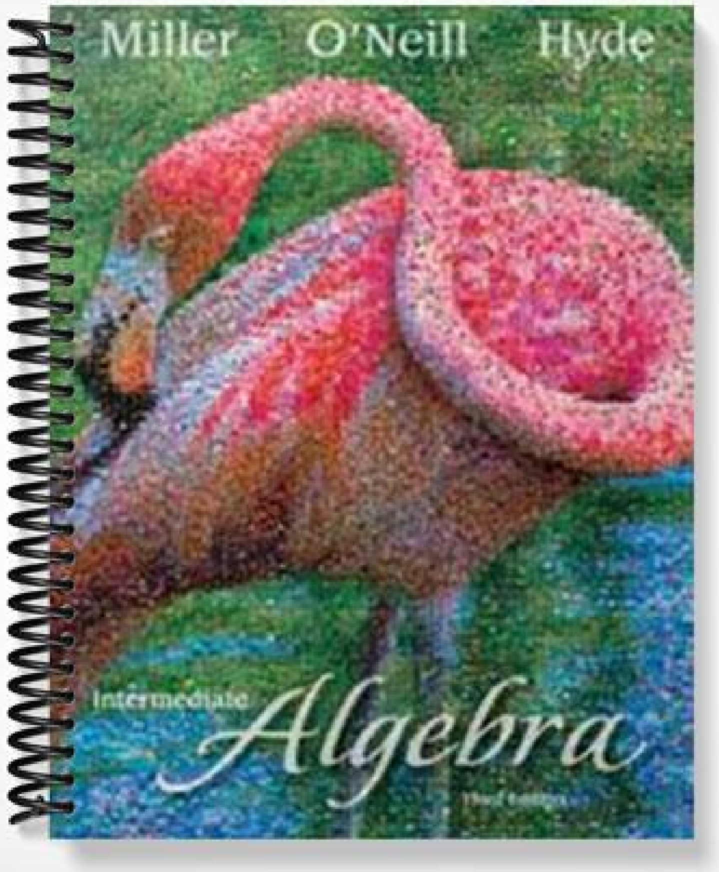
# SOLUTIONS MANUAL



# Chapter 2 Linear Equations in Two Variables and Functions

## Are You Prepared?

**1.** **X** 44 in.

**2.** **I** 3 yr

**3.** **E** $h = 2.5a + 31$
$h = 2.5(6) + 31 = 15 + 31 = 46$ in.

**4.** **T** $50 = 2.5a + 31$
$19 = 2.5a$
$7.6 = a$

**5.** **C** $h = 2.5a + 31$
$h = 2.5(11) + 31 = 27.5 + 31 = 58.5$ in.

A graph intersects the $x$-axis at an <u>x – i n t e r c e p t</u>.

## Section 2.1 Linear Equations in Two Variables

### Section 2.1 Practice Exercises

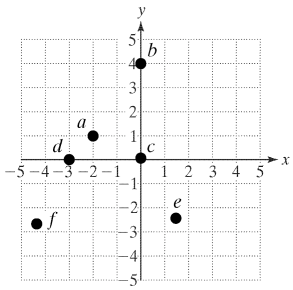
**1.** Answers will vary.

**2.**
**a.** A graph with two number lines drawn at right angles to each other, intersecting at the origin of each, forms a <u>rectangular coordinate system</u>.
**b.** The <u>*x*-axis</u> is the horizontal number line in the rectangular coordinate system.
**c.** The <u>*y*-axis</u> is the vertical number line in the rectangular coordinate system.
**d.** The <u>origin</u> is the point where the $x$-axis and $y$-axis intersect.
**e.** The $x$- and $y$-axes divide the graphing area into four regions called <u>quadrants</u>.
**f.** Points graphed in a rectangular coordinate system are defined by two numbers as an <u>ordered pair</u> $(x, y)$.
**g.** The first number of the ordered pair is called the <u>*x*-coordinate</u>.
**h.** The second number of the ordered pair is called the <u>*y*-coordinate</u>.
**i.** A <u>linear equation in two variables</u> is an equation that can be written in the form $Ax + By = C$ where $A$, $B$, and $C$ are real numbers such that $A$ and $B$ are not both zero.
**j.** An <u>*x*-intercept</u> of an equation is a point $(a, 0)$ where the graph intersects the $x$-axis.
**k.** A <u>*y*-intercept</u> of an equation is a point $(0, b)$ where the graph intersects the $y$-axis.
**l.** A <u>vertical line</u> is a line that can be written in the form $x = k$, where $k$ is a constant.
**m.** A <u>horizontal line</u> is a line that can be written in the form $y = k$, where $k$ is a constant.

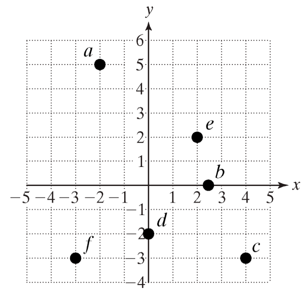
**3.** For $(x, y)$, if $x > 0$, $y > 0$, the point is in quadrant I. If $x < 0$, $y > 0$, the point is in quadrant II. If $x < 0$, $y < 0$, the point is in quadrant III. If $x > 0$, $y < 0$, the point is in quadrant IV.

**4,** The order of the $x$- and $y$-coordinates is important. For example, (2, 3) and (3, 2) define two different points.

**5.**



**6.**



**7.** 0

**8.** 0

**9.** A (–4, 5), II
B (–2, 0), *x*-axis
C (1, 1), I
D (4, –2), IV
E (–5, –3), III

**10.** A (–1, 3), II
B (2, 1), I
C (0, –3), *y*-axis
D (4, –3), IV
E (–2, –2), III

**11. a.** $2(0)-3(-3)=9$
$0+9=9$
$9=9$
$(0, -3)$ is a solution.

**b.** $2(-6)-3(1)=9$
$-12-3=9$
$-15=9$
$(-6, 1)$ is not a solution.

**c.** $2(1)-3\left(-\frac{7}{3}\right)=9$
$2+7=9$
$9=9$
$\left(1, -\frac{7}{3}\right)$ is a solution.

**12. a.** $-5(0)-2(3)=6$
$0-6=6$
$-6=6$
$(0, 3)$ is not a solution.

**b.** $-5\left(-\frac{6}{5}\right)-2(0)=6$
$6-0=6$
$6=6$
$\left(-\frac{6}{5}, 0\right)$ is a solution.

**c.** $-5(-2)-2(2)=6$
$10-4=6$
$6=6$
$(-2, 2)$ is a solution.

**13. a.** $-1=\frac{1}{3}(0)+1$
$-1=0+1$
$-1=1$
$(-1, 0)$ is not a solution.

**b.** $2=\frac{1}{3}(3)+1$
$2=1+1$
$2=2$
$(2, 3)$ is a solution.

**c.** $-6=\frac{1}{3}(1)+1$
$-6=\frac{1}{3}+1$
$-6=\frac{4}{3}$
$(-6, 1)$ is not a solution.

**14.** **a.**

$$-4 = -\frac{3}{2}(0) - 4$$
$$-4 = 0 - 4$$
$$-4 = -4$$

$(0, -4)$ is a solution.

**b.**

$$-7 = -\frac{3}{2}(2) - 4$$
$$-7 = -3 - 4$$
$$-7 = -7$$

$(2, -7)$ is a solution.

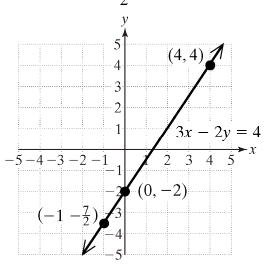
**c.**

$$-2 = -\frac{3}{2}(-4) - 4$$
$$-2 = 6 - 4$$
$$-2 = 2$$

$(-4, -2)$ is not a solution.

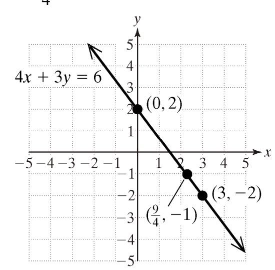
**15.** $3x - 2y = 4$

| $x$ | $y$ |
|---|---|
| 0 | –2 |
| 4 | 4 |
| –1 | $-\frac{7}{2}$ |



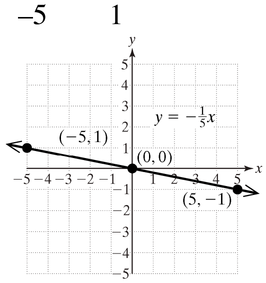

**16.** $4x + 3y = 6$

| $x$ | $y$ |
|---|---|
| 0 | 2 |
| 3 | –2 |
| $\frac{9}{4}$ | –1 |



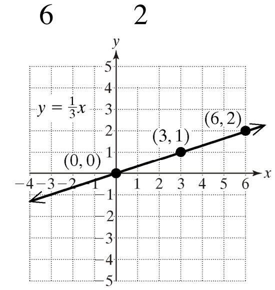

**17.** $y = -\frac{1}{5}x$

| $x$ | $y$ |
|---|---|
| 0 | 0 |
| 5 | –1 |
| –5 | 1 |

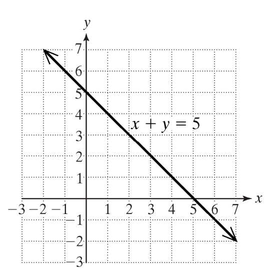



**18.** $y = \frac{1}{3}x$

| $x$ | $y$ |
|---|---|
| 0 | 0 |
| 3 | 1 |
| 6 | 2 |




**19.**

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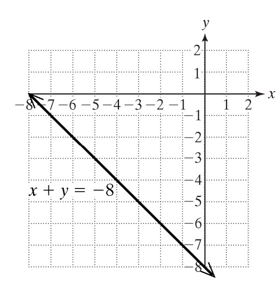

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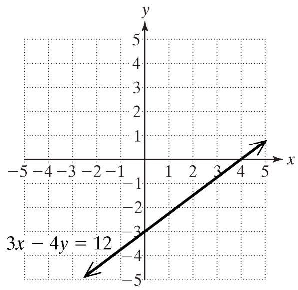


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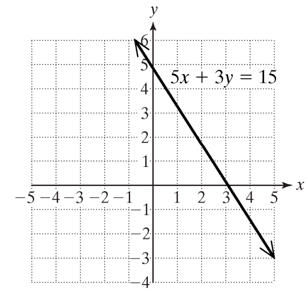


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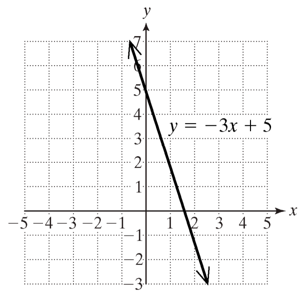


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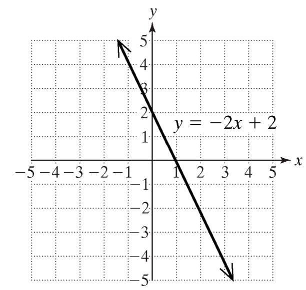
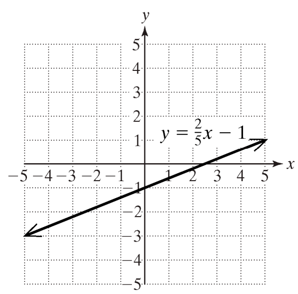
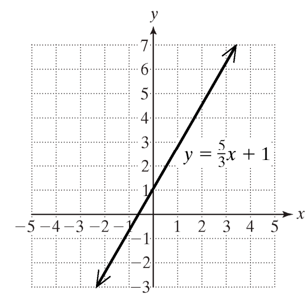


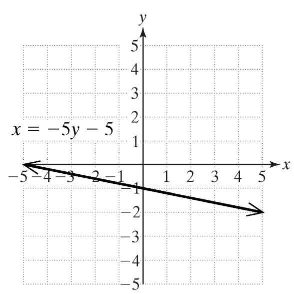

**25.**



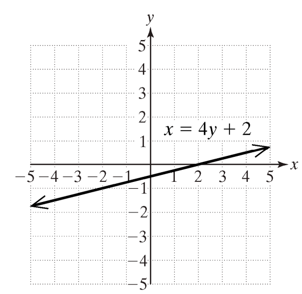

**26.**



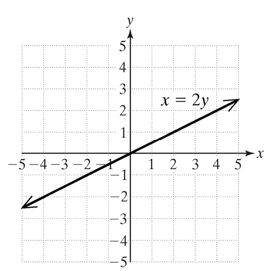

**27.**



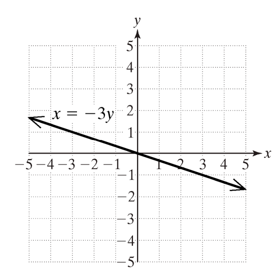

**28.**




**29.**




**30.**




**31.** To find an $x$ -intercept, substitute $y = 0$ and solve for $x$. To find a $y$-intercept, substitute $x = 0$ and solve for $y$.

**32.** No. Neither the $x$- nor the $y$-coordinate is zero.

**33.** $2x+3y=18$

**a.** $2x+3(0)=18$

$2x=18$

$x=9$

The $x$ -intercept is (9, 0).

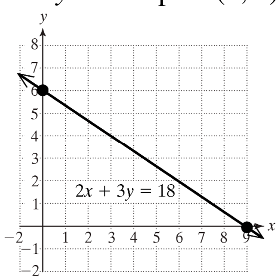
**b.** $2(0)+3y=18$

$3y=18$

$y=6$

The $y$-intercept is (0, 6).

**c.**




**34.** $2x-5y=10$

**a.** $2x-5(0)=10$

$2x=10$

$x=5$

The $x$ -intercept is (5, 0).

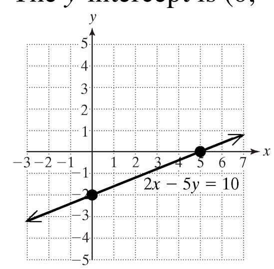
**b.** $2(0)-5y=10$

$-5y=10$

$y=-2$

The $y$-intercept is (0, –2).

**c.**




**35.** $x-2y=4$

**a.** $x-2(0)=4$

$x=4$

The $x$ -intercept is (4, 0).

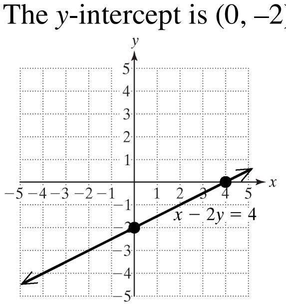
**b.** $0-2y=4$

$-2y=4$

$y=-2$

The $y$-intercept is (0, –2).

**c.**




**36.** $x+y=8$

**a.** $x+(0)=8$

$x=8$

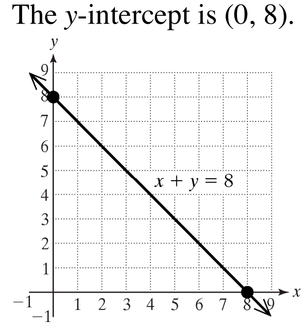
The $x$ -intercept is (8, 0).

**b.** $0+y=8$

$y=8$

The $y$-intercept is (0, 8).

**c.**




**37.** $5x=3y$

**a.** $5x=3(0)$

$5x=0$

$x=0$

The $x$ -intercept is (0, 0).

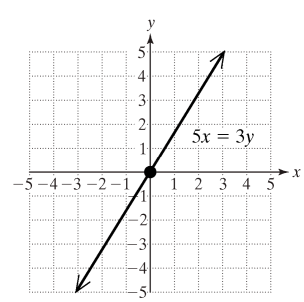
**b.** $5(0)=3y$

$0=3y$

$0=y$

The $y$-intercept is (0, 0).

**c.**



**38.** $3y = -5x$

**a.** $3(0) = -5x$

$0 = -5x$

$0 = x$

The $x$-intercept is (0, 0).

