Section 1.5

Check Point Exercises

1. The slope of the line $y = 3x + 1$ is 3.

$$y - y_1 = m(x - x_1)$$
$$y - 5 = 3(x - (-2))$$
$$y - 5 = 3(x + 2) \text{ point-slope}$$
$$y - 5 = 3x + 6$$
$$y = 3x + 11 \text{ slope-intercept}$$

2. **a.** Write the equation in slope-intercept form:

$$x + 3y - 12 = 0$$
$$3y = -x + 12$$
$$y = -\frac{1}{3}x + 4$$

The slope of this line is $-\frac{1}{3}$ thus the slope of any line perpendicular to this line is 3.

b. Use $m = 3$ and the point (–2, –6) to write the equation.

$$y - y_1 = m(x - x_1)$$
$$y - (-6) = 3(x - (-2))$$
$$y + 6 = 3(x + 2)$$
$$y + 6 = 3x + 6$$
$$-3x + y = 0$$
$$3x - y = 0 \text{ general form}$$

3. $m = \frac{\text{Change in } y}{\text{Change in } x} = \frac{14.7 - 9.0}{2008 - 1990} = \frac{5.7}{18} \approx 0.32$

The slope indicates that the number of U.S. men living alone increased at a rate of 0.32 million each year.
The rate of change is 0.32 million men per year.

4. **a.** $\frac{f(x_2) - f(x_1)}{x_2 - x_1} = \frac{1^3 - 0^3}{1 - 0} = 1$

b. $\frac{f(x_2) - f(x_1)}{x_2 - x_1} = \frac{2^3 - 1^3}{2 - 1} = \frac{8 - 1}{1} = 7$

c. $\frac{f(x_2) - f(x_1)}{x_2 - x_1} = \frac{0^3 - (-2)^3}{0 - (-2)} = \frac{8}{2} = 4$

5. $\frac{f(x_2) - f(x_1)}{x_2 - x_1} = \frac{f(3) - f(1)}{3 - 1}$

$$= \frac{0.05 - 0.03}{3 - 1}$$
$$= 0.01$$

The average rate of change in the drug's concentration between 1 hour and 3 hours is 0.01 mg per 100 mL per hour.

6. **a.** $s(1) = 4(1)^2 = 4$

$s(2) = 4(2)^2 = 16$

$\frac{\Delta s}{\Delta t} = \frac{16 - 4}{2 - 1} = 12$ feet per second

b. $s(1) = 4(1)^2 = 4$

$s(1.5) = 4(1.5)^2 = 9$

$\frac{\Delta s}{\Delta t} = \frac{9 - 4}{1.5 - 1} = 10$ feet per second

c. $s(1) = 4(1)^2 = 4$

$s(1.01) = 4(1.01)^2 = 4.0804$

$\frac{\Delta s}{\Delta t} = \frac{4.0804 - 4}{1.01 - 1} = 8.04$ feet per second

Concept and Vocabulary Check 1.5

1. the same

2. -1

3. $-\frac{1}{3}$; 3

4. -2 ; $\frac{1}{2}$

5. y; x

6. $\frac{f(x_2) - f(x_1)}{x_2 - x_1}$

7. $\frac{s(6) - s(3)}{6 - 3}$

Exercise Set 1.5

1. Since L is parallel to $y = 2x$, we know it will have slope $m = 2$. We are given that it passes through $(4, 2)$. We use the slope and point to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 2 = 2(x - 4)$$

Solve for y to obtain slope-intercept form.

$$y - 2 = 2(x - 4)$$
$$y - 2 = 2x - 8$$
$$y = 2x - 6$$

In function notation, the equation of the line is $f(x) = 2x - 6.$

2. L will have slope $m = -2$. Using the point and the slope, we have $y - 4 = -2(x - 3)$. Solve for y to obtain slope-intercept form.

$$y - 4 = -2x + 6$$
$$y = -2x + 10$$
$$f(x) = -2x + 10$$

3. Since L is perpendicular to $y = 2x$, we know it will have slope $m = -\frac{1}{2}$. We are given that it passes through $(2, 4)$. We use the slope and point to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 4 = -\frac{1}{2}(x - 2)$$

Solve for y to obtain slope-intercept form.

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

In function notation, the equation of the line is $f(x) = -\frac{1}{2}x + 5.$

4. L will have slope $m = \frac{1}{2}$. The line passes through (–1, 2). Use the slope and point to write the equation in point-slope form.

$$y - 2 = \frac{1}{2}(x - (-1))$$
$$y - 2 = \frac{1}{2}(x + 1)$$

Solve for y to obtain slope-intercept form.

$$y - 2 = \frac{1}{2}x + \frac{1}{2}$$
$$y = \frac{1}{2}x + \frac{1}{2} + 2$$
$$y = \frac{1}{2}x + \frac{5}{2}$$
$$f(x) = \frac{1}{2}x + \frac{5}{2}$$

5. $m = -4$ since the line is parallel to $y = -4x + 3$; $x_1 = -8$, $y_1 = -10$;

point-slope form: $y + 10 = -4(x + 8)$

slope-intercept form: $y + 10 = -4x - 32$

$y = -4x - 42$

6. $m = -5$ since the line is parallel to $y = -5x + 4$; $x_1 = -2$, $y_1 = -7$;

point-slope form: $y + 7 = -5(x + 2)$

slope-intercept form: $y + 7 = -5x - 10$

$y = -5x - 17$

7. $m = -5$ since the line is perpendicular to $y = \frac{1}{5}x + 6$; $x_1 = 2$, $y_1 = -3$;

point-slope form: $y + 3 = -5(x - 2)$

slope-intercept form: $y + 3 = -5x + 10$

$y = -5x + 7$

8. $m = -3$ since the line is perpendicular to $y = \frac{1}{3}x + 7$; $x_1 = -4$, $y_1 = 2$;

point-slope form: $y - 2 = -3(x + 4)$

slope-intercept form: $y - 2 = -3x - 12$

$y = -3x - 10$

9. $2x-3y-7=0$

$-3y=-2x+7$

$y=\frac{2}{3}x-\frac{7}{3}$

The slope of the given line is $\frac{2}{3}$, so $m=\frac{2}{3}$ since the lines are parallel.

point-slope form: $y-2=\frac{2}{3}(x+2)$

general form: $2x-3y+10=0$

10. $3x-2y-=0$

$-2y=-3x+5$

$y=\frac{3}{2}x-\frac{5}{2}$

The slope of the given line is $\frac{3}{2}$, so $m=\frac{3}{2}$ since the lines are parallel.

point-slope form: $y-3=\frac{3}{2}(x+1)$

general form: $3x-2y+9=0$

11. $x-2y-3=0$

$-2y=-x+3$

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

The slope of the given line is $\frac{1}{2}$, so $m=-2$ since the lines are perpendicular.

point-slope form: $y+7=-2(x-4)$

general form: $2x+y-1=0$

12. $x+7y-12=0$

$7y=-x+12$

$y=\frac{-1}{7}x+\frac{12}{7}$

The slope of the given line is $-\frac{1}{7}$, so $m=7$ since the lines are perpendicular.

