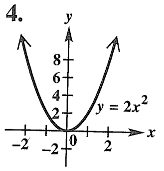
2.6 Exercises

1. (a) B (b) D (c) E (d) A (e) C
2. (a) E (b) C (c) D (d) A (e) B
3. (a) B (b) A (c) G (d) C (e) F (f) D (g) H (h) E

4.


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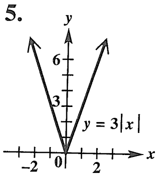

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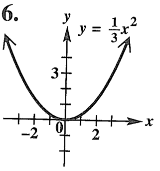

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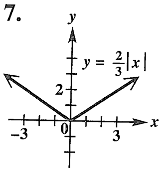

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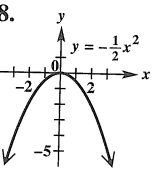

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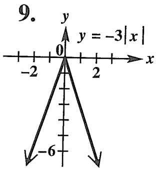

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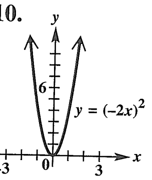

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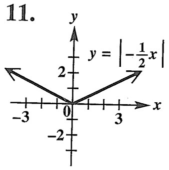
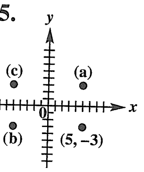


2. (a) (4, 12) (b) (8, 16)
3. (a) (8, 3) (b) (8, 48)
4. (a) (8, −12) (b) (−8, 12)

5.


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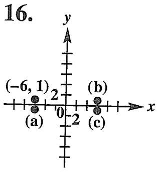

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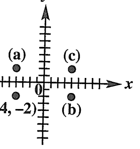

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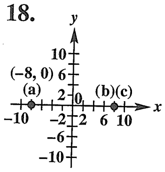


. *y*-axis **20.** *y*-axis
. *x*-axis, *y*-axis, origin
. *x*-axis, *y*-axis, origin
. origin **24.** origin
. none of these
. none of these **27.** odd
. odd **29.** even **30.** even
. neither **32.** neither

1. *Concept Check* Match each equation in Column I with a description of its graph from Column II as it relates to the graph of $y = x^2$.

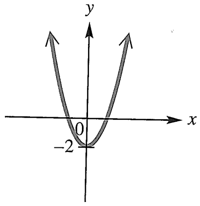
I	II
(a) $y = (x - 7)^2$	A. a translation 7 units to the left
(b) $y = x^2 - 7$	B. a translation 7 units to the right
(c) $y = 7x^2$	C. a translation 7 units up
(d) $y = (x + 7)^2$	D. a translation 7 units down
(e) $y = x^2 + 7$	E. a vertical stretch by a factor of 7

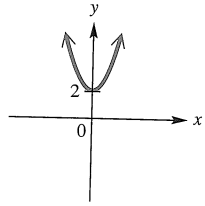
2. *Concept Check* Match each equation in Column I with a description of its graph from Column II as it relates to the graph of $y = \sqrt[3]{x}$.

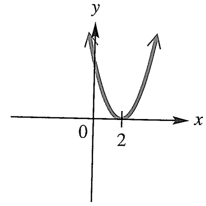
I	II
(a) $y = 4\sqrt[3]{x}$	A. a translation 4 units to the right
(b) $y = -\sqrt[3]{x}$	B. a translation 4 units down
(c) $y = \sqrt[3]{-x}$	C. a reflection across the *x*-axis
(d) $y = \sqrt[3]{x - 4}$	D. a reflection across the *y*-axis
(e) $y = \sqrt[3]{x} - 4$	E. a vertical stretch by a factor of 4

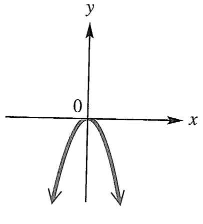
3. *Concept Check* Match each equation in parts (a)–(h) with the sketch of its graph.

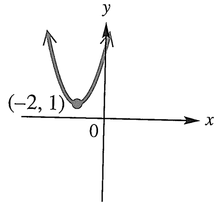
(a) $y = x^2 + 2$ (b) $y = x^2 - 2$ (c) $y = (x + 2)^2$
(d) $y = (x - 2)^2$ (e) $y = 2x^2$ (f) $y = -x^2$
(g) $y = (x - 2)^2 + 1$ (h) $y = (x + 2)^2 + 1$

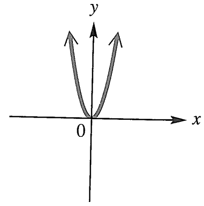
A.