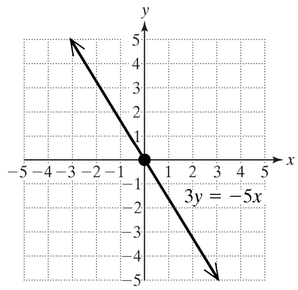
**b.** $3y = 5(0)$

$3y = 0$

$y = 0$

The $y$-intercept is (0, 0).

**c.**




**39.** $y = 2x + 4$

**a.** $0 = 2x + 4$

$-2x = 4$

$x = -2$

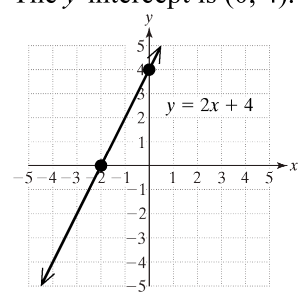
The $x$-intercept is (–2, 0).

**b.** $y = 2(0) + 4$

$y = 4$

The $y$-intercept is (0, 4).

**c.**




**40.** $y = -3x - 1$

**a.** $0 = -3x - 1$

$3x = -1$

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

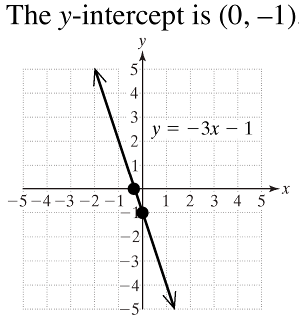
The $x$-intercept is $\left(-\frac{1}{3}, 0\right)$.

**b.** $y = -3(0) - 1$

$y = -1$

The $y$-intercept is (0, –1).

**c.**




**41.** $y = -\frac{4}{3}x + 2$

**a.** $0 = -\frac{4}{3}x + 2$

$\frac{4}{3}x = 2$

$x = \frac{3}{4} \cdot 2 = \frac{3}{2}$

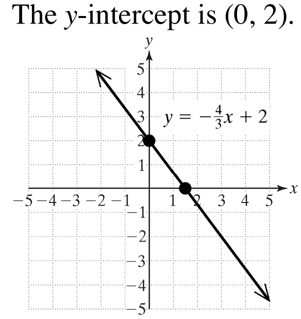
The $x$-intercept is $\left(\frac{3}{2}, 0\right)$.

**b.** $y = -\frac{4}{3}(0) + 2$

$y = 2$

The $y$-intercept is (0, 2).

**c.**



**42.** $y=-\frac{2}{5}x-1$

**a.** $0=-\frac{2}{5}x-1$

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

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

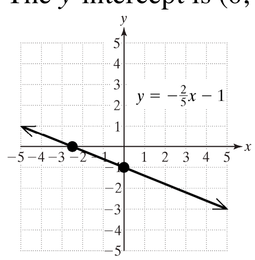
The $x$-intercept is $\left(-\frac{5}{2},\ 0\right)$

**b.** $y=-\frac{2}{5}(0)-1$

$y=-1$

The $y$-intercept is (0, –1).

**c.**




**43.** $x=\frac{1}{4}y$

**a.** $x=\frac{1}{4}(0)$

$x=0$

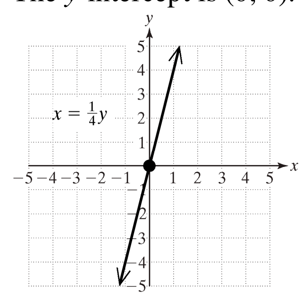
The $x$-intercept is $(0,\ 0)$.

**b.** $0=\frac{1}{4}y$

$0=y$

The $y$-intercept is (0, 0).

**c.**




**44.** $x=\frac{2}{3}y$

**a.** $x=\frac{2}{3}(0)$

$x=0$

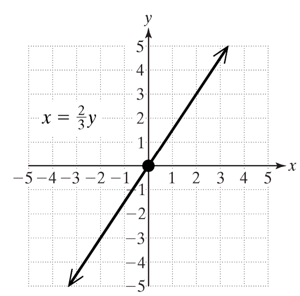
The $x$-intercept is $(0,\ 0)$

**b.** $0=\frac{2}{3}y$

$0=y$

The $y$-intercept is (0, 0).

**c.**




**45.** **a.** $y=15{,}000+0.08x$

$y=15{,}000+0.08(500{,}000)$

$=15{,}000+40{,}000=55{,}000$

The salary is $55,000.

**b.** $y=15{,}000+0.08(300{,}000)$

$=15{,}000+24{,}000=39{,}000$

The salary is $39,000.

**c.** $y=15{,}000+0.08(0)$

$=15{,}000+0=15{,}000$

The $y$-intercept is (0, 15,000). For $0 in sales, the salary is $15,000.

**d.** Total sales cannot be negative.

**46.** **a.** The charge is constant for less than 1 mile.

**b.** The $y$-intercept is (0, 3.50). The base fare is $3.50.

**c.** After the first mile, the cost increases with increasing miles.

**d.** $C=3.50+2.50(m-1)$

$C=3.50+2.50(3.5-1)$

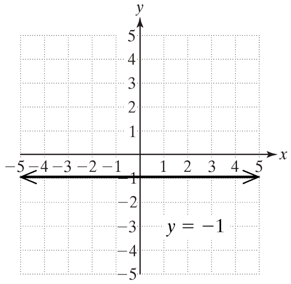
$=3.50+2.50(2.5)$

$=3.50+6.25$

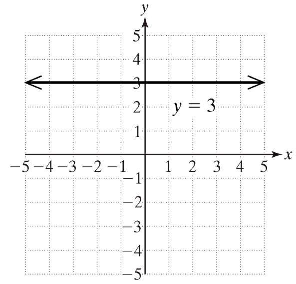
$=9.75$

It would cost $9.75 to take a cab 3.5 miles.

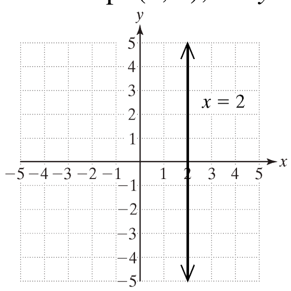
**47.** $y=-1$ Horizontal;
No $x$-intercept; $y$-intercept (0, –1)



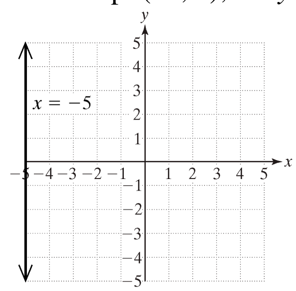

**48.** $y=3$ Horizontal;
No $x$-intercept; $y$-intercept (0, 3)




**49.** $x=2$ Vertical;
$x$-intercept (2, 0); No $y$-intercept

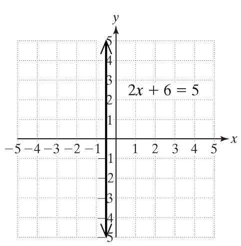



**50.** $x=-5$ Vertical;
$x$-intercept (–5, 0); No $y$-intercept



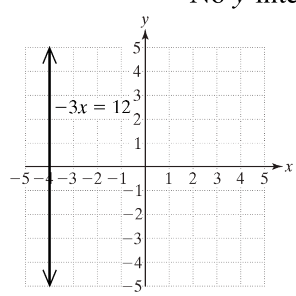

**51.** $2x+6=5$
$2x=-1$
$x=-\frac{1}{2}$

Vertical;
$x$-intercept $\left(-\frac{1}{2}, 0\right)$;
No $y$-intercept



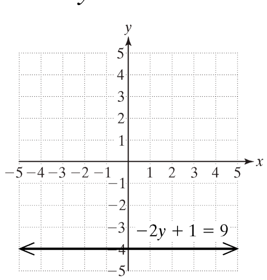

**52.** $-3x=12$
$x=-4$

Vertical;
$x$-intercept $(-4, 0)$;
No $y$-intercept



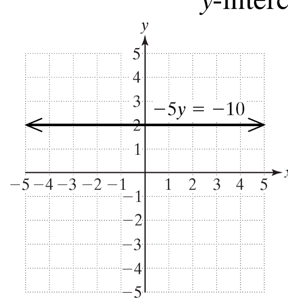

**53.** $-2y+1=9$
$-2y=8$
$y=-4$

Horizontal;
No $x$-intercept;
$y$-intercept (0, – 4)




**54.** $-5y=-10$
$y=2$

Horizontal;
No $x$-intercept;
$y$-intercept (0, 2)




**55.** A horizontal line parallel to the $x$-axis will not have an $x$-intercept. A vertical line parallel to the $y$-axis will not have a $y$-intercept.

**56.** b, c, d

**57.** a, b, c

**58.**

$$\frac{x}{2}+\frac{y}{3}=1 \qquad \frac{0}{2}+\frac{y}{3}=1$$

$$\frac{x}{2}+\frac{0}{3}=1 \qquad \frac{y}{3}=1$$

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

$$x=2$$

The $x$-intercept is (2, 0) and the $y$-intercept is (0, 3).

**59.**

$$\frac{x}{7}+\frac{y}{4}=1 \qquad \frac{0}{7}+\frac{y}{4}=1$$

$$\frac{x}{7}+\frac{0}{4}=1 \qquad \frac{y}{4}=1$$

$$\frac{x}{7}=1 \qquad y=4$$

$$x=7$$

The $x$-intercept is (7, 0) and the $y$-intercept is (0, 4).

**60.**

$$\frac{x}{a}+\frac{y}{b}=1 \qquad \frac{0}{a}+\frac{y}{b}=1$$

$$\frac{x}{a}+\frac{0}{b}=1 \qquad \frac{y}{b}=1$$

$$\frac{x}{a}=1 \qquad y=b$$

$$x=a$$

The $x$-intercept is ($a$, 0) and the $y$-intercept is (0, $b$).

**61.**

$$Ax+By=C$$

$$Ax+B(0)=C \qquad A(0)+By=C$$

$$Ax=C \qquad By=C$$

$$x=\frac{C}{A} \qquad y=\frac{C}{B}$$

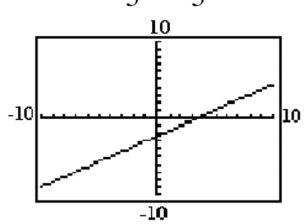
The $x$-intercept is $\left(\frac{C}{A},\,0\right)$ and the $y$-intercept is $\left(0,\frac{C}{B}\right)$.

**62.**

$$2x-3y=7$$

$$-3y=-2x+7$$

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

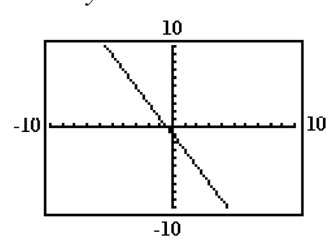



**63.**

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

$$2y=-4x-2$$

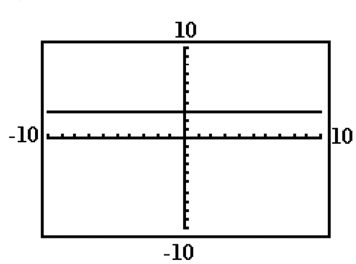
$$y=-2x-1$$




**64.**

$$3y=9$$

$$y=3$$

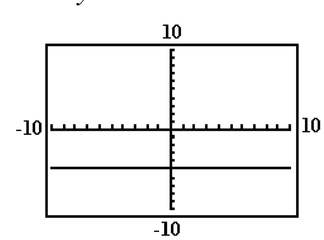



**65.**

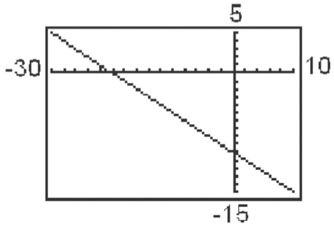
$$2y+10=0$$

$$2y=-10$$

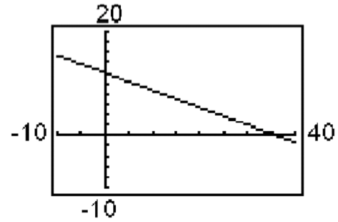
$$y=-5$$



**66.** $y = -\frac{1}{2}x - 10$



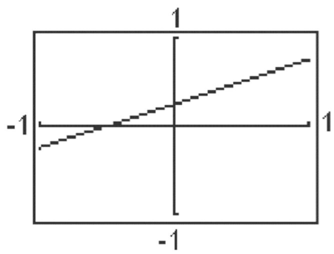

**67.** $y = -\frac{1}{3}x + 12$




**68.** $-2x + 4y = 1$

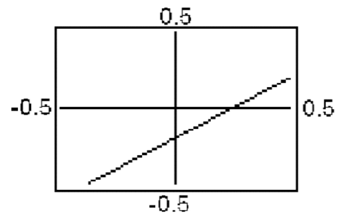
$4y = 2x + 1$

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




**69.** $5y = 4x - 1$

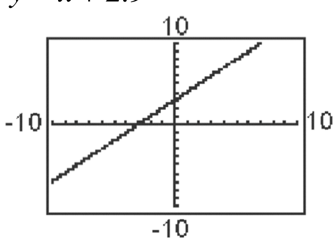
$y = \frac{4}{5}x - \frac{1}{5}$




**70.** $y = x + 3$

$y = x + 3.1$

$y = x + 2.9$

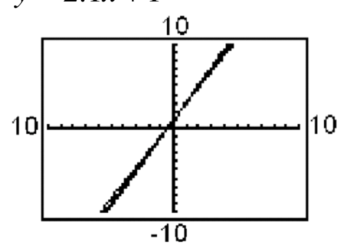



The lines look nearly indistinguishable. However, the linear equations are different.

**71.** $y = 2x + 1$

$y = 1.9x + 1$

$y = 2.1x + 1$




The lines look nearly indistinguishable. However, the linear equations are different.

## Section 2.2 Slope of a Line and Rate of Change

### Section 2.2 Practice Exercises

**1.** Answers will vary.

**2.** Slope is the ratio of the change in $y$ to the change in $x$.

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

**a.** $\frac{1}{2}(0) + y = 4$

$y = 4$

The ordered pair is (0, 4).

**b.** $\frac{1}{2}x + 0 = 4$

$\frac{1}{2}x = 4$

$x = 8$

The ordered pair is (8, 0).

**c.** $\frac{1}{2}(-4) + y = 4$

$-2 + y = 4$

$y = 6$

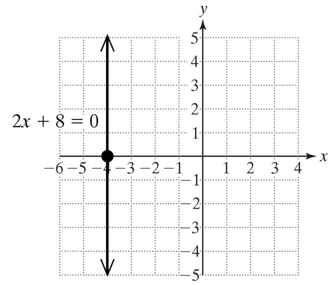
The ordered pair is (–4, 6).

**4.** $2x + 8 = 0$

$2x = -8$

$x = -4$

The $x$-intercept is (–4, 0).
There is no $y$-intercept.

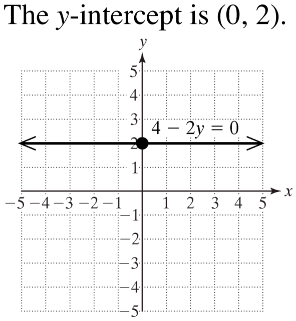



**5.** $4 - 2y = 0$

$-2y = -4$

$y = 2$

There is no $x$-intercept.
The $y$-intercept is (0, 2).




**6.** $2x - 2y - 6 = 0$

$2x - 2(0) - 6 = 0$

$2x = 6$

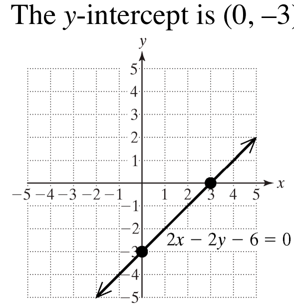
$x = 3$

$2(0) - 2y - 6 = 0$

$-2y = 6$

$y = -3$

The $x$-intercept is (3, 0).
The $y$-intercept is (0, –3).




**7.** $m = \frac{24}{7} = \frac{24}{7}$

**8.** $m = \frac{4}{10} = \frac{2}{5}$

**9.** $m = \frac{8}{72} = \frac{1}{9}$

**10.** $m = \frac{150}{500} = \frac{3}{10}$

**11.** $m = \frac{4}{100} = \frac{1}{25}$

**12.** $m = \frac{1000}{12{,}000} = \frac{1}{12}$

The plane gains 1 ft of elevation for every 12 ft it travels horizontally.

