1$

7. $\frac{x^2}{81} + \frac{y^2}{4} = 1$

8. $\frac{x^2}{9} + \frac{y^2}{25} = 1$

9. $\frac{x^2}{2.25} + \frac{y^2}{0.25} = 1$

10. $\frac{x^2}{64} + \frac{y^2}{256} = 1$

11. $\frac{x^2}{36} + \frac{y^2}{100} = 1$

12. $\frac{x^2}{12.25} + \frac{y^2}{25} = 1$

13. $\frac{x^2}{196} + \frac{y^2}{49} = 1$

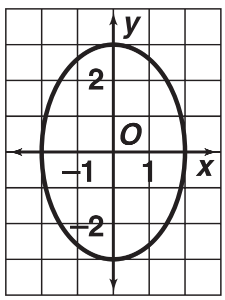
14. $x^2 + \frac{y^2}{16} = 1$

15. $\frac{x^2}{256} + \frac{y^2}{56.25} = 1$

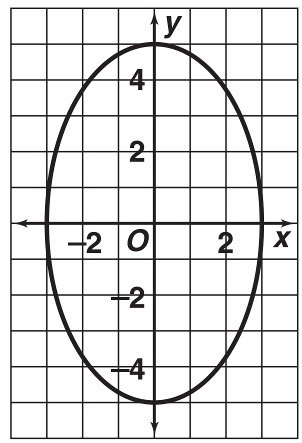
16. $\frac{x^2}{900} + \frac{y^2}{400} = 1$

