CHAPTER 3
Graphs and Functions

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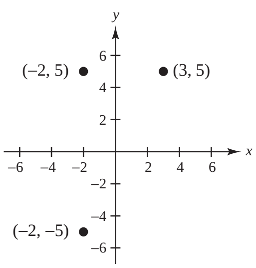
Graphs and Functions

Section 3.1 The Rectangular Coordinate System

Solutions to Even-Numbered Exercises

2.

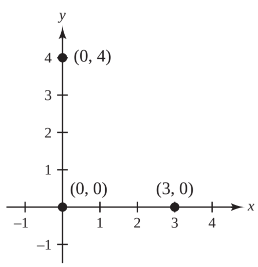


$(-2, 5)$ is 2 units to the left of the vertical axis and 5 units above the horizontal axis.

$(-2, -5)$ is 2 units to the left of the vertical axis and 5 units below the horizontal axis.

$(3, 5)$ is 3 units to the right of the vertical axis and 5 units above the horizontal axis.

4.

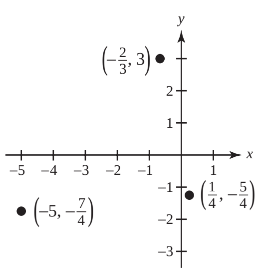


$(0, 4)$ is 0 units right or left of the vertical axis and 4 units above the horizontal axis.

$(0, 0)$ is the origin.

$(3, 0)$ is 3 units to the right of the vertical axis and 0 units above or below the horizontal axis.

6.

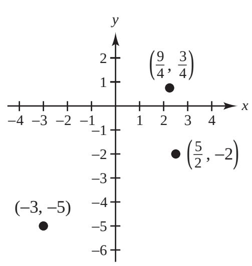


$\left(-\frac{2}{3}, 3\right)$ is $\frac{2}{3}$ units to the left of the vertical axis and 3 units above the horizontal axis.

$\left(\frac{1}{4}, -\frac{5}{4}\right)$ is $\frac{1}{4}$ units to the right of the vertical axis and $\frac{5}{4}$ units below the horizontal axis.

$\left(-5, -\frac{7}{4}\right)$ is 5 units to the left of the vertical axis and $\frac{7}{4}$ units below the horizontal axis.

8.



$(-3, -5)$ is 3 units to the left of the vertical axis and 5 units below the horizontal axis.

$\left(\frac{9}{4}, \frac{3}{4}\right)$ is $\frac{9}{4}$ units to the right of the vertical axis and $\frac{3}{4}$ units above the horizontal axis.

$\left(\frac{5}{2}, -2\right)$ is $\frac{5}{2}$ units to the right of the vertical axis and 2 units below the horizontal axis.

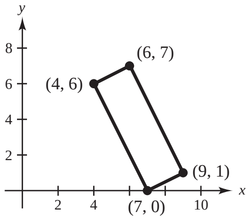
10.

Point	*Position*	*Coordinates*
A	3 left, 2 above	$(-3, 2)$
B	4 right, 1 below	$(4, -1)$
C	$\frac{1}{2}$ left, -2 below	$\left(-\frac{1}{2}, -2\right)$

12.

Point	*Position*	*Coordinates*
A	$\frac{7}{2}$ left, 2 below	$\left(-\frac{7}{2}, -2\right)$
B	5 right, 1 above	$(5, 1)$
C	0 right or left, 4 above	$(0, 4)$

14.



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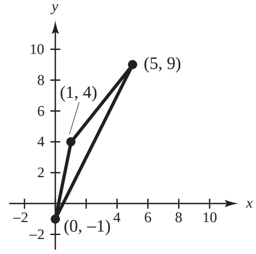

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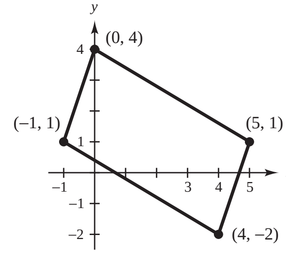

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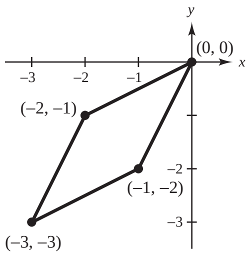


22. Point 10 units right of y-axis and 4 units below x-axis $= (10, -4)$.

24. Point 4 units right of y-axis and 6 units above x-axis $= (4, 6)$.

26. Coordinates of point are equal in magnitude and opposite in sign and point is 7 units right of y-axis $= (7, -7)$.

28. Point is on negative y-axis 5 units from the origin $= (0, -5)$.

30. $(4, -2)$ is in Quadrant IV.

32. $\left(\frac{5}{11}, \frac{3}{8}\right)$ is in Quadrant I.

34. $(-6.2, 8.05)$ is in Quadrant II.

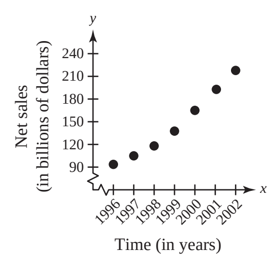
36. (x, y), $x > 0$, $y > 0$ is in Quadrant I.

38. $(10, y)$ is in Quadrant I or IV.

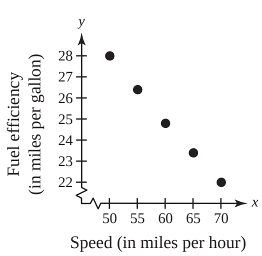
40. $(x, -6)$ is in Quadrant III or IV.

42. (x, y), $xy < 0$ is in Quadrant II or IV.

44.



46.



The relationship between x and y is as the value of x increases the value of y decreases.

48. $(-3, 5)$ shifted 6 units right and 3 units down $= (3, 2)$

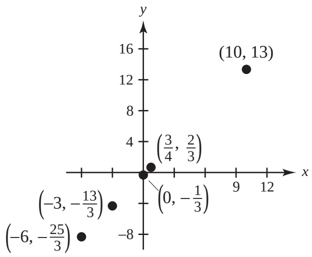
$(-1, 2)$ shifted 6 units right and 3 units down $= (5, -1)$

$(-3, -1)$ shifted 6 units right and 3 units down $= (3, -4)$

$(-5, 2)$ shifted 6 units right and 3 units down $= (1, -1)$

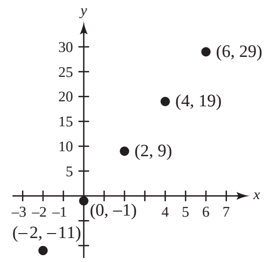
50.

x	-6	-3	0	$\frac{3}{4}$	10
$y = \frac{4}{3}x - \frac{1}{3}$	$-\frac{25}{3}$	$-\frac{13}{3}$	$-\frac{1}{3}$	$\frac{2}{3}$	13



52.

x	-2	0	2	4	6
$y = 5x - 1$	-11	-1	9	19	29



54.

x	-2	0	2	4	6
$y = 4x^2 + x - 2$	12	-2	16	66	148

Keystrokes: [Y=] 4 [X,T,θ] [x^2] [+] [X,T,θ] [−] 2 [GRAPH]

56. $y^2 - 4x = 8$

(a) $(0, 6)$

$$6^2 - 4(0) \stackrel{?}{=} 8$$
$$36 - 0 \stackrel{?}{=} 8$$
$$36 \neq 8$$

Not a solution

(b) $(-4, 2)$

$$2^2 - 4(-4) \stackrel{?}{=} 8$$
$$4 + 16 \stackrel{?}{=} 8$$
$$20 \neq 8$$

Not a solution

(c) $(-1, 3)$

$$3^2 - 4(-1) \stackrel{?}{=} 8$$
$$9 + 4 \stackrel{?}{=} 8$$
$$13 \neq 8$$

Not a solution

(d) $(7, 6)$

$$6^2 - 4(7) \stackrel{?}{=} 8$$
$$36 - 28 \stackrel{?}{=} 8$$
$$8 = 8$$

Solution

58. $5x - 2y + 50 = 0$

(a) $(-10, 0)$

$$5(-10) - 2(0) + 50 \stackrel{?}{=} 0$$
$$-50 - 0 + 50 \stackrel{?}{=} 0$$
$$0 = 0$$

Solution

(b) $(-5, 5)$

$$5(-5) - 2(5) + 50 \stackrel{?}{=} 0$$
$$-25 - 10 + 50 \stackrel{?}{=} 0$$
$$15 \neq 0$$

Not a solution

(c) $(0, 25)$

$$5(0) - 2(25) + 50 \stackrel{?}{=} 0$$
$$0 - 50 + 50 \stackrel{?}{=} 0$$
$$0 = 0$$

Solution

(d) $(20, -2)$

$$5(20) - 2(-2) + 50 \stackrel{?}{=} 0$$
$$100 + 4 + 50 \stackrel{?}{=} 0$$
$$154 \neq 0$$

Not a solution

60. $y = \frac{5}{8}x - 2$

(a) $(0, 0)$

$0 \stackrel{?}{=} \frac{5}{8}(0) - 2$

$0 \stackrel{?}{=} 0 - 2$

$0 \neq -2$

Not a solution

(b) $(8, 3)$

$3 \stackrel{?}{=} \frac{5}{8}(8) - 2$

$3 \stackrel{?}{=} 5 - 2$

$3 = 3$

Solution

(c) $(16, -7)$

$-7 \stackrel{?}{=} \frac{5}{8}(16) - 2$

$-7 \stackrel{?}{=} 10 - 2$

$7 \neq 8$

Not a solution

(d) $\left(-\frac{8}{5}, 3\right)$

$3 \stackrel{?}{=} \frac{5}{8}\left(-\frac{8}{5}\right) - 2$

$3 \stackrel{?}{=} -1 - 2$

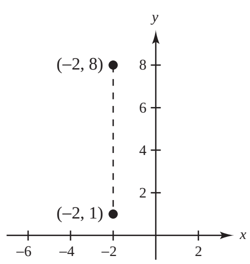
$3 \neq -3$

Not a solution

62. $d = |1 - 8|$

$= |-7|$

$= 7$



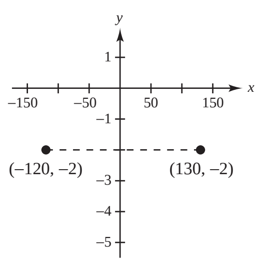
Vertical line

64. $d = |130 - (-120)|$

$= |130 + 120|$

$= |250|$

$= 250$

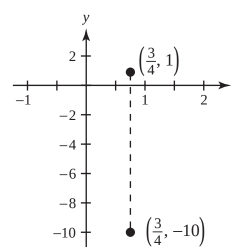


Horizontal line

66. $d = |-10 - 1|$

$= |-11|$

$= 11$



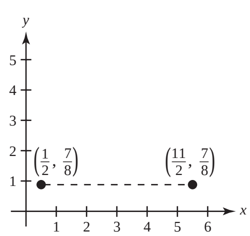
Vertical line

68. $d = \left|\frac{11}{2} - \frac{1}{2}\right|$

$= |5|$

$= 5$

Horizontal line



70. $d = \sqrt{(5 - 8)^2 + (2 - 3)^2}$

$= \sqrt{(-3)^2 + (1)^2}$

$= \sqrt{9 + 1}$

$= \sqrt{10}$

72. $d = \sqrt{(15 - 3)^2 + (5 - 10)^2}$

$= \sqrt{(12)^2 + (-5)^2}$

$= \sqrt{144 + 25}$

$= \sqrt{169}$

$= 13$

74. $d = \sqrt{(0 - 2)^2 + [-5 - (-8)]^2}$

$= \sqrt{(-2)^2 + (3)^2}$

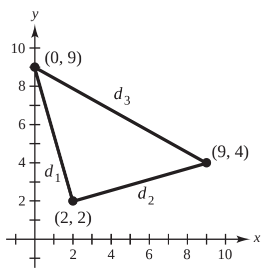
$= \sqrt{4 + 9}$

$= \sqrt{13}$

76. $d = \sqrt{[10 - (-5)]^2 + (-3 - 4)^2}$
$= \sqrt{(10 + 5)^2 + (-3 - 4)^2}$
$= \sqrt{15^2 + (-7)^2}$
$= \sqrt{225 + 49}$
$= \sqrt{274}$

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

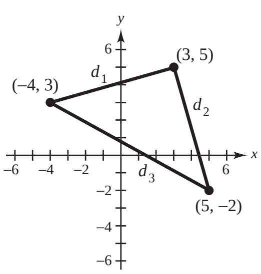
80.



$d_1 = \sqrt{(0 - 2)^2 + (9 - 2)^2} = \sqrt{4 + 49} = \sqrt{53}$
$d_2 = \sqrt{(2 - 9)^2 + (2 - 4)^2} = \sqrt{49 + 4} = \sqrt{53}$
$d_3 = \sqrt{(0 - 9)^2 + (9 - 4)^2} = \sqrt{81 + 25} = \sqrt{106}$
$\left(\sqrt{53}\right)^2 + \left(\sqrt{53}\right)^2 \stackrel{?}{=} \left(\sqrt{106}\right)^2$
$53 + 53 \stackrel{?}{=} 106$
$106 = 106$

By Pythagorean Theorem, it is a right triangle.

82.



$d_1 = \sqrt{(-4 - 3)^2 + (3 - 5)^2} = \sqrt{49 + 4} = \sqrt{53}$
$d_2 = \sqrt{(3 - 5)^2 + [5 - (-2)]^2} = \sqrt{4 + 49} = \sqrt{53}$
$d_3 = \sqrt{(-4 - 5)^2 + [3 - (-2)]^2} = \sqrt{81 + 25} = \sqrt{106}$
$\left(\sqrt{53}\right)^2 + \left(\sqrt{53}\right)^2 \stackrel{?}{=} \left(\sqrt{106}\right)^2$
$53 + 53 \stackrel{?}{=} 106$
$106 = 106$

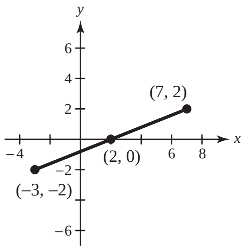
By Pythagorean Theorem, it is a right triangle.

84. $d = \sqrt{(-1 - 2)^2 + (6 - 4)^2} = \sqrt{(-3)^2 + 2^2} = \sqrt{9 + 4} = \sqrt{13}$
$d = \sqrt{[-3 - (-1)]^2 + (1 - 6)^2} = \sqrt{(-2)^2 + (-5)^2} = \sqrt{4 + 25} = \sqrt{29}$
$d = \sqrt{(-3 - 2)^2 + (1 - 4)^2} = \sqrt{(-5)^2 + (-3)^2} = \sqrt{25 + 9} = \sqrt{34}$
$\sqrt{13} + \sqrt{29} \neq \sqrt{34}$ Not collinear

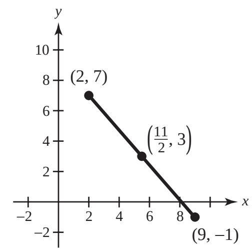
86. $d = \sqrt{(1 - 2)^2 + (1 - 4)^2} = \sqrt{(-1)^2 + (-3)^2} = \sqrt{1 + 9} = \sqrt{10}$
$d = \sqrt{(0 - 1)^2 + (-2 - 1)^2} = \sqrt{(-1)^2 + (-3)^2} = \sqrt{1 + 9} = \sqrt{10}$
$d = \sqrt{(0 - 2)^2 + (-2 - 4)^2} = \sqrt{(-2)^2 + (-6)^2} = \sqrt{4 + 36} = \sqrt{40} = 2\sqrt{10}$
$\sqrt{10} + \sqrt{10} = 2\sqrt{10}$ Collinear

88. $d = \sqrt{[-1 - (-5)]^2 + [4 - (-2)]^2} = \sqrt{4^2 + 6^2} = \sqrt{16 + 36} = \sqrt{52} = 2\sqrt{13}$
$d = \sqrt{[3 - (-1)]^2 + (-1 - 4)^2} = \sqrt{4^2 + (-5)^2} = \sqrt{16 + 25} = \sqrt{41}$
$d = \sqrt{[3 - (-5)]^2 + [-1 - (-2)]^2} = \sqrt{8^2 + 1^2} = \sqrt{64 + 1} = \sqrt{65}$
$P = 2\sqrt{13} + \sqrt{41} + \sqrt{65} \approx 21.68$

90. $M = \left(\frac{-3+7}{2}, \frac{-2+2}{2}\right) = \left(\frac{4}{2}, \frac{0}{2}\right) = (2, 0)$



92. $M = \left(\frac{2+9}{2}, \frac{7+(-1)}{2}\right) = \left(\frac{11}{2}, \frac{6}{2}\right) = \left(\frac{11}{2}, 3\right)$



94.

x	0	1	2	3	4
$y = 15x + 600$	600	615	630	645	660

$y = 15(0) + 600 = 0 + 600 = 600$

$y = 15(1) + 600 = 15 + 600 = 615$

$y = 15(2) + 600 = 30 + 600 = 630$

$y = 15(3) + 600 = 45 + 600 = 645$

$y = 15(4) + 600 = 60 + 600 = 660$

The employee's weekly pay is at least $600, and increases $15 for every overtime hour.