**13.** $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-3-0}{0-6} = \frac{-3}{-6} = \frac{1}{2}$

**14.** $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4-0}{0-(-5)} = \frac{4}{5} = \frac{4}{5}$

**15.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{-7-3}{4-(-2)}=\dfrac{-10}{6}=-\dfrac{5}{3}$

**16.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{-7-(-4)}{1-(-5)}=\dfrac{-3}{6}=-\dfrac{1}{2}$

**17.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{-3-5}{2-(-2)}=\dfrac{-8}{4}=-2$

**18.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{-8-(-2)}{6-4}=\dfrac{-6}{2}=-3$

**19.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{-0.8-(-1.1)}{-0.1-0.3}=\dfrac{0.3}{-0.4}=-\dfrac{3}{4}$

**20.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{-0.1-(-0.2)}{0.3-0.4}=\dfrac{0.1}{-0.1}=-1$

**21.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{7-3}{2-2}=\dfrac{4}{0}$ Undefined

**22.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{0-5}{-1-(-1)}=\dfrac{-5}{0}$ Undefined

**23.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{-1-(-1)}{-3-5}=\dfrac{0}{-8}=0$

**24.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{4-4}{1-(-8)}=\dfrac{0}{9}=0$

**25.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{6.4-4.1}{0-(-4.6)}=\dfrac{2.3}{4.6}=\dfrac{1}{2}$

**26.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{-0.3-4}{-3.2-1.1}=\dfrac{-4.3}{-4.3}=1$

**27.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{1-\frac{4}{3}}{\frac{7}{2}-\frac{3}{2}}=\dfrac{-\frac{1}{3}}{\frac{4}{2}}=-\dfrac{1}{3}\cdot\dfrac{1}{2}=-\dfrac{1}{6}$

**28.** $m=\dfrac{-\frac{3}{2}-\left(-\frac{1}{2}\right)}{-\frac{1}{6}-\frac{2}{3}}=\dfrac{-1}{-\frac{5}{6}}=-1\cdot\left(-\dfrac{6}{5}\right)=\dfrac{6}{5}$

**29.** $m=\dfrac{y_2-y_1}{x_2-x_1}=\dfrac{2\frac{1}{3}-\frac{7}{3}}{\frac{1}{2}-\frac{3}{4}}=\dfrac{\frac{7}{3}-\frac{7}{3}}{\frac{2}{4}-\frac{3}{4}}=\dfrac{0}{-\frac{1}{4}}=0$

**30.** $m=\dfrac{\frac{1}{10}-\frac{2}{5}}{2\frac{1}{4}-\frac{9}{4}}=\dfrac{\frac{1}{10}-\frac{4}{10}}{\frac{9}{4}-\frac{9}{4}}=\dfrac{-\frac{3}{10}}{0}$ Undefined

**31.** The slope of a line is positive if the graph increases from left to right. The slope of a line is negative if the graph decreases from left to right. The slope of a line is zero if the graph is horizontal. The slope of a line is undefined if the graph is vertical.

**32.** $\dfrac{4}{3}=\dfrac{y}{6}$
$3y=24$
$y=8$
The change in $y$ will be 8 units.

**33.** $m=0$

**34.** $m=1$

**35.** $m=\dfrac{1}{10}$

**36.** Undefined

**37.** $m=-1$

**38.** $m=-\dfrac{1}{2}$

**39.** **a.** $m = 5$

**b.** $m = -\frac{1}{5}$

**40.** **a.** $m = 3$

**b.** $m = -\frac{1}{3}$

**41.** **a.** $m = -\frac{4}{7}$

**b.** $m = \frac{7}{4}$

**42.** **a.** $m = -\frac{2}{11}$

**b.** $m = \frac{11}{2}$

**43.** **a.** $m = 0$

**b.** $m$ is undefined.

**44.** **a.** $m$ is undefined.

**b.** $m = 0$

**45.** No, because the product of the slopes of perpendicular lines must be –1. The product of two positive numbers is not negative.

**46.** $x = 2$ is the equation of a vertical line; thus, a perpendicular line will be a horizontal line whose slope is $m = 0$.

**47.** $y = -5$ is the equation of a horizontal line; thus a perpendicular line will be a vertical line whose slope is undefined.

**48.** $x = -3$ is the equation of a vertical line; thus, a parallel line will also be a vertical line whose slope is undefined.

**49.** $m = 0$

**50.** $m = 0$

**51.** undefined

**52.** undefined

**53.**
$$m_{L_1} = \frac{9-5}{4-2} = \frac{4}{2} = 2$$
$$m_{L_2} = \frac{2-4}{3-(-1)} = \frac{-2}{4} = -\frac{1}{2}$$
The lines are perpendicular.

**54.**
$$m_{L_1} = \frac{2-(-5)}{-1-(-3)} = \frac{7}{2}$$
$$m_{L_2} = \frac{2-4}{7-0} = \frac{-2}{7} = -\frac{2}{7}$$
The lines are perpendicular.

**55.**
$$m_{L_1} = \frac{-1-(-2)}{3-4} = \frac{1}{-1} = -1$$
$$m_{L_2} = \frac{-16-(-1)}{-10-(-5)} = \frac{-15}{-5} = 3$$
The lines are neither parallel nor perpendicular.

**56.**
$$m_{L_1} = \frac{3-0}{2-0} = \frac{3}{2}$$
$$m_{L_2} = \frac{-2-5}{0-(-2)} = \frac{-7}{2} = -\frac{7}{2}$$
The lines are neither parallel nor perpendicular.

**57.**
$$m_{L_1} = \frac{9-3}{5-5} = \frac{6}{0} \text{ Undefined}$$
$$m_{L_2} = \frac{2-2}{0-4} = \frac{0}{-4} = 0$$
The lines are perpendicular. One line is horizontal and the other is vertical.

**58.**
$$m_{L_1} = \frac{5-5}{2-3} = \frac{0}{-1} = 0$$
$$m_{L_2} = \frac{4-4}{0-2} = \frac{0}{-2} = 0$$
The lines are parallel.

**59.**
$$m_{L_1} = \frac{3-(-2)}{2-(-3)} = \frac{5}{5} = 1$$
$$m_{L_2} = \frac{5-1}{0-(-4)} = \frac{4}{4} = 1$$
The lines are parallel.

**60.**
$$m_{L_1} = \frac{0-1}{0-7} = \frac{-1}{-7} = \frac{1}{7}$$
$$m_{L_2} = \frac{-6-(-8)}{4-(-10)} = \frac{2}{14} = \frac{1}{7}$$
The lines are parallel.

**61.** **a.** $m = \frac{232-70}{2006-1998} = \frac{162}{8} = 20.25$

**b.** The number of cell phone subscriptions increased at a rate of 20.25 million per year during this period.

**62.** **a.** $m = \frac{281-227}{20-0} = \frac{54}{20} = 2.7$

**b.** The U.S. population has grown at a rate of 2.7 million people per year since 1980.

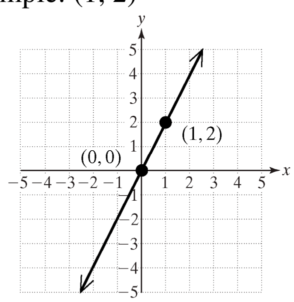
**63.** **a.** $m = \frac{74.5-44.5}{10-5} = \frac{30}{5} = 6$

**b.** The weight of boys tends to increase by 6 lb/yr during this period of growth.

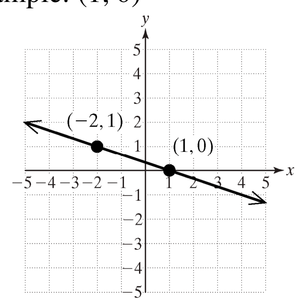
**64.** **a.** $m = \frac{87.5-42.5}{11-5} = \frac{45}{6} = 7.5$

**b.** The weight of girls tends to increase by 7.5 lb/yr during this period of growth.

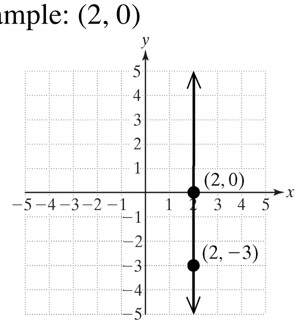
**65.** For example: (1, 2)



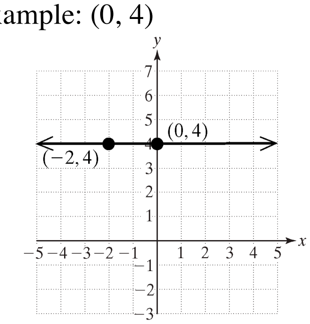

**66.** For example: (1, 0)



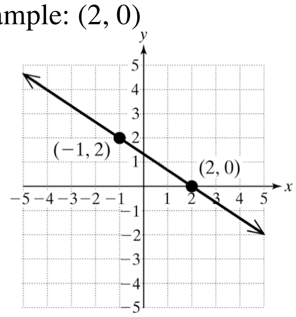

**67.** For example: (2, 0)



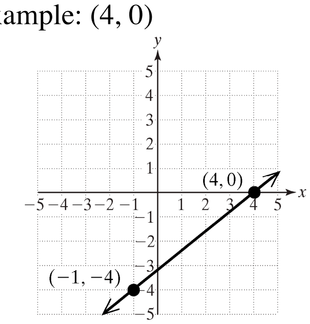

**68.** For example: (0, 4)




**69.** For example: (2, 0)




**70.** For example: (4, 0)



**71.** 
$$\frac{6-y}{4-(-2)}=-\frac{3}{2}$$
$$\frac{6-y}{6}=-\frac{3}{2}$$
$$6-y=6\left(-\frac{3}{2}\right)$$
$$6-y=-9$$
$$-y=-15$$
$$y=15$$

**72.** 
$$\frac{2-(-4)}{3-x}=\frac{6}{7}$$
$$\frac{6}{3-x}=\frac{6}{7}$$
$$6(7)=6(3-x)$$
$$42=18-6x$$
$$24=-6x$$
$$-4=x$$

**73.** **a.** $\text{Pitch}=\frac{4}{24}=\frac{1}{6}$

**b.** $m=\frac{4}{12}=\frac{1}{3}$

## Section 2.3 Equations of a Line

### Section 2.3 Practice Exercises

**1.** Answers will vary.

**2.** **a.** The standard form of the equation of a line is $Ax+By=C$ where $A$ and $B$ are not both zero.

**b.** The slope-intercept form of the equation of a line is $y=mx+b$ where $m$ is the slope and the point $(0, b)$ is the $y$-intercept.

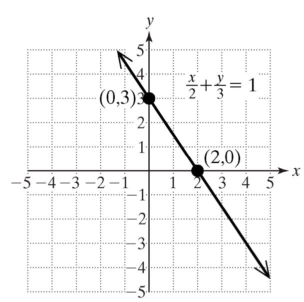
**c.** The point-slope formula is given by $y-y_1=m(x-x_1)$ where $m$ is the slope of the line and $(x_1, y_1)$ is a known point on the line.

**3.** 
$$\frac{x}{2}+\frac{y}{3}=1$$
$$\frac{x}{2}+\frac{0}{3}=1$$
$$\frac{x}{2}=1$$
$$x=2$$

$$\frac{0}{2}+\frac{y}{3}=1$$
$$\frac{y}{3}=1$$
$$y=3$$

**a.** The $x$-intercept is (2, 0).
**b.** The $y$-intercept is (0, 3).

**c.**




**4.** Two lines with the same slope are parallel.

**5.** If the slope of one line is the opposite of the reciprocal of the slope of the other line, then the lines are perpendicular.

**6.** $m=\frac{y_2-y_1}{x_2-x_1}$

**7.** $y=-\frac{2}{3}x-4$
Slope: $-\frac{2}{3}$
$y$-intercept: (0, –4)

**8.** $y = \frac{3}{7}x - 1$
Slope: $\frac{3}{7}$
$y$-intercept: (0, –1)

**9.** $y = 2 + 3x$
$y = 3x + 2$
Slope: 3
$y$-intercept: (0, 2)

**10.** $y = 5 - 7x$
$y = -7x + 5$
Slope: –7
$y$-intercept: (0, 5)

**11.** $17x + y = 0$
$y = -17x$
Slope: –17
$y$-intercept: (0, 0)

**12.** $x + y = 0$
$y = -x$
Slope: –1
$y$-intercept: (0, 0)

**13.** $18 = 2y$
$9 = y$
$y = 0x + 9$
Slope: 0
$y$-intercept: (0, 9)

**14.** $-7 = \frac{1}{2}y$
$-14 = y$
$y = 0x - 14$
Slope: 0
$y$-intercept: (0, –14)

**15.** $8x + 12y = 9$
$12y = -8x + 9$
$y = -\frac{8}{12}x + \frac{9}{12} = -\frac{2}{3}x + \frac{3}{4}$
Slope: $-\frac{2}{3}$
$y$-intercept: $\left(0, \frac{3}{4}\right)$

**16.** $-9x + 10y = -4$
$10y = 9x - 4$
$y = \frac{9}{10}x - \frac{4}{10} = \frac{9}{10}x - \frac{2}{5}$
Slope: $\frac{9}{10}$
$y$-intercept: $\left(0, -\frac{2}{5}\right)$

**17.** $y = 0.625x - 1.2$
Slope: 0.625
$y$-intercept: (0, –1.2)

**18.** $y = -2.5x + 1.8$
Slope: –2.5
$y$-intercept: (0, 1.8)

**19.** d

**20.** c

**21.** f

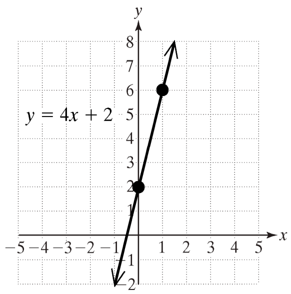
**22.** a

**23.** b

**24.** e

**25.** $y - 2 = 4x$

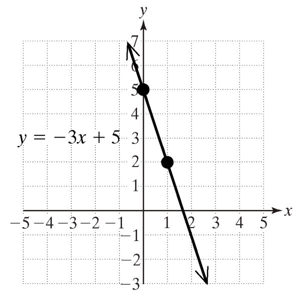
$y = 4x + 2$




**26.** $3x = 5 - y$

$y + 3x = 5$

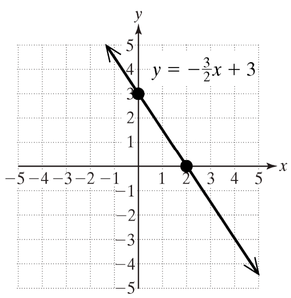
$y = -3x + 5$




**27.** $3x + 2y = 6$

$2y = -3x + 6$

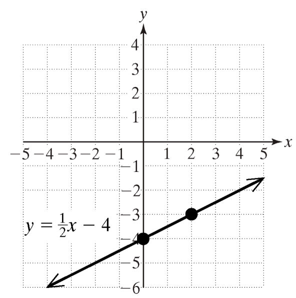
$y = -\frac{3}{2}x + 3$




**28.** $x - 2y = 8$

$-2y = -x + 8$

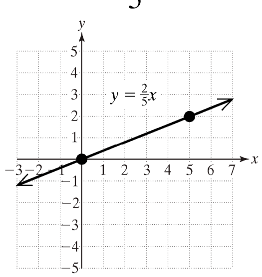
$y = \frac{1}{2}x - 4$




**29.** $2x - 5y = 0$

$-5y = -2x$

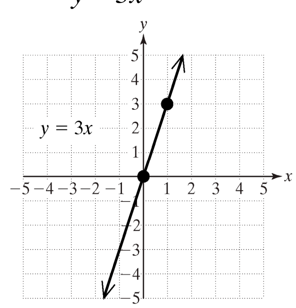
$y = \frac{2}{5}x$




**30.** $3x - y = 0$

$3x = y$

$y = 3x$




**31.** $Ax + By = C$

$By = -Ax + C$

$y = -\frac{A}{B}x + \frac{C}{B}$

The slope is given by $m = -\frac{A}{B}$.