point-slope form: $y+9=7(x-5)$

general form: $7x-y-44=0$

13. $\frac{15-0}{5-0}=\frac{15}{5}=3$

14. $\frac{24-0}{4-0}=\frac{24}{4}=6$

15. $\frac{5^2+2\cdot5-(3^2+2\cdot3)}{5-3}=\frac{25+10-(9+6)}{2}$

$=\frac{20}{2}$

$=10$

16. $\frac{6^2-2(6)-(3^2-2\cdot3)}{6-3}=\frac{36-12-(9-6)}{3}=\frac{21}{3}=7$

17. $\frac{\sqrt{9}-\sqrt{4}}{9-4}=\frac{3-2}{5}=\frac{1}{5}$

18. $\frac{\sqrt{16}-\sqrt{9}}{16-9}=\frac{4-3}{7}=\frac{1}{7}$

19. **a.** $s(3)=10(3)^2=90$

$s(4)=10(4)^2=160$

$\frac{\Delta s}{\Delta t}=\frac{160-90}{4-3}=70$ feet per second

b. $s(3)=10(3)^2=90$

$s(3.5)=10(3.5)^2=122.5$

$\frac{\Delta s}{\Delta t}=\frac{122.5-90}{3.5-3}=65$ feet per second

c. $s(3)=10(3)^2=90$

$s(3.01)=10(3.01)^2=90.601$

$\frac{\Delta s}{\Delta t}=\frac{90.601-90}{3.01-3}=60.1$ feet per second

d. $s(3)=10(3)^2=90$

$s(3.001)=10(3.001)^2=90.06$

$\frac{\Delta s}{\Delta t}=\frac{90.06-90}{3.001-3}=60.01$ feet per second

20. **a.** $s(3)=12(3)^2=108$

$s(4)=12(4)^2=192$

$\frac{\Delta s}{\Delta t}=\frac{108-192}{4-3}=84$ feet per second

b. $s(3)=12(3)^2=108$

$s(3.5)=12(3.5)^2=147$

$\frac{\Delta s}{\Delta t}=\frac{147-108}{3.5-2}=78$ feet per second

c. $s(3) = 12(3)^2 = 108$

$s(3.01) = 12(3.01)^2 = 108.7212$

$\frac{\Delta s}{\Delta t} = \frac{108.7212 - 108}{3.01 - 3} = 72.12$ feet per second

d. $s(3) = 12(3)^2 = 108$

$s(3.001) = 12(3.001)^2 = 108.07201$

$\frac{\Delta s}{\Delta t} = \frac{108.07201 - 108}{3.001 - 3} = 72.01$ feet per second

21. Since the line is perpendicular to $x = 6$ which is a vertical line, we know the graph of f is a horizontal line with 0 slope. The graph of f passes through $(-1, 5)$, so the equation of f is $f(x) = 5$.

22. Since the line is perpendicular to $x = -4$ which is a vertical line, we know the graph of f is a horizontal line with 0 slope. The graph of f passes through $(-2, 6)$, so the equation of f is $f(x) = 6$.

23. First we need to find the equation of the line with $x-$intercept of 2 and $y-$intercept of -4. This line will pass through $(2, 0)$ and $(0, -4)$. We use these points to find the slope.

$m = \frac{-4 - 0}{0 - 2} = \frac{-4}{-2} = 2$

Since the graph of f is perpendicular to this line, it will have slope $m = -\frac{1}{2}$.

Use the point $(-6, 4)$ and the slope $-\frac{1}{2}$ to find the equation of the line.

$$y - y_1 = m(x - x_1)$$
$$y - 4 = -\frac{1}{2}(x - (-6))$$
$$y - 4 = -\frac{1}{2}(x + 6)$$
$$y - 4 = -\frac{1}{2}x - 3$$
$$y = -\frac{1}{2}x + 1$$
$$f(x) = -\frac{1}{2}x + 1$$

24. First we need to find the equation of the line with $x-$intercept of 3 and $y-$intercept of -9. This line will pass through $(3, 0)$ and $(0, -9)$. We use these points to find the slope.

$m = \frac{-9 - 0}{0 - 3} = \frac{-9}{-3} = 3$

Since the graph of f is perpendicular to this line, it will have slope $m = -\frac{1}{3}$.

Use the point $(-5, 6)$ and the slope $-\frac{1}{3}$ to find the equation of the line.

$$y - y_1 = m(x - x_1)$$
$$y - 6 = -\frac{1}{3}(x - (-5))$$
$$y - 6 = -\frac{1}{3}(x + 5)$$
$$y - 6 = -\frac{1}{3}x - \frac{5}{3}$$
$$y = -\frac{1}{3}x + \frac{13}{3}$$
$$f(x) = -\frac{1}{3}x + \frac{13}{3}$$

25. First put the equation $3x - 2y - 4 = 0$ in slope-intercept form.

$$3x - 2y - 4 = 0$$
$$-2y = -3x + 4$$
$$y = \frac{3}{2}x - 2$$

The equation of f will have slope $-\frac{2}{3}$ since it is perpendicular to the line above and the same $y-$intercept -2.

So the equation of f is $f(x) = -\frac{2}{3}x - 2$.

26. First put the equation $4x - y - 6 = 0$ in slope-intercept form.

$$4x - y - 6 = 0$$
$$-y = -4x + 6$$
$$y = 4x - 6$$

The equation of f will have slope $-\frac{1}{4}$ since it is perpendicular to the line above and the same $y-$intercept -6.

So the equation of f is $f(x) = -\frac{1}{4}x - 6$.

27. $p(x) = -0.25x + 22$

28. $p(x) = 0.22x + 3$

29. $m = \dfrac{1163 - 617}{1998 - 1994} = \dfrac{546}{4} \approx 137$

There was an average increase of approximately 137 discharges per year.

30. $m = \dfrac{623 - 1273}{2006 - 2001} = \dfrac{-650}{5} \approx -130$

There was an average decrease of approximately 130 discharges per year.

31. **a.** $f(x) = 1.1x^3 - 35x^2 + 264x + 557$

$f(0) = 1.1(0)^3 - 35(0)^2 + 264(0) + 557 = 557$

$f(4) = 1.1(4)^3 - 35(4)^2 + 264(4) + 557 = 1123.4$

$m = \dfrac{1123.4 - 557}{4 - 0} \approx 142$

b. This overestimates by 5 discharges per year.

32. **a.** $f(x) = 1.1x^3 - 35x^2 + 264x + 557$

$f(0) = 1.1(7)^3 - 35(7)^2 + 264(7) + 557 = 1067.3$

$f(12) = 1.1(12)^3 - 35(12)^2 + 264(12) + 557 = 585.8$

$m = \dfrac{585.8 - 1067.3}{12 - 7} \approx -96$

b. This underestimates the decrease by 34 discharges per year.

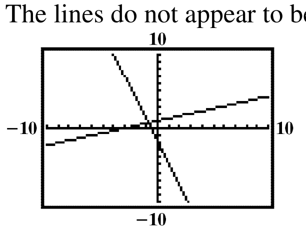
33. – 38. Answers will vary.

39. $y = \dfrac{1}{3}x + 1$

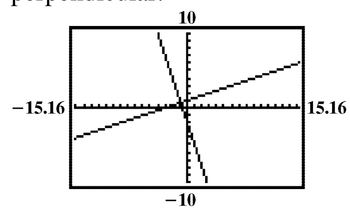
$y = -3x - 2$

a. The lines are perpendicular because their slopes are negative reciprocals of each other. This is verified because product of their slopes is –1.

b. The lines do not appear to be perpendicular.



c. The lines appear to be perpendicular. The calculator screen is rectangular and does not have the same width and height. This causes the scale of the *x*–axis to differ from the scale on the *y*–axis despite using the same scale in the window settings. In part (b), this causes the lines not to appear perpendicular when indeed they are. The zoom square feature compensates for this and in part (c), the lines appear to be perpendicular.



40. makes sense

41. makes sense

42. does not make sense; Explanations will vary. Sample explanation: Slopes can be used for segments of the graph.

43. makes sense

44. Write $Ax + By + C = 0$ in slope-intercept form.

$Ax + By + C = 0$

$By = -Ax - C$

$\dfrac{By}{B} = \dfrac{-Ax}{B} - \dfrac{C}{B}$

$y = -\dfrac{A}{B}x - \dfrac{C}{B}$

The slope of the given line is $-\dfrac{A}{B}$.

The slope of any line perpendicular to $Ax + By + C = 0$ is $\dfrac{B}{A}$.

45. The slope of the line containing $(1,-3)$ and $(-2,4)$ has slope $m = \dfrac{4-(-3)}{-2-1} = \dfrac{4+3}{-3} = \dfrac{7}{-3} = -\dfrac{7}{3}$

Solve $Ax + y - 2 = 0$ for y to obtain slope-intercept form.