17. $x^2 + \frac{y^2}{6.25} = 1$

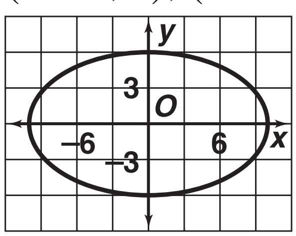
18. $(0, \sqrt{5}), (0, -\sqrt{5})$



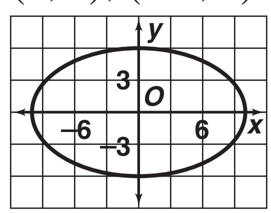
19. $(0, 4), (0, -4)$



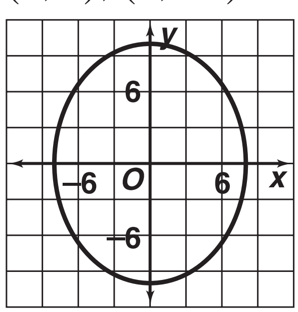
20. $(4\sqrt{2}, 0), (-4\sqrt{2}, 0)$



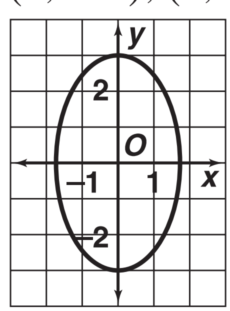
21. $(8, 0), (-8, 0)$



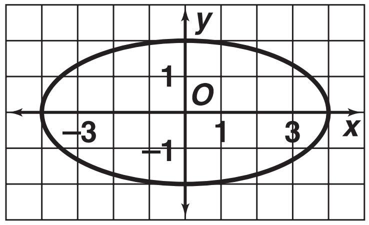
22. $(0, 6), (0, -6)$



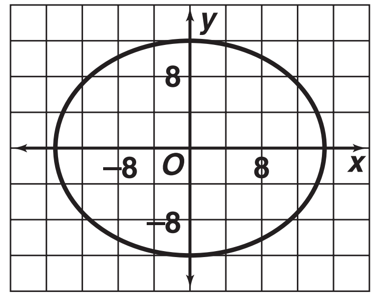
23. $(0, \sqrt{6}), (0, -\sqrt{6})$



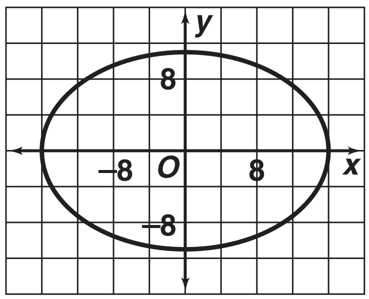
24. $(2\sqrt{3}, 0), (-2\sqrt{3}, 0)$



25. $(9, 0), (-9, 0)$



26. $(3\sqrt{15}, 0), (-3\sqrt{15}, 0)$



27. $\frac{x^2}{100} + \frac{y^2}{64} = 1$

28. $\frac{x^2}{64} + \frac{y^2}{128} = 1$

29. $\frac{x^2}{89} + \frac{y^2}{64} = 1$

30. $\frac{x^2}{4} + \frac{y^2}{20} = 1$

31. $\frac{x^2}{245} + \frac{y^2}{49} = 1$

32. $\frac{x^2}{514} + \frac{y^2}{225} = 1$

33. $(\sqrt{5}, 0), (-\sqrt{5}, 0)$

34. $(0, 2\sqrt{3}), (0, -2\sqrt{3})$

35. $(0, 4\sqrt{2}), (0, -4\sqrt{2})$

36. $(0, \sqrt{21}), (0, -\sqrt{21})$

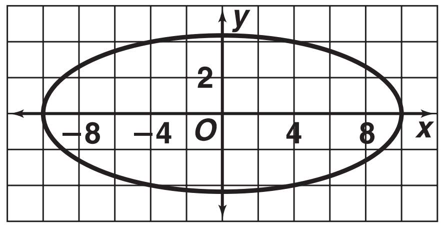
37. $(0, 2\sqrt{7}), (0, -2\sqrt{7})$

38. $(0, 1), (0, -1)$

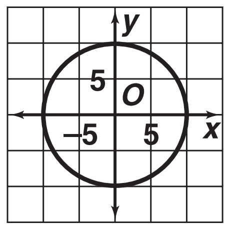
39. $(-3, 8), (-3, 2)$

40. $(-2, \sqrt{2}), (-2, -\sqrt{2})$

41. **a.** 0.9;



b. 0.1;



c. The shape is close to a circle.

d. The shape is close to a line segment.

42. B

43. **a.** Since $c^2 = a^2 - b^2$, if the foci are close to 0, c^2 will be close to 0 and a^2 will be close to b^2. This means a will be close to b and hence the ellipse will be close to a circle.

b. If F_1 and F_2 are considered distinct pts., then a circle is not an ellipse. If F_1 and F_2 are the same pt., then a circle is an ellipse.

44. $\frac{x^2}{9} + \frac{y^2}{4} = 1$

45. $\frac{x^2}{16} + y^2 = 1$

46. $x^2 + \frac{y^2}{9} = 1$

47. $\frac{x^2}{4} + \frac{y^2}{16} = 1$

48. The vertices are the points farthest from the center and the co-vertices are the points closest to the center.

49. Check students' work.

50. $\frac{x^2}{4} + \frac{y^2}{3} = 1$

51. $\frac{x^2}{25} + \frac{y^2}{4} = 1$

52. $\frac{x^2}{121} + \frac{y^2}{81} = 1$

53. $\frac{x^2}{702.25} + \frac{y^2}{210.25} = 1$

54. $\frac{x^2}{169} + \frac{y^2}{144} = 1$

55. $\frac{x^2}{256} + \frac{y^2}{324} = 1$

56. $\frac{x^2}{72.25} + \frac{y^2}{90.25} = 1$

57. $\frac{x^2}{400} + \frac{y^2}{100} = 1$

58. $\frac{x^2}{16} + \frac{y^2}{12} = 1$

59. $\frac{x^2}{16} + \frac{y^2}{25} = 1$

60. $\frac{x^2}{39} + \frac{y^2}{64} = 1$

61. $\frac{x^2}{36} + \frac{y^2}{27} = 1$

62. $\frac{x^2}{4} + \frac{y^2}{9} = 1$

63. $\frac{x^2}{18} + \frac{y^2}{20} = 1$

64. **a.** The vertices are at the points where the curve intersects the line through the holes made by the tacks. The co-vertices are the points where the curve intersects the perpendicular bisector of the segment connecting the vertices.

b. at the points where the tacks are stuck in the paper

c. Check students' work.

65. When c is close to 0, the values of a and b are almost the same, and πab is close to πa^2, that is, close to the area of a circle of radius a.