The $y$-intercept is $\left(0, \frac{C}{B}\right)$.

**32.** $3x + 7y = 9$

$A = 3, \ B = 7, \ C = 9$

$m = -\frac{3}{7}$

$y$-intercept: $\left(0, \frac{9}{7}\right)$

**33.** $-3y = 5x - 1$

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

$m_1 = -\frac{5}{3}$

$6x = 10y - 12$

$10y = 6x + 12$

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

$m_2 = \frac{3}{5}$

The lines are perpendicular.

**34.** $x = 6y - 3$

$6y = x + 3$

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

$m_1 = \frac{1}{6}$

$3x + \frac{1}{2}y = 0$

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

$y = -6x$

$m_2 = -6$

The lines are perpendicular.

**35.** $3x - 4y = 12$

$-4y = -3x + 12$

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

$m_1 = \frac{3}{4}$

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

$6\left(\frac{1}{2}x - \frac{2}{3}y\right) = 6 \cdot 1$

$3x - 4y = 6$

$-4y = -3x + 6$

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

$m_2 = \frac{3}{4}$

The lines are parallel.

**36.** $4.8x = 1.2y + 3.6$

$4.8x - 3.6 = 1.2y$

$y = 4x - 3$

$m_1 = 4$

$y - 1 = 4x$

$y = 4x + 1$

$m_2 = 4$

The lines are parallel.

**37.** $3y = 5x + 6$

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

$m_1 = \frac{5}{3}$

$5x + 3y = 9$

$3y = -5x + 9$

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

$m_2 = -\frac{5}{3}$

The lines are neither parallel nor perpendicular.

**38.** $-y = 3x - 2$

$y = -3x + 2$

$m_1 = -3$

$-6x + 2y = 6$

$2y = 6x + 6$

$y = 3x + 3$

$m_2 = 3$

The lines are neither parallel nor perpendicular.

**39.** $m = 3$, point: $(0, 5)$

$y = mx + b$

$y = 3x + 5$

**40.** $m = -4$, point: $(0, 3)$

$y = mx + b$

$y = -4x + 3$

**41.** $m = 2$, point: $(4, -3)$

$y = mx + b$

$-3 = 2(4) + b$

$-3 = 8 + b$

$-11 = b$

$y = 2x - 11$

**42.** $m = 3$, point: $(-1, 5)$

$y = mx + b$

$5 = 3(-1) + b$

$5 = -3 + b$

$8 = b$

$y = 3x + 8$

**43.** $m = -\frac{4}{5}$, point: $(10, 0)$

$y = mx + b$

$0 = -\frac{4}{5}(10) + b$

$0 = -8 + b$

$8 = b$

$y = -\frac{4}{5}x + 8$

**44.** $m = -\frac{2}{7}$, point: $(-3, 1)$

$y = mx + b$

$1 = -\frac{2}{7}(-3) + b$

$1 = \frac{6}{7} + b$

$\frac{1}{7} = b$

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

**45.** $m = 3$, $y$-intercept: $(0, -2)$

$y = 3x - 2$ or $3x - y = 2$

**46.** $m = -\frac{1}{2}$, $y$-intercept: $(0, 5)$

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

$x + 2y = 10$

**47.** $m = 2$, point: $(2, 7)$

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

$y - 7 = 2(x - 2)$

$y - 7 = 2x - 4$

$y = 2x + 3$ or $2x - y = -3$

**48.** $m = -2$, point: $(3, 10)$

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

$y - 10 = -2(x - 3)$

$y - 10 = -2x + 6$

$y = -2x + 16$ or $2x + y = 16$

**49.** $m = -3$, point: $(-2, -5)$

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

$y - (-5) = -3(x - (-2))$

$y + 5 = -3x - 6$

$y = -3x - 11$ or $3x + y = -11$

**50.** $m = 4$, point: $(-1, -6)$

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

$y - (-6) = 4(x - (-1))$

$y + 6 = 4x + 4$

$y = 4x - 2$ or $4x - y = 2$

**51.** $m = -\frac{4}{5}$, point: $(6, -3)$

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

$y - (-3) = -\frac{4}{5}(x - 6)$

$y + 3 = -\frac{4}{5}x + \frac{24}{5}$

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

$4x + 5y = 9$

**52.** $m = \frac{7}{2}$, point: $(7, -2)$

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

$y - (-2) = \frac{7}{2}(x - 7)$

$y + 2 = \frac{7}{2}x - \frac{49}{2}$

$y = \frac{7}{2}x - \frac{53}{2}$ or $\frac{7}{2}x - y = \frac{53}{2}$

$7x - 2y = 53$

**53.**
$$m=\frac{0-4}{3-0}=\frac{-4}{3}=-\frac{4}{3}$$
$$y-y_1=m(x-x_1)$$
$$y-4=-\frac{4}{3}(x-0)$$
$$y-4=-\frac{4}{3}x+0$$
$$y=-\frac{4}{3}x+4 \quad \text{or} \quad \frac{4}{3}x+y=4$$
$$4x+3y=12$$

**54.**
$$m=\frac{7-1}{3-1}=\frac{6}{2}=3$$
$$y-y_1=m(x-x_1)$$
$$y-1=3(x-1)$$
$$y-1=3x-3$$
$$y=3x-2 \quad \text{or} \quad 3x-y=2$$

**55.**
$$m=\frac{10-12}{4-6}=\frac{-2}{-2}=1$$
$$y-y_1=m(x-x_1)$$
$$y-12=1(x-6)$$
$$y-12=x-6$$
$$y=x+6 \quad \text{or} \quad x-y=-6$$

**56.**
$$m=\frac{-4-(-1)}{3-(-2)}=\frac{-3}{5}=-\frac{3}{5}$$
$$y-y_1=m(x-x_1)$$
$$y-(-1)=-\frac{3}{5}(x-(-2))$$
$$y+1=-\frac{3}{5}x-\frac{6}{5}$$
$$y=-\frac{3}{5}x-\frac{11}{5} \quad \text{or} \quad \frac{3}{5}x+y=-\frac{11}{5}$$
$$3x+5y=-11$$

**57.**
$$m=\frac{2-2}{-1-(-5)}=\frac{0}{4}=0$$
$$y-y_1=m(x-x_1)$$
$$y-2=0(x-(-5))$$
$$y-2=0$$
$$y=2$$

**58.**
$$m=\frac{-1-(-1)}{2-(-4)}=\frac{0}{6}=0$$
$$y-y_1=m(x-x_1)$$
$$y-(-1)=0(x-(-4))$$
$$y+1=0$$
$$y=-1$$

**59.**
$$m=-\frac{3}{4}, \quad \text{point: } (3,2)$$
$$y-y_1=m(x-x_1)$$
$$y-2=-\frac{3}{4}(x-3)$$
$$y-2=-\frac{3}{4}x+\frac{9}{4}$$
$$y=-\frac{3}{4}x+\frac{17}{4} \quad \text{or} \quad \frac{3}{4}x+y=\frac{17}{4}$$
$$3x+4y=17$$

**60.**
$$m=\frac{1}{2}, \quad \text{point: } (-1,\ 4)$$
$$y-y_1=m(x-x_1)$$
$$y-4=\frac{1}{2}(x-(-1))$$
$$y-4=\frac{1}{2}x+\frac{1}{2}$$
$$y=\frac{1}{2}x+\frac{9}{2} \quad \text{or} \quad \frac{1}{2}x-y=-\frac{9}{2}$$
$$x-2y=-9$$

**61.** $m=\frac{4}{3}$, point: $(3,2)$

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

$y-2=\frac{4}{3}(x-3)$

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

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

$4x-3y=6$

**62.** $m=-2$, point: $(-2,\ 5)$

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

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

$y-5=-2x-4$

$y=-2x+1$ or $2x+y=1$

**63.** $3x-4y=-7$

$-4y=-3x-7$

$y=\frac{3}{4}x+\frac{7}{4}$

$m=\frac{3}{4}$, point: $(2,\ -5)$

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

$y-(-5)=\frac{3}{4}(x-2)$

$y+5=\frac{3}{4}x-\frac{3}{2}$

$y=\frac{3}{4}x-\frac{13}{2}$ or $\frac{3}{4}x-y=\frac{13}{2}$

$3x-4y=26$

**64.** $2x+3y=-12$

$3y=-2x-12$

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

$m=-\frac{2}{3}$, point: $(-6,\ -1)$

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

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

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

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

$2x+3y=-15$

**65.** $-15x+3y=9$

$3y=15x+9$

$y=5x+3$

$m=5$, $m_{\perp}=-\frac{1}{5}$, point: $(-8,\ -1)$

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

$y-(-1)=-\frac{1}{5}(x-(-8))$

$y+1=-\frac{1}{5}x-\frac{8}{5}$

$y=-\frac{1}{5}x-\frac{13}{5}$ or $\frac{1}{5}x+y=-\frac{13}{5}$

$x+5y=-13$

**66.** $4x+3y=-6$

$3y=-4x-6$

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

$m=-\frac{4}{3}$, $m_{\perp}=\frac{3}{4}$, point: $(4,\ -2)$

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

$y-(-2)=\frac{3}{4}(x-4)$

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

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

$3x-4y=20$

**67.** $3x = 2y$

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

$$m = \frac{3}{2}, \quad \text{point: } (4, 0)$$

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

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

$$y = \frac{3}{2}x - 6 \text{ or } \frac{3}{2}x - y = 6$$

$$3x - 2y = 12$$

**68.** $-5x = 6y$

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

$$m = -\frac{5}{6}, \quad \text{point: } (-3, 0)$$

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

$$y - 0 = -\frac{5}{6}(x - (-3))$$

$$y = -\frac{5}{6}x - \frac{5}{2} \text{ or } \frac{5}{6}x + y = -\frac{5}{2}$$

$$5x + 6y = -15$$

**69.** $3y + 2x = 21$

$$3y = -2x + 21$$

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

$$m_\perp = \frac{3}{2}, \quad \text{point: } (2, 4)$$

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

$$y - 4 = \frac{3}{2}(x - 2)$$

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

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

$$3x - 2y = -2$$

**70.** $7y - x = -21$

$$7y = x - 21$$

$$y = \frac{1}{7}z - 3$$

$$m_\perp = -7, \quad \text{point: } (-14, 8)$$

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

$$y - 8 = -7(x - (-14))$$

$$y - 8 = -7x - 98$$

$$y = -7x - 90 \text{ or } 7x + y = -90$$

**71.** $\frac{1}{2}y = x$

$$y = 2x$$

$$m_\perp = -\frac{1}{2}, \quad \text{point: } (-3, 5)$$

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

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

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

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

$$x + 2y = 7$$

**72.** $-\frac{1}{4}y = x$

$$y = -4x$$

$$m_\perp = \frac{1}{4}, \quad \text{point: } (-1, -5)$$

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

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

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

$$y = \frac{1}{4}x - \frac{19}{4} \text{ or } \frac{1}{4}x - y = \frac{19}{4}$$

$$x - 4y = 19$$

**73.** $3x + y = 7$

$y = -3x + 7$

$m_{\parallel} = -3$, point: $(0, 0)$

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

$y - 0 = -3(x - 0)$

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

**74.** $-2x + y = -5$

$y = 2x - 5$

$m_{\parallel} = 2$, point: $(0, 0)$

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

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

$y = 2x$ or $2x - y = 0$

**75.** $m = 0$, point: $(2, -3)$

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

$y - (-3) = 0(x - 2)$

$y + 3 = 0$

$y = -3$

**76.** A line with an undefined slope is a vertical line, which is in the form $x = c$. Therefore, a line containing $\left(\frac{5}{2}, 0\right)$ would have the equation $x = \frac{5}{2}$.

**77.** A line with an undefined slope is a vertical line, which is in the form $x = c$. Therefore, a line containing (2, –3) would have the equation $x = 2$.

**78.** $m = 0$, point: $\left(\frac{5}{2}, 0\right)$

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

$y - 0 = 0\left(x - \frac{5}{2}\right)$

$y = 0$

**79.** A line parallel to the *x*-axis has the form $y = c$. Therefore, a line containing the point (4, 5) would have the equation $y = 5$.

**80.** A line perpendicular to the *x*-axis is a vertical line, which is in the form $x = c$. Therefore, a line containing (4, 5) would have the equation $x = 4$.

**81.** A line parallel to the line $x = 4$ is a vertical line and has the form $x = c$. Therefore, a line containing the point (5, 1) would have the equation $x = 5$.

**82.** A line parallel to the line $y = -2$ is a horizontal line and has the form $y = c$. Therefore, a line containing the point (–3, 4) would have the equation $y = 4$.

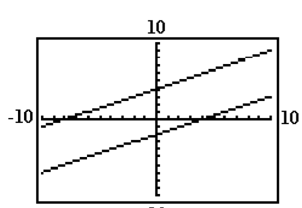
**83.** $x = -2$ is not in the slope-intercept form. It has no *y*-intercept and its slope is undefined.

**84.** $x = 1$ is not in the slope-intercept form. It has no *y*-intercept and its slope is undefined.

**85.** $y = 3$ is in the slope-intercept form, $y = 0x + 3$. Its slope is 0 and the *y*-intercept is (0, 3).

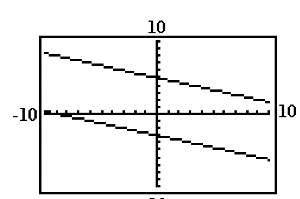
**86.** $y = -5$ is in the slope-intercept form, $y = 0x - 5$. Its slope is 0 and the *y*-intercept is (0, –5).

**87.**



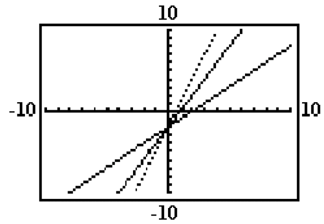

The lines have the same slope but different *y*-intercepts; they are parallel lines.

**88.**



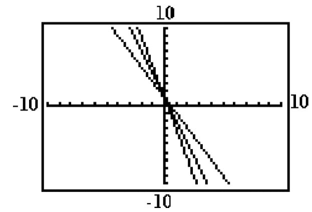

The lines have the same slope but different *y*-intercepts; they are parallel lines.

**89.**



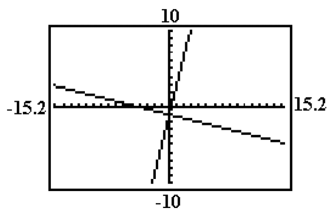

The lines have different slopes but the same $y$-intercept.

**90.**



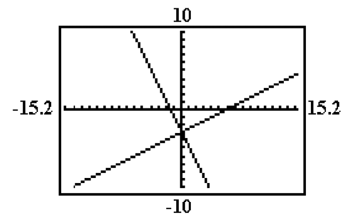

The lines have different slopes but the same $y$-intercept.

**91.**



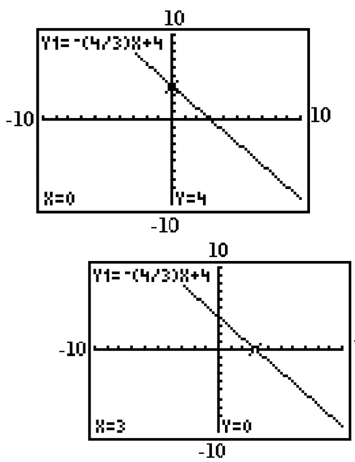

The lines are perpendicular, and have the same $y$-intercept.

**92.**

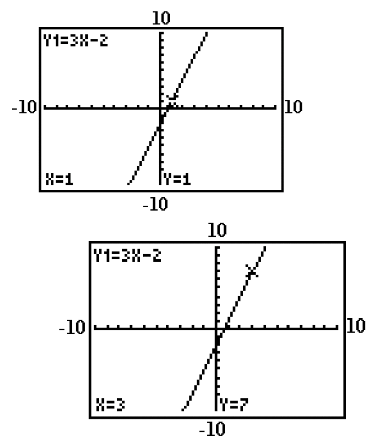



The lines are perpendicular, and have the same $y$-intercept.