96. $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

let $(x_1, y_1) = (12, 18)$ and $(x_2, y_2) = (50, 42)$

$d = \sqrt{(50 - 12)^2 + (42 - 18)^2}$

$= \sqrt{38^2 + 24^2}$

$= \sqrt{1444 + 576}$

$= \sqrt{2020} = 2\sqrt{505} \approx 44.94$ yards

98. There is a strong relationship between the temperature outside and the amount of natural gas used. The relationship is the lower the temperature the more natural gas used. A family can expect to use about 500 cubic feet of natural gas if the tempertaure is 45°.

100. let $(x_1, y_1) = (2000, \$12{,}494)$ and

$(x_2, y_2) = (2002, \$19{,}597)$

$\text{Midpoint} = \left(\frac{x_1 + x_2}{2} + \frac{y_1 + y_2}{2}\right)$

$= \left(\frac{2000 + 2002}{2} + \frac{12{,}494 + 19{,}597}{2}\right)$

$= \left(\frac{4002}{2} + \frac{32{,}091}{2}\right)$

$= (2001, 16{,}045.5)$

Revenue in 2001 is $16,045.5 million.

102. The x-coordinate measures the distance from the y-axis to the point. The y-coordinate measures the distance from the x-axis to the point.

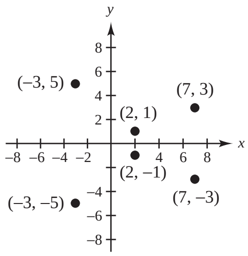
104. $(-3, 4)$ is not a solution point of $y = 4x + 15$ because

$4 \neq 4(-3) + 15$

$4 \neq 3$

106. The Pythagorean Theorem states that, for a right triangle with hypotenuse c and sides a and b, $a^2 + b^2 = c^2$.

108.



When the sign of the y-coordinate is changed, the point is on the opposite side of the x-axis as the original point.

Section 3.2 Graphs of Equations

2. $y = 2 + x$

Matches graph (b)

4. $y = x^2$

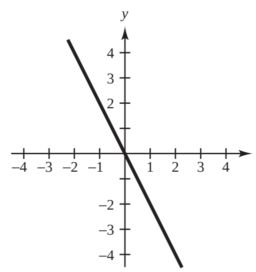
Matches graph (a)

6. $y = |x|$

Matches graph (c)

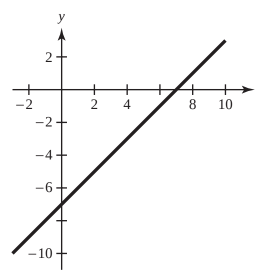
8.

x	-2	-1	0	1	2
$y = -2x$	4	2	0	-2	-4
Solution	$(-2, 4)$	$(-1, 2)$	$(0, 0)$	$(1, -2)$	$(2, -4)$



10.

x	-2	-1	0	1	2
$y = x - 7$	-9	-8	-7	-6	-5
Solution	$(-2, -9)$	$(-1, -8)$	$(0, -7)$	$(1, -6)$	$(2, -5)$

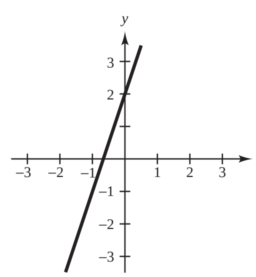


12. $3x - y = -2$

$-y = -3x - 2$

$y = 3x + 2$

x	-2	-1	0	1	2
$y = 3x + 2$	-4	-1	2	5	8
Solution	$(-2, -4)$	$(-1, -1)$	$(0, 2)$	$(1, 5)$	$(2, 8)$

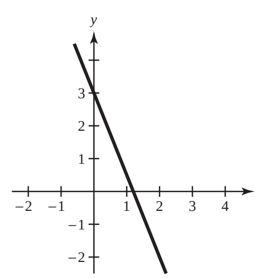


14. $2y + 5x = 6$

$2y = -5x + 6$

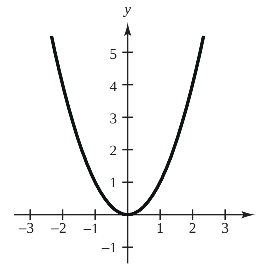
$y = -\frac{5}{2}x + 3$

x	-2	-1	0	1	2
$y = -\frac{5}{2}x + 3$	8	5.5	3	0.5	-2
Solution	$(-2, 8)$	$(-1, 5.5)$	$(0, 3)$	$(1, 0.5)$	$(2, -2)$



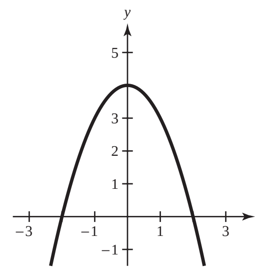
16.

x	-2	-1	0	1	2
$y = x^2$	4	1	0	1	4
Solution	$(-2, 4)$	$(-1, 1)$	$(0, 0)$	$(1, 1)$	$(2, 4)$



18.

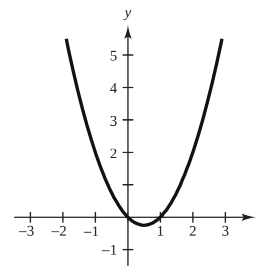
x	-2	-1	0	1	2
$y = 4 - x^2$	0	3	4	3	0
Solution	$(-2, 0)$	$(-1, 3)$	$(0, 4)$	$(1, 3)$	$(2, 0)$



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

$$y = x^2 - x$$

x	-2	-1	0	1	2
$y = x^2 - x$	6	2	0	0	2
Solution	$(-2, 6)$	$(-1, 2)$	$(0, 0)$	$(1, 0)$	$(2, 2)$

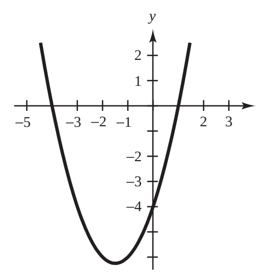


22. $x^2 + 3x - y = 4$

$$-y = -x^2 - 3x + 4$$

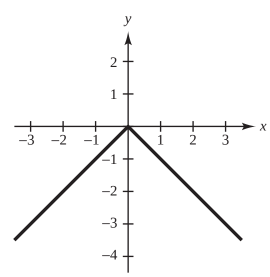
$$y = x^2 + 3x - 4$$

x	-2	-1	0	1	2
$y = x^2 + 3x - 4$	-6	-6	-4	0	6
Solution	$(-2, -6)$	$(-1, -6)$	$(0, -4)$	$(1, 0)$	$(2, 6)$



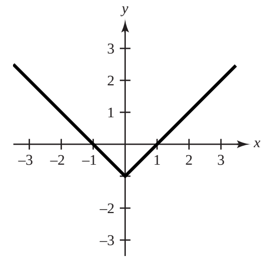
24.

x	-2	-1	0	1	2
$y = -\lvert x\rvert$	-2	-1	0	-1	-2
Solution	$(-2, -2)$	$(-1, -1)$	$(0, 0)$	$(1, -1)$	$(2, -2)$



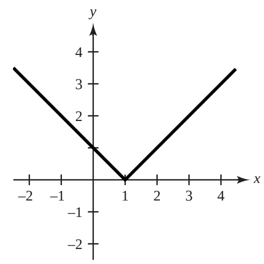
26.

x	-2	-1	0	1	2
$y = \lvert x\rvert - 1$	1	0	-1	0	1
Solution	$(-2, 1)$	$(-1, 0)$	$(0, -1)$	$(1, 0)$	$(2, 1)$



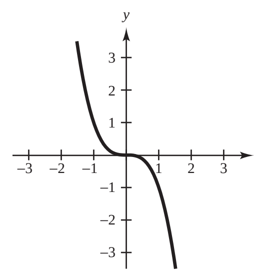
28.

x	-2	-1	0	1	2
$y = \lvert x - 1\rvert$	3	2	1	0	1
Solution	$(-2, 3)$	$(-1, 2)$	$(0, 1)$	$(1, 0)$	$(2, 1)$



30.

x	-2	-1	0	1	2
$y = -x^3$	8	1	0	-1	-8
Solution	$(-2, 8)$	$(-1, 1)$	$(0, 0)$	$(1, -1)$	$(2, -8)$



32. $y = 4 - 3x$

y-intercept: $y = 4 - 3(0)$

$y = 4 \qquad (0, 4)$

x-intercept: $0 = 4 - 3x$

$-4 = -3x \qquad \left(\frac{4}{3}, 0\right)$

$\frac{-4}{-3} = x$

$\frac{4}{3} = x$

34. $y = \frac{3}{4}x + 15$

y-intercept: $y = \frac{3}{4}(0) + 15$

$y = 15 \qquad (0, 15)$

x-intercept: $0 = \frac{3}{4}x + 15$

$-15 = \frac{3}{4}x$

$-20 = x \qquad (-20, 0)$

36. $3x - 2y = 12$

y-intercept: $3(0) - 2y = 12$

$0 - 2y = 12$

$-2y = 12$

$y = -6 \qquad (0, -6)$

x-intercept: $3x - 2(0) = 12$

$3x - 0 = 12$

$3x = -12$

$x = -4 \qquad (-4, 0)$

38. $2x + 3y - 8 = 0$

y-intercept: $2(0) + 3y - 8 = 0$

$3y = 8$

$y = \frac{8}{3} \qquad \left(0, \frac{8}{3}\right)$

x-intercept: $2x + 3(0) - 8 = 0$

$2x = 8$

$x = 4 \qquad (4, 0)$

40. $y = |x| + 4$

y-intercept: $y = |0| + 4$

$y = 4 \qquad (0, 4)$

x-intercept: $0 = |x| + 4$

$-4 = |x|$

None

42. $y = |x - 4|$

y-intercept: $y = |0 - 4|$

$y = 4 \qquad (0, 4)$

x-intercept: $0 = |x - 4|$

$0 = x - 4$

$4 = x \qquad (4, 0)$

44. $y = |x + 3| - 1$

y-intercept: $y = |0 + 3| - 1$

$y = 3 - 1$

$y = 2 \qquad (0, 2)$

x-intercept: $0 = |x + 3| - 1$

$1 = |x + 3|$

$1 = x + 3$ or $x + 3 = -1$

$-2 = x \qquad x = -4 \qquad (-2, 0), (-4, 0)$

46. $3x - y + 9 = 0$

Estimate: y-intercept ≈ 9

x-intercept ≈ -3

Check: $3(0) - y + 9 = 0$

$y = 9 \qquad (0, 9)$

$3x - 0 + 9 = 0$

$3x = -9$

$x = -3 \qquad (-3, 0)$

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

Estimate: y-intercept ≈ 0

x-intercepts $\approx 0, 4$

Check: $y = -0^2 + 4(0)$

$= 0 \qquad (0, 0)$

$0 = -x^2 + 4x$

$0 = -x(x - 4)$

$0 = -x \qquad x - 4 = 0$

$0 = x \qquad x = 4$

$(0, 0), (4, 0)$

50. $x = 3$

Estimate: no y-intercept

x-intercept ≈ 3

Check: $x \neq 0$

$x = 3 \qquad (3, 0)$

52. $y = 5x - 20$

Keystrokes: [Y=] 5 [X,T,θ] [−] 20 [GRAPH]

Estimate: y-intercept ≈ -20, x-intercept ≈ 4

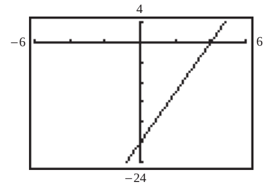
Check: $y = 5(0) - 20$

$y = -20 \qquad (0, -20)$

Check: $0 = 5x - 20$

$20 = 5x$

$4 = x \qquad (4, 0)$



54. $y = (x + 2)(x - 3)$

Keystrokes: [Y=] [(] [X,T,θ] [+] 2 [)] [(] [X,T,θ] [−] 3 [)] [GRAPH]

Estimate: y-intercept ≈ -6, x-intercepts $\approx -2, 3$

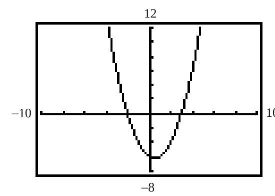
Check: $y = (0 + 2)(0 - 3)$

$y = -6 \qquad (0, -6)$

Check: $0 = (x + 2)(x - 3)$

$x = -2 \quad x = 3$

$(-2, 0), (3, 0)$



56. $y = |2x - 4| + 1$

Keystrokes: [Y=] [ABS] [(] 2 [X,T,θ] [−] 4 [)] [+] 1 [GRAPH]