66. **a.** 3×10^6 mi

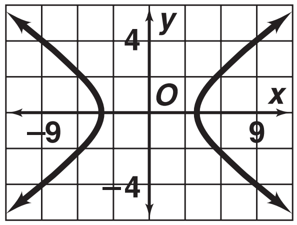
b. about 0.016

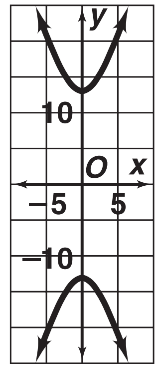
c. $\frac{x^2}{8.649 \times 10^{15}} + \frac{y^2}{8.64675 \times 10^{15}} = 1$

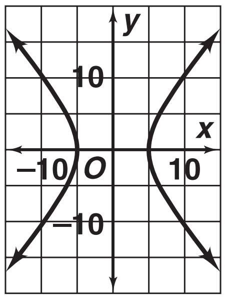
67. area of blue region = 3(area of white region)

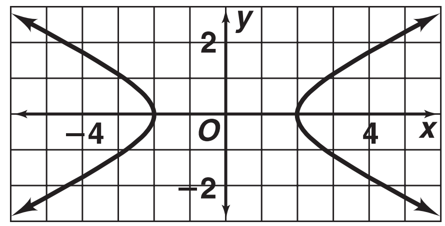
68. $10\sqrt{799}$ or about 282.7 ft

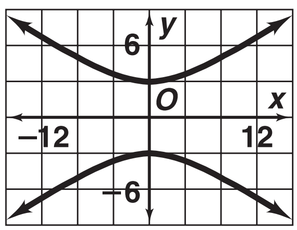
Answers for Lesson 10-5 Exercises

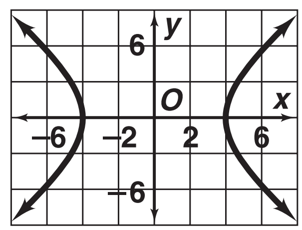
1. 

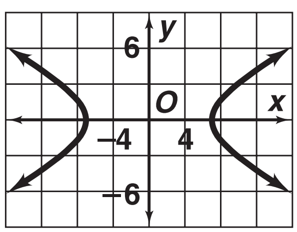
2. 

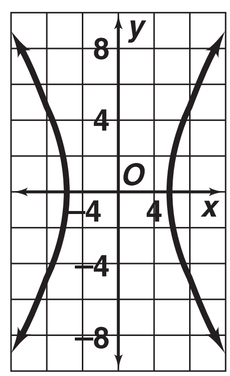
3. 

4. 

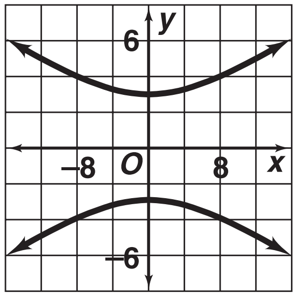
5. 

6. 

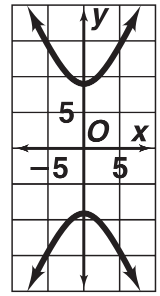
7. 

8. 

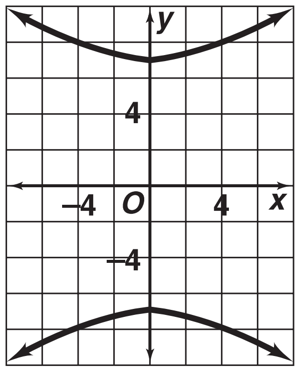
9.