**93.**




**94.**




## Problem Recognition Exercises: Characteristics of Linear Equations

**1.** b, f

**2.** a, c, d, h

**3.** a

**4.** b, g

**5.** c, e

**6.** a

**7.** c, h

**8.** b

**9.** e

**10.** g

**11.** c, h

**12.** a

**13.** g

**14.** e

**15.** h

**16.** f

**17.** e

**18.** g

**19.** d, h

**20.** b, f

## Section 2.4 Applications of Linear Equations and Modeling

### Section 2.4 Practice Exercises

**1.** Answers will vary.

**2.** A mathematical model is a formula or equation that represents a relationship between two or more variables in a real-world application.

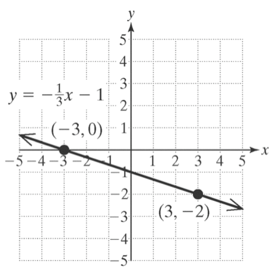
**3.** **a.** $m = \dfrac{-2-0}{3-(-3)} = \dfrac{-2}{6} = -\dfrac{1}{3}$

**b.** $y - 0 = -\dfrac{1}{3}\left(x - (-3)\right)$

$y = -\dfrac{1}{3}x - 1$ or $\dfrac{1}{3}x + y = -1$

$x + 3y = -3$

**c.**



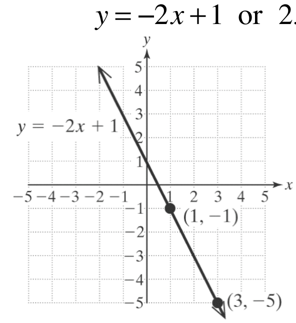

**4.** **a.** $m = \dfrac{-5-(-1)}{3-1} = \dfrac{-4}{2} = -2$

**b.** $y - (-1) = -2(x - 1)$

$y + 1 = -2x + 2$

$y = -2x + 1$ or $2x + y = 1$

**c.**



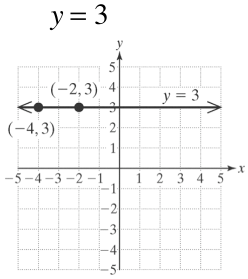

**5.** **a.** $m = \dfrac{3-3}{-2-(-4)} = \dfrac{0}{2} = 0$

**b.** $y - 3 = 0\left(x - (-4)\right)$

$y - 3 = 0$

$y = 3$

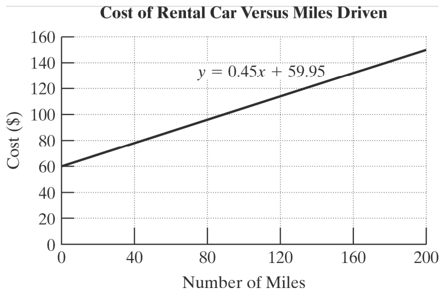
**c.**




**6.** undefined

**7.** **a.** $y = 0.45x + 59.95$

**b.**




**c.** The $y$-intercept is (0, 59.95). The cost is $59.95 when 0 miles are driven.

**d.** $y = 0.45(50) + 59.95$

$= 22.50 + 59.95 = \$82.45$

It cost $82.45 to drive 50 miles.

$y = 0.45(100) + 59.95$

$= 45.00 + 59.95 = 104.95$

It costs $104.95 to drive 100 miles.

$y = 0.45(200) + 59.95$

$= 90 + 59.95 = 149.95$

It costs $149.95 to drive 200 miles.

**e.** $m = 0.45$ ; The slope means that the cost to rent a car increases at a rate of $0.45 per mile driven.

**f.** $C = 104.95 + 0.06(104.95)$

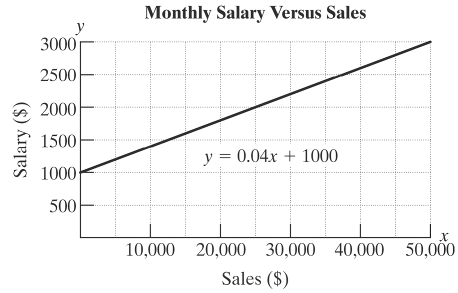
$= 104.95 + 6.30 = 111.25$

The cost with the sales tax is $111.25.

**g.** It is not reasonable to use negative values for $x$ because one cannot drive a negative number of miles.

**8.** **a.** $y = 0.04x + 1000$

**b.**




**c.** The $y$-intercept is (0, 1000). Alex's base salary (with $0 sales) is $1000.

**d.** $m = 0.04 = \dfrac{4}{100}$ . Alex receives $4 for every $100 sold.

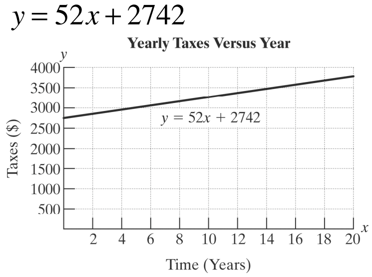
**e.** $y = 0.04(30{,}000) + 1000$

$= 1200 + 1000 = 2200$

Alex will make $2200 if he has sales of $30,000.

**9.** **a.** $y = 52x + 2742$

**b.**




**c.** $m = 52$ . The taxes increase $52 per year.

**d.** The $y$-intercept is (0, 2742). In the initial year ($x = 0$) the taxes were $2742.

**e.** $y = 52(10) + 2742 = 520 + 2742 = 3262$

After 10 years the taxes are $3262.

$y = 52(15) + 2742 = 780 + 2742 = 3522$

After 15 years the taxes are $3522.

**10.** **a.** $y = 5x + 19$

**b.** $y = 5(4) + 19 = 20 + 19 = 39$

In 4 years he will have 39 restaurants.

**c.** $100 = 5x + 19$

$81 = 5x$

$16.2 = x$

In 16.2 years he will have 100 stores.

**11. a.** $y = 0.2(4) = 0.8$

The storm is 0.8 mi away when the time difference is 4 sec.

$y = 0.2(12) = 2.4$

The storm is 2.4 mi away when the time difference is 12 sec.

$y = 0.2(16) = 3.2$

The storm is 3.2 mi away when the time difference is 16 sec.

**b.** $4.2 = 0.2x$

$21 = x$

When the storm is 4.2 miles away, the time difference is 21 sec.

**12. a.** $y = 2.5(6) = 15$

15 pounds of force stretch the spring 6 in.

$y = 2.5(12) = 30$

30 pounds of force stretch the spring 12 in.

**b.** $45 = 2.5x$

$18 = x$

When 45 pounds of force are applied, the spring will stretch 18 in.

**13. a.** The year 2005 is represented by $x = 25$.

$y = 5.3(25) + 63.4$

$= 132.5 + 63.4 = 195.9$

The approximate cost of a house in 2005 is \$195.9 thousand or \$195,900.

**b.** The year 1988 is represented by $x = 8$.

$y = 5.3(8) + 63.4$

$= 42.4 + 63.4 = 105.8$

The approximate cost of a house in 1988 is \$105.8 thousand or \$105,800 which is \$4200 higher than the median cost.

**c.** $m = 5.3$. There is a \$5300 increase in median housing cost per year.

**d.** The $y$-intercept is (0, 63.4). In 1980 ($x = 0$) the median cost was \$63,400.

**14. a.** The year 2005 is represented by $x = 25$.

$y = 142(25) + 9060$

$= 3550 + 9060 = 12{,}610$

The approximate yearly mileage in 2005 is 12,610 mi.

**b.** The year 1985 is represented by $x = 5$.

$y = 142(5) + 9060$

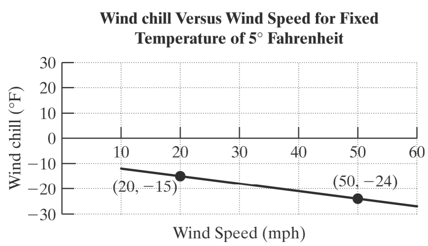
$= 710 + 9060 = 9770$

The approximate yearly mileage in 1985 is 9770 mi which is 70 mi more than the actual value.

**c.** $m = 142$. There is a 142 mile increase per year.

**d.** The $y$-intercept is (0, 9060). In 1980 ($x = 0$) the average mileage was 9060 mi.

**15. a.**




**b.** $m = \frac{-24-(-15)}{50-20} = \frac{-9}{30} = -\frac{3}{10} = -0.3$

$y - (-15) = -0.3(x - 20)$

$y + 15 = -0.3x + 6$

$y = -0.3x - 9$

**c.** $y = -0.3(40) - 9 = -12 - 9 = -21°\text{F}$

**d.** $y = -0.3(50) - 9 = -15 - 9 = -24°\text{F}$

**e.** $m = -0.3$. This means that temperature decreases at a rate of 0.3°F for every 1 mph increase in wind speed.

**16.** **a.** $m=\dfrac{48.7-57.3}{48-0}=\dfrac{-8.6}{48}\approx -0.18$

$y=-0.18x+57.3$

**b.** The year 1972 is represented by $x = 24$.

$y=-0.18(24)+57.3$

$=-4.32+57.3=52.98$

The approximate winning time in the 1972 Olympics is 52.98 sec which is 1.78 sec slower than the record.

**c.** The year 1988 is represented by $x = 40$.

$y=-0.18(40)+57.3$

$=-7.2+57.3=50.1$

The approximate winning time in the 1988 Olympics is 50.1 sec.

**d.** $m=-0.18$. Times have decreased by 0.18 sec/yr.

**e.** $0=-0.18x+57.3$

$0.18x=57.3$

$x\approx 318\frac{1}{3}$

The $x$-intercept is $\left(318\frac{1}{3},0\right)$. In the year 2266 the winning time would be 0 sec. This trend will not continue for the next 50 years.

**17.** **a.** $m=\dfrac{665-455}{34-20}=\dfrac{210}{14}=15$

$y-455=15(x-20)$

$y-455=15x-300$

$y=15x+155$

**b.** The slope is 15 and means that the number of associate degrees awarded in the United States increased by 15 thousand per year.

**c.** $y=15(40)+155=600+155=755$

The number of associate degrees awarded in the United States in 2010 will be about 755 thousand.

**18.** **a.** $m=\dfrac{1220-1003}{8-4}=\dfrac{217}{4}=54.25$

$y-1220=54.25(x-8)$

$y-1220=54.25x-434$

$y=54.25x+786$

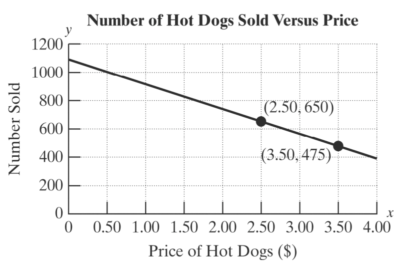
**b.** The slope is 54.25 and means that the number of number of prisoners increased at a rate of 54.25 thousand per year during this time period.

**c.** $y=54.25(22)+786$

$=1193.5+786=1979.5$

There will be approximately 1979.5 thousand prisoners by the year 2012.

**19.** **a.**




**b.** $m=\dfrac{475-650}{3.50-2.50}=\dfrac{-175}{1.00}=-175$

$y-650=-175(x-2.50)$

$y-650=-175x+437.5$

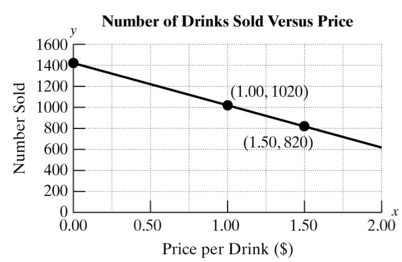
$y=-175x+1087.5$

**c.** $y=-175(4.00)+1087.5$

$=-700+1087.5=387.5$

Approximately 388 hotdogs would be sold when the price of a hotdog is \$4.00.

**20.** **a.**




**b.** $m=\dfrac{820-1020}{1.50-1.00}=\dfrac{-200}{0.50}=-400$

$y-1020=-400(x-1.00)$

$y-1020=-400x+400$

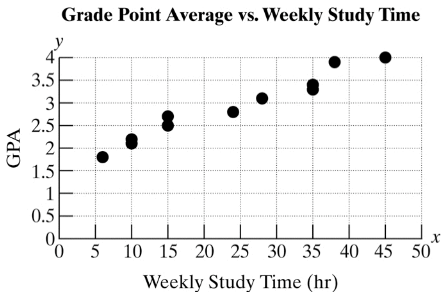
$y=-400x+1420$

**c.** $y=-400(2.00)+1420$

$=-800+1420=620$

Approximately 620 drinks would be sold when the price of a drink is \$2.00.

**21. a.**




**b.** Yes, there is a linear trend.

**c.** $m=\dfrac{3.1-2.2}{28-10}=\dfrac{0.9}{18}=0.05$

$y-2.2=0.05(x-10)$

$y-2.2=0.05x-0.5$

$y=0.05x+1.7$

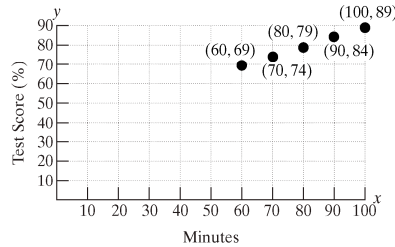
**d.** $y=0.05(30)+1.7=1.5+1.7=3.2$

A student who studies 30 hours per week will have a GPA of approximately 3.2.

**e.** $y=0.05(46)+1.7=2.3+1.7=4.0$

This model is not reasonable for study times greater than 46 hours per week, because the GPA would exceed 4.0.

**22. a.**




Yes, there is a linear trend.

**b.** $m=\dfrac{74-69}{70-60}=\dfrac{5}{10}=\dfrac{1}{2}$

$y-74=\dfrac{1}{2}(x-70)$

$y-74=\dfrac{1}{2}x-35$

$y=\dfrac{1}{2}x+39$

**c.** $90=\dfrac{1}{2}x+39$

$51=\dfrac{1}{2}x$

$102=x$

Loraine needs to study for 102 minutes per day to make at least 90% on her exam. This model is not appropriate for other students because it is based on Loraine's scores.

**d.** $y=\dfrac{1}{2}(30)+39=15+39=54$

Loraine's score will be 54% for a week when she studies 30 min/day.

**23.** $m=\dfrac{-5-(-4)}{0-3}=\dfrac{-1}{-3}=\dfrac{1}{3}$

$m=\dfrac{-2-(-5)}{9-0}=\dfrac{3}{9}=\dfrac{1}{3}$

$m=\dfrac{-2-(-4)}{9-3}=\dfrac{2}{6}=\dfrac{1}{3}$

Since the slopes are equal, the points are collinear.

**24.** $m=\dfrac{-1-3}{-4-4}=\dfrac{-4}{-8}=\dfrac{1}{2}$

$m=\dfrac{2-(-1)}{2-(-4)}=\dfrac{3}{6}=\dfrac{1}{2}$

$m=\dfrac{2-3}{2-4}=\dfrac{-1}{-2}=\dfrac{1}{2}$

Since the slopes are equal, the points are collinear.

**25.** $m=\dfrac{12-2}{-2-0}=\dfrac{10}{-2}=-5$

$m=\dfrac{6-12}{-1-(-2)}=\dfrac{-6}{1}=-6$

Since the slopes are not equal, the points are not collinear.

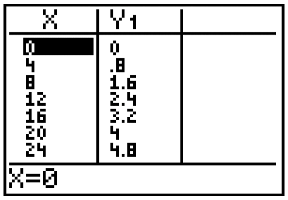
**26.** $m=\dfrac{-3-(-2)}{0-(-2)}=\dfrac{-1}{2}=-\dfrac{1}{2}$

$m=\dfrac{-1-(-3)}{-4-0}=\dfrac{2}{-4}=-\dfrac{1}{2}$

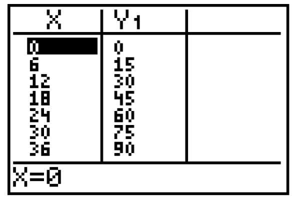
$m=\dfrac{-1-(-2)}{-4-(-2)}=\dfrac{1}{-2}=-\dfrac{1}{2}$

Since the slopes are equal, the points are collinear.