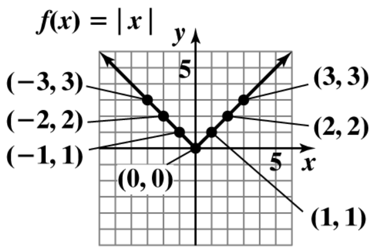
$Ax + y - 2 = 0$

$y = -Ax + 2$

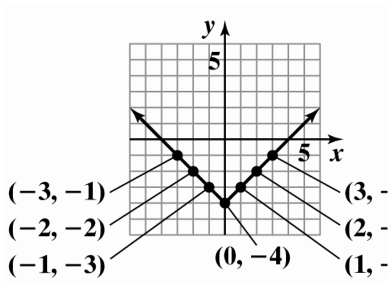
So the slope of this line is $-A$.

This line is perpendicular to the line above so its slope is $\dfrac{3}{7}$. Therefore, $-A = \dfrac{3}{7}$ so $A = -\dfrac{3}{7}$.

46. **a.**

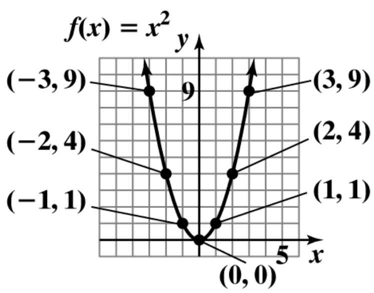


b.



c. The graph in part (b) is the graph in part (a) shifted down 4 units.

47. **a.**



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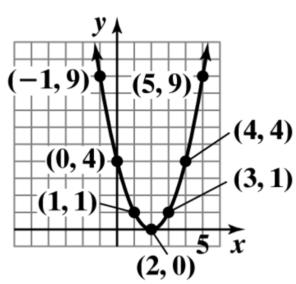
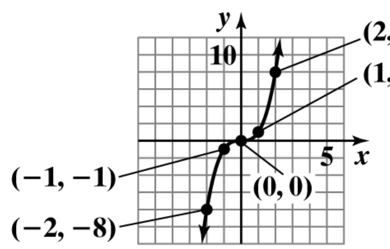
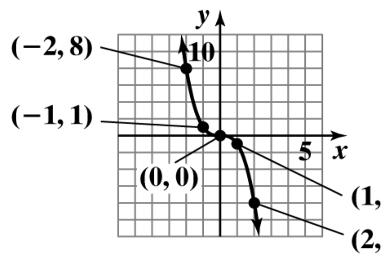


c. The graph in part (b) is the graph in part (a) shifted to the right 2 units.

48. **a.**



b.



c. The graph in part (b) is the graph in part (a) reflected across the y-axis.

Mid-Chapter 1 Check Point

1. The relation is not a function.
The domain is $\{1, 2\}$.
The range is $\{-6, 4, 6\}$.

2. The relation is a function.
The domain is $\{0, 2, 3\}$.
The range is $\{1, 4\}$.

3. The relation is a function.
The domain is $\{x \mid -2 \le x < 2\}$.
The range is $\{y \mid 0 \le y \le 3\}$.

4. The relation is not a function.
The domain is $\{x \mid -3 < x \le 4\}$.
The range is $\{y \mid -1 \le y \le 2\}$.

5. The relation is not a function.
The domain is $\{-2, -1, 0, 1, 2\}$.
The range is $\{-2, -1, 1, 3\}$.

6. The relation is a function.
The domain is $\{x \mid x \le 1\}$.
The range is $\{y \mid y \ge -1\}$.

7. $x^2 + y = 5$

$$y = -x^2 + 5$$

For each value of x, there is one and only one value for y, so the equation defines y as a function of x.

8. $x + y^2 = 5$

$y^2 = 5 - x$

$y = \pm\sqrt{5 - x}$

Since there are values of x that give more than one value for y (for example, if $x = 4$, then $y = \pm\sqrt{5-4} = \pm 1$), the equation does not define y as a function of x.

9. No vertical line intersects the graph in more than one point. Each value of x corresponds to exactly one value of y.

10. Domain: $(-\infty, \infty)$

11. Range: $(-\infty, 4]$

12. x-intercepts: –6 and 2

13. y-intercept: 3

14. increasing: $(-\infty, -2)$

15. decreasing: $(-2, \infty)$

16. $x = -2$

17. $f(-2) = 4$

18. $f(-4) = 3$

19. $f(-7) = -2$ and $f(3) = -2$

20. $f(-6) = 0$ and $f(2) = 0$

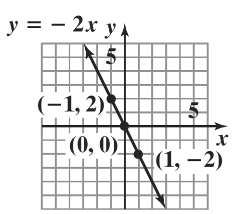
21. $(-6, 2)$

22. $f(100)$ is negative.

23. neither; $f(-x) \neq x$ and $f(-x) \neq -x$

24. $\dfrac{f(x_2) - f(x_1)}{x_2 - x_1} = \dfrac{f(4) - f(-4)}{4 - (-4)} = \dfrac{-5 - 3}{4 + 4} = -1$

25.



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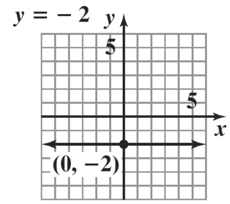

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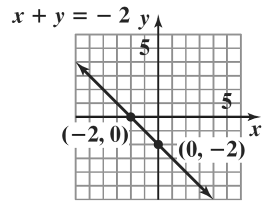

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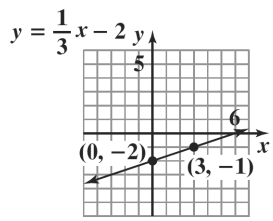

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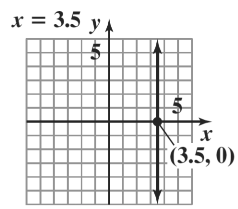

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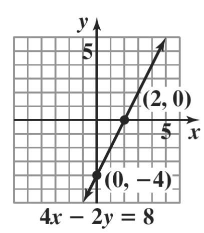

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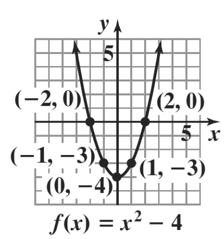

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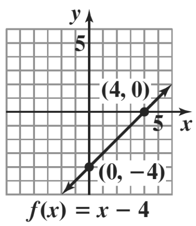

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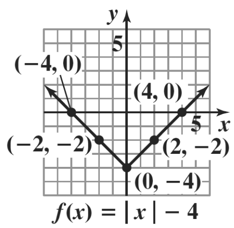
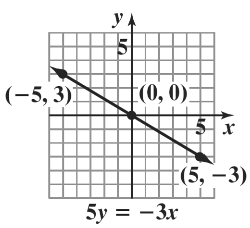


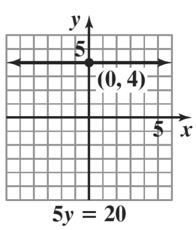
34. $5y = -3x$

$y = -\frac{3}{5}x$



35. $5y = 20$

$y = 4$



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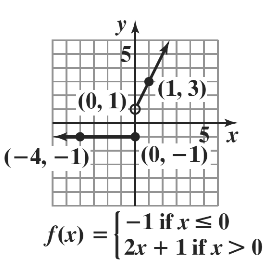


37. **a.** $f(-x) = -2(-x)^2 - x - 5$

$= -2x^2 - x - 5$

neither; $f(-x) \neq x$ and $f(-x) \neq -x$

b. $\frac{f(x+h) - f(x)}{h}$

$= \frac{-2(x+h)^2 + (x+h) - 5 - (-2x^2 + x - 5)}{h}$

$= \frac{-2x^2 - 4xh - 2h^2 + x + h - 5 + 2x^2 - x + 5}{h}$

$= \frac{-4xh - 2h^2 + h}{h}$

$= \frac{h(-4x - 2h + 1)}{h}$

$= -4x - 2h + 1$

38. $C(x) = \begin{cases} 30 & \text{if } 0 \leq t \leq 200 \\ 30 + 0.40(t - 200) & \text{if } t > 200 \end{cases}$

a. $C(150) = 30$

b. $C(250) = 30 + 0.40(250 - 200) = 50$

39. $y - y_1 = m(x - x_1)$

$y - 3 = -2(x - (-4))$

$y - 3 = -2(x + 4)$

$y - 3 = -2x - 8$

$y = -2x - 5$

$f(x) = -2x - 5$

40. $m = \frac{\text{Change in } y}{\text{Change in } x} = \frac{1 - (-5)}{2 - (-1)} = \frac{6}{3} = 2$