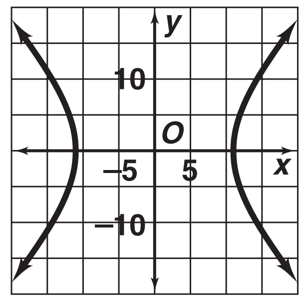
10. $(0, \sqrt{97}), (0, -\sqrt{97})$



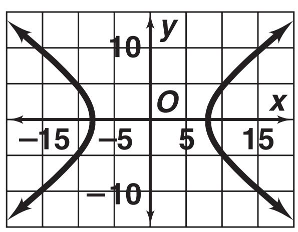
11. $(0, \sqrt{113}), (0, -\sqrt{113})$



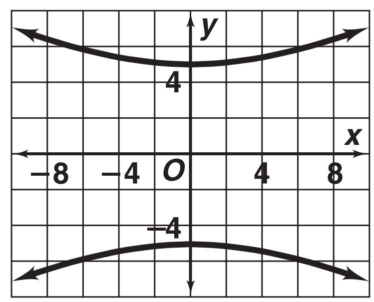
12. $(\sqrt{265}, 0), (-\sqrt{265}, 0)$



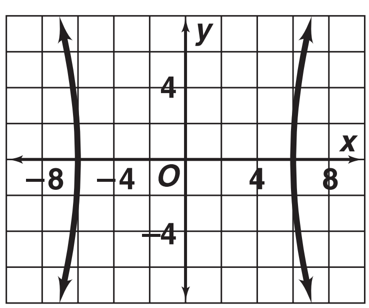
13. $(10, 0), (-10, 0)$



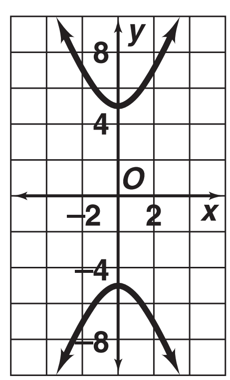
14. $(0, 5\sqrt{5}), (0, -5\sqrt{5})$



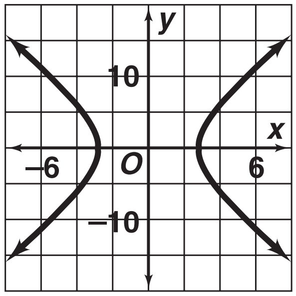
15. $(\sqrt{205}, 0), (-\sqrt{205}, 0)$



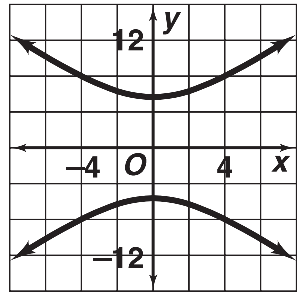
16. $(0, \sqrt{29}), (0, -\sqrt{29})$



17. $(2\sqrt{11}, 0), (-2\sqrt{11}, 0)$



18. $(0, 4\sqrt{3}), (0, -4\sqrt{3})$



19. $\frac{x^2}{69{,}169} - \frac{y^2}{96{,}480} = 1$

20. $\frac{x^2}{240{,}000} - \frac{y^2}{10{,}000} = 1$

21. $\frac{x^2}{192{,}432{,}384} - \frac{y^2}{170{,}203{,}465} = 1$

22. $\frac{x^2}{1.856 \times 10^{12}} - \frac{y^2}{5.270 \times 10^{11}} = 1$

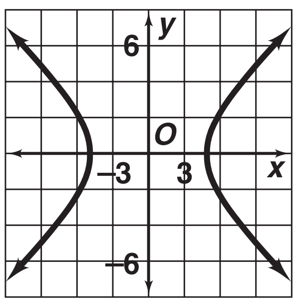
23. $\frac{x^2}{9} - \frac{y^2}{16} = 1$

24. $\frac{y^2}{25} - \frac{x^2}{144} = 1$

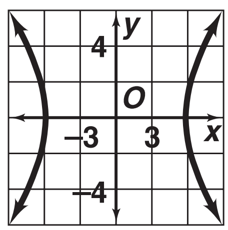
25. $y^2 - \frac{x^2}{3} = 1$

26. $\frac{x^2}{4} - y^2 = 1$

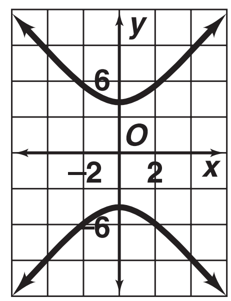
27.



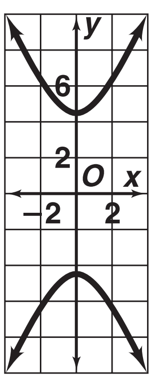
28.



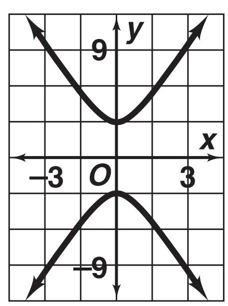
29.



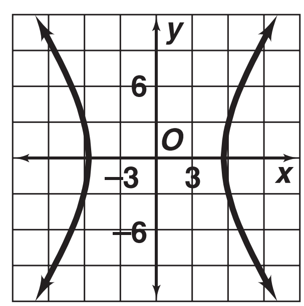
30. $\frac{y^2}{20.25} - \frac{x^2}{4} = 1$



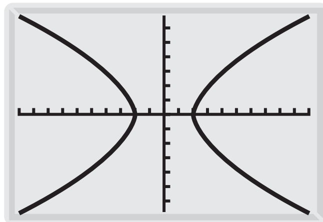
31. $\frac{y^2}{9} - x^2 = 1$



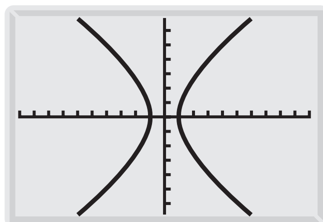
32. $\frac{x^2}{32} - \frac{y^2}{64} = 1$