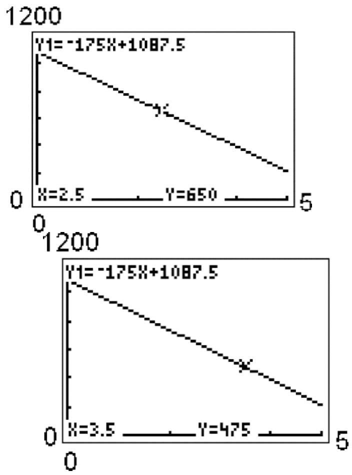
**27.**



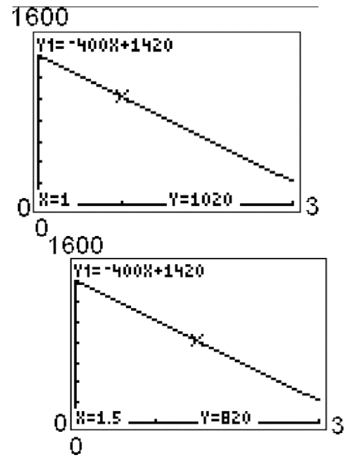

**28.**




**29.**




**30.**




# Section 2.5 Introduction to Relations

## Section 2.5 Practice Exercises

**1.** Answers will vary.

**2.** **a.** Any set of ordered pairs $(x, y)$ is called a relation in $x$ and $y$.
**b.** The set of first components in the ordered pairs is called the domain of the relation.
**c.** The set of second components in the ordered pairs is called the range of the relation.

**3.** **a.**
$$2x - 3 = 4$$
$$2x = 7$$
$$x = \frac{7}{2} \quad \text{vertical line}$$

**b.** The slope is undefined because this is a vertical line.

**c.** The $x$-intercept is $\left(\frac{7}{2}, 0\right)$.

**d.** There is no $y$-intercept.

**4.** **a.**
$$2x - 3y = 4$$
$$-3y = -2x + 4$$
$$y = \frac{2}{3}x - \frac{4}{3} \quad \text{slanted line}$$

**b.** $m = \frac{2}{3}$

**c.**
$$2x - 3(0) = 4$$
$$2x = 4$$
$$x = 2 \quad \text{The } x\text{-intercept is } (2, 0).$$

**d.** The $y$-intercept is $\left(0, -\frac{4}{3}\right)$.

**5.** **a.** $3x-2y=4$
$-2y=-3x+4$
$y=\frac{3}{2}x-2$ slanted line

**b.** $m=\frac{3}{2}$

**c.** $3x-2(0)=4$
$3x=4$
$x=\frac{4}{3}$

The $x$-intercept is $\left(\frac{4}{3},\ 0\right)$.

**d.** The $y$-intercept is $(0,\ -2)$.

**6.** **a.** $2-3y=4$
$-3y=2$
$y=-\frac{2}{3}$ horizontal line

**b.** $m=0$

**c.** There is no $x$-intercept.

**d.** The $y$-intercept is $\left(0,\ -\frac{2}{3}\right)$.

**7.** **a.** {(Alabama, 15.3), (Florida, 20.2), (Massachusetts, 13.4), (California, 18.8), (Minnesota, 7.9)}
**b.** Domain: {Alabama, Florida, Massachusetts, California, Minnesota};
Range: {15.3, 20.2, 13.4, 18.8, 7.9}

**8.** **a.** $\{(0,\ 3),\ (-2,\ \frac{1}{2}),\ (-7,\ 1),\ (-2,\ 8),\ (5,\ 1)\}$
**b.** Domain: $\{0,\ -2,\ 5,\ -7\}$; Range: $\{3,\ \frac{1}{2},\ 1,\ 8\}$

**9.** **a.** {(USSR, 1961), (USA, 1962), (Poland, 1978), (Vietnam, 1980), (Cuba, 1980)}
**b.** Domain: {USSR, USA, Poland, Vietnam, Cuba}; Range: {1961, 1962, 1978, 1980}

**10.** **a.** {(Maine, 1820), (Nebraska, 1823), (Utah, 1847), (Hawaii, 1959), (Alaska, 1959)}
**b.** Domain: {Maine, Nebraska, Utah, Hawaii, Alaska}; Range: {1820, 1823, 1847, 1959}

**11.** **a.** $\{(A,\ 1),\ (A,\ 2),\ (B,\ 2),\ (C,\ 3),\ (D,\ 5),\ (E,\ 4)\}$
**b.** Domain: {A, B, C, D, E}; Range: $\{1,\ 2,\ 3,\ 4,\ 5\}$

**12.** **a.** $\{(5,\ 3),\ (10,\ 2),\ (15,\ 2),\ (20,\ 2)\}$
**b.** Domain: $\{5,\ 10,\ 15,\ 20\}$; Range: $\{2,\ 3\}$

**13.** **a.** $\{(-4,\ 4),\ (1,\ 1),\ (2,\ 1),\ (3,\ 1),\ (4,\ -2)\}$
**b.** Domain: $\{-4,\ 1,\ 2,\ 3,\ 4\}$; Range: $\{-2,\ 1,\ 4\}$

**14.** **a.** $\{(-3,\ 3),\ (-3,\ -2),\ (0,\ 0),\ (2,\ 3),\ (2,\ 0)\}$
**b.** Domain: $\{-3,\ 0,\ 2\}$; Range: $\{-2,\ 0,\ 3\}$

**15.** Domain: $[0,\ 4]$; Range: $[-2,\ 2]$

**16.** Domain: $[-3,\ 3]$; Range: $[-4,\ 4]$

**17.** Domain: $[-5, 3]$; Range: $[-2.1, 2.8]$

**18.** Domain: $[-3.1, 3.2]$; Range: $[-3, 3]$

**19.** Domain: $(-\infty, 2]$
Range: $(-\infty, \infty)$

**20.** Domain: $(-\infty, \infty)$
Range: $(-\infty, 3]$

**21.** Domain: $(-\infty, \infty)$
Range: $(-\infty, \infty)$

**22.** Domain: $(-\infty, \infty)$
Range: $(-\infty, \infty)$

**23.** Domain: $\{-3\}$
Range: $(-\infty, \infty)$

**24.** Domain: $(-\infty, \infty)$
Range: $\{-2\}$

**25.** Domain: $(-\infty, 2)$
Range: $[-1.3, \infty)$

**26.** Domain: $[-4, \infty)$
Range: $(-2, \infty)$

**27.** Domain: $\{-3, -1, 1, 3\}$
Range: $\{0, 1, 2, 3\}$

**28.** Domain: $\{-4, -3, -1, 2, 4\}$
Range: $\{-4, -2, -1, 0, 4\}$

**29.** Domain: $[-4, 5)$
Range: $\{-2, 1, 3\}$

**30.** Domain: $(-5, 1) \cup (1, 5)$
Range: $\{-1, 1, 3\}$

**31.** **a.** 2.85
**b.** 9.33
**c.** December
**d.** (November, 2.66)
**e.** (Sept., 7.63)
**f.** {Jan., Feb., Mar., Apr., May, June, July, Aug., Sept., Oct., Nov., Dec.}

**32.** **a.** {20, 30, 40, 50, 60}
**b.** {200. 190, 180, 170, 160}
**c.** 20
**d.** (50, 170)
**e.** (30, 190)

**33.** **a.** $y = 0.146x + 31$
$y = 0.146(6) + 31 = 0.876 + 31$
$y = 31.876$ million or 31,876,000
**b.** $32.752 = 0.146x + 31$
$1.752 = 0.146x$
$x = 12$
The year 2012.

**34.** **a.** $y = 0.159x - 10.79$
$y = 0.159(500) - 10.79$
$y = 79.5 - 10.79 = 68.71$ sec
**b.** $y = 0.159(1000) - 10.79$
$y = 159 - 10.79 = 148.21$ sec
The time is not exactly the same because the equation represents approximate times.

**35.** **a.** For example:
{(Julie, New York), (Peggy, Florida), (Stephen, Kansas), (Pat, New York)}
**b.** Domain: {Julie, Peggy, Stephen, Pat}
Range: {New York, Florida, Kansas}

**36.** **a.** For example:
{(Michigan, Lansing), (Florida, Tallahassee), (Texas, Austin), (New York, Albany)}
**b.** Domain: {Michigan, Florida, Texas, New York}
Range: {Lansing, Tallahassee, Austin, Albany}

**37.** $y = 2x - 1$

**38.** $y = x + 3$

**39.** $y = x^2$

**40.** $y = \frac{1}{4}x$

## Section 2.6 Introduction to Functions

### Section 2.6 Practice Exercises

**1.** Answers will vary.

**2.** **a.** Given a relation in $x$ and $y$, we say "$y$ is a <u>function</u> of $x$" if for every element $x$ in the domain, there corresponds exactly one element $y$ in the range.
**b.** When a function is defined by an equation, we use <u>function notation</u> such as $f(x) = 2x$.
**c.** The <u>domain</u> of $f$ is the set of all $x$-values that when substituted into the functions produce a real number.
**d.** The <u>range</u> of $f$ is the set of all $y$-values corresponding to the values of $x$ in the domain.
**e.** <u>Vertical line test</u> - Consider a relation defined by a set of points $(x, y)$ in a rectangular coordinate system. The graph defines $y$ as a function of $x$ if no vertical line intersects the graph in more than one point.

**3.** **a.** {(Kevin, Kayla), (Kevin, Kira), (Kathleen, Katie), (Kathleen, Kira)}
**b.** Domain: {Kevin, Kathleen}
**c.** Range: {Kayla, Katie, Kira}

**4.** **a.** $\{(-2,-4), (-1,-1), (0,0), (1,-1), (2,-4)\}$
**b.** Domain: $\{-2, -1, 0, 1, 2\}$
**c.** Range: $\{-4, -1, 0\}$

**5.** Function

**6.** Not a function

**7.** Not a function

**8.** Function

**9.** Function

**10.** Function

**11.** Not a function

**12.** Function

**13.** Function

**14.** Not a function

**15.** Not a function

**16.** Not a function

**17.** $g(2) = -(2)^2 - 4(2) + 1 = -4 - 8 + 1 = -11$

**18.** $k(2) = |2 - 2| = |0| = 0$

**19.** $g(0) = -(0)^2 - 4(0) + 1 = 0 - 0 + 1 = 1$

**20.** $h(0) = 7$

**21.** $k(0) = |0 - 2| = |-2| = 2$

**22.** $f(0) = 6(0) - 2 = 0 - 2 = -2$

**23.** $f(t)=6(t)-2=6t-2$

**24.** $g(a)=-(a)^2-4(a)+1=-a^2-4a+1$

**25.** $h(u)=7$

**26.** $k(v)=|v-2|$

**27.** $g(-3)=-(-3)^2-4(-3)+1=-9+12+1=4$

**28.** $h(-5)=7$

**29.** $k(-2)=|-2-2|=|-4|=4$

**30.** $f(-6)=6(-6)-2=-36-2=-38$

**31.** $f(x+1)=6(x+1)-2=6x+6-2=6x+4$

**32.** $h(x+1)=7$

**33.** $$\begin{aligned} g(2x)&=-(2x)^2-4(2x)+1\\ &=-(4x^2)-8x+1\\ &=-4x^2-8x+1 \end{aligned}$$

**34.** $k(x-3)=|x-3-2|=|x-5|$

**35.** $g(-\pi)=-(-\pi)^2-4(-\pi)+1=-\pi^2+4\pi+1$

**36.** $$\begin{aligned} g(a^2)&=-(a^2)^2-4(a^2)+1\\ &=-(a^4)-4a^2+1=-a^4-4a^2+1 \end{aligned}$$

**37.** $h(a+b)=7$

**38.** $f(x+h)=6(x+h)-2=6x+6h-2$

**39.** $f(-a)=6(-a)-2=-6a-2$

**40.** $g(-b)=-(-b)^2-4(-b)+1=-b^2+4b+1$

**41.** $k(-c)=|-c-2|$

**42.** $h(-x)=7$

**43.** $f\left(\frac{1}{2}\right)=6\left(\frac{1}{2}\right)-2=3-2=1$

**44.** $g\left(\frac{1}{4}\right)=-\left(\frac{1}{4}\right)^2-4\left(\frac{1}{4}\right)+1=-\frac{1}{16}-1+1=-\frac{1}{16}$

**45.** $h\left(\frac{1}{7}\right)=7$

**46.** $k\left(\frac{3}{2}\right)=\left|\frac{3}{2}-2\right|=\left|-\frac{1}{2}\right|=\frac{1}{2}$

**47.** $f(-2.8)=6(-2.8)-2=-16.8-2=-18.8$

**48.** $k(-5.4)=|-5.4-2|=|-7.4|=7.4$

**49.** $p(2)=-7$

**50.** $p(1)=0$

**51.** $p(3)=2\pi$

**52.** $p\left(\frac{1}{2}\right)=6$

**53.** $q(2)=-5$

**54.** $q\left(\frac{3}{4}\right)=\frac{1}{5}$

**55.** $q(6)=4$

**56.** $q(0)=9$

**57.**
**a.** $f(0)=3$
**b.** $f(3)=1$
**c.** $f(-2)=1$
**d.** $x=-3$
**e.** $x=0,\ x=2$
**f.** Domain: $(-\infty,\ 3]$
**g.** Range: $(-\infty,\ 5]$

**58.**
**a.** $g(-1)=2$
**b.** $g(1)=1$
**c.** $g(4)=1$
**d.** $x=2$
**e.** $x=-3,\ x=5$
**f.** Domain: $[-3,\ \infty)$
**g.** Range: $(-\infty,\ 3]$

**59.**
**a.** $H(-3)=3$
**b.** $H(4)=$ not defined (4 not in domain)
**c.** $H(3)=4$
**d.** $x=-3$ and $x=2$
**e.** all $x$ in the interval $[-2,\ 1]$
**f.** Domain: $[-4,\ 4)$
**g.** Range: $[2,\ 5)$

**60.**
**a.** $K(0)=-1$
**b.** $K(-5)=$ not defined (–5 not in domain)
**c.** $K(1)=0$
**d.** $x=-1$, $x=1$, and $x=3$
**e.** $x=-4$
**f.** Domain: $(-5,\ 5]$
**g.** Range: $[-1,\ 4)$

**61.** Domain: $\{-3,\ -7,\ -\frac{3}{2},\ 1.2\}$

**62.** Range: $\{5,\ -3,\ 4\}$

**63.** Range: $\{6,\ 0\}$

**64.** Domain: $\{0,\ 2,\ 6,\ 1\}$

**65.** –3 and 1.2

**66.** –7

**67.** 6 and 1

**68.** 0 and 2

**69.** $f(-7)=-3$

**70.** $g(0)=6$

**71.** The domain is the set of all real numbers for which the denominator is not zero. Set the denominator equal to zero, and solve the resulting equation. The solution(s) to the equation must be excluded from the domain. In this case setting $x-2=0$ indicates that $x=2$ must be excluded from the domain, The domain is $(-\infty,\ 2)\cup(2,\ \infty)$.

**72,** The domain is the set of all real numbers for which $x-3$ is nonnegative. Set the quantity $x-3\geq 0$ and solve the inequality. The solution set for the inequality is the domain of the function. Thus the domain is $[3,\ \infty)$.

**73.**
$$k(x)=\frac{x-3}{x+6}$$
$$x+6=0$$
$$x=-6$$
Domain: $(-\infty,\ -6)\cup(-6,\ \infty)$

**74.**
$$m(x)=\frac{x-1}{x-4}$$
$$x-4=0$$
$$x=4$$
Domain: $(-\infty,\ 4)\cup(4,\ \infty)$

**75.** $f(t)=\frac{5}{t}$

$t=0$

Domain: $(-\infty,\ 0)\cup(0,\ \infty)$

**76.** $g(t)=\frac{t-7}{t}$

$t=0$

Domain: $(-\infty,\ 0)\cup(0,\ \infty)$

**77.** $h(p)=\frac{p-4}{p^2+1}$

$p^2+1$ will never equal zero.