Estimate: y-intercept ≈ 5, no x-intercepts

Check: $y = |2(0) - 4| + 1$

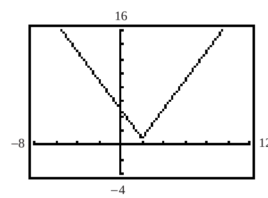
$y = 4 + 1$

$y = 5 \qquad (0, 5)$

Check: $0 = |2x - 4| + 1$

$-1 = |2x - 4|$

None



58. $y = x - 3$

$y = 0 - 3$

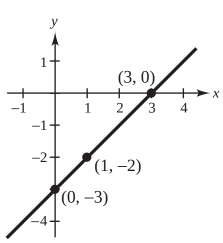
$y = -3 \qquad (0, -3)$

$0 = x - 3$

$3 = x \qquad (3, 0)$

$y = 1 - 3$

$y = -2 \qquad (1, -2)$



60. $y = -4x + 8$

$0 = -4x + 8$

$4x = 8$

$x = 2 \qquad (2, 0)$

$y = -4(0) + 8$

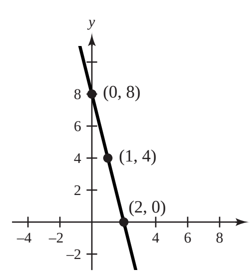
$y = 0 + 8$

$y = 8 \qquad (0, 8)$

$y = -4(1) + 8$

$y = -4 + 8$

$y = 4 \qquad (1, 4)$



62. $y - 2x = -4$

$0 - 2x = -4$

$-2x = -4$

$x = 2 \qquad (2, 0)$

$y - 2(0) = -4$

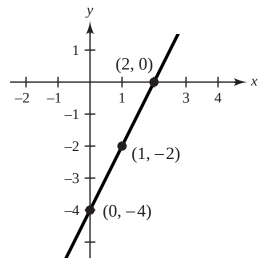
$y - 0 = -4$

$y = -4 \qquad (0, -4)$

$y - 2(1) = -4$

$y - 2 = -4$

$y = -2 \qquad (1, -2)$



64. $3x + 4y = 12$

$3(0) + 4y = 12$

$0 + 4y = 12$

$4y = 12$

$y = 3 \qquad (0, 3)$

$3x + 4(0) = 12$

$3x + 0 = 12$

$3x = 12$

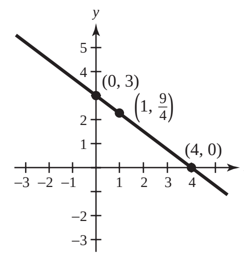
$x = 4 \qquad (4, 0)$

$3(1) + 4y = 12$

$3 + 4y = 12$

$4y = 9$

$y = \frac{9}{4} \qquad \left(1, \frac{9}{4}\right)$



66. $5x - y = 10$

$5(0) - y = 10$

$0 - y = 10$

$-y = 10$

$y = -10 \qquad (0, -10)$

$5x - (0) = 10$

$5x = 10$

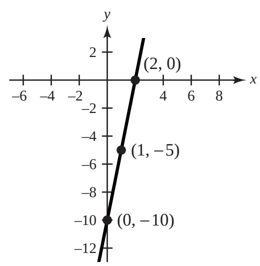
$x = 2 \qquad (2, 0)$

$5(1) - y = 10$

$5 - y = 10$

$-y = 5$

$y = -5 \qquad (1, -5)$



68. $y = 9 - x^2$

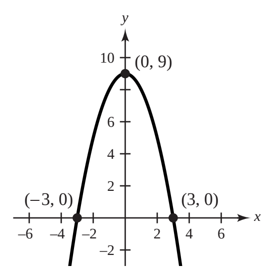
$0 = 9 - x^2$

$x^2 = 9$

$x = 3$ or $x = -3 \qquad (3, 0)$ or $(-3, 0)$

$y = 9 - 0^2$

$y = 9 \qquad (0, 9)$



70. $y = x^2 - 4$

$y = 0^2 - 4$

$= -4 \qquad (0, -4)$

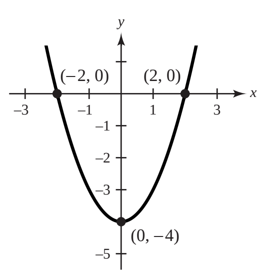
$y = x^2 - 4$

$0 = x^2 - 4$

$4 = x^2$

$\pm 2 = x$

$(-2, 0), (2, 0)$



72. $y = -x(x + 4)$

$y = -(0)(0 + 4)$

$y = 0 \qquad (0, 0)$

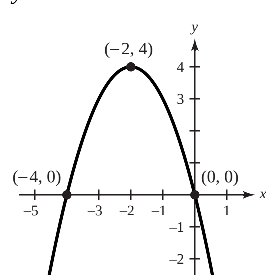
$0 = -x(x + 4)$

$x = 0$ or $x = -4 \qquad (0, 0), (-4, 0)$

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

$y = 2(2)$

$y = 4 \qquad (-2, 4)$



74. $y = |x| + 2$

$y = |-1| + 2$

$y = 1 + 2$

$y = 3 \qquad (-1, 3)$

$y = |0| + 2$

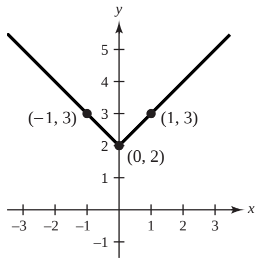
$y = 0 + 2$

$y = 2 \qquad (0, 2)$

$y = |1| + 2$

$y = 1 + 2$

$y = 3 \qquad (1, 3)$



76. $y = |x - 3|$

$0 = |x - 3|$

$x = 3 \qquad (3, 0)$

$y = |0 - 3|$

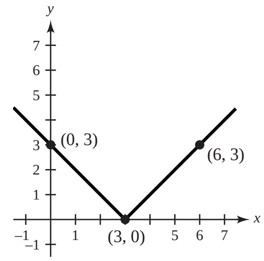
$y = |-3|$

$y = 3 \qquad (0, 3)$

$y = |6 - 3|$

$y = |3|$

$y = 3 \qquad (6, 3)$



78. $y = |x| + |x - 2|$

$y = |0| + |0 - 2|$

$y = 0 + |-2|$

$y = 0 + 2$

$y = 2 \qquad (0, 2)$

$y = |1| + |1 - 2|$

$y = 1 + |-1|$

$y = 1 + 1$

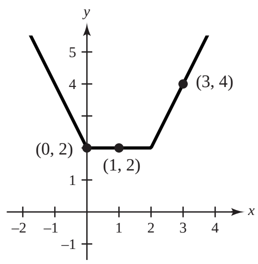
$y = 2 \qquad (1, 2)$

$y = |3| + |3 - 2|$

$y = 3 + |1|$

$y = 3 + 1$

$y = 4 \qquad (3, 4)$



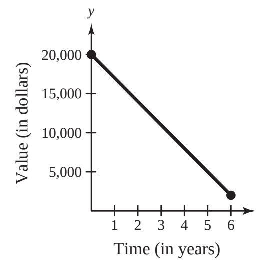
80. $y = 20{,}000 - 3000t$

$y = 20{,}000 - 3000(0)$

$y = 20{,}000 \qquad (0, 20{,}000)$

$y = 20{,}000 - 3000(6)$

$y = 2000 \qquad (6, 2000)$

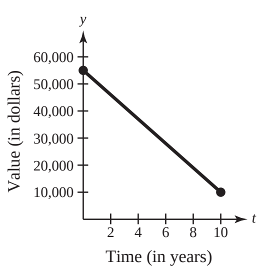


82. $0 \le t \le 10$

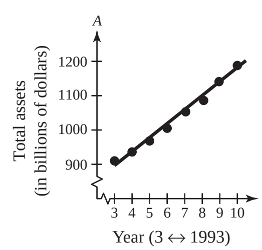
$(0, 55{,}000), (10, 10{,}000)$

$$m = \frac{55{,}000 - 10{,}000}{0 - 10} = \frac{45{,}000}{-10} = -4500$$

$y = -4500t + 55{,}000$



84. (a)



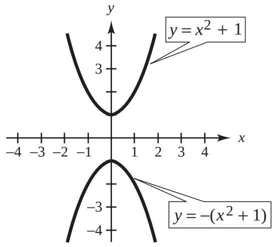
(b) The model is a good representation of the data because the data points differ only slightly from the model.

(c) $A = 40.2t + 775$

$A = 40.2(15) + 775$

$A = 603 + 775$

$A = \$1378$ billion

86. 

When the expression for y is multiplied by -1, the graph is reflected in the x-axis.

Additional Example: $y = x^2$ and $y = -x^2$

88. There are an infinite number of solution points that make up the graph of $y = 2x - 1$.

90. To find the x-intercepts, let $y = 0$ and solve the equation for x. To find the y-intercepts, let $x = 0$ and solve the equation for y.

Example: $2x - y = 4$

$2x - 0 = 4$

$2x = 4$

$x = 2$ $(2, 0)$

x-intercept

$2(0) - y = 4$

$-y = 4$

$y = -4$ $(0, -4)$

y-intercept

Section 3.3 Slope and Graphs of Linear Equations

2. $(0, 5)$ and $(4, 3)$

$$m = \frac{3 - 5}{4 - 0} = \frac{-2}{4} = \frac{-1}{2}$$

4. $(2, 0)$ and $(3, 4)$

$$m = \frac{4 - 0}{3 - 2} = \frac{4}{1} = 4$$

6. $(0, 5)$ and $(3, 5)$

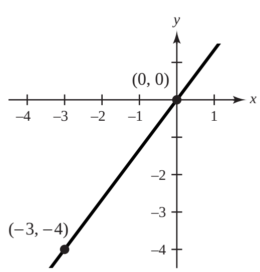
$$m = \frac{5 - 5}{3 - 0} = \frac{0}{3} = 0$$

8. (a) $m = -\frac{5}{2} \implies L_2$

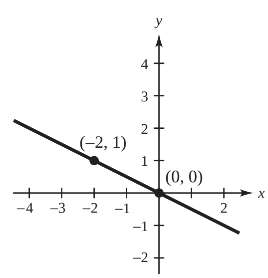
(b) m is undefined $\implies L_3$

(c) $m = 2 \implies L_1$

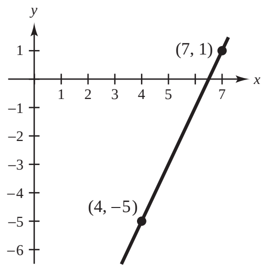
10. $m = \dfrac{-4 - 0}{-3 - 0} = \dfrac{-4}{-3} = \dfrac{4}{3}$ Line rises.



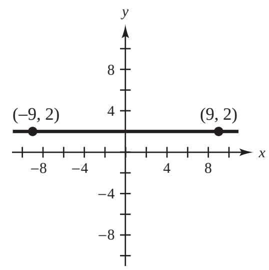
12. $m = \dfrac{1 - 0}{-2 - 0} = \dfrac{1}{-2}$ Line falls.



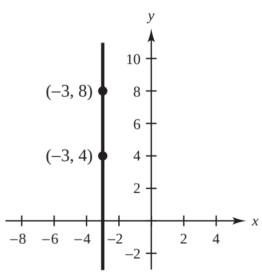
14. $m = \dfrac{-5 - 1}{4 - 7} = \dfrac{-6}{-3} = 2$ Line rises.



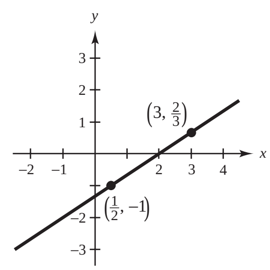
16. $m = \dfrac{2 - 2}{-9 - 2} = \dfrac{0}{-11} = 0$ Line is horizontal.



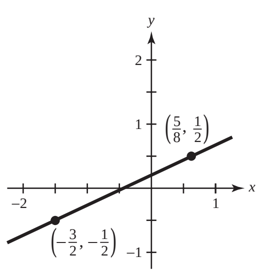
18. $m = \dfrac{8 - 4}{-3 - (-3)} = \dfrac{4}{0} =$ undefined Line is vertical.



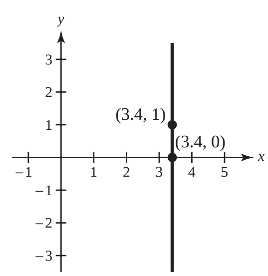
20. $m = \dfrac{\frac{2}{3} - (-1)}{3 - \frac{1}{2}} \cdot \dfrac{6}{6} = \dfrac{4 + 6}{18 - 3} = \dfrac{10}{15} = \dfrac{2}{3}$ Line rises.



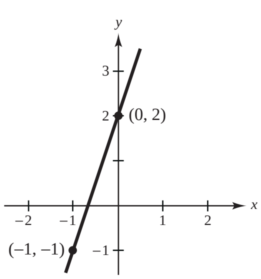
22. $m = \dfrac{\frac{1}{2} - \left(-\frac{1}{2}\right)}{\frac{5}{8} - \left(-\frac{3}{2}\right)} = \dfrac{\frac{1}{2} + \frac{1}{2}}{\frac{5}{8} + \frac{3}{2}} = \dfrac{1}{\frac{5}{8} + \frac{12}{8}} = \dfrac{1}{\frac{17}{8}} = \dfrac{8}{17}$ Line rises.



24. $m = \dfrac{1 - 0}{3.4 - 3.4} = \dfrac{1}{0} =$ undefined Line is vertical.



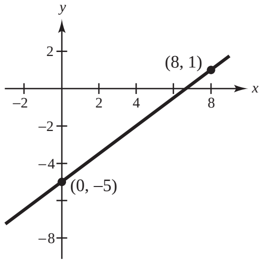
26.



x	-1	0	1
$y = 3x + 2$	-1	2	5
Solution	$(-1, -1)$	$(0, 2)$	$(1, 5)$

$m = \dfrac{5 - 2}{1 - 0} = \dfrac{3}{1} = 3$

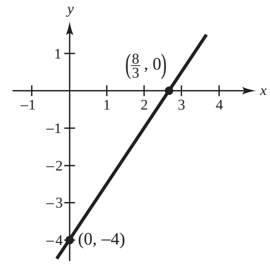
28.



x	-1	0	1
$y = \frac{3}{4}x - 5$	$-5\frac{3}{4}$	-5	$-4\frac{1}{4}$
Solution	$\left(-1, -5\frac{3}{4}\right)$	$(0, -5)$	$\left(1, -4\frac{1}{4}\right)$

$$m = \frac{-4\frac{1}{4} - (-5)}{1 - 0} = -\frac{17}{4} + \frac{20}{4} = \frac{3}{4}$$

30.



x	-1	0	1
$y = \frac{3}{2}x - 4$	$-5\frac{1}{2}$	-4	$-2\frac{1}{2}$
Solution	$\left(-1, -5\frac{1}{2}\right)$	$(0, -4)$	$\left(1, -2\frac{1}{2}\right)$

$$3x - 2y = 8$$
$$-2y = -3x + 8$$
$$y = \frac{3}{2}x - 4$$
$$m = \frac{-2\frac{1}{2} - (-4)}{1 - 0} = -\frac{5}{2} + \frac{8}{2} = \frac{3}{2}$$

32.
$$\frac{3}{4} = \frac{0 - (-2)}{5 - x}$$
$$\frac{3}{4} = \frac{2}{5 - x}$$
$$3(5 - x) = 8$$
$$15 - 3x = 8$$
$$-3x = -7$$
$$x = \frac{7}{3}$$

34.
$$-6 = \frac{y - 20}{2 - (-3)}$$
$$-6 = \frac{y - 20}{5}$$
$$-30 = y - 20$$
$$-10 = y$$

36. $\frac{y - 3}{x - (-4)}$ is not possible.

$x + 4 = 0$

Vertical line:

$(-4, 1), (-4, 2), (-4, 3)$

Any point with an x-coordinate of -4.

38. $2 = \frac{y + 5}{x + 1}$

Let $x = 0$, solve for y:
$$2 = \frac{y + 5}{1}$$
$$2 = y + 5$$
$$-3 = y$$
$(0, -3)$

Let $x = 1$, solve for y:
$$2 = \frac{y + 5}{2}$$
$$4 = y + 5$$
$$-1 = y$$
$(1, -1)$

40. $-3 = \frac{y - 6}{x - (-2)}$

Let $x = -1$, solve for y:
$$-3 = \frac{y - 6}{1}$$
$$-3 = y - 6$$
$$3 = y$$
$(-1, 3)$

Let $x = 0$, solve for y:
$$-3 = \frac{y - 6}{2}$$
$$-6 = y - 6$$
$$0 = y$$
$(0, 0)$

42. $-\frac{3}{4} = \frac{y-1}{x+1}$

Let $x = 3$, solve for y:

$-\frac{3}{4} = \frac{y-1}{4}$

$-3 = y - 1$

$-2 = y$

$(3, -2)$

Let $x = 7$, solve for y:

$-\frac{3}{4} = \frac{y-1}{8}$

$-6 = y - 1$

$-5 = y$

$(7, -5)$

44. $2x + 4y = 16$

$4y = -2x + 16$

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

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

46. $3x - 2y = -10$

$-2y = -3x - 10$

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

48. $8x - 6y + 1 = 0$

$-6y = -8x - 1$

$y = \frac{4}{3}x + \frac{1}{6}$

50. $x = -\frac{3}{2}y + \frac{2}{3}$

$6x = -9y + 4$

$9y = -6x + 4$

$\frac{9y}{9} = -\frac{6x}{9} + \frac{4}{9}$

$y = -\frac{2}{3}x + \frac{4}{9}$

52. $y = 4 - 2x$

$m = -2$

$(0, 4)$

54. $4x + 8y = -1$

$8y = -4x - 1$

$y = -\frac{4}{8}x - \frac{1}{8}$

$y = -\frac{1}{2}x - \frac{1}{8}$

$m = -\frac{1}{2}; \left(0, -\frac{1}{8}\right)$

56. $6y - 5x + 18 = 0$

$6y = 5x - 18$

$y = \frac{5}{6}x - 3$

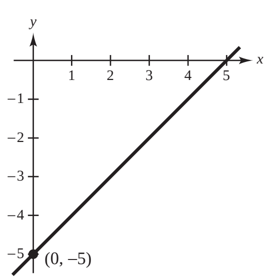
$m = \frac{5}{6}; (0, -3)$

58. $x - y - 5 = 0$

$-y = -x + 5$

$y = x - 5$

slope $= 1$ y-intercept $= -5$

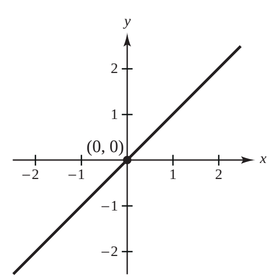


60. $x - y = 0$

$-y = -x$

$y = x$

slope $= 1$ y-intercept $= 0$

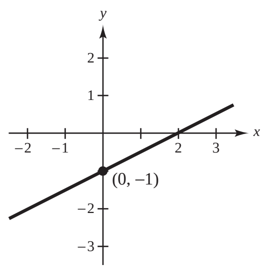


62. $x - 2y - 2 = 0$

$$-2y = -x + 2$$

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

slope $= \frac{1}{2}$ y-intercept $= -1$



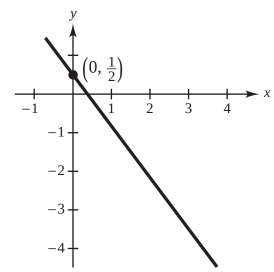
64. $8x + 6y - 3 = 0$

$$6y = -8x + 3$$

$$y = -\frac{8}{6}x + \frac{3}{6}$$

$$y = -\frac{4}{3}x + \frac{1}{2}$$

slope $= -\frac{4}{3}$ y-intercept $= \frac{1}{2}$



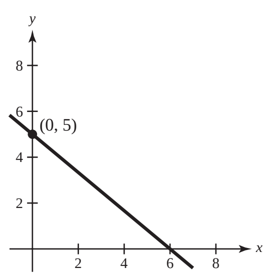
66. $0.5x + 0.6y - 3 = 0$

$$0.6y = -0.5x + 3$$

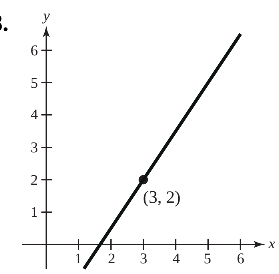
$$y = -\frac{5}{6}x + 5$$

slope $= -\frac{5}{6}$

y-intercept $= 5$



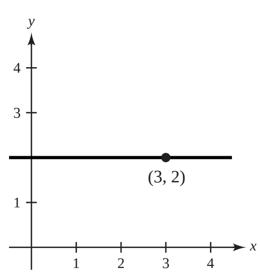
68.



Locate a second point with the slope of $\frac{3}{2}$.

$$m = \frac{3}{2} = \frac{\text{change in } y}{\text{change in } x}$$

70.



Locate a second point with the slope of 0.

Line is horizontal.