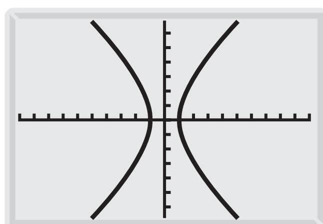
33. $y = \pm\frac{1}{2}\sqrt{2x^2 - 8}$; $(2, 0)$, $(-2, 0)$



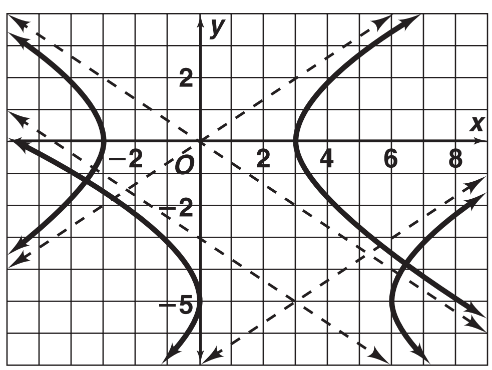
34. $y = \pm\sqrt{x^2 - 1}$; $(1, 0)$, $(-1, 0)$



35. $y = \pm\sqrt{3x^2 - 2}$; $(-0.816, 0)$, $(0.816, 0)$



36. $\frac{x^2}{9} - \frac{y^2}{4} = 1$; $\frac{(x - 3)^2}{9} - \frac{(y - 5)^2}{4} = 1$



37. Check students' work.

38. Answers may vary. Sample: axes of symmetry, vertices, asymptotes

39. Answers may vary. Sample: Similarities—Both have two axes of symmetry that intersect at the center of the figure. Both have two foci that lie on the same line as the two "principal" vertices. Differences—An ellipse consists of points whose distances from the foci have a constant sum, but a hyperbola consists of points whose distances from the foci have a constant difference. An ellipse is a closed curve, but a hyperbola is not and has two separate branches that do not touch. Hyperbolas have asymptotes, but ellipses do not. An ellipse intersects both its axes of symmetry, but a hyperbola intersects only one of its axes of symmetry.

40. $(0, \pm 1), y = \pm x$

41. $(\pm 1, 0), y = \pm \frac{1}{3}x$

42. $(0, \pm 8), y = \pm 2x$

43. $(\pm 5, 0), y = \pm \frac{4}{5}x$

44. $(0, \pm 4), y = \pm 2x$

45. $(\pm 7, 0), y = \pm \frac{5}{7}x$

46. a. If the hyperbola $\frac{y^2}{a^2} - \frac{x^2}{b^2} = 1$ crossed either $y = \frac{a}{b}x$ or $y = -\frac{a}{b}x$, then there would have to be a value of x and a value of y for which $\frac{a}{b}\sqrt{x^2 + b^2} = \frac{a}{b}x$ or $\frac{a}{b}\sqrt{x^2 + b^2} = -\frac{a}{b}x$. That would require that $\sqrt{x^2 + b^2} = x$ or $\sqrt{x^2 + b^2} = -x$. But squaring these equations gives $x^2 + b^2 = x^2$. This would mean that $b^2 = 0$ and hence $b = 0$. But for any hyperbola, $b > 0$. So the hyperbola never intersects its asymptotes.

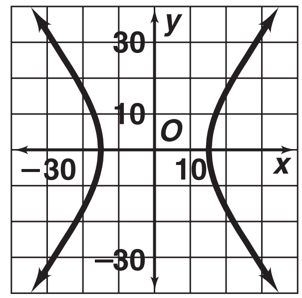
b. Yes; multiply both sides by $\frac{1}{4}$ to obtain $\frac{y^2}{64} - \frac{x^2}{36} = 1$. This equation is clearly an equation of a hyperbola. Yes; multiply both sides by -1 to obtain $\frac{x^2}{9} - \frac{y^2}{16} = 1$. This equation is clearly an equation of a hyperbola.

47. **a.** your airport

b. 30 km

c. $\frac{x^2}{225} - \frac{y^2}{351} = 1$

d.