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

**78.** $n(p)=\frac{p+8}{p^2+2}$

$p^2+2$ will never equal zero.

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

**79.** $h(t)=\sqrt{t+7}$

$t+7\geq 0$

$t\geq -7$

Domain: $[-7,\ \infty)$

**80.** $k(t)=\sqrt{t-5}$

$t-5\geq 0$

$t\geq 5$

Domain: $[5,\ \infty)$

**81.** $f(a)=\sqrt{a-3}$

$a-3\geq 0$

$a\geq 3$

Domain: $[3,\ \infty)$

**82.** $g(a)=\sqrt{a+2}$

$a+2\geq 0$

$a\geq -2$

Domain: $[-2,\ \infty)$

**83.** $m(x)=\sqrt{1-2x}$

$1-2x\geq 0$

$-2x\geq -1$

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

Domain: $(-\infty,\ \frac{1}{2}]$

**84.** $n(x)=\sqrt{12-6x}$

$12-6x\geq 0$

$-6x\geq -12$

$x\leq 2$

Domain: $(-\infty,\ 2]$

**85.** $p(t)=2t^2+t-1$

There are no restrictions on the domain.

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

**86.** $q(t)=t^3+t-1$

There are no restrictions on the domain.

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

**87.** $f(x)=x+6$

There are no restrictions on the domain.

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

**88.** $g(x)=8x-\pi$

There are no restrictions on the domain.

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

**89.** $h(t) = -16t^2 + 80$

**a.** $h(1) = -16(1)^2 + 80 = -16 + 80 = 64$

$h(1.5) = -16(1.5)^2 + 80$

$= -16(2.25) + 80 = -36 + 80 = 44$

**b.** After 1 sec, the height of the ball is 64 ft. After 1.5 sec, the height of the ball is 44 ft.

**90.** $h(t) = -4.9t^2 + 50$

**a.** $h(1) = -4.9(1)^2 + 50 = -4.9 + 50 = 45.1$

$h(1.5) = -4.9(1.5)^2 + 50$

$= -4.9(2.25) + 50 = -11.025 + 50$

$= 38.975$

**b.** After 1 sec, the height of the ball is 45.1 m. After 1.5 sec, the height of the ball is 38.975 m.

**91.** $d(t) = 11.5t$

**a.** $d(1) = 11.5(1) = 11.5$

$d(1.5) = 11.5(1.5) = 17.25$

**b.** After 1 hr, the distance is 11.5 mi. After 1.5 hr, the distance is 17.25 mi.

**92.**

$P(x) = \dfrac{100x^2}{50 + x^2}$

$P(0) = \dfrac{100(0)^2}{50 + (0)^2} = \dfrac{0}{50} = 0\%$

$P(5) = \dfrac{100(5)^2}{50 + (5)^2} = \dfrac{100(25)}{50 + 25} = \dfrac{2500}{75} = \dfrac{100}{3} \approx 33.3\%$

$P(10) = \dfrac{100(10)^2}{50 + (10)^2} = \dfrac{100(100)}{50 + 100} = \dfrac{10{,}000}{150} = \dfrac{200}{3} \approx 66.7\%$

$P(15) = \dfrac{100(15)^2}{50 + (15)^2} = \dfrac{100(225)}{50 + 225} = \dfrac{22{,}500}{275} = \dfrac{900}{11} \approx 81.8\%$

$P(20) = \dfrac{100(20)^2}{50 + (20)^2} = \dfrac{100(400)}{50 + 400} = \dfrac{40{,}000}{450} = \dfrac{800}{9} \approx 88.9\%$

$P(25) = \dfrac{100(25)^2}{50 + (25)^2} = \dfrac{100(625)}{50 + 625} = \dfrac{62{,}500}{675} = \dfrac{2500}{27} \approx 92.6\%$

If Brian studies for 25 hours, he will get a score of 92.6%.

**93.** $f(x) = 2x + 3$

**94.** $f(x) = x^2 - 4$

**95.** $f(x) = |x| - 10$

**96.** $f(x) = 16\sqrt{x}$

**97.**

$q(x) = \dfrac{2}{\sqrt{x + 2}}$

$x + 2 > 0$

$x > -2$

Domain: $(-2, \infty)$

**98.**

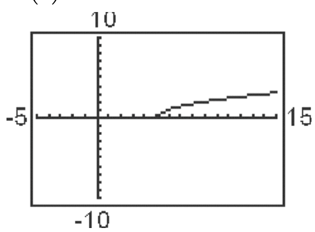
$p(x) = \dfrac{8}{\sqrt{x - 4}}$

$x - 4 > 0$

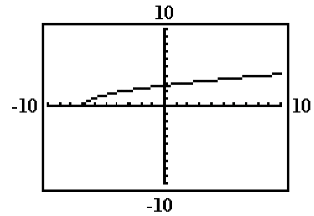
$x > 4$

Domain: $(4, \infty)$

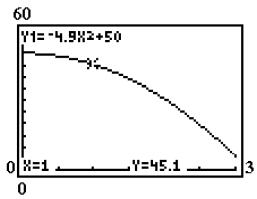
**99.** $k(t)=\sqrt{t-5}$




**100.** $h(t)=\sqrt{t+7}$

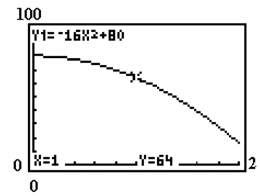



**101.** **a.** $h(t)=-4.9t^2+50$




**b.** $h(1)=45.1$

**102.** **a.** $h(t)=-16t^2+80$




**b.** $h(1)=64$

# Section 2.7 Graphs of Functions

## Section 2.7 Practice Exercises

**1.** Answers will vary.

**2.** **a.** A function that can be written in the form $f(x)=mx+b$ where $m$ and $b$ are real numbers such that $m \neq 0$ is a linear function.

**b.** A function that can be written in the form $f(x)=b$ where $b$ is a real number is a constant function.

**c.** A quadratic function can be written in the form $f(x)=ax^2+bx+c$ where $a$, $b$, and $c$ are real numbers and $a \neq 0$.

**d.** The graph of a quadratic function is in the shape of a parabola.

**3.** **a.** Yes, the relation is a function.
**b.** Domain: {6, 5, 4, 3}
**c.** Range: {1, 2, 3, 4}

**4.** **a.** Yes, the relation is a function.
**b.** Domain: {7, 2, –5}
**c.** Range: {3}

**5.** $f(x)=\sqrt{x+4}$

**a.** $f(0)=\sqrt{0+4}=\sqrt{4}=2$

$f(-3)=\sqrt{-3+4}=\sqrt{1}=1$

$f(-4)=\sqrt{-4+4}=\sqrt{0}=0$

$f(-5)=\sqrt{-5+4}=\sqrt{-1}$ cannot be evaluated because $x=-5$ is not in the domain of $f$.

**b.** Domain: $[-4, \infty)$

**6.** $f(x)=3x$

$f(3)=3(3)=9$

$f(10)=3(10)=30$

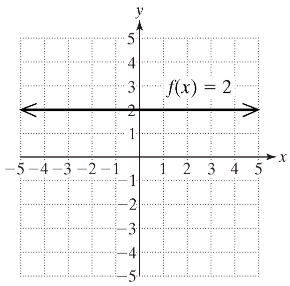
$f(3)=9$ means that 9 lb of force is required to stretch the spring 3 in.

$f(10)=30$ means that 30 lb of force is required to stretch the spring 10 in.

**7.** Horizontal

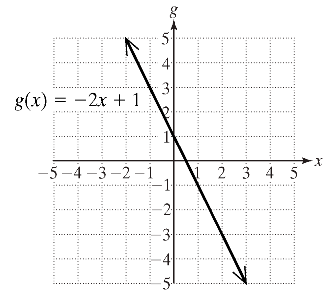
**8.** $m$ is the slope, and $(0, b)$ is the $y$-intercept.

**9.** $f(x) = 2$




Domain: $(-\infty, \infty)$; Range: $\{2\}$

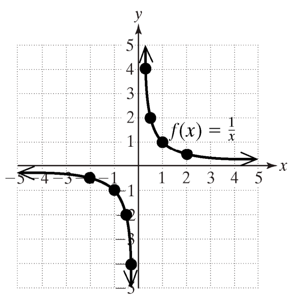
**10.** $g(x) = -2x + 1$




Domain: $(-\infty, \infty)$; Range: $(-\infty, \infty)$

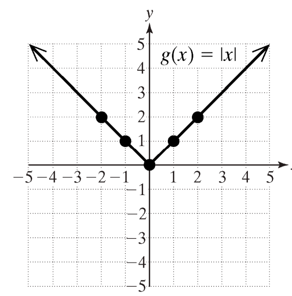
**11.** $f(x) = \dfrac{1}{x}$

| $x$ | $f(x)$ |
|---|---|
| $-2$ | $-\frac{1}{2}$ |
| $-1$ | $-1$ |
| $-\frac{1}{2}$ | $-2$ |
| $-\frac{1}{4}$ | $-4$ |
| $\frac{1}{4}$ | $4$ |
| $\frac{1}{2}$ | $2$ |
| $1$ | $1$ |
| $2$ | $\frac{1}{2}$ |



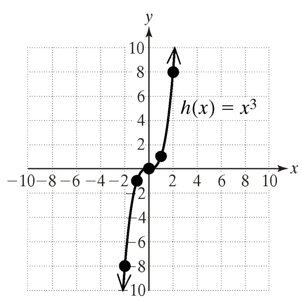

**12.** $g(x) = |x|$

| $x$ | $g(x)$ |
|---|---|
| $-2$ | $2$ |
| $-1$ | $1$ |
| $0$ | $0$ |
| $1$ | $1$ |
| $2$ | $2$ |



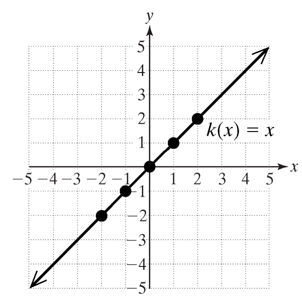

**13.** $h(x) = x^3$

| $x$ | $h(x)$ |
|---|---|
| $-2$ | $-8$ |
| $-1$ | $-1$ |
| $0$ | $0$ |
| $1$ | $1$ |
| $2$ | $8$ |



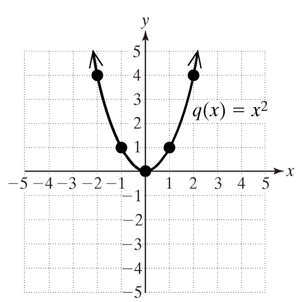

**14.** $k(x) = x$

| $x$ | $k(x)$ |
|---|---|
| $-2$ | $-2$ |
| $-1$ | $-1$ |
| $0$ | $0$ |
| $1$ | $1$ |
| $2$ | $2$ |



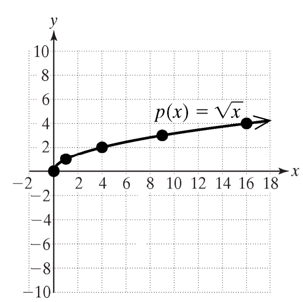

**15.** $q(x) = x^2$

| $x$ | $q(x)$ |
|---|---|
| $-2$ | $4$ |
| $-1$ | $1$ |
| $0$ | $0$ |
| $1$ | $1$ |
| $2$ | $4$ |




**16.** $p(x) = \sqrt{x}$

| $x$ | $p(x)$ |
|---|---|
| $0$ | $0$ |
| $1$ | $1$ |
| $4$ | $2$ |
| $9$ | $3$ |
| $16$ | $4$ |



**17.** $f(x)=2x^2+3x+1$ Quadratic function

**18.** $g(x)=-x^2+4x+12$ Quadratic function

**19.** $k(x)=-3x-7$ Linear function

**20.** $h(x)=-x-3$ Linear function

**21.** $m(x)=\frac{4}{3}$ Constant function

**22.** $n(x)=0.8$ Constant function

**23.** $p(x)=\frac{2}{3x}+\frac{1}{4}$ None of these

**24.** $Q(x)=\frac{1}{5x}-3$ None of these

**25.** $t(x)=\frac{2}{3}x+\frac{1}{4}$ Linear function

**26.** $r(x)=\frac{1}{5}x-3$ Linear function

**27.** $w(x)=\sqrt{4-x}$ None of these

**28.** $T(x)=-|x+10|$ None of these

**29.** $f(x)=5x-10$

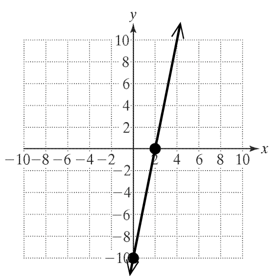
$5x-10=0$

$5x=10$

$x=2$ $x$-intercept: $(2, 0)$

$f(0)=5(0)-10=0-10=-10$

$y$-intercept: $(0, -10)$



**30.** $f(x)=-3x+12$

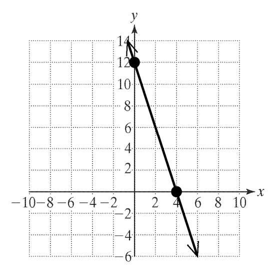
$-3x+12=0$

$-3x=-12$

$x=4$ $x$-intercept: $(4, 0)$

$f(0)=-3(0)+12=0+12=12$

$y$-intercept: $(0, 12)$



**31.** $g(x)=-6x+5$

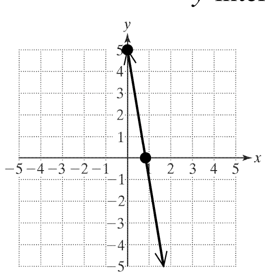
$-6x+5=0$

$-6x=-5$

$x=\frac{5}{6}$ $x$-intercept: $\left(\frac{5}{6}, 0\right)$

$g(0)=-6(0)+5=0+5=5$

$y$-intercept: $(0, 5)$



**32.** $h(x)=2x+9$

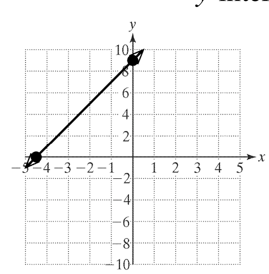
$2x+9=0$

$2x=-9$

$x=-\frac{9}{2}$ $x$-intercept: $\left(-\frac{9}{2}, 0\right)$

$h(0)=2(0)+9=0+9=9$

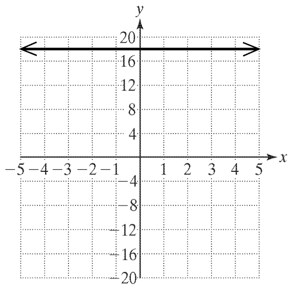
$y$-intercept: $(0, 9)$



**33.** $f(x) = 18$

$18 \neq 0$ $x$-intercept: none

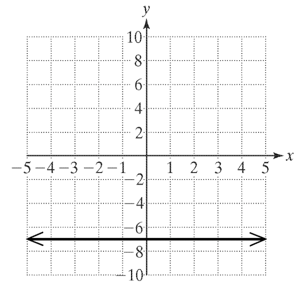
$f(0) = 18$ $y$-intercept: $(0, 18)$



**34.** $g(x) = -7$

$-7 \neq 0$ $x$-intercept: none

$g(0) = -7$ $y$-intercept: $(0, -7)$



**35.** $g(x) = \frac{2}{3}x + 2$

$\frac{2}{3}x + 2 = 0$

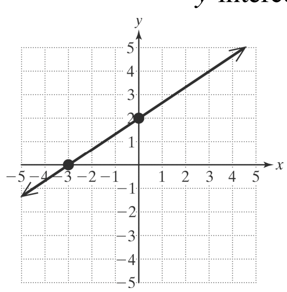
$\frac{2}{3}x = -2$

$2x = -6$

$x = -3$ $x$-intercept: $(-3, 0)$

$g(0) = \frac{2}{3}(0) + 2 = 0 + 2 = 2$

$y$-intercept: $(0, 2)$



**36.** $h(x) = -\frac{3}{5}x - 3$

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

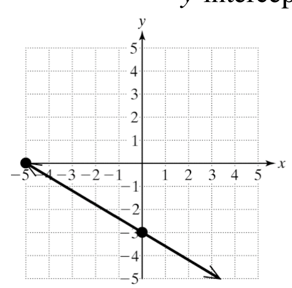
$-\frac{3}{5}x = 3$

$-3x = 15$

$x = -5$ $x$-intercept: $(-5, 0)$

$h(0) = -\frac{3}{5}(0) - 3 = 0 - 3 = -3$

$y$-intercept: $(0, -3)$



**37.** **a.** $f(x) = 0$ when $x = -1$

**b.** $f(0) = 1$

**38.** **a.** $f(x) = 0$ when $x = 1$

**b.** $f(0) = -1$

**39.** **a.** $f(x) = 0$ when $x = -2$ and $x = 2$

**b.** $f(0) = -2$

**40.** **a.** $f(x) = 0$ There are none.

**b.** $f(0) = 1$

**41.** **a.** $f(x) = 0$ There are none.

**b.** $f(0) = 2$

**42.** **a.** $f(x) = 0$ when $x = -1$ and $x = 1$

**b.** $f(0) = 1$

**43.** $q(x) = 2x^2$

**a.** $(-\infty, \infty)$

**b.** $q(0) = 2(0)^2 = 2(0) = 0$

$y$-intercept is $(0, 0)$.