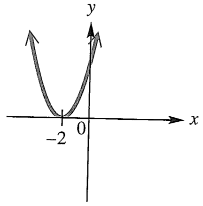
B.


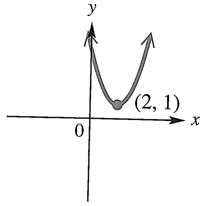
C.


D.


E.


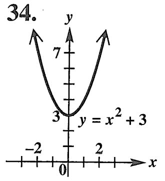
F.


G.


H.


Graph each function. See Examples 1 and 2.

4. $y = 2x^2$ **5.** $y = 3|x|$ **6.** $y = \frac{1}{3}x^2$ **7.** $y = \frac{2}{3}|x|$

34.


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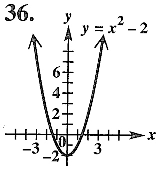

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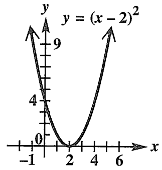

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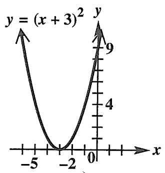

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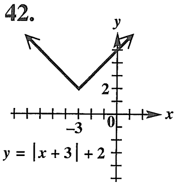

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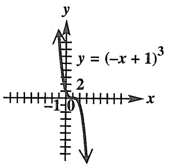
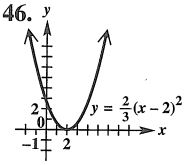
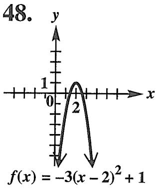


46.


48.


8. $y = -\frac{1}{2}x^2$ **9.** $y = -3|x|$ **10.** $y = (-2x)^2$ **11.** $y = \left|-\frac{1}{2}x\right|$

Concept Check Suppose the point $(8, 12)$ *is on the graph of* $y = f(x)$. *Find a point on the graph of each function.*

12. (a) $y = f(x + 4)$
(b) $y = f(x) + 4$

13. (a) $y = \frac{1}{4}f(x)$
(b) $y = 4f(x)$

14. (a) the reflection of the graph of $y = f(x)$ across the x-axis
(b) the reflection of the graph of $y = f(x)$ across the y-axis

*Concept Check Plot each point, and then plot the points that are symmetric to the given point with respect to the **(a)** x-axis, **(b)** y-axis, and **(c)** origin.*

15. $(5, -3)$ **16.** $(-6, 1)$ **17.** $(-4, -2)$ **18.** $(-8, 0)$

Without graphing, determine whether each equation has a graph that is symmetric with respect to the x-axis, the y-axis, the origin, or none of these. See Examples 3 and 4.

19. $y = x^2 + 2$ **20.** $y = 2x^4 - 1$ **21.** $x^2 + y^2 = 10$ **22.** $y^2 = \frac{-5}{x^2}$

23. $y = -3x^3$ **24.** $y = x^3 - x$ **25.** $y = x^2 - x + 7$ **26.** $y = x + 12$

Decide whether each function is even, odd, or neither. See Example 5.

27. $f(x) = -x^3 + 2x$ **28.** $f(x) = x^5 - 2x^3$

29. $f(x) = .5x^4 - 2x^2 + 1$ **30.** $f(x) = .75x^2 + |x| + 1$

31. $f(x) = x^3 - x + 3$ **32.** $f(x) = x^4 - 5x + 2$

Graph each function. See Examples 6–8.