$y - y_1 = m(x - x_1)$

$y - 1 = 2(x - 2)$

$y - 1 = 2x - 4$

$y = 2x - 3$

$f(x) = 2x - 3$

41. $3x - y - 5 = 0$

$$-y = -3x + 5$$
$$y = 3x - 5$$

The slope of the given line is 3, and the lines are parallel, so $m = 3$.

$$y - y_1 = m(x - x_1)$$
$$y - (-4) = 3(x - 3)$$
$$y + 4 = 3x - 9$$
$$y = 3x - 13$$
$$f(x) = 3x - 13$$

42. $2x - 5y - 10 = 0$

$$-5y = -2x + 10$$
$$\frac{-5y}{-5} = \frac{-2x}{-5} + \frac{10}{-5}$$
$$y = \frac{2}{5}x - 2$$

The slope of the given line is $\frac{2}{5}$, and the lines are perpendicular, so $m = -\frac{5}{2}$.

$$y - y_1 = m(x - x_1)$$
$$y - (-3) = -\frac{5}{2}\left(x - (-4)\right)$$
$$y + 3 = -\frac{5}{2}x - 10$$
$$y = -\frac{5}{2}x - 13$$
$$f(x) = -\frac{5}{2}x - 13$$

43. $m_1 = \dfrac{\text{Change in } y}{\text{Change in } x} = \dfrac{0 - (-4)}{7 - 2} = \dfrac{4}{5}$

$$m_2 = \frac{\text{Change in } y}{\text{Change in } x} = \frac{6 - 2}{1 - (-4)} = \frac{4}{5}$$

The slope of the lines are equal thus the lines are parallel.

44. **a.** $m = \dfrac{\text{Change in } y}{\text{Change in } x} = \dfrac{42 - 26}{180 - 80} = \dfrac{16}{100} = 0.16$

b. For each minute of brisk walking, the percentage of patients with depression in remission increased by <u>0.16</u>%. The rate of change is <u>0.16</u>% per <u>minute of brisk walking</u>.

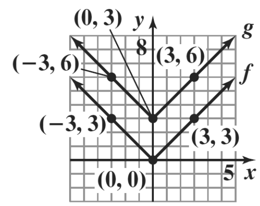
45. $\dfrac{f(x_2) - f(x_1)}{x_2 - x_1} = \dfrac{f(2) - f(-1)}{2 - (-1)}$

$$= \frac{\left(3(2)^2 - 2\right) - \left(3(-1)^2 - (-1)\right)}{2 + 1}$$
$$= 2$$

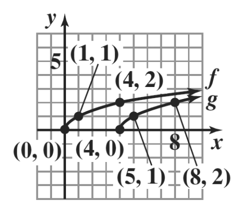
Section 1.6

Check Point Exercises

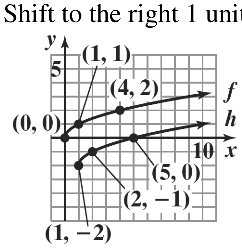
1. Shift up vertically 3 units.



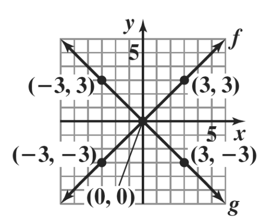
2. Shift to the right 4 units.



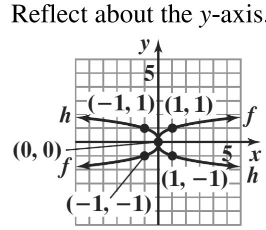
3. Shift to the right 1 unit and down 2 units.



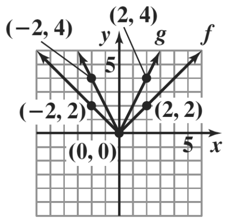
4. Reflect about the x-axis.



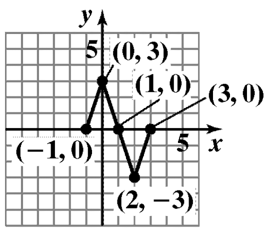
5. Reflect about the y-axis.



6. Vertically stretch the graph of $f(x)=|x|$.

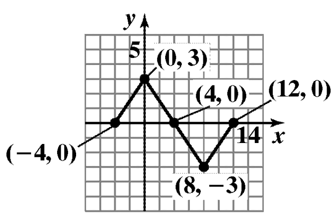


7. **a.** Horizontally shrink the graph of $y = f(x)$.



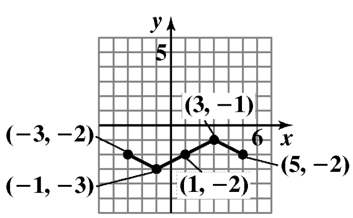
$g(x) = f(2x)$

b. Horizontally stretch the graph of $y = f(x)$.



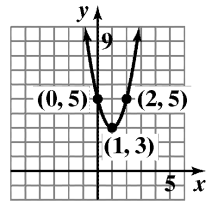
$h(x) = f\left(\frac{1}{2}x\right)$

8. The graph of $y = f(x)$ is shifted 1 unit left, shrunk by a factor of $\frac{1}{3}$, reflected about the x-axis, then shifted down 2 units.



$y = -\frac{1}{3}f(x+1)-2$

9. The graph of $f(x)=x^2$ is shifted 1 unit right, stretched by a factor of 2, then shifted up 3 units.



$g(x) = 2(x-1)^2+3$

Concept and Vocabulary Check 1.6

1. vertical; down

2. horizontal; to the right

3. *x*-axis

4. *y*-axis

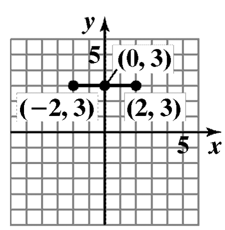
5. vertical; *y*

6. horizontal; *x*

7. false

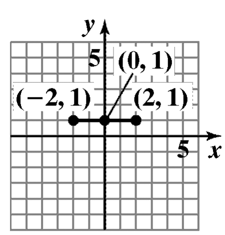
Exercise Set 1.6

1.



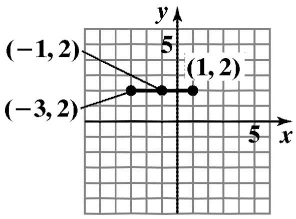
$g(x) = f(x)+1$

2.



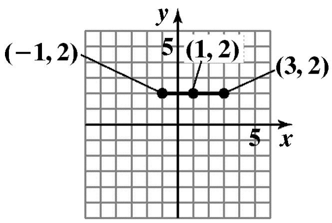
$g(x) = f(x)-1$

3.



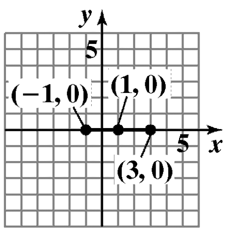
$g(x) = f(x+1)$

4.



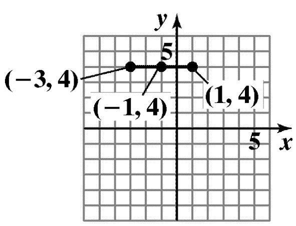
$g(x) = f(x-1)$

5.



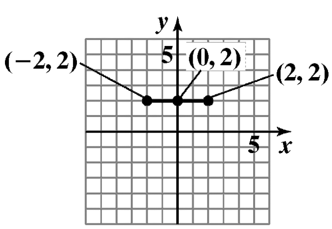
$g(x) = f(x-1) - 2$

6.