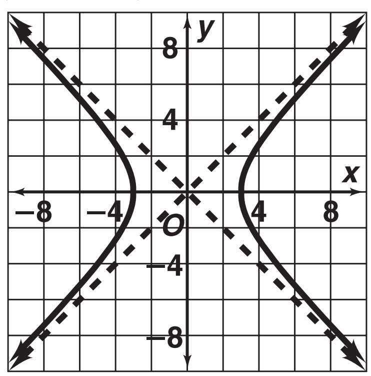
the branch that contains the vertex closest to your airport

48. **a.** For the x-values in those rows, the value of $x^2 - 9$ is negative and so $\sqrt{x^2 - 9}$ is not a real number.

b. As x increases, y increases, but the difference between x and y gets closer to zero.

c. No; for positive values of x greater than 3, $x = \sqrt{x^2}$ and $\sqrt{x^2} \neq \sqrt{x^2 - 9}$.

d. $y = x$, $y = -x$;



Answers for Lesson 10-6 Exercises

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

2. $\frac{(x-5)^2}{16} + \frac{(y-3)^2}{36} = 1$

3. $\frac{x^2}{36} + \frac{(y+4)^2}{25} = 1$

4. $\frac{(x-3)^2}{9} + \frac{(y+6)^2}{49} = 1$

5. $\frac{(x+3)^2}{16} - \frac{(y+3)^2}{9} = 1$

6. $\frac{(y+3)^2}{4} - \frac{(x-4)^2}{32} = 1$

7. $\frac{(x+1)^2}{9} - \frac{(y-2)^2}{40} = 1$

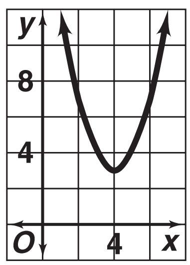
8. $\frac{(y+1)^2}{25} - \frac{(x+1)^2}{56} = 1$

9. $\frac{(y-1)^2}{9} - \frac{x^2}{16} = 1$

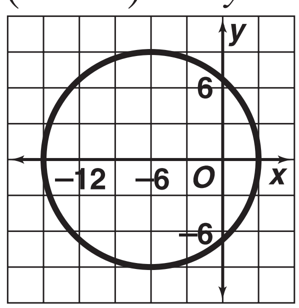
10. $\frac{(x-150)^2}{1296} - \frac{y^2}{21{,}204} = 1$

11. $\frac{(x-175)^2}{1936} - \frac{y^2}{28{,}689} = 1$

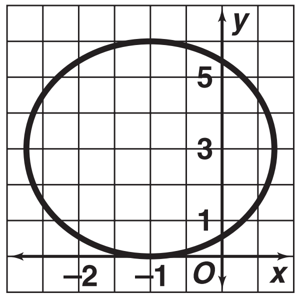
12. $y = (x-4)^2 + 3$; parabola, vertex $(4, 3)$



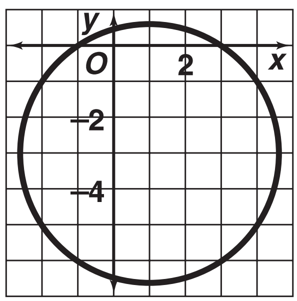
13. $(x+6)^2 + y^2 = 81$; circle, center $(-6, 0)$, radius 9



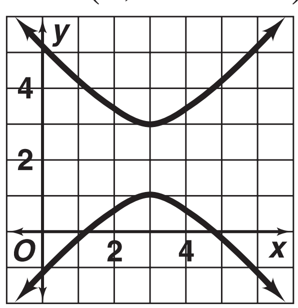
14. $\frac{(x+1)^2}{3} + \frac{(y-3)^2}{9} = 1$; ellipse, center $(-1, 3)$, foci $(-1, 3 \pm \sqrt{6})$



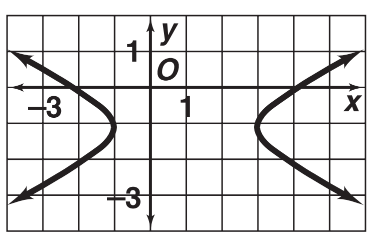
15. $(x-1)^2 + (y+3)^2 = 13$; circle, center $(1, -3)$, radius $\sqrt{13}$



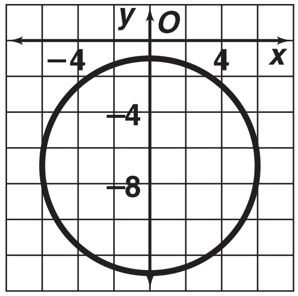
16. $(y-2)^2 - (x-3)^2 = 1$; hyperbola, center $(3, 2)$, foci $(3, 2 \pm \sqrt{2})$



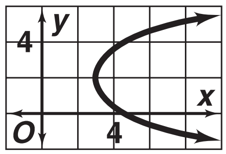
17. $\frac{(x-1)^2}{4} - (y+1)^2 = 1$; hyperbola, center $(1, -1)$, foci $(1 \pm \sqrt{5}, -1)$