72. $3x + 5y + 15 = 0$

$$3(0) + 5y + 15 = 0$$

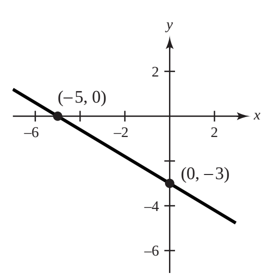
$$5y = -15$$

$$y = -3 \qquad (0, -3)$$

$$3x - 5(0) - 15 = 0$$

$$3x = -15$$

$$x = -5 \qquad (-5, 0)$$



74. $3x - 5y - 15 = 0$

$3(0) - 5y - 15 = 0$

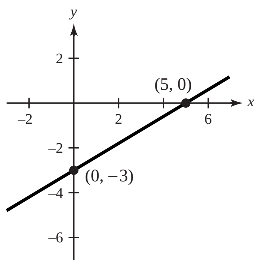
$-5y = 15$

$y = -3 \qquad (0, -3)$

$3x - 5(0) - 15 = 0$

$3x = 15$

$x = 5 \qquad (5, 0)$



76. L_1: $y = 3x - 2$

L_2: $y = 3x + 1$

$m_1 = 3$ and $m_2 = 3$

$m_1 = m_2$ so the lines are parallel.

78. L_1: $y = -\frac{2}{3}x - 5$

L_2: $y = \frac{3}{2}x + 1$

$m_1 = -\frac{2}{3}$ and $m_2 = \frac{3}{2}$

$m_1 \cdot m_2 = -1$ so the lines are perpendicular.

80. L_1: $m_1 = \frac{3 - 4}{-2 - 3} = \frac{-1}{-5} = \frac{1}{5}$

L_2: $m_2 = \frac{-1 - (-3)}{2 - 0} = \frac{2}{2} = 1$

$m_1 \neq m_2$ nor $m_1 \cdot m_2 = -1$ so the lines are neither parallel nor perpendicular.

82. L_1: $m_1 = \frac{-2 - 2}{-1 - 3} = \frac{-4}{-4} = 1$

L_2: $m_2 = \frac{-1 - 0}{3 - 2} = \frac{-1}{1} = -1$

$m_1 \cdot m_2 = -1$ so the lines are perpendicular.

84. $\frac{1}{10} = \frac{4}{x}$

$x = 40$ feet

$c = \sqrt{4^2 + 40^2} = \sqrt{1616} = 4\sqrt{101} \approx 40.2$ feet

86. $\frac{4}{5} = \frac{h}{15}$

$h = \frac{4 \cdot 15}{5} = 12$ feet

88. (a) $y = 8000 + 600(0) = 8000 + 0 = \$8,000$

$y = 8000 + 600(1) = 8000 + 600 = \$8,600$

$y = 8000 + 600(2) = 8000 + 1200 = \$9,200$

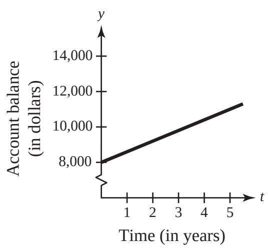
$y = 8000 + 600(3) = 8000 + 1800 = \$9,800$

$y = 8000 + 600(4) = 8000 + 2400 = \$10,400$

$y = 8000 + 600(5) = 8000 + 3000 = \$11,000$

t	0	1	2	3	4	5
y	\$8,000	\$8,600	\$9,200	\$9,800	\$10,400	\$11,000

(b)



(c) $$\text{average rate of change} = \frac{\$11,000 - \$8,000}{5 - 0} = \frac{3,000}{5} = \$600$$

90. Yes, any pair of points on a line can be used to calculate the slope of the line. When different pairs of points are selected, the change in y and the change in x are the lengths of the sides of similar triangles. Corresponding sides of similar triangles are proportional.

92. The line with slope -3 is steeper. There is a vertical change of 3 units for each 1 unit change in x. The slope $3/2$ means that there is a vertical change of 3 units for every 2 unit change in x.

94. The x-coordinate of the x-intercept is the same as the solution of the equation when $y = 0$.

Section 3.4 Equations of Lines

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

Matches graph (d)

4. $y = -3x + 2$

Matches graph (c)

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

8. $$\frac{2}{3} = \frac{y - 9}{x - 6}$$
$$2(x - 6) = 3(y - 9)$$
$$2x - 12 = 3y - 27$$
$$2x - 3y = -15 \text{ or } y = \frac{2}{3}x + 5$$

10. $$-\frac{1}{6} = \frac{y - (3/2)}{x - (-2)}$$
$$x + 2 = -6\left(y - \frac{3}{2}\right)$$
$$x + 2 = -6y + 9$$
$$x + 6y = 7 \text{ or } y = -\frac{1}{6}x + \frac{7}{6}$$

12. $$y - 0 = \tfrac{1}{5}(x - 0)$$
$$y = \tfrac{1}{5}x$$

14. $$y - 5 = 2(x - 0)$$
$$y - 5 = 2x$$
$$y = 2x + 5$$

16. $$y - (-8) = \tfrac{2}{3}(x - 0)$$
$$y + 8 = \tfrac{2}{3}x$$
$$y = \tfrac{2}{3}x - 8$$

18. $y - (-1) = 3(x - 4)$
$y + 1 = 3(x - 4)$
$y + 1 = 3x - 12$
$y = 3x - 13$

20. $y - (-8) = -\frac{2}{3}(x - 6)$
$y + 8 = -\frac{2}{3}(x - 6)$
$y + 8 = -\frac{2}{3}x + 4$
$y = -\frac{2}{3}x - 4$

22. $y - \left(-\frac{3}{2}\right) = 1(x - 1)$
$y + \frac{3}{2} = 1(x - 1)$
$y = x - \frac{5}{2}$

24. $y - \frac{1}{2} = -\frac{2}{5}\left[x - \left(-\frac{5}{2}\right)\right]$
$y - \frac{1}{2} = -\frac{2}{5}\left(x + \frac{5}{2}\right)$
$y - \frac{1}{2} = -\frac{2}{5}x - 1$
$y = -\frac{2}{5}x - \frac{1}{2}$

26. $y - 5 = 0(x + 8)$ or
$y - 5 = 0$
$y = 5$

28. $m = \frac{-5 - 0}{3 - 0} = \frac{-5}{3}$
$y - 0 = -\frac{5}{3}(x - 0)$
$y = -\frac{5}{3}x$
$3y = -5x$
$5x + 3y = 0$

30. $m = \frac{0 - (-2)}{2 - 0} = \frac{2}{2} = 1$
$y - (-2) = 1(x - 0)$
$y + 2 = x$
$x - y - 2 = 0$

32. $m = \frac{1 - 6}{4 - 2} = -\frac{5}{2}$
$y - 6 = -\frac{5}{2}(x - 2)$
$y - 6 = -\frac{5}{2}x + 5$
$2y - 12 = -5x + 10$
$5x + 2y - 22 = 0$

34. $m = \frac{(-6) - (-3)}{(-4) - (-2)} = \frac{-6 + 3}{-4 + 2} = \frac{-3}{-2}$
$= \frac{3}{2}$
$y - (-3) = \frac{3}{2}[x - (-2)]$
$y + 3 = \frac{3}{2}x + 3$
$2y + 6 = 3x + 6$
$3x - 2y = 0$

36. $m = \frac{\frac{7}{3} - \frac{1}{3}}{4 - (-1)} = \frac{\frac{6}{3}}{5} = \frac{2}{5}$
$y - \frac{1}{3} = \frac{2}{5}[x - (-1)]$
$y - \frac{1}{3} = \frac{2}{5}x + \frac{2}{5}$
$15y - 5 = 6x + 6$
$6x - 15y + 11 = 0$

38. $m = \frac{-\frac{2}{5} - \frac{3}{5}}{\frac{3}{4} - (-4)} = \frac{-\frac{5}{5}}{\frac{3}{4} + \frac{16}{4}} = \frac{-1}{\frac{19}{4}} = -\frac{4}{19}$
$y - \frac{3}{5} = -\frac{4}{19}[x - (-4)]$
$y - \frac{3}{5} = -\frac{4}{19}x - \frac{16}{19}$
$95y - 57 = -20x - 80$
$20x + 95y + 23 = 0$

40. $m = \dfrac{2.3 - (-8)}{6 - 2} = \dfrac{10.3}{4} = \dfrac{103}{40}$

$$y - (-8) = \frac{103}{40}(x - 2)$$

$$y + 8 = \frac{103x}{40} - \frac{103}{20}$$

$$40y + 320 = 103x - 206$$

$$103x - 40y - 526 = 0$$

42. $m = \dfrac{-3.4 - 0.6}{3 - (-5)} = \dfrac{-4}{8} = -\dfrac{1}{2}$

$$y - 0.6 = -\frac{1}{2}[x - (-5)]$$

$$y - \frac{6}{10} = -\frac{1}{2}(x + 5)$$

$$y - \frac{3}{5} = -\frac{1}{2}x - \frac{5}{2}$$

$$10\left(y - \frac{3}{5}\right) = 10\left(-\frac{1}{2}x - \frac{5}{2}\right)$$

$$10y - 6 = -5x - 25$$

$$5x + 10y + 19 = 0$$

44. $m = \dfrac{0 - 10}{5 - 0} = \dfrac{-10}{5} = -2$

$$y = 10 = -2(x - 0)$$

$$y - 10 = -2x$$

$$y = -2x + 10$$

46. $m = \dfrac{3 - (-3)}{4 - (-6)} = \dfrac{3 + 3}{4 + 6} = \dfrac{6}{10} = \dfrac{3}{5}$

$$y - 3 = \frac{3}{5}(x - 4)$$

$$y - 3 = \frac{3}{5}x - \frac{12}{5}$$

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

48. $x = 2$ because every x-coordinate is 2.

50. $y = 6$ because every y-coordinate is 6.

52. $y = 4$ because both points have a y-coordinate of 4.

54. $x + 6y = 12$

$$6y = -x + 12$$

$$y = -\frac{1}{6}x + 2 \quad \text{slope} = -\frac{1}{6}$$

(a) $y - 4 = -\dfrac{1}{6}(x + 3)$

$$y - 4 = -\frac{1}{6}x - \frac{1}{2}$$

$$y = -\frac{1}{6}x + \frac{7}{2}$$

(b) $y - 4 = 6(x + 3)$

$$y - 4 = 6x + 18$$

$$y = 6x + 22$$

56. $3x + 10y = 24 \quad \text{slope} = -\dfrac{3}{10}$

$$10y = -3x + 24$$

$$y = -\frac{3}{10}x + \frac{24}{10}$$

(a) $y - (-4) = -\dfrac{3}{10}(x - 6)$

$$y + 4 = -\frac{3}{10}x + \frac{9}{5}$$

$$y = -\frac{3}{10}x + \frac{9}{5} - \frac{20}{5}$$

$$y = -\frac{3}{10}x - \frac{11}{5}$$

(b) $y - (-4) = \dfrac{10}{3}(x - 6)$

$$y + 4 = \frac{10}{3}x - 20$$

$$y = \frac{10}{3}x - 24$$

58. $2x + 5y - 12 = 0$

$$5y = -2x + 12$$

$$y = -\frac{2}{5}x + \frac{12}{5} \quad \text{slope} = -\frac{2}{5}$$

(a) $y - (-10) = -\frac{2}{5}[x - (-5)]$

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

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

$$y = -\frac{2}{5}x - 12$$

(b) $y - (-10) = \frac{5}{2}[x - (-5)]$

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

$$y + 10 = \frac{5}{2}x + \frac{25}{2}$$

$$y = \frac{5}{2}x + \frac{25}{2} - \frac{20}{2}$$

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

60. $-5x + 4y = 0$

$$\frac{5}{4}x = y \quad \text{slope} = \frac{5}{4}$$

(a) $y - \frac{9}{4} = \frac{5}{4}\left(x - \frac{5}{8}\right)$

$$y - \frac{9}{4} = \frac{5}{4}x - \frac{25}{32}$$

$$y = \frac{5}{4}x - \frac{25}{32} + \frac{72}{32}$$

$$y = \frac{5}{4}x + \frac{47}{32}$$

(b) $y - \frac{9}{4} = -\frac{4}{5}\left(x - \frac{5}{8}\right)$

$$y - \frac{9}{4} = -\frac{4}{5}x + \frac{1}{2}$$

$$y = -\frac{4}{5}x + \frac{2}{4} + \frac{9}{4}$$

$$y = -\frac{4}{5}x + \frac{11}{4}$$

62. $x - 10 = 0$

$x = 10$ The slope is undefined because the line is vertical.

(a) $x = 3$

$x - 3 = 0$

(b) $y = -4$

$y + 4 = 0$

64. $\frac{x}{-6} + \frac{y}{2} = 1$

$$-\frac{x}{6} + \frac{y}{2} = 1$$

66. $\frac{x}{-\frac{8}{3}} + \frac{y}{-4} = 1$

$$-\frac{3x}{8} - \frac{y}{4} = 1$$

68. $m = \frac{10 - 5}{50 - 41} = \frac{5}{9}$

$C - 5 = \frac{5}{9}(F - 41)$

$C - 5 = \frac{5}{9}F - \frac{205}{9}$

$C = \frac{5}{9}F - \frac{205}{9} + \frac{45}{9}$

$C = \frac{5}{9}F - \frac{160}{9}$

$C = \frac{5}{9}(72) - \frac{160}{9}$

$C = 40 - \frac{160}{9}$

$C \approx 22.2°$

70. $m = \frac{250{,}000 - 150{,}000}{5 - 3} = \frac{100{,}000}{2} = 50{,}000$

$S - 250{,}000 = 50{,}000(t - 5)$

$S - 250{,}000 = 50{,}000t - 250{,}000$

$S = 50{,}000t$

$S = 50{,}000(6)$

$S = \$300{,}000$

72. $m = \frac{159 - 142}{100 - 50} = \frac{17}{50} = 0.34$

$C - 142 = 0.34(x - 50)$

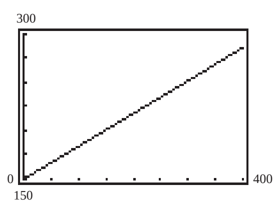
$C - 142 = 0.34x - 17$

$C = 0.34x + 125$

The sales representative is reimbursed $0.34 per mile.

74. (a) $C = 0.35x + 150$

(b)



$C = 0.35(230) + 150$

$C = 80.5 + 150$

$C = \$230.50$

estimate = $230.50

(c) estimate 143 miles

$200 = 0.35x + 150$

$50 = 0.35x$

$\frac{50}{0.35} = x$

$142.857 \approx x$

$143 \approx x$ miles

76. (a) (0, $27,500) (5, $12,000)

$m = \frac{12{,}000 - 27{,}500}{5 - 0} = \frac{-15{,}500}{5} = -3100$

$V - 27{,}500 = -3100(t - 0)$

$V = -3100t + 27{,}500$

(b) $V = -3100(2) + 27{,}500$

$V = -6200 + 27{,}500$

$V = \$21{,}300$

78. (a) $(0.80, 6000) \quad (1, 4000)$

$$m = \frac{6000 - 4000}{0.80 - 1.00} = \frac{2000}{-0.20} = -10{,}000$$

$$x - 4000 = -10{,}000(p - 1)$$

$$x - 4000 = -10{,}000p + 10{,}000$$

$$x = -10{,}000p + 14{,}000$$

(b) $x = -10{,}000(1.10) + 14{,}000$

$x = -11{,}000 + 14{,}000$

$x = 3000$

Thus, if the price is \$1.10, the demand will be 3000 cans.

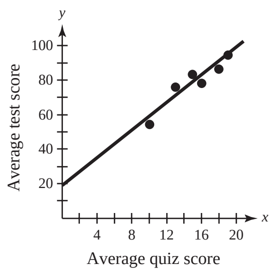
(c) $x = -10{,}000(0.90) + 14{,}000$

$x = -9000 + 14{,}000$

$x = 5000$

Thus, if the price is \$0.90, the demand will be 5000 cans.

80. (a) and (b)



(c) Answers will vary.
Two points taken from the "best-fitting" line sketched in part (b) are (12, 67) and (20, 99).

$$m = \frac{99 - 67}{20 - 12} = \frac{32}{8} = 4$$

$$y - 67 = 4(x - 12)$$

$$y - 67 = 4x - 48$$

$$y = 4x + 19$$

(d) $y = 4(17) + 19 = 68 + 19 = 87$

82. $m = \dfrac{2 - 6}{12 - 0} = \dfrac{-4}{12} = -\dfrac{1}{3}$

$$y - 6 = -\frac{1}{3}(x - 0)$$

$$y - 6 = -\frac{1}{3}x$$

$$3y - 18 = -x$$

$$3y + x - 18 = 0$$

Distance from the tall end	0	3	6	9	12
Height of block	6	5	4	3	2

(a) $6 - 6 = -\frac{1}{3}x$

$0 = -\frac{1}{3}x$

$0 = x$

(b) $5 - 6 = -\frac{1}{3}x$

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

$3 = x$

(c) $4 - 6 = -\frac{1}{3}x$

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

$6 = x$

(d) $3 - 6 = -\frac{1}{3}x$

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

$9 = x$

(e) $2 - 6 = -\frac{1}{3}x$

$-4 = -\frac{1}{3}x$

$12 = x$

84. Yes. When different pairs of points are selected, the change in y and the change in x are the lengths of the sides of similar triangles. Corresponding sides of similar triangles are proportional.