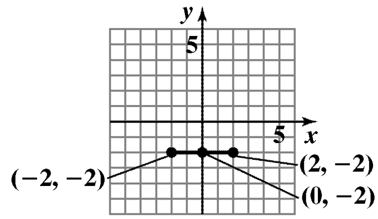
$g(x) = f(x+1) + 2$

7.



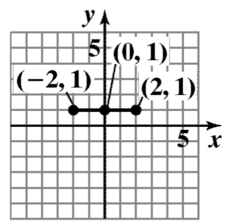
$g(x) = -f(x)$

8.



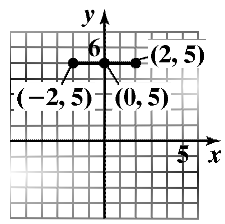
$g(x) = -f(x)$

9.



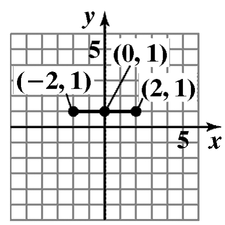
$g(x) = -f(x) + 3$

10.



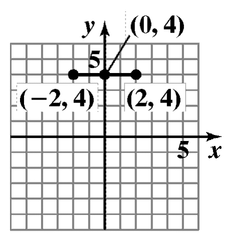
$g(x) = f(-x) + 3$

11.



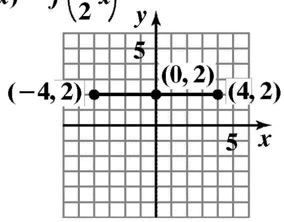
$g(x) = \frac{1}{2}f(x)$

12.

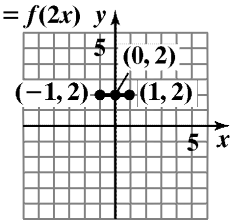


$g(x) = 2f(x)$

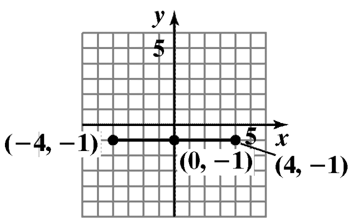
13. $g(x) = f\left(\frac{1}{2}x\right)$



14. $g(x) = f(2x)$

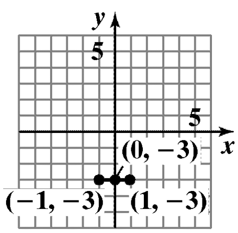


15.



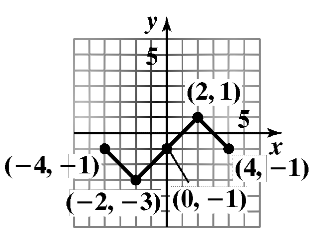
$g(x) = -f\left(\frac{1}{2}x\right) + 1$

16.



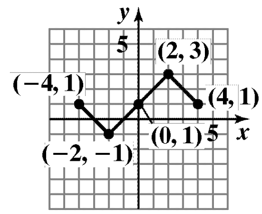
$g(x) = -f(2x) - 1$

17.



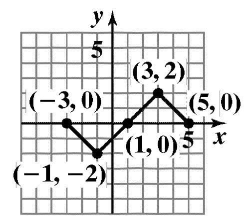
$g(x) = f(x) - 1$

18.



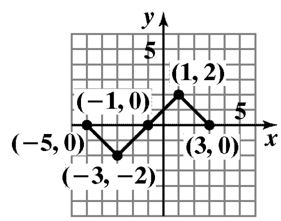
$g(x) = f(x) + 1$

19.



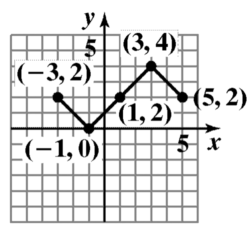
$g(x) = f(x - 1)$

20.



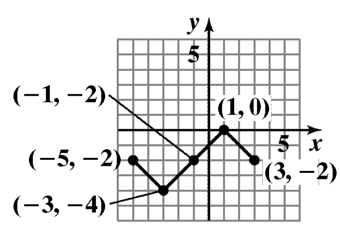
$g(x) = f(x + 1)$

21.



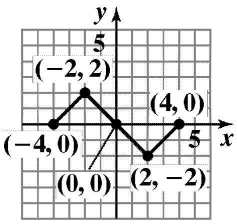
$g(x) = f(x - 1) + 2$

22.



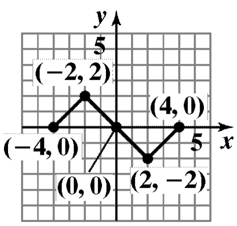
$g(x) = f(x + 1) - 2$

23.



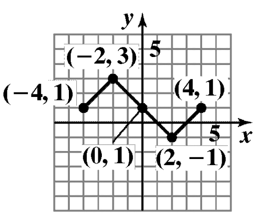
$g(x) = -f(x)$

24.



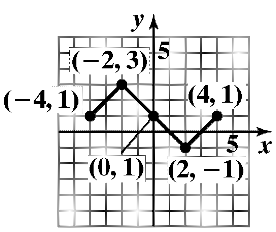
$g(x) = f(-x)$

25.



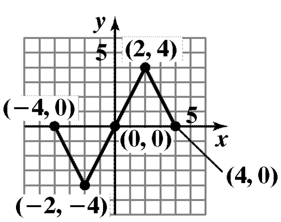
$g(x) = f(-x) + 1$

26.



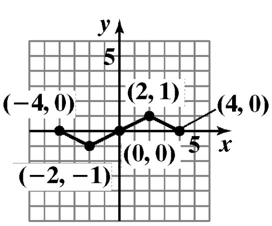
$g(x) = -f(x) + 1$

27.



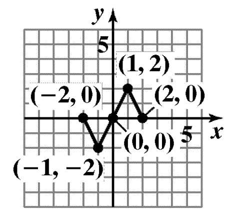
$g(x) = 2f(x)$

28.



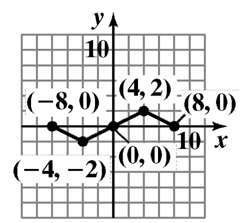
$g(x) = \frac{1}{2}f(x)$

29.



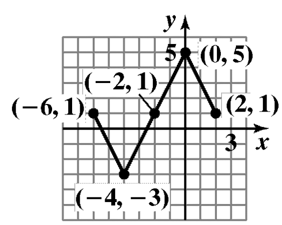
$g(x) = f(2x)$

30.



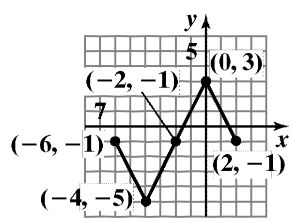
$g(x) = f\left(\frac{1}{2}x\right)$

31.



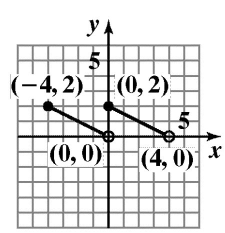
$g(x) = 2f(x + 2) + 1$

32.



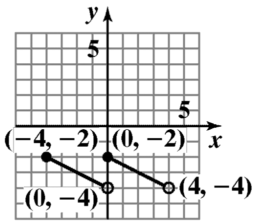
$g(x) = 2f(x + 2) - 1$

33.



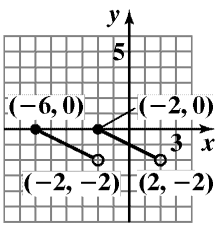
$g(x) = f(x) + 2$

34.



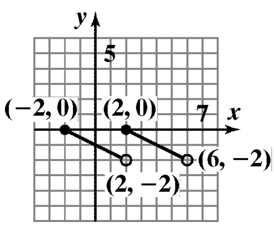
$g(x) = f(x) - 2$

35.



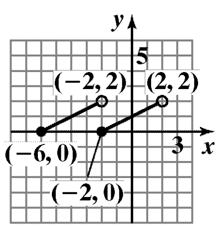
$g(x) = f(x + 2)$

36.