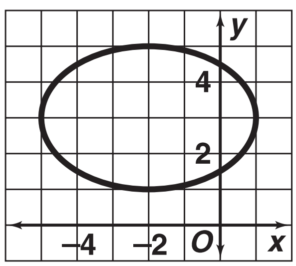
18. $x^2 + (y + 7)^2 = 36$; circle, center $(0, -7)$, radius 6



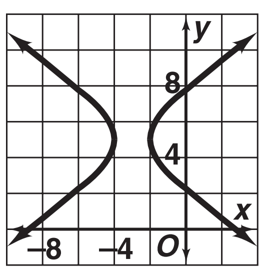
19. $x - 3 = \frac{1}{2}(y - 2)^2$; parabola, vertex $(3, 2)$



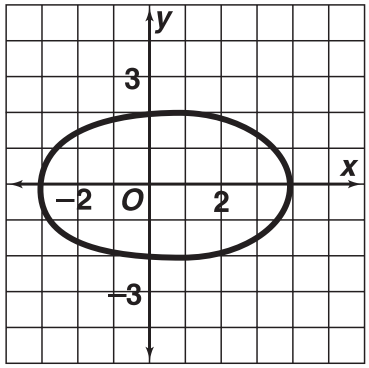
20. $\frac{(x + 2)^2}{9} + \frac{(y - 3)^2}{4} = 1$; ellipse, center $(-2, 3)$, foci $(-2 \pm \sqrt{5}, 3)$



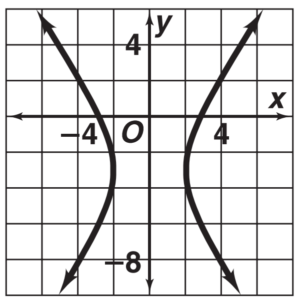
21. $(x + 3)^2 - (y - 5)^2 = 1$; hyperbola, center $(-3, 5)$, foci $(-3 \pm \sqrt{2}, 5)$



22. $\frac{(x-1)^2}{16} + \frac{y^2}{4} = 1$; ellipse, center $(1, 0)$, foci $(1 \pm 2\sqrt{3}, 0)$



23. $\frac{x^2}{4} - \frac{(y+3)^2}{9} = 1$; hyperbola, center $(0, -3)$, foci $(\pm\sqrt{13}, -3)$



24. Translate the equation $\frac{x^2}{16} - \frac{y^2}{8} = 1$, a hyperbola centered at $(0, 0)$, 3 units left.

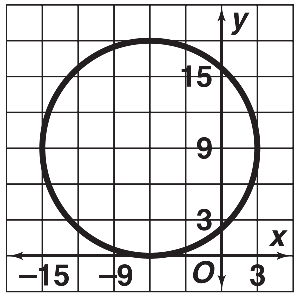
25. **a.** hyperbola
b. line

26. C

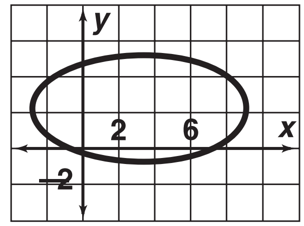
27. The hyperbola originally had center $(0, 0)$ and a horizontal or vertical transverse axis. If the new center is (h, k), then the equations of the new asymptotes are obtained by replacing x with $x - h$ and y with $y - k$ in the equations of the original asymptotes.

28. Check students' work.

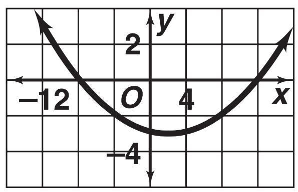
29. $(x + 6)^2 + (y - 9)^2 = 81$



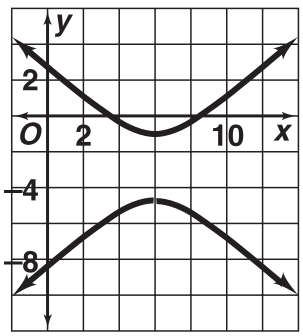
30. $\frac{(x - 3)^2}{36} + \frac{(y - 2)^2}{9} = 1$