86. In the equation $y = 3x + 5$, 3 is the slope and 5 is the y-intercept.

Section 3.5 Graphs of Linear Inequalities

2. $x + y < 3$

(a) $0 + 6 \overset{?}{<} 3$

$6 \not< 3$

$(0, 6)$ *is not* a solution.

(b) $4 + 0 \overset{?}{<} 3$

$4 \not< 3$

$(4, 0)$ *is not* a solution.

(c) $0 + (-2) \overset{?}{<} 3$

$-2 < 3$

$(0, -2)$ *is* a solution.

(d) $1 + 1 \overset{?}{<} 3$

$2 < 3$

$(1, 1)$ *is* a solution.

4. $-3x + 5y \ge 6$

(a) $-3(2) + 5(8) \overset{?}{\ge} 6$

$-6 + 40 \overset{?}{\ge} 6$

$34 \ge 6$

$(2, 8)$ *is* a solution.

(b) $-3(-10) + 5(-3) \overset{?}{\ge} 6$

$30 - 15 \overset{?}{\ge} 6$

$15 \ge 6$

$(-10, -3)$ *is* a solution.

(c) $-3(0) + 5(0) \overset{?}{\ge} 6$

$0 + 0 \overset{?}{\ge} 6$

$0 \not\ge 6$

$(0, 0)$ *is not* a solution.

(d) $-3(-3) + 5(3) \overset{?}{\ge} 6$

$-9 + 15 \overset{?}{\ge} 6$

$6 \ge 6$

$(3, 3)$ *is* a solution.

6. $y < 3.5x + 7$

(a) $5 \overset{?}{<} -3.5(1) + 7$

$5 \overset{?}{<} -3.5 + 7$

$5 \not< 3.5$

$(1, 5)$ *is not* a solution.

(b) $-1 \overset{?}{<} -3.5(5) + 7$

$-1 \overset{?}{<} -17.5 + 7$

$-1 \not< -10.5$

$(5, -1)$ *is not* a solution.

(c) $4 \overset{?}{<} -3.5(-1) + 7$

$4 \overset{?}{<} -3.5 + 7$

$4 < 10.5$

$(-1, 4)$ *is* a solution.

(d) $\frac{4}{3} \overset{?}{<} -3.5(0) + 7$

$\frac{4}{3} \overset{?}{<} 0 + 7$

$\frac{4}{3} < 7$

$\left(0, \frac{4}{3}\right)$ *is* a solution.

8. $y \ge |x - 3|$

(a) $0 \overset{?}{\ge} |0 - 3|$

$0 \overset{?}{\ge} |-3|$

$0 \not\ge 3$

$(0, 0)$ *is not* a solution.

(b) $2 \overset{?}{\ge} |1 - 3|$

$2 \overset{?}{\ge} |-2|$

$2 \ge 2$

$(1, 2)$ *is* a solution.

(c) $10 \overset{?}{\ge} |4 - 3|$

$10 \overset{?}{\ge} |1|$

$10 \ge 1$

$(4, 10)$ *is* a solution.

(d) $-1 \overset{?}{\ge} |5 - 3|$

$-1 \overset{?}{\ge} |2|$

$-1 \not\ge 2$

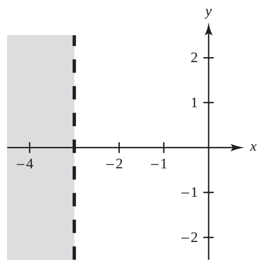
$(5, -1)$ *is not* a solution.

10. $x < -2$; (a)

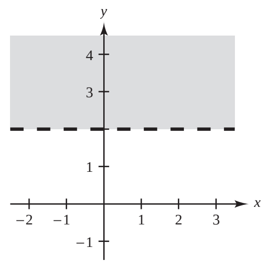
12. $3x - 2y > 0$; (e)

14. $x + y \leq 4$; (c)

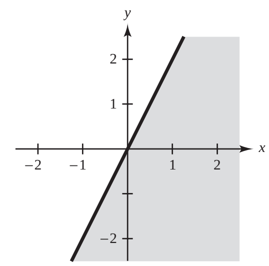
16. $x < -3$



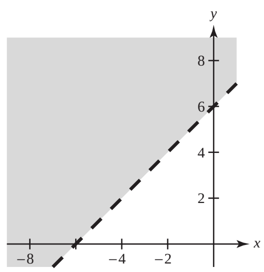
18. $y > 2$



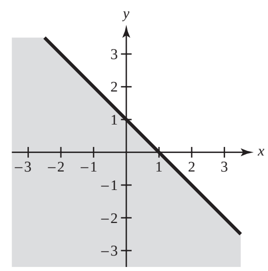
20. $y \leq 2x$



22. $y > x + 6$

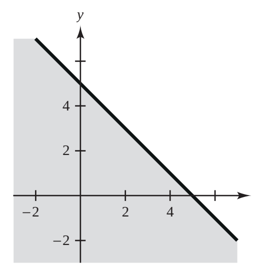


24. $y \leq 1 - x$



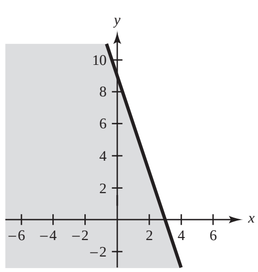
26. $x + y \leq 5$

$y \leq -x + 5$



28. $3x + y \leq 9$

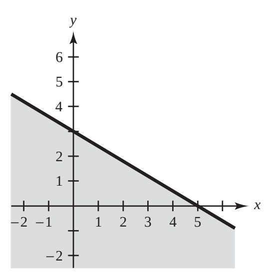
$y \leq -3x + 9$



30. $3x + 5y \leq 15$

$5y \leq -3x + 15$

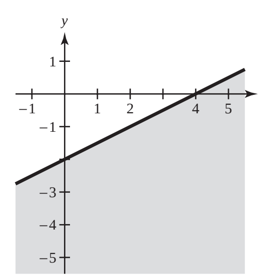
$y \leq -\frac{3}{5}x + 3$



32. $2x - 2y \geq 8 + 2y$

$-4y \geq -2x + 8$

$y \leq \frac{1}{2}x - 2$

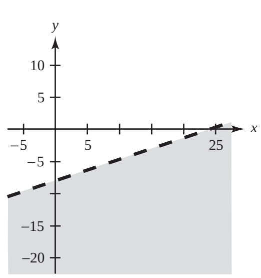


34. $0.25x - 0.75y > 6$

$25x - 75y > 600$

$-75y > -25x + 600$

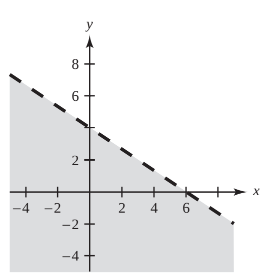
$y < \dfrac{1}{3}x - 8$



36. $y - 2 < -\dfrac{2}{3}(x - 3)$

$y - 2 = -\dfrac{2}{3}x + 2$

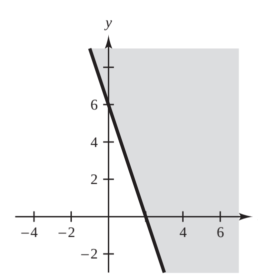
$y = -\dfrac{2}{3}x + 4$



38. $\dfrac{x}{2} + \dfrac{y}{6} \geq 1$

$3x + y \geq 6$

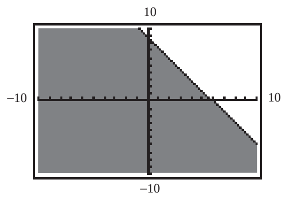
$y \geq -3x + 6$



40. $y \le 9 - \frac{3}{2}x$

Keystrokes:

[DRAW] 7 [(] −10, 9 [−] 1.5 [X,T,θ] [)] [ENTER]

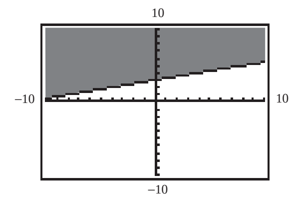


42. $y \ge \frac{1}{4}x + 3$

Keystrokes:

[Y=] [X,T,θ] [÷] 4 [+] 3

[DRAW] 7 [(] [Y-VARS] 1 1 [,] 10 [)] [ENTER]



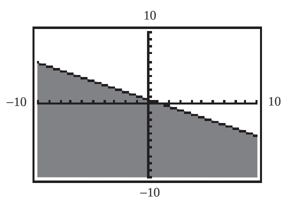
44. $2x + 4y - 3 \le 0$

$$4y \le -2x + 3$$

$$y \le -\tfrac{1}{2}x + \tfrac{3}{4}$$

[Y=] [(−)] [X,T,θ] [÷] 2 [+] 3 [÷] 4

[DRAW] 7 [(] [(−)] 10 [,] [Y-VARS] 1 1 [)] [ENTER]

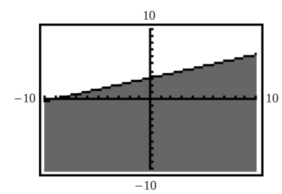


46. $x - 3y + 9 \ge 0$

$$-3y \ge -x - 9$$

$$y \le \tfrac{1}{3}x + 3$$

[DRAW] 7 [(] −10, [X,T,θ] [÷] 3 [+] 3 [)] [ENTER]



48. $m = \dfrac{6-2}{4-0} = \dfrac{4}{4} = 1$

$$y - 2 < 1(x - 0)$$

$$y - 2 < x$$

$$y < x + 2$$

$$-x + y < 2$$

50. $x < 2$

52. $m = \dfrac{1-0}{-1-0} = \dfrac{1}{-1} = -1$

$$y - 0 < -1(x - 0)$$

$$y < -x$$

$$x + y < 0$$

54. $P = 2x + 2y$

$$2x + 2y \ge 100$$

$$x + y \ge 50$$

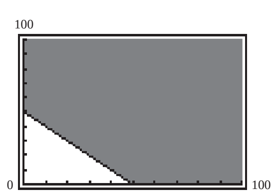
$$y \ge -x + 50$$

(*Note:* x and y cannot be negative.)

Keystrokes:

[Y=] [(−)] [X,T,θ] [+] 50

[DRAW] 7 [(] [Y-VARS] 1 1 [,] 100 [)] [ENTER]



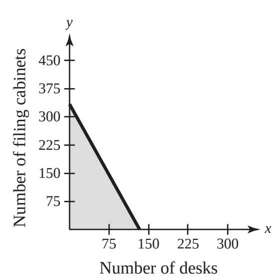
56. $15x + 6y \le 2000$

$$6y \le -15x + 2000$$

$$y \le -\tfrac{15}{6}x + \tfrac{2000}{6}$$

$$y \le -\tfrac{5}{2}x + \tfrac{1000}{3}$$

(*Note:* x and y cannot be negative.)



58. (a) *Verbal Model:* [Cost of cheese pizzas] + [Cost for extra toppings] + [Cost for drinks] $\leq$ 48

Labels: Cost of cheese pizzas $= 3(9) = \$27$

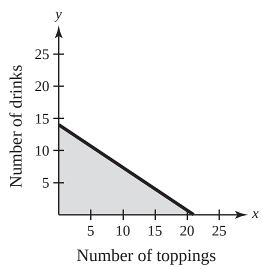
Cost for extra toppings $= 1.00x$ (dollars)

Cost for drinks $= 1.50y$ (dollars)

Inequality:
$$27 + 1.00x + 1.50y \leq 48$$
$$1.00x + 1.50y \leq 21$$
$$x + 1.5y \leq 21$$

(*Note:* x and y cannot be negative.)

(b)

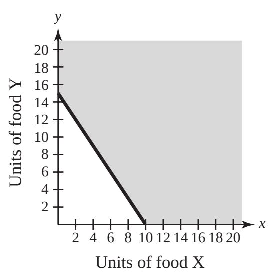


(c) (6, 8)
$$6 + 1.5(8) \stackrel{?}{\leq} 21$$
$$6 + 12 \stackrel{?}{\leq} 21$$
$$18 \leq 21 \text{ yes}$$

60. (a) $30x + 20y \geq 300$

(*Note:* x and y cannot be negative.)
$$20y \geq -30x + 300$$
$$y \geq -\tfrac{3}{2}x + 15$$

(b)



(x, y): (2, 12), (4, 9), (8, 3)

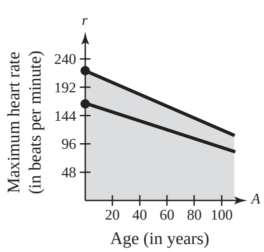
62. $6x + 5y \geq 120$
$$5y \geq -6x + 120$$
$$y \geq -\tfrac{6}{5}x + 24$$

(*Note:* x and y cannot be negative.)

Here are some examples of ordered pairs that are solutions. Note that there are other correct answers.

(5, 18), (10, 12), (15, 16)

64. $r = 0.75(220 - A)$



66. (x_1, y_1) is a solution of a linear inequality in x and y means the inequality is true when x_1 and y_1 are substituted for x and y respectively.

68. The solution of $x - y > 1$ does not include the points on the line $x - y = 1$. The solution of $x - y \ge 1$ does include the points on the line $x - y = 1$.

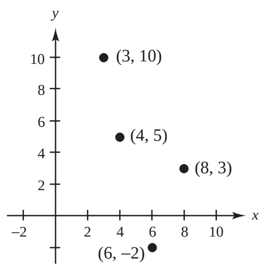
70. On the real number line, the solution of $x \le 3$ is an unbounded interval.

On a rectangular coordinate system, the solution of $x \le 3$ is a half-plane.

Section 3.6 Relations and Functions

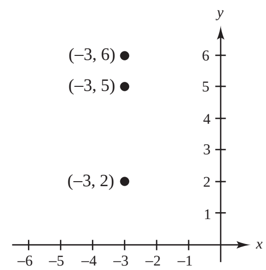
2. Domain $= \{3, 4, 6, 8\}$

Range $= \{-2, 3, 5, 10\}$



4. Domain $= \{-3\}$

Range $= \{2, 5, 6\}$



6. (8, 480), (10, 600), (7.5, 450), (4, 240)

8. $(-1, -1)$, (0, 0), (1, 1), (2, 8), (3, 27), (4, 64)

10. (1981, Reagan), (1985, Reagan), (1989, G. Bush), (1993, Clinton), (1997, Clinton), (2001, G.W. Bush)

12. Yes, this relation is a function because each element in the domain is assigned exactly one element in the range.

14. No, this relation is not a function as 100 in the domain is paired with two numbers in the range (25 and 30).

16. Yes, this relation is a function as each number in the domain is paired with exactly one number in the range.

18. Yes, this relation is a function because each element in the domain is assigned exactly one element in the range.

20. No, this relation is not a function as 0 in the domain is paired with two numbers in the range (1 and 20) as is 1 (8 and 15).

22. Yes, this relation is a function as each number in the domain is paired with exactly one number in the range.

24. (a) No (b) Yes (c) No (d) Yes

26.
$$x^2 + 4y^2 = 16$$
$$0^2 + 4(2)^2 \stackrel{?}{=} 16$$
$$16 = 16$$
$$0^2 + 4(-2)^2 \stackrel{?}{=} 16$$
$$16 = 16$$

Both (0, 2) and $(0, -2)$ are solutions of $x^2 + 4y^2 = 16$ which implies y is not a function of x.

28.
$$|y - 2| = x$$
$$|4 - 2| \stackrel{?}{=} 2$$
$$2 = 2$$
$$|0 - 2| \stackrel{?}{=} 2$$
$$2 = 2$$

Both (2, 4) and (2, 0) are solutions of $|y - 2| = x$ which implies y is not a function of x.

30. $y = 3 - 8x$ represents y as a function of x because there is one value of y associated with each value of x.

32. $x - 9y + 3 = 0$ represents y as a function of x because there is one value of y associated with each value of x.

34. $y = (x + 2)^2 + 3$ represents y as a function of x because there is one value of y associated with each value of x.