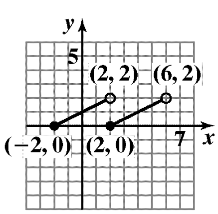
$g(x) = f(x - 2)$

37.



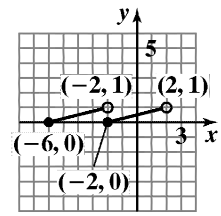
$g(x) = -f(x + 2)$

38.



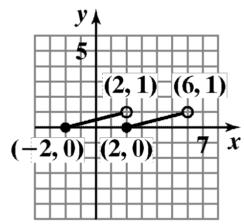
$g(x) = -f(x - 2)$

39.



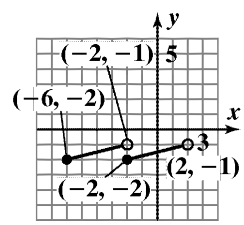
$g(x) = -\frac{1}{2}f(x + 2)$

40.



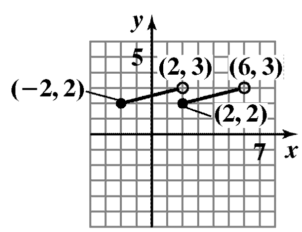
$g(x) = -\frac{1}{2}f(x - 2)$

41.



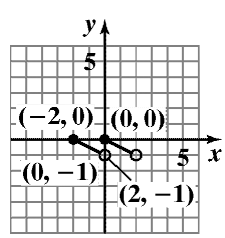
$g(x) = -\frac{1}{2}f(x + 2) - 2$

42.



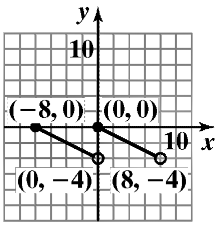
$g(x) = -\frac{1}{2}f(x - 2) + 2$

43.



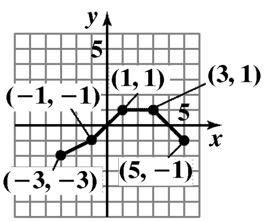
$g(x) = \frac{1}{2}f(2x)$

44.



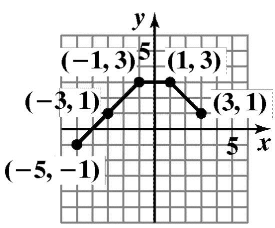
$g(x) = 2f\left(\frac{1}{2}x\right)$

45.



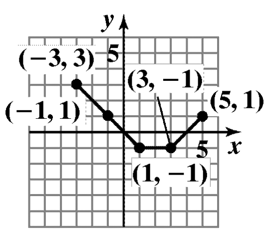
$g(x) = f(x - 1) - 1$

46.



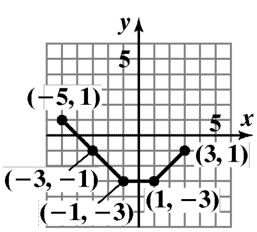
$g(x) = f(x + 1) + 1$

47.



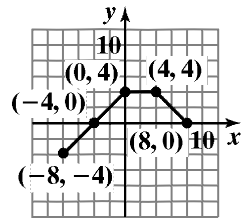
$g(x) = -f(x - 1) + 1$

48.



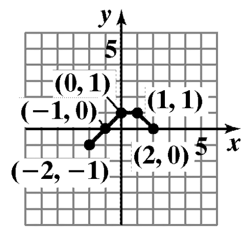
$g(x) = -f(x + 1) - 1$

49.



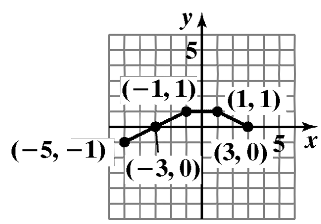
$g(x) = 2f\left(\frac{1}{2}x\right)$

50.



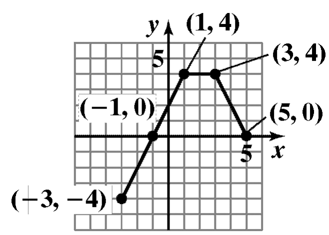
$g(x) = \frac{1}{2}f(2x)$

51.



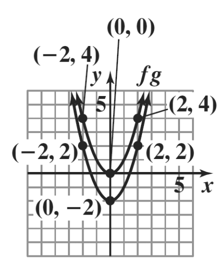
$g(x) = \frac{1}{2}f(x + 1)$

52.



$g(x) = 2f(x - 1)$

53.



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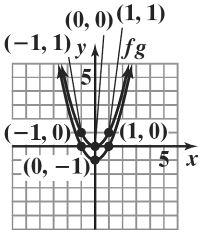

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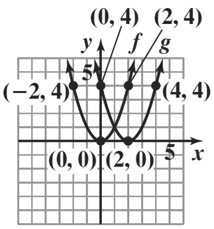

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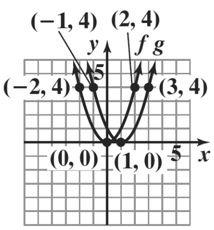

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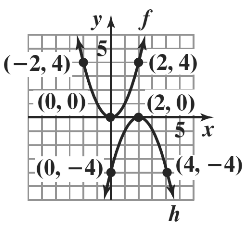

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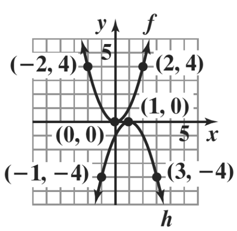

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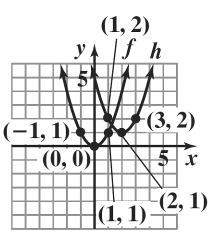

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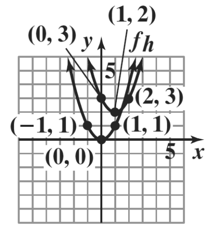

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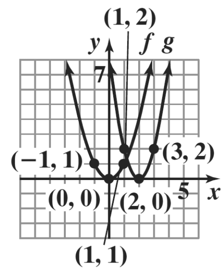

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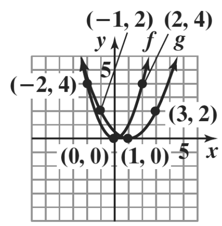

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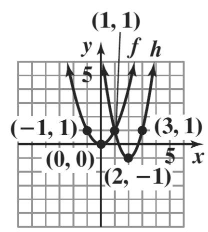

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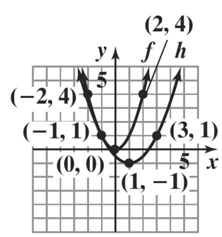

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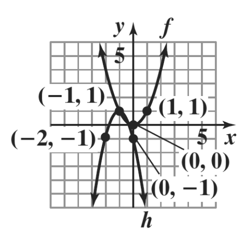

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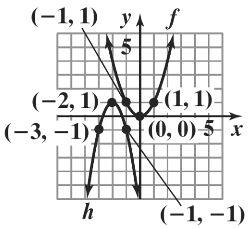

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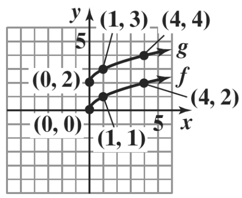

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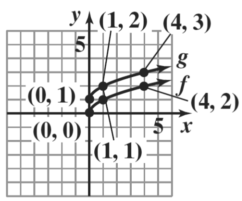

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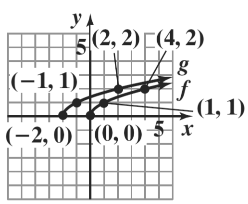

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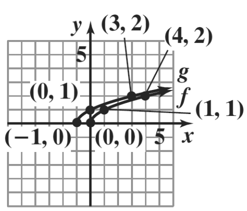

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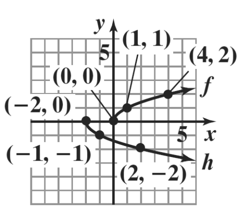