33. $y = x^2 - 1$ **34.** $y = x^2 + 3$ **35.** $y = x^2 + 2$

36. $y = x^2 - 2$ **37.** $y = (x - 4)^2$ **38.** $y = (x - 2)^2$

39. $y = (x + 2)^2$ **40.** $y = (x + 3)^2$ **41.** $y = |x| - 1$

42. $y = |x + 3| + 2$ **43.** $y = -(x + 1)^3$ **44.** $y = (-x + 1)^3$

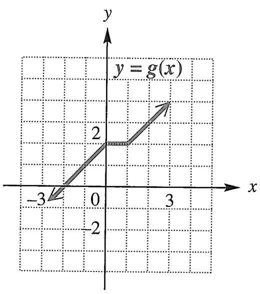
45. $y = 2x^2 - 1$ **46.** $y = \frac{2}{3}(x - 2)^2$ **47.** $f(x) = 2(x - 2)^2 - 4$

48. $f(x) = -3(x - 2)^2 + 1$

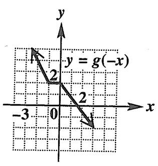
For Exercises 49 and 50, see Example 9.

49. Given the graph of $y = g(x)$ in the figure, sketch the graph of each function, and explain how it is obtained from the graph of $y = g(x)$.

(a) $y = g(-x)$ **(b)** $y = g(x - 2)$
(c) $y = -g(x) + 2$

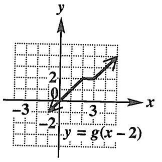


49. **(a)**



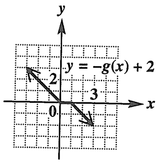
The graph of $g(x)$ is reflected across the y-axis.

(b)



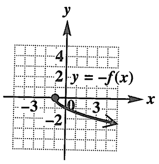
The graph of $g(x)$ is translated to the right 2 units.

(c)



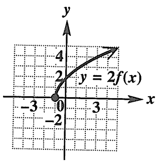
The graph of $g(x)$ is reflected across the x-axis and translated 2 units up.

50. **(a)**



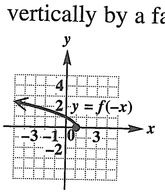
The graph of $f(x)$ is reflected across the x-axis.

(b)



The graph is the same shape as that of $f(x)$, but stretched vertically by a factor of 2.

(c)

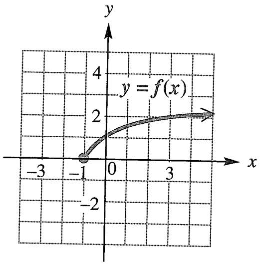


The graph of $f(x)$ is reflected across the y-axis.

51. It is the graph of $f(x) = |x|$ translated 1 unit to the left, reflected across the x-axis, and translated 3 units up. The equation is $y = -|x + 1| + 3$.

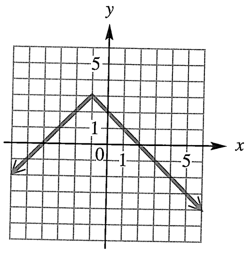
50. Given the graph of $y = f(x)$ in the figure, sketch the graph of each function, and explain how it is obtained from the graph of $y = f(x)$.

(a) $y = -f(x)$ **(b)** $y = 2f(x)$
(c) $y = f(-x)$

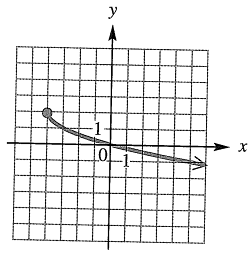


Concept Check *Each of the following graphs is obtained from the graph of* $f(x) = |x|$ *or* $g(x) = \sqrt{x}$ *by applying several of the transformations discussed in this section. Describe the transformations and give the equation for the graph.*

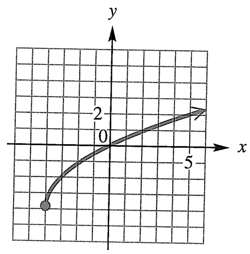
51.



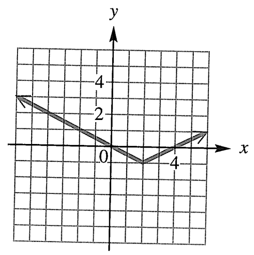
52.



53.



54.



Concept Check *Suppose* $f(3) = 6$. *For the given assumptions in Exercises 55–60, find another function value.*

55. The graph of $y = f(x)$ is symmetric with respect to the origin.

56. The graph of $y = f(x)$ is symmetric with respect to the y-axis.

57. The graph of $y = f(x)$ is symmetric with respect to the line $x = 6$.

58. For all x, $f(-x) = f(x)$.

59. For all x, $f(-x) = -f(x)$.

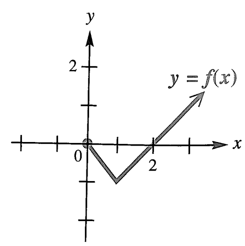
60. f is an odd function.