36. $f(x) = 6 - 2x$

(a) $f(3) = 6 - 2(3) = 6 - 6 = 0$

(b) $f(-4) = 6 - 2(-4) = 6 + 8 = 14$

(c) $f(n) = 6 - 2n$

(d) $f(n - 2) = 6 - 2(n - 2) = 6 - 2n + 4 = 10 - 2n$

38. $f(x) = \sqrt{x + 8}$

(a) $f(1) = \sqrt{1 + 8} = \sqrt{9} = 3$

(b) $f(-4) = \sqrt{-4 + 8} = \sqrt{4} = 2$

(c) $f(h) = \sqrt{h + 8}$

(d) $f(h - 8) = \sqrt{h - 8 + 8} = \sqrt{h}$

40. $f(x) = \dfrac{2x}{x - 7}$

(a) $f(2) = \dfrac{2(2)}{2 - 7} = -\dfrac{4}{5}$

(b) $f(-3) = \dfrac{2(-3)}{-3 - 7} = \dfrac{-6}{-10} = \dfrac{3}{5}$

(c) $f(t) = \dfrac{2t}{t - 7}$

(d) $f(t + 5) = \dfrac{2(t + 5)}{t + 5 - 7} = \dfrac{2t + 10}{t - 2}$

42. $f(x) = 3 - 7x$

(a) $f(-1) = 3 - 7(-1) = 3 + 7 = 10$

(b) $f\left(\dfrac{1}{2}\right) = 3 - 7\left(\dfrac{1}{2}\right) = 3 - \dfrac{7}{2} = \dfrac{6}{2} - \dfrac{7}{2} = -\dfrac{1}{2}$

(c) $f(t) + f(-2) = 3 - 7(t) + 3 - 7(-2) = 3 - 7t + 3 + 14 = -7t + 20$

(d) $f(2t - 3) = 3 - 7(2t - 3) = 3 - 14t + 21 = 24 - 14t$

44. $h(x) = x^2 - 2x$

(a) $h(2) = 2^2 - 2(2) = 4 - 4 = 0$

(b) $h(0) = 0^2 - 2(0) = 0$

(c) $h(1) - h(-4) = [1^2 - 2(1)] - [(-4)^2 - 2(-4)] = 1 - 2 - 16 - 8 = -25$

(d) $h(4t) = (4t)^2 - 2(4t) = 16t^2 - 8t$

46. $h(x) = \sqrt{2x - 3}$

(a) $h(4) = \sqrt{2(4) - 3} = \sqrt{5}$

(b) $h(2) = \sqrt{2(2) - 3} = \sqrt{1} = 1$

(c) $h(4n) = \sqrt{2(4n) - 3} = \sqrt{8n - 3}$

(d) $h(n + 2) = \sqrt{2(n + 2) - 3} = \sqrt{2n + 4 - 3} = \sqrt{2n + 1}$

48. $g(x) = 2|x + 1| - 2$

(a) $g(2) = 2|2 + 1| - 2 = 2|3| - 2 = 6 - 2 = 4$

(b) $g(-1) = 2|-1 + 1| - 2 = 2|0| - 2 = 0 - 2 = -2$

(c) $g(-4) = 2|-4 + 1| - 2 = 2|-3| - 2 = 6 - 2 = 4$

(d) $$\begin{aligned} g(3) + g(-5) &= (2|3 + 1| - 2) + (2|-5 + 1| - 2) \\ &= (2|4| - 2) + (2|-4| - 2) \\ &= 8 - 2 + 8 - 2 \\ &= 12 \end{aligned}$$

50. $f(x) = \dfrac{x + 2}{x - 3}$

(a) $f(-3) = \dfrac{-3 + 2}{-3 - 3} = \dfrac{-1}{-6} = \dfrac{1}{6}$

(b) $f\left(-\dfrac{3}{2}\right) = \dfrac{-\dfrac{3}{2} + 2}{-\dfrac{3}{2} - 3} \cdot \dfrac{2}{2} = \dfrac{-3 + 4}{-3 - 6} = -\dfrac{1}{9}$

(c) $f(4) + f(8) = \dfrac{4 + 2}{4 - 3} + \dfrac{8 + 2}{8 - 3} = \dfrac{6}{1} + \dfrac{10}{5} = 6 + 2 = 8$

(d) $f(x - 5) = \dfrac{x - 5 + 2}{x - 5 - 3} = \dfrac{x - 3}{x - 8}$

52. $f(x) = \begin{cases} -x, \text{ if } x \le 0 \\ 6 - 3x, \text{ if } x > 0 \end{cases}$

(a) $f(0) = -0 = 0$

(b) $f\left(-\dfrac{3}{2}\right) = -\left(-\dfrac{3}{2}\right) = \dfrac{3}{2}$

(c) $f(4) = 6 - 3(4) = 6 - 12 = -6$

(d) $f(-2) + f(25) = -(-2) + 6 - 3(25) = 2 + 6 - 75 = -67$

54. $f(x) = \begin{cases} x^2, \text{ if } x < 1 \\ x^2 - 3x + 2, \text{ if } x \ge 1 \end{cases}$

(a) $f(1) = (1)^2 - 3(1) + 2 = 1 - 3 + 2 = 0$

(b) $f(-1) = (-1)^2 = 1$

(c) $f(2) = (2)^2 - 3(2) + 2 = 4 - 6 + 2 = 0$

(d) $f(-3) + f(3) = (-3)^2 + (3)^2 - 3(3) + 2 = 9 + 9 - 9 + 2 = 11$

56. $f(x) = 3x + 4$

(a) $\dfrac{f(x + 1) - f(1)}{x} = \dfrac{3(x + 1) + 4 - [3(1) + 4]}{x} = \dfrac{3x + 3 + 4 - 3 - 4}{x} = \dfrac{3x}{x} = 3$

(b) $\dfrac{f(x - 5) - f(5)}{x} = \dfrac{3(x - 5) + 4 - [3(5) + 4]}{x} = \dfrac{3x - 15 + 4 - 19}{x} = \dfrac{3x - 30}{x}$

58. The domain of $f(x) = 3x^2 - x$ is all real numbers x.

60. The domain if $g(s) = \dfrac{s-2}{(s-6)(s-10)}$ is all real numbers s such that $s \neq 6, 10$ because $(s-6)(s-10) \neq 0$ means $s - 6 \neq 0$ and $s \neq 6$ and $s - 10 \neq 0$ and $s \neq 10$.

62. The domain of $f(x) = \sqrt{2-x}$ is all real numbers x such that $x \leq 2$ because $2 - x \geq 0$ means $-x \geq -2$ and $x \leq 2$.

64. The domain of $G(x) = \sqrt{8-3x}$ is all real numbers x such that $x \leq \dfrac{8}{3}$ because $8 - 3x \geq 0$ means $-3x \geq -8$ and $x \leq \dfrac{8}{3}$.

66. The domain of $f(x) = |x+3|$ is all real numbers x.

68. Domain: $\{-3, -1, 2, 5\}$

Range: $\{0, 3, 4\}$

70. Domain: $\left\{\frac{1}{2}, \frac{3}{4}, 1, \frac{5}{4}\right\}$

Range: $\{4, 5, 6, 7\}$

72. Domain: all real numbers such that $s > 0$

Range: all real numbers such that $A > 0$

74. Domain: all real numbers such that $r > 0$

Range: all real numbers such that $V > 0$

76. *Verbal Model:* $\boxed{\text{Surface}} = 6 \cdot \boxed{\text{Length of edge}}^2$

Labels: Surface $= S(x)$

Length of edge $= x$

Function: $S(x) = 6x^2$

78. *Verbal Model:* $\boxed{\text{Length of diagonal}} = \sqrt{2} \cdot \boxed{\text{Length of side}}$

Labels: Length of diagonal $= L(x)$

Length of side $= x$

Function: $L = \sqrt{2}x$

80. *Verbal Model:* $\boxed{\text{Distance}} = \boxed{\text{Rate}} \cdot \boxed{\text{Time}}$

Labels: Distance $= d(t)$

Rate $= 230$

Time $= t$

Function: $d(t) = 230t$

82. *Verbal Model:* $\boxed{\text{Distance}} = \boxed{\text{Rate}} \cdot \boxed{\text{Time}}$

Labels: Distance $= d(s)$

Rate $= s$

Time $= 4$

Function: $d(s) = 4s$

84. *Verbal Model:* $\boxed{\text{Distance}} = \boxed{\text{Rate}} \cdot \boxed{\text{Time}}$

Labels: Distance $= d(s)$

Rate $= s$

Time $= 8$

Function: $d(s) = 8s$

$d(35) = 8(35) = 280$ miles

86. *Verbal Model:* $\boxed{\text{Area}} = \boxed{\text{Side}} \cdot \boxed{\text{Side}}$

Label: Area $= A(x)$

Function: $A(x) = (32-2x)(32-2x) = (32-2x)^2$

$= 2(16-x) \cdot 2(16-x)$

$= 4(16-x)^2$

88. (a) $P(1600) = 50\sqrt{1600} - 0.5(1600) - 500$

$= 50(40) - 800 - 500$

$= 2000 - 800 - 500$

$= \$700$

(b) $P(2500) = 50\sqrt{2500} - 0.5(2500) - 500$

$= 50(50) - 1250 - 500$

$= 2500 - 1250 - 500$

$= \$750$

90. $W(a) = \begin{cases} 12h, & 0 < h \leq 40 \\ 18(h-40) + 480, & h > 40 \end{cases}$

(a) $W(30) = 12(30) = \$360$

$W(40) = 12(40) = \$480$

$W(45) = 18(45-40) + 480 = 90 + 480 = \$570$

$W(50) = 18(50-40) + 480 = 180 + 480 = \$660$

(b) No. $h < 0$ is not in the domain of W.

92. $f(1999) = 57{,}000{,}000$

57,000,000 students

94. A relation is any set of ordered pairs. A function is a relation in which no two ordered pairs have the same first component and different second components.

96. The domain is the set of inputs of the function and the range is the set of outputs of the function.

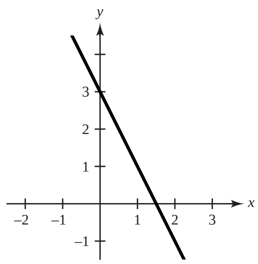
98. You can name the function $(f, g$, etc.), which is convenient when more than one function is used in solving a problem. The values of the independent and the dependent variables are easily seen in function notation.

100. (a) This is not a correct mathematical use of the word function.

(b) This is a correct mathematical use of the word function.

Section 3.7 Graphs of Functions

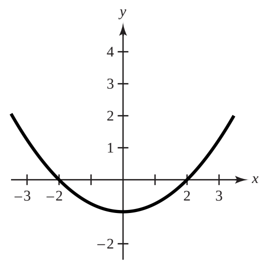
2.



Domain: $-\infty < x < \infty$

Range: $-\infty < y < \infty$

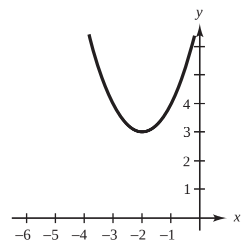
4.



Domain: $-\infty < x < x$

Range: $[-1, \infty)$ or $-1 \le y < \infty$

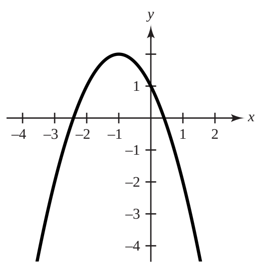
6.



Domain: $-\infty < x < \infty$

Range: $[3, \infty)$ or $3 \le y < \infty$

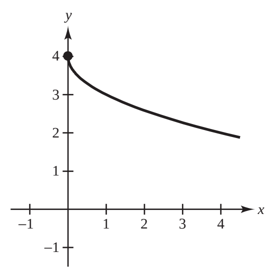
8.



Domain: $-\infty < x < \infty$

Range: $[-\infty, 2)$ or $-\infty < y \le 2$

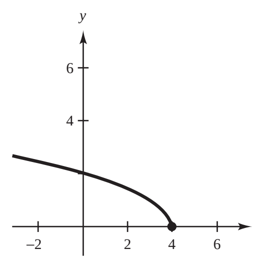
10.



Domain: $0 \le x < \infty$

Range: $-\infty < y \le 4$ or $(-\infty, 4]$

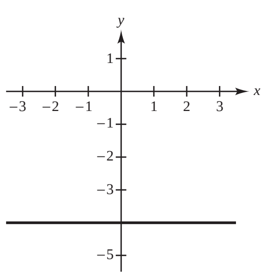
12.



Domain: $(-\infty, 4]$ or $-\infty < x \le 4$

Range: $[0, \infty)$ or $0 \le y < \infty$

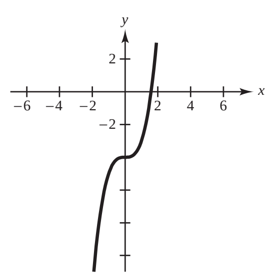
14.



Domain: $-\infty < x < \infty$

Range: $y = -4$

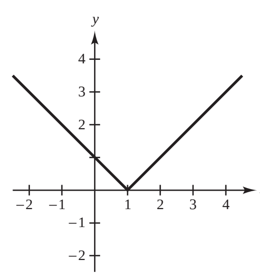
16.



Domain: $-\infty < x < \infty$

Range: $-\infty < y < \infty$

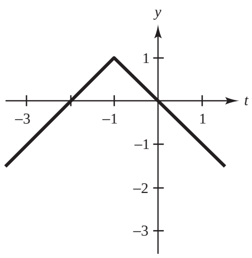
18.



Domain: $-\infty < x < \infty$

Range: $0 \le y < \infty$ or $[0, \infty)$

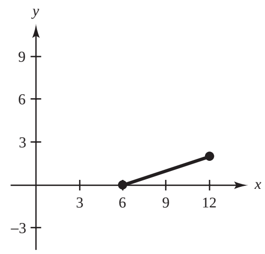
20.



Domain: $-\infty < t < \infty$

Range: $(-\infty, 1]$ or $-\infty < y \le 1$

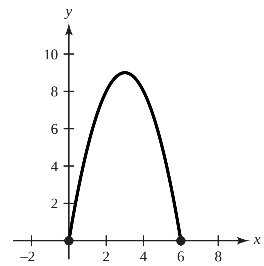
22.



Domain: $6 \le x \le 12$ or $[6, 12]$

Range: $0 \le y \le 2$ or $[0, 2]$

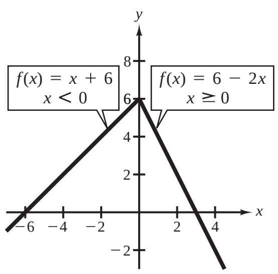
24.



Domain: $0 \le x \le 6$ or $[0, 6]$

Range: $0 \le y \le 9$ or $[0. 9]$

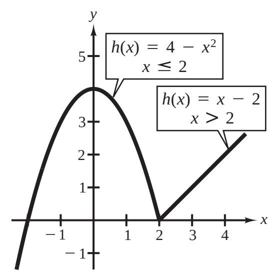
26.



Domain: $-\infty < x < \infty$

Range: $(-\infty, 6]$ or $-\infty < y \le 6$

28.



Domain: $-\infty < x < \infty$

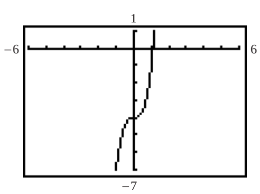
Range: $-\infty < y < \infty$

30. *Keystrokes:*

[Y=] 3 [X,T,θ] [^] 3 [−] 4 [GRAPH]

Domain: $-\infty < x < \infty$

Range: $-\infty \le y < \infty$

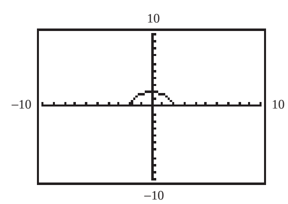


32. *Keystrokes:*

[Y=] [√] [(] 4 [−] [X,T,θ] [x²] [)] [GRAPH]

Domain: $[-2, 2]$ or $-2 \le x \le 2$

Range: $[0, 2]$ or $0 \le y \le 2$

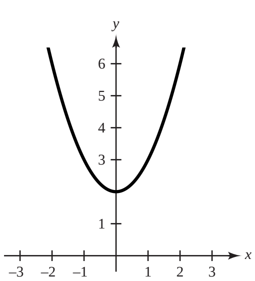


34. Yes, $y = x^2 - 2x$ passes the Vertical Line Test and is a function of x.

36. No, y is not a function of x by the Vertical Line Test.

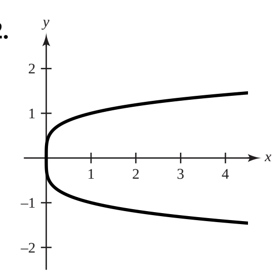
38. No, y is not a function of x by the Vertical Line Test.

40.



y is a function of x.

42.

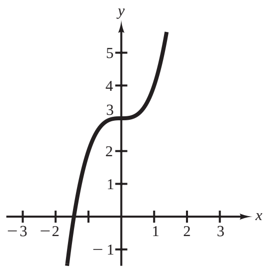


y is not a function of x.

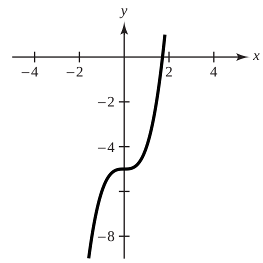
44. (d) graph matches $f(x) = (x - 2)^2$

46. (c) graph matches $f(x) = |x + 2|$

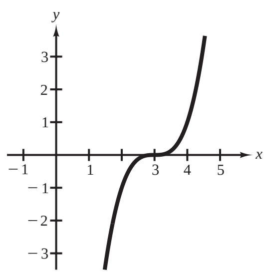
48. (a) Vertical shift 3 units upward



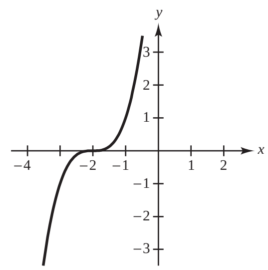
(b) Vertical shift 5 units downward



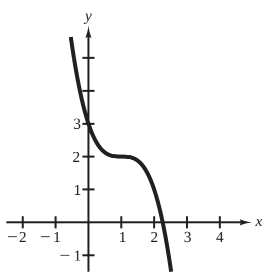
(c) Horizontal shift 3 units to the right



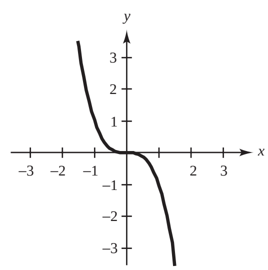
(d) Horizontal shift 2 units to the left



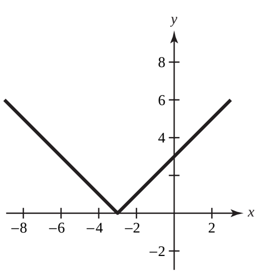
(e) Reflection in the x-axis followed by a horizontal shift 1 unit to the right followed by a vertical shift 2 units upward



(f) Reflection in the x-axis

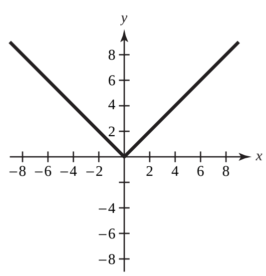


50.