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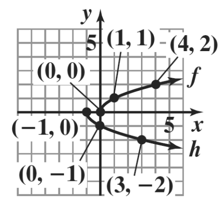

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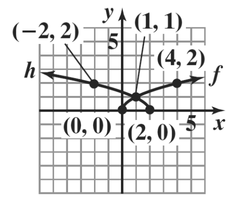

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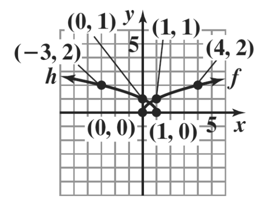

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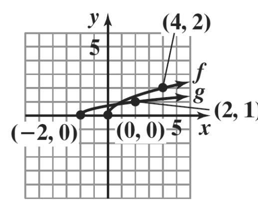

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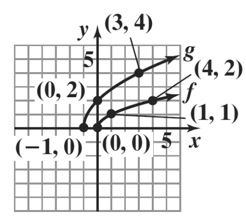

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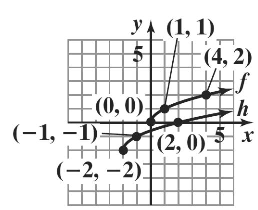

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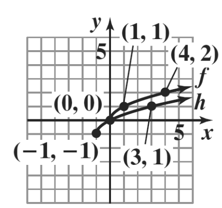

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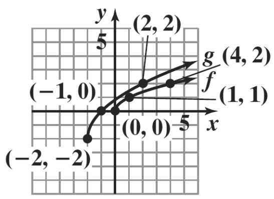

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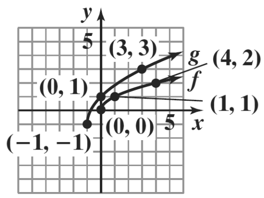

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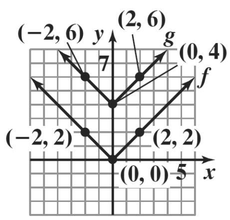

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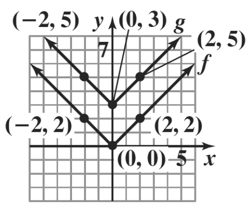

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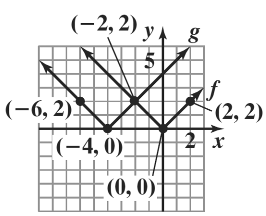

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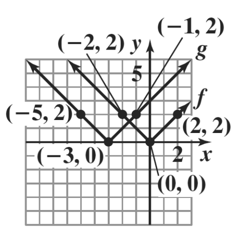

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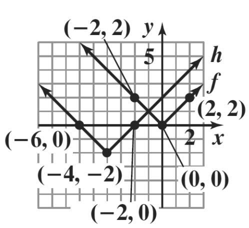

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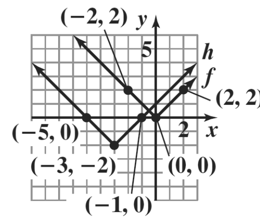

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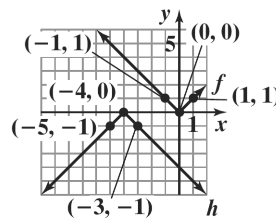

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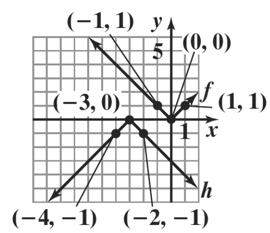

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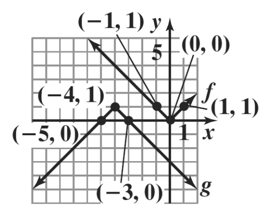

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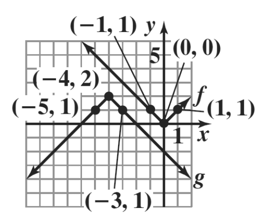

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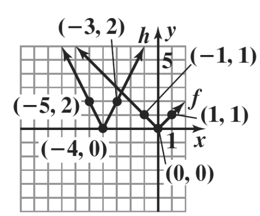

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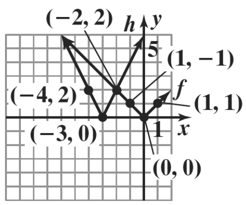

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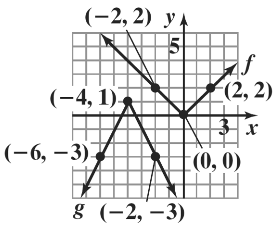

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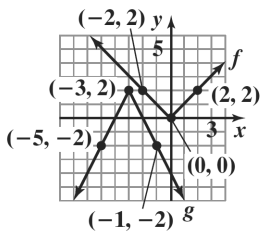

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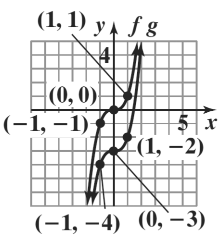

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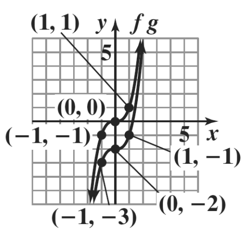

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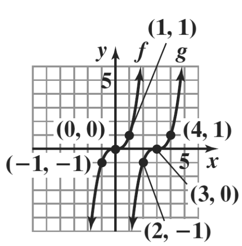

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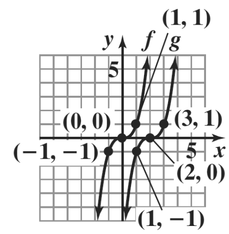

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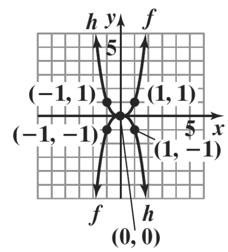

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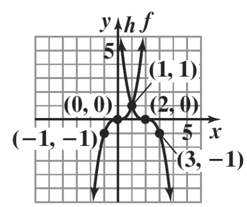

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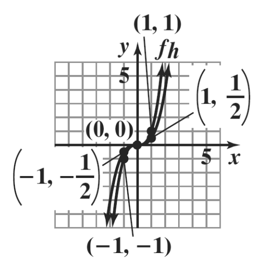

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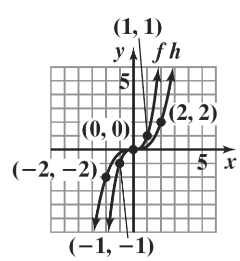

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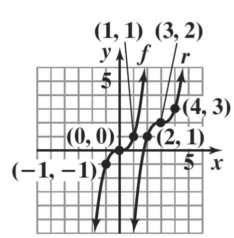

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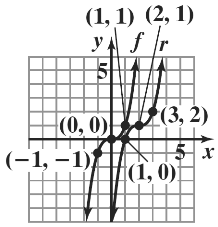

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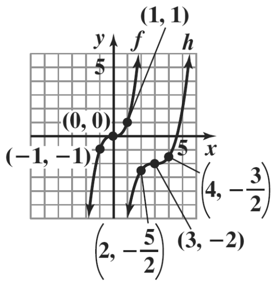

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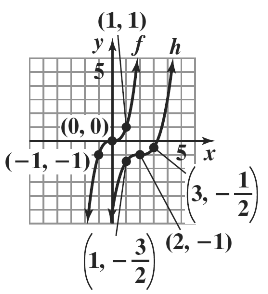

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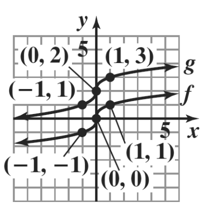

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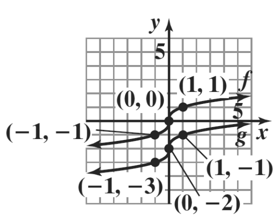

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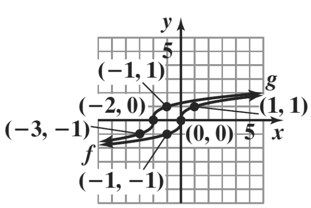