61. Find the function g whose graph can be obtained by translating the graph of $f(x) = 2x + 5$ up 2 units and to the left 3 units.

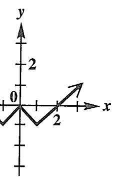
62. Find the function g whose graph can be obtained by translating the graph of $f(x) = 3 - x$ down 2 units and to the right 3 units.

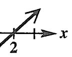
63. Complete the left half of the graph of $y = f(x)$ in the figure for each condition.

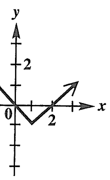
(a) $f(-x) = f(x)$ **(b)** $f(-x) = -f(x)$

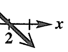


graph of $g(x) = \sqrt{x}$
units to the left,
oss the x-axis, and
units up. The equation
$x + 4 + 2$.
graph of $g(x) = \sqrt{x}$
units to the left,
rtically by a factor
nslated 4 units down.
n is $y = 2\sqrt{x + 4} -$
the graph of
ranslated 2 units to the
en vertically by a
and translated 1 unit
quation is
$2| - 1$.
$= -6$
$= 6$ **57.** $f(9) = 6$
$= 6$
$= -6$
$= -6$
$x + 13$
$-x + 4$

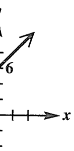






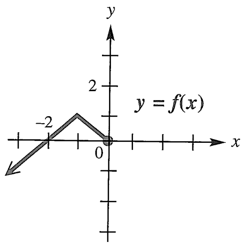


lated 6 units up.



64. Complete the right half of the graph of $y = f(x)$ in the figure for each condition.

(a) f is odd. **(b)** f is even.



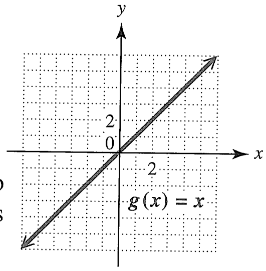
65. Suppose the equation $y = F(x)$ is changed to $y = c \cdot F(x)$, for some constant c. What is the effect on the graph of $y = F(x)$? Discuss the effect depending on whether $c > 0$ or $c < 0$, and $|c| > 1$ or $|c| < 1$.

66. Suppose $y = F(x)$ is changed to $y = F(x + h)$. How are the graphs of these equations related? Is the graph of $y = F(x) + h$ the same as the graph of $y = F(x + h)$? If not, how do they differ?

Relating Concepts

For individual or collaborative investigation
(Exercises 67–73)

In Section 2.3 we introduced linear functions of the form $g(x) = ax + b$. Consider the graph of the simplest linear function defined by $g(x) = x$, shown here. ***Work Exercises 67–73 in order.***



67. How does the graph of $F(x) = x^2 + 6$ compare to the graph of $f(x) = x^2$ if a *vertical* translation is considered?

68. Graph the linear function defined by $G(x) = x + 6$.

69. How does the graph of $G(x) = x + 6$ compare to the graph of $g(x) = x$ if a vertical translation is considered? (*Hint:* Look at the y-intercept.)

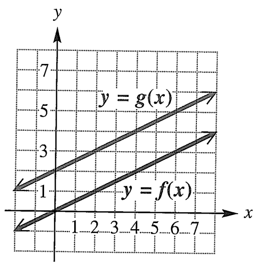
70. How does the graph of $F(x) = (x - 6)^2$ compare to the graph of $f(x) = x^2$ if a *horizontal* translation is considered?

71. Graph the linear function defined by $G(x) = x - 6$.

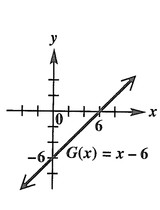
72. How does the graph of $G(x) = x - 6$ compare to the graph of $g(x) = x$ if a horizontal translation is considered? (*Hint:* Look at the x-intercept.)

73. Consider the two functions in the figure.

(a) Find a value of c for which $g(x) = f(x) + c$.
(b) Find a value of c for which $g(x) = f(x + c)$.



69. It is translated 6 units up. **70.** It is translated 6 units to the right. **71.**



72. It is translated 6 units to the right. **73.** **(a)** 2 **(b)** 4