31. $y = \frac{1}{20}(x - 2)^2 - 3$



32. $\frac{(y + 3)^2}{4} - \frac{(x - 6)^2}{5} = 1$



33. $\frac{(x - 1)^2}{9} + \frac{(y + 1)^2}{16} = 1$

34. $\frac{(x - 3)^2}{36} - \frac{(y + 2)^2}{15.84} = 1$

35. $(x + 4)^2 + (y + 4)^2 = 25$

36. $x - 1 = (y + 3)^2$

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

38. $\frac{(x - 6)^2}{64} + \frac{(y - 2)^2}{36} = 1$

39. $y - 5 = 4(x - 3)^2$

40. $\frac{(x - 3)^2}{16} - \frac{(y - 5)^2}{9} = 1$

41. $\frac{(x - 5)^2}{36} - \frac{(y - 8)^2}{25} = 1$

42. $\frac{(x - 6)^2}{4} + \frac{(y - 9)^2}{9} = 1$

43. $\frac{(x - 2)^2}{16} + \frac{(y - 7)^2}{9} = 1$

44. $\frac{x^2}{16} + \frac{(y - 5)^2}{4} = 1$

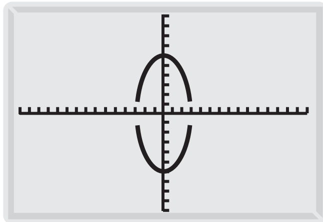
45. $\frac{(x - 4)^2}{16} - (y - 9)^2 = 1$

46. $(x - 8)^2 = 12(y - 11)$

47. $\frac{x^2}{16} + \frac{(y - 10)^2}{25} = 1$

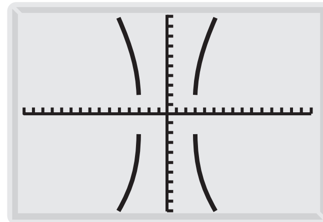
48. $x^2 - (y - 10)^2 = 1$

49.



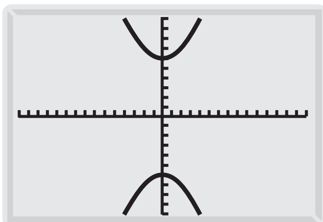
ellipse, $\frac{x^2}{9} + \frac{y^2}{36} = 1$

50.



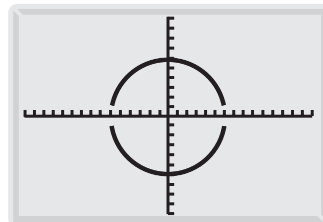
hyperbola, $\frac{x^2}{9} - \frac{y^2}{36} = 1$

51.



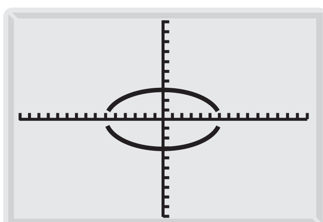
hyperbola, $\frac{y^2}{36} - \frac{x^2}{9} = 1$

52.



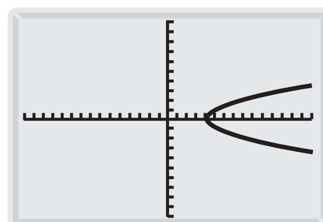
circle, $x^2 + y^2 = 36$

53.



ellipse, $\frac{x^2}{36} + \frac{y^2}{9} = 1$

54.



parabola, $x = y^2 + 4$

55. Check students' work.

56. Check students' work.

57. **a.** $A = B$; $A \neq B$ and A and B have the same sign; A and B have opposite signs; $A = 0$ or $B = 0$, but not both A and B are zero.

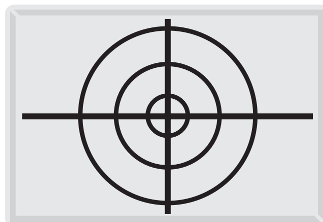
b. No; answers may vary. Sample: If $C = D = E = 0$, then the graph will be the single point $(0, 0)$.

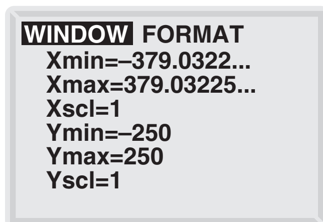
c. two intersecting lines ($y = x$ and $y = -x$)

58. **a.** Earth: $\frac{x^2}{(149.60)^2} + \frac{y^2}{(149.58)^2} = 1$

Mars: $\frac{x^2}{(227.9)^2} + \frac{y^2}{(226.9)^2} = 1$

Mercury: $\frac{x^2}{(57.9)^2} + \frac{y^2}{(56.6)^2} = 1$





b. Earth: $\frac{a}{b}$ is closest to 1 for Earth.