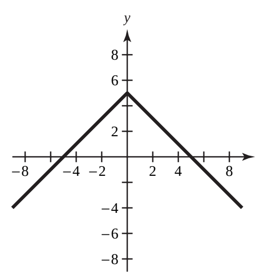
Horizontal shift 3 units to the left

52.



Reflection in the y-axis

54.



Reflection in the x-axis and vertical shift 5 units upward

56. Graph is shifted 3 units upward

$h(x) = x^2 + 3$

58. Graph is reflected in the x-axis and shifted 1 unit upward

$h(x) = -x^2 + 1$

60. Graph is reflected in the x-axis and shifted 3 units downward

$h(x) = -x^2 - 3$

62. $h(x) = \sqrt{x} + 1$

Graph is shifted 1 unit upward

64. $h(x) = \sqrt{x - 3}$

Graph is shifted 3 units right

66. $h(x) = \sqrt{1 - x}$

Graph is shifted 1 unit right and reflected across the y-axis

68. $f(x) = \sqrt{x + 3}$

Keystrokes:

Y= √ (X,T,θ + 3) GRAPH

(a) $f(x) = \sqrt{x + 3 + 3} = \sqrt{x + 6}$

Keystrokes:

Y= √ (X,T,θ + 6) GRAPH

(b) $f(x) = \sqrt{x + 3} - 5$

Keystrokes:

Y= √ (X,T,θ + 3) − 5 GRAPH

(c) $f(x) = \sqrt{x + 3} + 1$

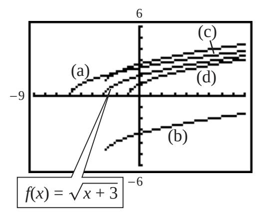
Keystrokes:

Y= √ (X,T,θ + 3) + 1 GRAPH

(d) $f(x) = \sqrt{x + 3 - 2} = \sqrt{x + 1}$

Keystrokes:

Y= √ (X,T,θ + 1) GRAPH



70. *Basic function:* $y = |x|$

Transformation: Vertical shift 3 units upward

Equation of graphed function: $y = |x| + 3$

72. *Basic function:* $y = c$, where c is any constant

Transformation: Vertical shift 7 units upward

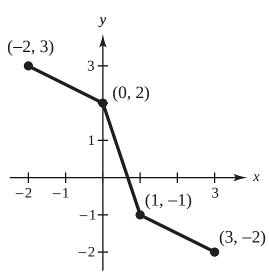
Equation of graphed function: $y = 7$

74. *Basic function:* $y = x^3$

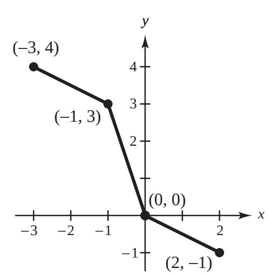
Transformation: Reflection in the x- or y-axis and a vertical shift 1 unit upward

Equation of graphed function: $y = -x^3 + 1$ or $y = (-x)^3 + 1$

76. (a) $y = f(x) - 1$



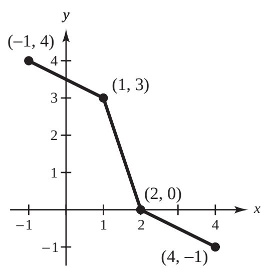
(b) $y = f(x + 1)$



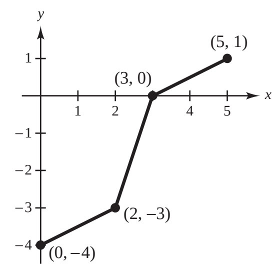
—CONTINUED—

76. —CONTINUED—

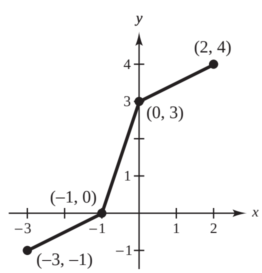
(c) $y = f(x - 1)$



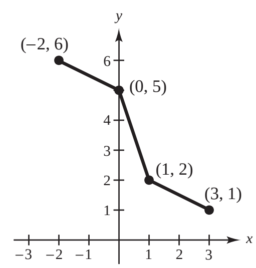
(d) $y = -f(x - 2)$



(e) $y = f(-x)$



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

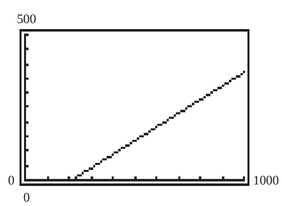


78. *Keystrokes:*

[Y=] .47 [X,T,θ] [−] 100 [÷] [(] [X,T,θ] [≥] 0

[AND] [X,T,θ] [≤] 1000 [)] [GRAPH]

(a)



(b) $0 = 0.47x - 100$

$100 = 0.47x$

$213 \approx x$

(c) $300 = 0.47x - 100$

$400 = 0.47x$

$851 \approx x$

80. (a) *Verbal Model:* [Perimeter] = 2 [Length] + 2 [Width] + 8 [Width of walkway]

Labels: Perimeter $= P(x)$

Length $= 40$ ft

Width $= 30$ ft

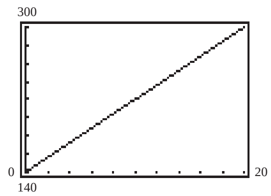
Width of walkway $= x$

Function: $P(x) = 2(40) + 2(30) + 8x$

$= 80 + 60 + 8x$

$P(x) = 140 + 8x$

(b) *Keystrokes:* Y= 140 + 8 X,T,θ GRAPH



(c) Slope $= 8$ so for each 1-foot increase in the width of the walkway the perimeter increases by 8 feet.

82. (a) T is a function of t because to each time t there corresponds one and only one temperature T.

(b) $T(4) = 60°$, $T(15) = 72°$

(c) If the thermostat were reprogrammed to produce a temperature H where $H(t) = T(t - 1)$, all the temperature changes would occur 1 hour later.

(d) If the thermostat were reprogrammed to produce a temperature $H(t) = T(t) - 1$, the temperature would be decreased by 1 degree.

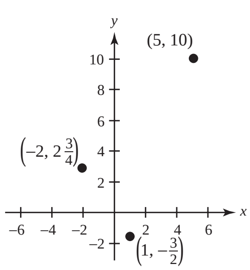
84. Use the Vertical Line Test to determine if an equation represents y as a function of x. If the graph of an equation has the property that no vertical line intersects the graph at two (or more) points, the equation represents y as a function of x.

86. $g(x) = -f(x)$ is a reflection in the x-axis of the graph of $f(x)$.

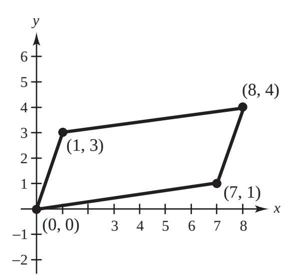
88. $g(x) = f(x - 2)$ is a horizontal shift 2 units to the right of the graph of $f(x)$.

Review Exercises for Chapter 3

2.



4.



6. Quadrant III

8. Quadrant I or III

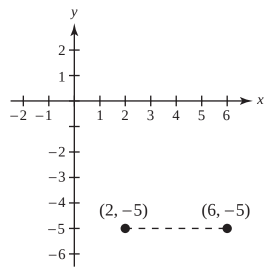
10. (a) $(3, 10)$
$$3(3) - 2(10) + 18 \stackrel{?}{=} 0$$
$$9 - 20 + 18 \stackrel{?}{=} 0$$
$$7 \neq 0 \text{ no}$$

(b) $(0, 9)$
$$3(0) - 2(9) + 18 \stackrel{?}{=} 0$$
$$0 - 18 + 18 \stackrel{?}{=} 0$$
$$0 = 0 \text{ yes}$$

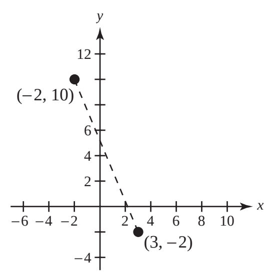
(c) $(-4, 3)$
$$3(-4) - 2(3) + 18 \stackrel{?}{=} 0$$
$$-12 - 6 + 18 \stackrel{?}{=} 0$$
$$0 = 0 \text{ yes}$$

(d) $(-8, 0)$
$$3(-8) - 2(0) + 18 \stackrel{?}{=} 0$$
$$-24 - 0 + 18 \stackrel{?}{=} 0$$
$$-6 \neq 0 \text{ no}$$

12. $d = \sqrt{(6-2)^2 + [-5-(-5)]^2} = \sqrt{4^2 + 0^2} = \sqrt{16} = 4$



14. $d = \sqrt{[3-(-2)]^2 + (-2-10)^2} = \sqrt{25 + 144} = \sqrt{169} = 13$



16. let $A = (-5, 7)$, $B = (-1, 2)$, $C = (3, -4)$

$AB = \sqrt{(-5 - -1)^2 + (7-2)^2} = \sqrt{(-4)^2 + (5)^2} = \sqrt{16 + 25} = \sqrt{41}$

$BC = \sqrt{(-1-3)^2 + [2-(-4)]^2} = \sqrt{(-4)^2 + (6)^2} = \sqrt{16 + 36} = \sqrt{52}$

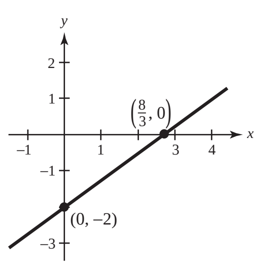
$AC = \sqrt{(-5-3)^2 + [(7-(-4)]^2} = \sqrt{(-8)^2 + (11)^2} = \sqrt{64 + 121} = \sqrt{185}$

$\sqrt{41} + \sqrt{52} \neq \sqrt{185}$ not collinear

18. Midpoint $= \left(\frac{-1+5}{2}, \frac{3+5}{2}\right) = \left(\frac{4}{2}, \frac{8}{2}\right) = (2, 4)$

20. Midpoint $= \left(\frac{1+6}{2}, \frac{6+1}{2}\right) = \left(\frac{7}{2}, \frac{7}{2}\right)$

22.
$$y = \tfrac{3}{4}x - 2$$
$$0 = \tfrac{3}{4}x - 2$$
$$2 = \tfrac{3}{4}x$$
$$\tfrac{8}{3} = x \qquad \left(\tfrac{8}{3}, 0\right)$$
$$y = \tfrac{3}{4}(0) - 2$$
$$y = 0 - 2$$
$$y = -2 \qquad (0, -2)$$



24. $3x + 4y + 12 = 0$

$3x + 4(0) + 12 = 0$

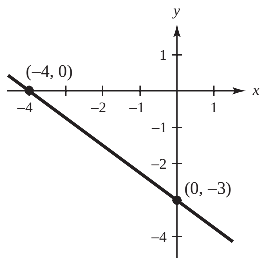
$3x = -12$

$x = -4 \qquad (-4, 0)$

$3(0) + 4y + 12 = 0$

$4y = -12$

$y = -3 \qquad (0, -3)$



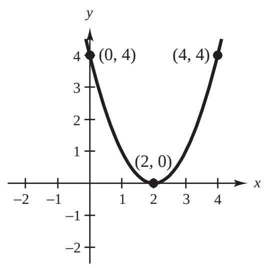
26. $y = (x - 2)^2$

$y = (0 - 2)^2 = 4 \qquad (0, 4)$

$0 = (x - 2)^2$

$0 = x - 2$

$2 = x \qquad (2, 0)$



28. $y = |x - 3|$

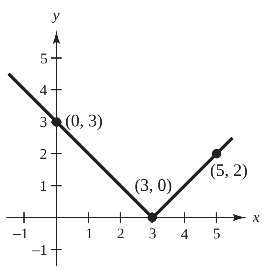
$y = |0 - 3|$

$= 3 \qquad (0, 3)$

$0 = |x - 3|$

$0 = x - 3$

$3 = x \qquad (3, 0)$



30. $y = 3x + 9$

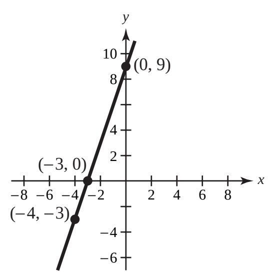
y-intercept: $y = 3(0) + 9$

$= 9 \qquad (0, 9)$

x-intercept: $0 = 3x + 9$

$-9 = 3x$

$-3 = x \qquad (-3, 0)$



32. $5x + 4y = 10$

y-intercept: $5(0) + 4y = 10$

$4y = 10$

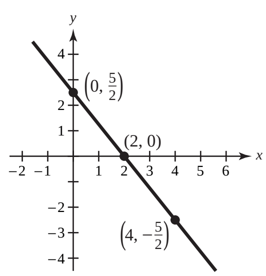
$y = \frac{10}{4}$

$y = \frac{5}{2} \qquad \left(0, \frac{5}{2}\right)$

x-intercept: $5x + 4(0) = 10$

$5x = 10$

$x = 2 \qquad (2, 0)$



34. $y = |x| + 4$

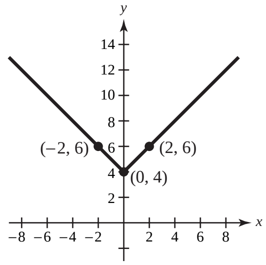
y-intercept: $y = |0| + 4$

$= 4 \qquad (0, 4)$

x-intercept: $0 = |x| + 4$

$-4 = |x|$

None



36. $y = |3 - 6x| - 15$

y-intercept: $y = |3 - 6(0)| - 15$

$= 3 - 15$

$= -12 \qquad (0, -12)$

x-intercepts: $0 = |3 - 6x| - 15$

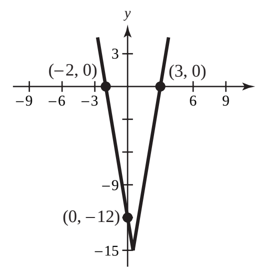
$15 = |3 - 6x|$

$15 = 3 - 6x$ or $-15 = 3 - 6x$

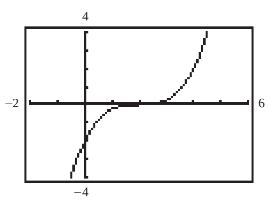
$12 = -6x \qquad -18 = -6x$

$-2 = x \qquad 3 = x$

$(-2, 0),\ (3, 0)$

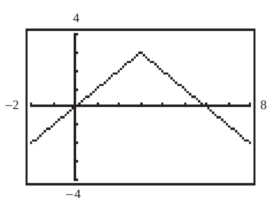


38. *Keystrokes:* [Y=] [(] 1 [÷] 4 [)] [(] [X,T,θ] [−] 2 [)] [^] 3 [GRAPH]



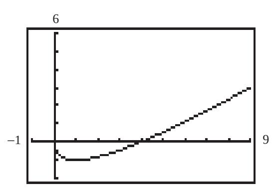
(2, 0), (0, −2)

40. *Keystrokes:* [Y=] 3 [−] [ABS] [(] [X,T,θ] [−] 3 [)] [GRAPH]



(0, 0), (6, 0)

42. *Keystrokes:* [Y=] [X,T,θ] [−] 2 [√] [X,T,θ] [GRAPH]



(0, 0), (4, 0)

44. (a) let $A = (0, 20{,}000)$ $B = (6, 2{,}000)$

$$m = \frac{2{,}000 - 20{,}000}{6 - 0}$$

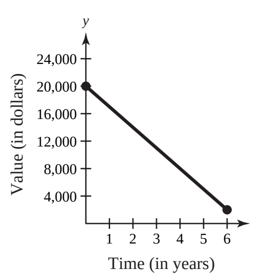
$$= \frac{-18{,}000}{6}$$

$$= -3{,}000$$

$y = -3000t + 20{,}000$

$0 \le t \le 6$

(b)



(c) y-intercept $= (0, 20{,}000)$

The y-intercept represents the initial purchase price.

46. $m = \dfrac{-8 - 5}{3 - (-2)} = -\dfrac{13}{5}$

48. $m = \dfrac{8 - 2}{7 - 7} = \dfrac{6}{0}$ is undefined.