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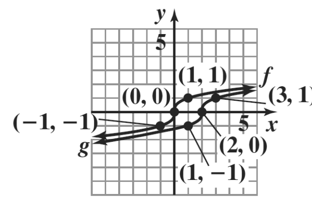

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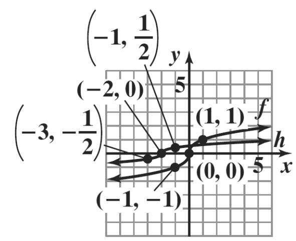

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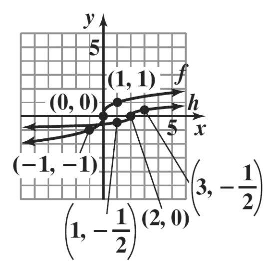

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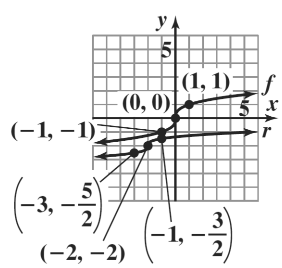

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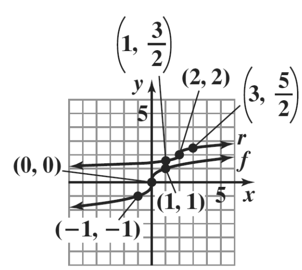

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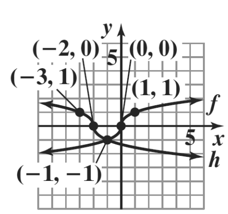

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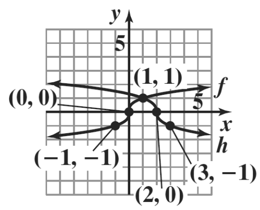

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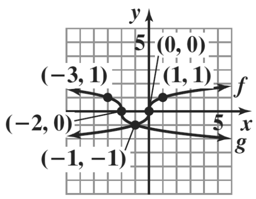

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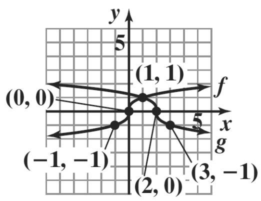

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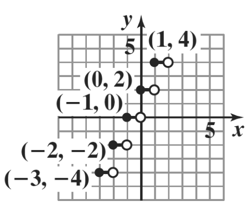
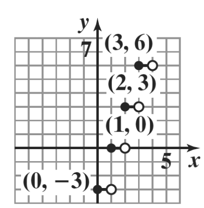


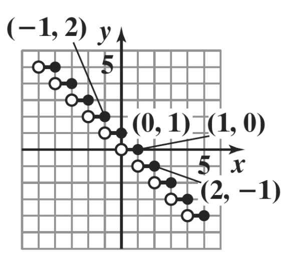
g(x) = 2 int (x + 1)

120.



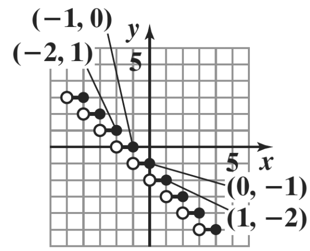
g(x) = 3 int (x − 1)

121.



h(x) = int (−x) + 1

122.



h(x) = int (−x) − 1

123. $y=\sqrt{x-2}$

124. $y=-x^3+2$

125. $y=(x+1)^2-4$

126. $y=\sqrt{x-2}+1$

127. a. First, vertically stretch the graph of $f(x)=\sqrt{x}$ by the factor 2.9; then shift the result up 20.1 units.

b. $f(x)=2.9\sqrt{x}+20.1$

$f(48)=2.9\sqrt{48}+20.1\approx 40.2$

The model describes the actual data very well.

c. $$\frac{f(x_2)-f(x_1)}{x_2-x_1}$$
$$=\frac{f(10)-f(0)}{10-0}$$
$$=\frac{\left(2.9\sqrt{10}+20.1\right)-\left(2.9\sqrt{0}+20.1\right)}{10-0}$$
$$=\frac{29.27-20.1}{10}$$
$$\approx 0.9$$

0.9 inches per month

d. $$\frac{f(x_2)-f(x_1)}{x_2-x_1}$$
$$=\frac{f(60)-f(50)}{60-50}$$
$$=\frac{\left(2.9\sqrt{60}+20.1\right)-\left(2.9\sqrt{50}+20.1\right)}{60-50}$$
$$=\frac{42.5633-40.6061}{10}$$
$$\approx 0.2$$

This rate of change is lower than the rate of change in part (c). The relative leveling off of the curve shows this difference.

128. a. First, vertically stretch the graph of $f(x) = \sqrt{x}$ by the factor 3.1; then shift the result up 19 units.

b. $f(x) = 3.1\sqrt{x} + 19$

$f(48) = 3.1\sqrt{48} + 19 \approx 40.5$

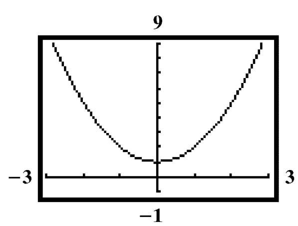
The model describes the actual data very well.

c.
$$\frac{f(x_2) - f(x_1)}{x_2 - x_1}$$
$$= \frac{f(10) - f(0)}{10 - 0}$$
$$= \frac{\left(3.1\sqrt{10} + 19\right) - \left(3.1\sqrt{0} + 19\right)}{10 - 0}$$
$$= \frac{28.8031 - 19}{10}$$
$$\approx 1.0$$
1.0 inches per month

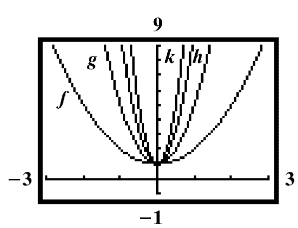
d.
$$\frac{f(x_2) - f(x_1)}{x_2 - x_1}$$
$$= \frac{f(60) - f(50)}{60 - 50}$$
$$= \frac{\left(3.1\sqrt{60} + 19\right) - \left(3.1\sqrt{50} + 19\right)}{60 - 50}$$
$$= \frac{43.0125 - 40.9203}{10}$$
$$\approx 0.2$$
This rate of change is lower than the rate of change in part (c). The relative leveling off of the curve shows this difference.

ns 129. – 134. Answers will vary.

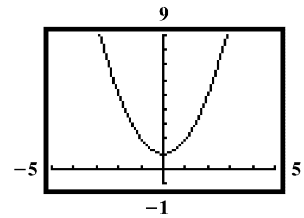
135. a.



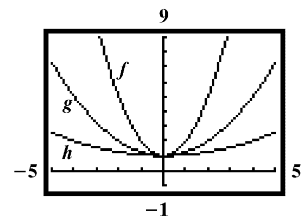
b.



136. a.



b.



137. makes sense

138. makes sense

139. does not make sense; Explanations will vary. Sample explanation: The reprogram should be $y = f(t+1)$.

140. does not make sense; Explanations will vary. Sample explanation: The reprogram should be $y = f(t-1)$.

141. false; Changes to make the statement true will vary. A sample change is: The graph of *g* is a translation of *f* three units to the <u>left</u> and three units upward.

142. false; Changes to make the statement true will vary. A sample change is: The graph of *f* is a reflection of the graph of $y = \sqrt{x}$ in the *x*-axis, while the graph of *g* is a reflection of the graph of $y = \sqrt{x}$ in the *y*-axis.

143. false; Changes to make the statement true will vary. A sample change is: The stretch will be 5 units and the downward shift will be 10 units.

144. true

145. $g(x) = -(x+4)^2$

146. $g(x) = -|x-5| + 1$

147. $g(x) = -\sqrt{x-2} + 2$

148. $g(x) = -\frac{1}{4}\sqrt{16 - x^2} - 1$

149. $(-a, b)$

150. $(a, 2b)$

151. $(a + 3, b)$