50. $m = \dfrac{6 - 0}{\frac{7}{2} - 0} = \dfrac{6}{\frac{7}{2}} = \dfrac{12}{7}$

52. $2 = \dfrac{y - \left(\frac{1}{2}\right)}{x - (-4)}$

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

$\left(-3, \dfrac{5}{2}\right), \left(-2, \dfrac{9}{2}\right)$

There are many solutions to this problem.

54. $-\dfrac{1}{3} = \dfrac{y - \left(-\frac{3}{2}\right)}{x - (-3)}$

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

$\left(0, -\dfrac{5}{2}\right), \left(3, -\dfrac{7}{2}\right)$

There are many solutions to this problem.

56. $0 = \dfrac{y - (-2)}{x - 7}$

$0 = \dfrac{y + 2}{x - 7}$

$(0, -2), (-3, -2)$

There are many solutions to this problem.

58. *Verbal Model:* $\boxed{\dfrac{\text{Rise}}{\text{Run}}} = \boxed{\dfrac{\text{Rise}}{\text{Run}}}$

Proportion: $-\dfrac{9}{100} = \dfrac{-1500}{x}$

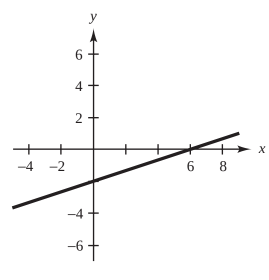
$x = \dfrac{-1500(100)}{-9}$

$x = 16{,}666\dfrac{2}{3}$ feet

60. $x - 3y - 6 = 0$

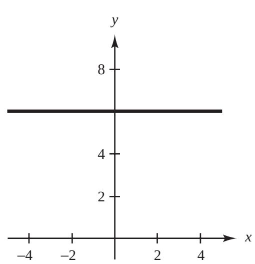
$-3y = -x + 6$

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



62. $y - 6 = 0$

$y = 6$



64. L_1: $y = 2x - 5$

L_2: $y = 2x + 3$

$m_1 = 2, m_2 = 2$

$m_1 = m_2$ so the lines are parallel

66. L_1: $y = -0.3x - 2$

L_2: $y = 0.3x + 1$

$m_1 = -0.3, m_2 = 0.3$

$m_1 \neq m_2, m_1 \cdot m_2 \neq -1$

so the lines are neither

68. L_1: $4x + 3y - 6 = 0$

$3y = -4x + 6$

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

$m_1 = -\frac{4}{3}$

L_2: $3x - 4y - 8 = 0$

$-4y = -3x + 8$

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

$m_2 = \frac{3}{4}$

$m_1 \cdot m_2 = -1$

so the lines are perpendicular

70. let $(t_1, c_1) = (1990, 5.45)$ and $(t_2, c_2) = (2000, 6.82)$

average rate of change $= \dfrac{c_2 - c_1}{t_2 - t_1} = \dfrac{6.82 - 5.45}{2000 - 1990} = \dfrac{1.37}{10} = 0.137 \approx \$0.14$

72.
$$\begin{aligned} y - (-5) &= 3[x - (-5)] \\ y + 5 &= 3(x + 5) \\ y + 5 &= 3x + 15 \\ 3x - y + 10 &= 0 \end{aligned}$$

74.
$$\begin{aligned} y - (-2) &= -2(x - 5) \\ y + 2 &= -2x + 10 \\ 2x + y - 8 &= 0 \end{aligned}$$

76.
$$\begin{aligned} y - \left(-\tfrac{4}{3}\right) &= \tfrac{3}{2}[x - (-2)] \\ y + \tfrac{4}{3} &= \tfrac{3}{2}(x + 2) \\ y + \tfrac{4}{3} &= \tfrac{3}{2}x + 3 \\ 6\left(y + \tfrac{4}{3}\right) &= 6\left(\tfrac{3}{2}x + 3\right) \\ 6y + 8 &= 9x + 18 \\ 9x - 6y + 10 &= 0 \end{aligned}$$

78.
$$\begin{aligned} y - 8 &= -\tfrac{3}{5}(x - 7) \\ y - 8 &= -\tfrac{3}{5}x + \tfrac{21}{5} \\ 5y - 40 &= -3x + 21 \\ 5y + 3x - 61 &= 0 \end{aligned}$$

80. $m = \dfrac{8 - 10}{6 - 0} = -\dfrac{2}{6} = -\dfrac{1}{3}$

$$\begin{aligned} y - 10 &= -\frac{1}{3}x \\ y &= -\frac{1}{3}x + 10 \end{aligned}$$

82. $m = \dfrac{-7 - 2}{4 - (-10)} = -\dfrac{9}{14}$

$$\begin{aligned} y - (-7) &= -\frac{9}{14}(x - 4) \\ y + 7 &= -\frac{9}{14}x + \frac{18}{7} \\ y &= -\frac{9}{14}x + \frac{18}{7} - \frac{49}{7} \\ y &= -\frac{9}{14}x - \frac{31}{7} \end{aligned}$$

84. $m = \dfrac{5 - 0}{\frac{5}{2} - \frac{1}{2}} = \dfrac{5}{\frac{4}{2}} = \dfrac{5}{2}$

$$\begin{aligned} y - 0 &= \frac{5}{2}\left(x - \frac{1}{2}\right) \\ y &= \frac{5}{2}x - \frac{5}{4} \end{aligned}$$

86. $x = -2$

88. $y = 8$

90.
$$\begin{aligned} 2x + 4y &= 1 \\ 4y &= -2x + 1 \\ y &= -\frac{1}{2}x + \frac{1}{4} \quad m = -\frac{1}{2} \end{aligned}$$

(a)
$$\begin{aligned} y - 5 &= -\frac{1}{2}[x - (-1)] \\ y - 5 &= -\frac{1}{2}(x + 1) \\ y - 5 &= -\frac{1}{2}x - \frac{1}{2} \\ 2(y - 5) &= 2\left(-\frac{1}{2}x - \frac{1}{2}\right) \\ 2y - 10 &= -x - 1 \\ x + 2y - 9 &= 0 \end{aligned}$$

(b)
$$\begin{aligned} y - 5 &= 2[x - (-1)] \\ y - 5 &= 2(x + 1) \\ y - 5 &= 2x + 2 \\ 0 &= 2x - y + 7 \end{aligned}$$

92. $4x - 3y = 12$

$$-3y = -4x + 12$$

$$y = \frac{4}{3}x - 4 \quad m = \frac{4}{3}$$

(a) $y - 3 = \frac{4}{3}\left(x - \frac{3}{8}\right)$

$y - 3 = \frac{4}{3}x - \frac{1}{2}$

$6(y - 3) = 6\left(\frac{4}{3}x - \frac{1}{2}\right)$

$6y - 18 = 8x - 3$

$0 = 8x - 6y + 15$

(b) $y - 3 = -\frac{3}{4}\left(x - \frac{3}{8}\right)$

$y - 3 = -\frac{3}{4}x + \frac{9}{32}$

$32(y - 3) = 32\left(-\frac{3}{4}x + \frac{9}{32}\right)$

$32y - 96 = -24x + 9$

$24x + 32y - 105 = 0$

94. (a) $R = 525 + 55(t - 8)$ $\quad t$ corresponds to 1998

(b) $2007 - 1998 = 9$, $9 + 8 = 17$ $\quad R = 525 + 55(17 - 8) = \$1020$

(c) $2001 - 1998 = 3$, $3 + 8 = 11$ $\quad R = 525 + 55(11 - 8) = \$690$

96. $2x + 4y - 14 < 0$

(a) $2(0) + 4(0) - 14 \overset{?}{<} 0$

$0 + 0 - 14 < 0$

$-14 < 0$ yes

(b) $2(3) + 4(2) - 14 \overset{?}{<} 0$

$6 + 8 - 14 < 0$

$0 \not< 0$ no

(c) $2(1) + 4(3) - 14 \overset{?}{<} 0$

$2 + 12 - 14 < 0$

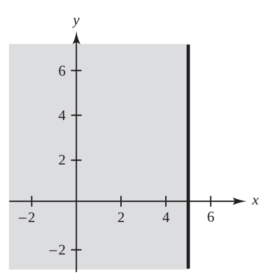
$0 \not< 0$ no

(d) $2(-4) + 4(1) - 14 \overset{?}{<} 0$

$-8 + 4 - 14 < 0$

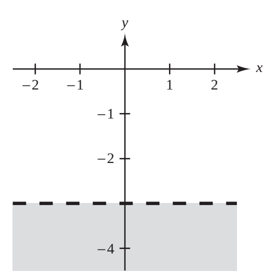
$-18 < 0$ yes

98. $x \leq 5$



100. $y + 3 < 0$

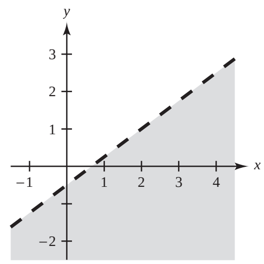
$y < -3$



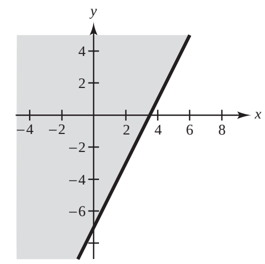
102. $3x - 4y > 2$

$-4y > -3x + 2$

$y < \frac{3}{4}x - \frac{1}{2}$



104. $(y - 3) \geq 2(x - 5)$

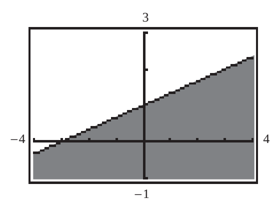


106. $y \leq \frac{1}{3}x + 1$

Keystrokes:

[Y=] [(] 1 [÷] 3 [X,T,θ] [+] 1

[DRAW] 7 [(−)] 10 [,] [Y-VARS] 1 1 [)] [ENTER]



108. $4x - 3y \geq 2$

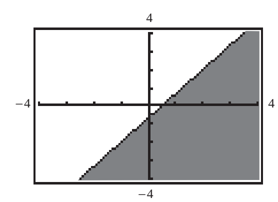
$-3y \geq -4x + 2$

$y \leq \frac{4}{3}x - \frac{2}{3}$

Keystrokes:

[Y=] [(] 4 [÷] 3 [)] [X,T,θ] [−] [(] 2 [÷] 3 [)]

[DRAW] 7 [(−)] 10 [,] [Y-VARS] 1 1 [)] [ENTER]



110. (a) $7x + 10y \geq 200$ or

$10y \geq -7x + 200$

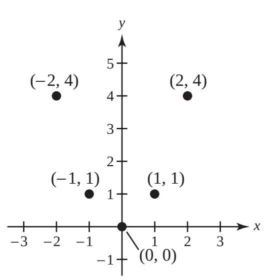
$y \geq -\frac{7}{10}x + 20$

(Note: x and y cannot be negative.)

(b) (8, 15), (10, 13), (14, 11)

112. Domain: $\{-2, -1, 0, 1, 2\}$

Range: $\{0, 1, 4\}$



114. Yes, this relation is a function because each number in the domain is paired to only one number in the range.

116. No, this relation is not a function because the 6 in the domain is paired to two numbers (3 and 12) in the range.

118. $h(x) = x(x - 8)$

(a) $h(8) = 8(8 - 8) = 8(0) = 0$

(b) $h(10) = 10(10 - 8) = 10(2) = 20$

(c) $h(-3) + h(4) = [-3(-3 - 8)] + [4(4 - 8)] = (-3)(-11) + (4)(-4) = 33 - 16 = 17$

(d) $h(4t) = (4t)(4t - 8) = 16t^2 - 32t$ or $16t(t - 2)$

120. $g(x) = |x + 4|$

(a) $g(0) = |0 + 4| = |4| = 4$

(b) $g(-8) = |-8 + 4| = |-4| = 4$

(c) $g(2) - g(-5) = |2 + 4| - |-5 + 4| = |6| - |-1| = 6 - 1 = 5$

(d) $g(x - 2) = |x - 2 + 4| = |x + 2|$

122. $h(x) = \begin{cases} x^3, & \text{if } x \le 1 \\ (x - 1)^2 + 1, & \text{if } x > 1 \end{cases}$

(a) $h(2) = (2 - 1)^2 + 1 = 1^2 + 1 = 2$

(b) $h\left(-\frac{1}{2}\right) = \left(-\frac{1}{2}\right)^3 = -\frac{1}{8}$

(c) $h(0) = 0^3 = 0$

(d) $h(4) - h(3) = [(4 - 1)^2 + 1] - [(3 - 1)^2 + 1] = 3^2 + 1 - 2^2 - 1 = 9 - 4 = 5$

124. $f(x) = 7x + 10$

(a) $\dfrac{f(x + 1) - f(1)}{x} = \dfrac{7(x + 1) + 10 - [7(1) + 10]}{x} = \dfrac{7x + 7 + 10 - 7 - 10}{x} = \dfrac{7x}{x} = 7$

(b) $\dfrac{f(x - 5) - f(5)}{x} = \dfrac{7(x - 5) + 10 - [7(5) + 10]}{x} = \dfrac{7x - 35 + 10 - 35 - 10}{x} = \dfrac{7x - 70}{x}$

126. $s - 1 \ne 0 \qquad s + 5 \ne 0$

$s \ne 1 \qquad s \ne -5$

Domain: $(-\infty, -5) \cup (-5, 1) \cup (1, \infty)$ or
$-\infty < s < -5,\ -5 < s < 1,\ 1 < s < \infty$

128. Domain: all real values of x.

$-\infty < x < \infty$

130. *Verbal Model:* [Perimeter] = 2 [Length] + 2 [Width]

$100 = 2\text{ Length} + 2x$

$\dfrac{100 - 2x}{2} = \text{Length}$

$50 - x = \text{Length}$

Verbal Model: [Area] = [Length] · [Width]

Labels: Area = $A(x)$

Length = $50 - x$

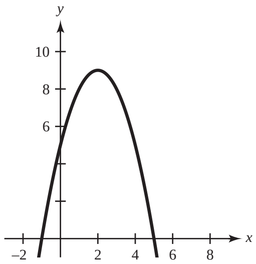
Width = x

Function: $A(x) = x(50 - x)$

$0 < x < 25$

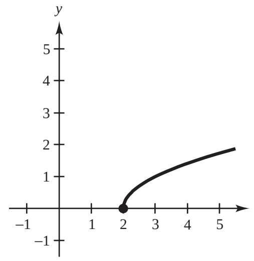
132. Domain: $-\infty < x < \infty$

Range: $-\infty < y \le 9$ or $(-\infty, 9]$



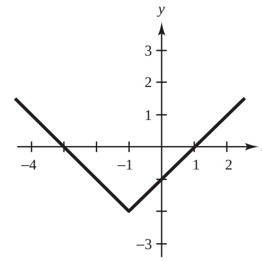
134. Domain: $2 \le t < \infty$ or $[2, \infty)$

Range: $0 \le y < \infty$ $[0, \infty)$



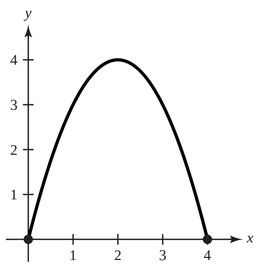
136. Domain: $-\infty < x < \infty$

Range: $-2 \le y < \infty$ or $[-2, \infty)$



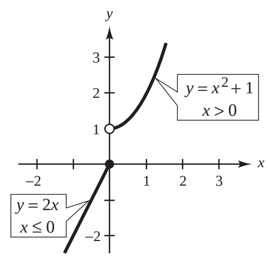
138. Domain: $0 \le x \le 4$ or $[0, 4]$

Range: $0 \le y \le 4$ or $[0, 4]$



140. Domain: $-\infty < x < \infty$

Range: $-\infty < y \le 0$, $1 < y < \infty$ or $(-\infty, 0] \cup (1, \infty)$



142. $f(x) = |x| - 3$ (c)

144. $f(x) = (x - 2)^3$ (f)

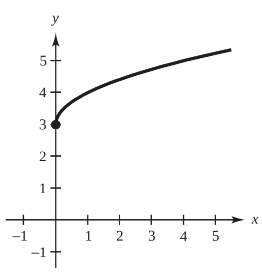
146. $f(x) = x$ (b)

148. Yes, y is a function of x, because y passes the Vertical Line Test.

150. No, y is not a function of x, because y does not pass the Vertical Line Test.

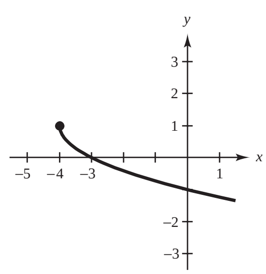
152. $h(x) = \sqrt{x} + 3$

Vertical shift 3 units upward



154. $h(x) = 1 - \sqrt{x + 4}$

Reflection in the x-axis, horizontal shift 4 units to the left, and a vertical shift 1 unit upward



156. $y = (x - 1)^2$

Horizontal shift 1 unit to the right

158. $y = -x^2 + 1$

Reflection in the x-axis and a vertical shift 1 unit upward