**c.** Graph: vi

**44.** $p(x) = -2x^2 + 1$

**a.** $(-\infty, \infty)$

**b.** $p(0) = -2(0)^2 + 1 = -2(0) + 1 = 0 + 1 = 1$

$y$-intercept is $(0, 1)$.

**c.** Graph: iii

**45.** $h(x) = x^3 + 1$

**a.** $(-\infty, \infty)$

**b.** $h(0) = (0)^3 + 1 = 0 + 1 = 1$

$y$-intercept is $(0, 1)$.

**c.** Graph: viii

**46.** $k(x) = x^3 - 2$

**a.** $(-\infty, \infty)$

**b.** $k(0) = (0)^3 - 2 = 0 - 2 = -2$

$y$-intercept is $(0, -2)$.

**c.** Graph: v

**47.** $r(x) = \sqrt{x+1}$

**a.** $[-1, \infty)$

**b.** $r(0) = \sqrt{0+1} = \sqrt{1} = 1$

$y$-intercept is $(0, 1)$.

**c.** Graph: vii

**48.** $s(x) = \sqrt{x+4}$

**a.** $[-4, \infty)$

**b.** $s(0) = \sqrt{0+4} = \sqrt{4} = 2$

$y$-intercept is $(0, 2)$.

**c.** Graph: i

**49.** $f(x) = \dfrac{1}{x-3}$

**a.** $(-\infty, 3) \cup (3, \infty)$

**b.** $f(0) = \dfrac{1}{0-3} = -\dfrac{1}{3}$

$y$-intercept is $\left(0, -\dfrac{1}{3}\right)$.

**c.** Graph: ii

**50.** $g(x) = \dfrac{1}{x+1}$

**a.** $(-\infty, -1) \cup (-1, \infty)$

**b.** $g(0) = \dfrac{1}{0+1} = \dfrac{1}{1} = 1$

$y$-intercept is $(0, 1)$.

**c.** Graph: x

**51.** $k(x) = |x+2|$

**a.** $(-\infty, \infty)$

**b.** $k(0) = |0+2| = |2| = 2$

$y$-intercept is $(0, 2)$.

**c.** Graph: iv

**52.** $h(x) = |x-1| + 2$

**a.** $(-\infty, \infty)$

**b.** $h(0) = |0-1| + 2 = |-1| + 2 = 1 + 2 = 3$

$y$-intercept is $(0, 3)$.

**c.** Graph: ix

**53. a.** Linear

**b.** $G(90) = \dfrac{3}{4}(80) + \dfrac{1}{4}(90) = 60 + 22.5$

$= 82.5$

This means that if the student gets a 90% on her final exam, then her overall course average is 82.5%.

**c.** $G(50) = \dfrac{3}{4}(80) + \dfrac{1}{4}(50) = 60 + 12.5$

$= 72.5$

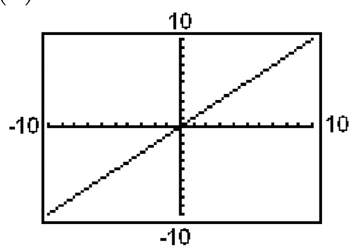
This means that if the student gets a 50% on her final exam, then her overall course average is 72.5%.

**54.** **a.** Quadratic

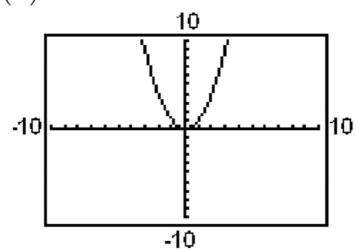
**b.** $E(5)=0.14(5)^2+7.8(5)+540$
$=0.14(25)+7.8(5)+540$
$=3.5+39+540=582.5$
This means that for $x = 5$ (the year 2005), the median weekly earnings for women was \$582.50.

**c.** $E(10)=0.14(10)^2+7.8(10)+540$
$=0.14(100)+7.8(10)+540$
$=14+78+540=632$
This means that for $x = 10$ (the year 2010), the median weekly earnings for women was \$632.

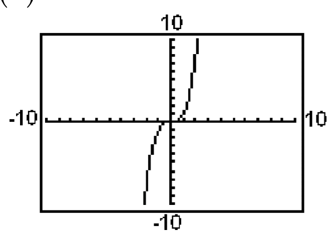
**55.** $f(x)=x$



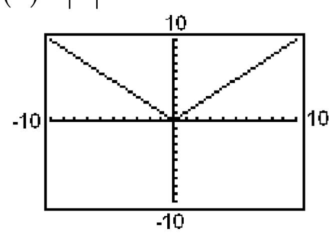

**56.** $f(x)=x^2$



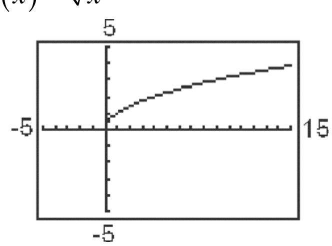

**57.** $f(x)=x^3$



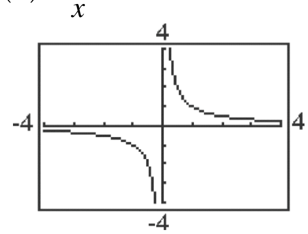

**58.** $f(x)=|x|$



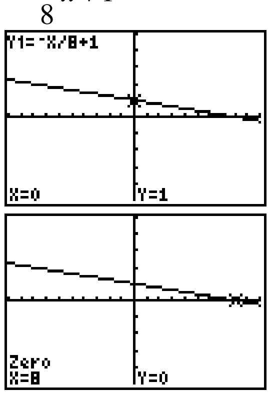

**59.** $f(x)=\sqrt{x}$




**60.** $f(x)=\frac{1}{x}$



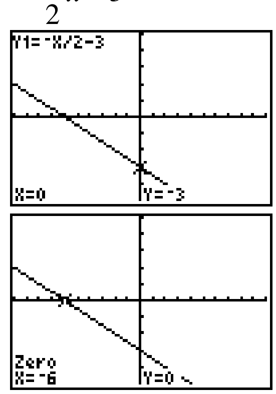

**61.** $y=-\frac{1}{8}x+1$




*y*-intercept: (0, 1)

*x*-intercept: (8, 0)

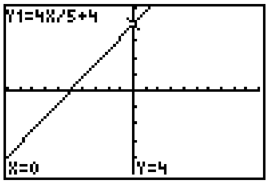
**62.** $y=-\frac{1}{2}x-3$



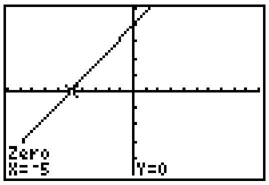

*y*-intercept: (0, –3)

*x*-intercept: (–6, 0)

**63.** $y=\frac{4}{5}x+4$

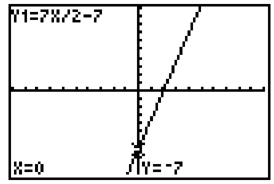



$y$-intercept: (0, 4)

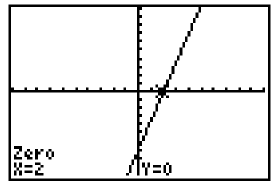



$x$-intercept: (–5, 0)

**64.** $y=\frac{7}{2}x-7$




$y$-intercept: (0, –7)




$x$-intercept: (2, 0)

## Problem Recognition Exercises: Characteristics of Relations

**1.** a, c, d, f, g

**2.** a, b, d, f, h

**3.** $c(-1)=3(-1)^2-2(-1)-1$
$=3(1)-2(-1)-1=3+2-1=4$

**4.** $f(-4)=2$

**5.** $\{0, 1, \frac{1}{2}, -3, 2\}$

**6.** $\{4, 3, 6, 1, 10\}$

**7.** $[-2, 4]$

**8.** $[0, \infty)$

**9.** $(0, 3)$

**10.** $5x-9=0$
$5x=9$
$x=\frac{9}{5}$ $\left(\frac{9}{5}, 0\right)$ is the $x$-intercept.

**11.** $(0, 1)$ and $(0, -1)$

**12.** $x=1$

**13.** c

**14.** d

**15.** $5x-9=6$
$5x=15$
$x=3$

## Group Activity: Deciphering a Coded Message

**1. a.** Message:

**M A T H _ I S _ T H E _ K E Y _ T O _ T H E _ S C I E N C E S**

Original:

13 1 20 8 27 9 19 27 20 8 5 27 11 5 25 27 20 15 27 20 8 5 27 19 3 9 5 14 3 5 19

Coded:

54,6,82,34,110,38,78,110,82,34,22,110,46,22,102,110,82,62,110,82,34,22,110,78,14,38,22,58,14,22,78

**b.** Message: **M A T H _ I S _ N O T _ A _ S P E C T A T O R _ S P O R T**

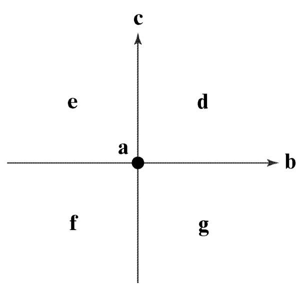
Original: 13 1 20 8 27 9 19 27 14 15 20 27 1 27 19 16 5 3 20 1 20 15 18 27 19 16 15 18 20

Coded: 38,2,59,23,80,26,56,80,41,44,59,80, 2,80,56,47,14, 8,59,2,59,44,53,80,56,47,44,53,59

## Chapter 2 Review Exercises

### Section 2.1

**1.**




**2.** $-2x+4y=-16$

$-2(2)+4(5)=-4+20=16\neq-16$

(2, 5) is not a solution of the equation.

**3.** $5x=-15$

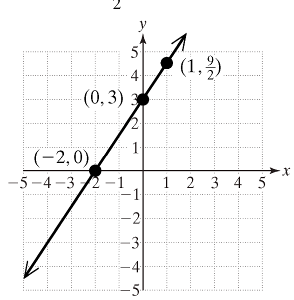
$5(-3)=-15=-15$

(–3, 4) is a solution of the equation.

**4.** $A(0, 0)$; $B(2, 1)$; $C(0, -4)$; $D(-2, -4)$; $E(-2, 0)$; $F(-5, 1)$; $G(4, -3)$

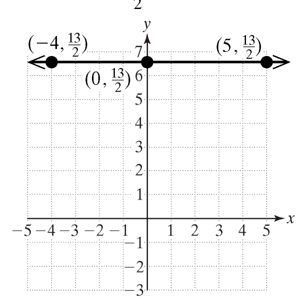
**5.** $3x-2y=-6$

| $x$ | $y$ |
|---|---|
| 0 | 3 |
| –2 | 0 |
| 1 | $\frac{9}{2}$ |



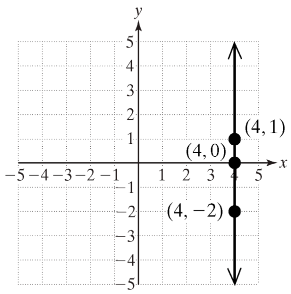

**6.** $2y-3=10$

| $x$ | $y$ |
|---|---|
| 0 | $\frac{13}{2}$ |
| 5 | $\frac{13}{2}$ |
| –4 | $\frac{13}{2}$ |



**7.** $6 - x = 2$

| $x$ | $y$ |
|---|---|
| 4 | 0 |
| 4 | 1 |
| 4 | –2 |



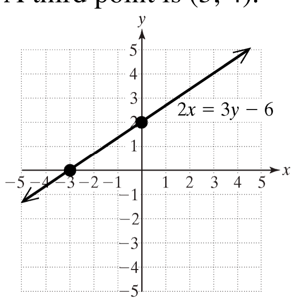

**8.** $2x = 3y - 6$

$2x = 3(0) - 6 \qquad 2(0) = 3y - 6$

$2x = -6 \qquad 6 = 3y$

$x = -3 \qquad 2 = y$

The $x$-intercept is (–3, 0).
The $y$-intercept is (0, 2).
A third point is (3, 4).



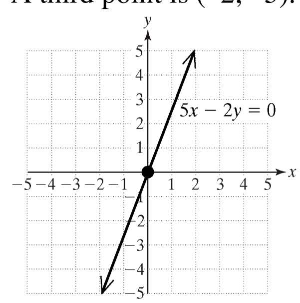

**9.** $5x - 2y = 0$

$5x - 2(0) = 0 \qquad 5(0) - 2y = 0$

$5x = 0 \qquad -2y = 0$

$x = 0 \qquad y = 0$

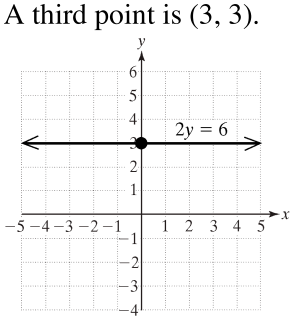
The $x$-intercept is (0, 0).
The $y$-intercept is (0, 0).
A second point is (2, 5).
A third point is (–2, –5).




**10.** $2y = 6$

$y = 3$

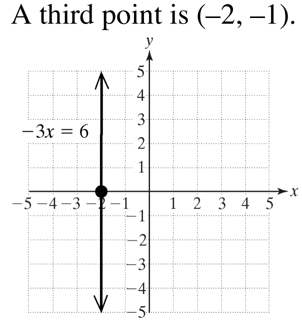
There is no $x$-intercept.
The $y$-intercept is (0, 3).
A second point is (–2, 3).
A third point is (3, 3).




**11.** $-3x = 6$

$x = -2$

The $x$-intercept is (–2, 0).
There is no $y$-intercept.
A second point is (–2, 5).
A third point is (–2, –1).



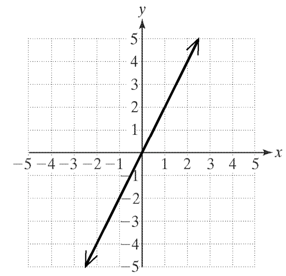
## Section 2.2

**12.** **a.** $m=\frac{1}{2}$

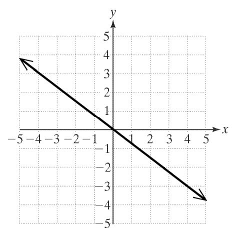
**b.** $m=\frac{-3}{1}=-3$

**c.** $m=0$

**13.** For example: $y=2x$



**14.** For example: $y=-\frac{3}{4}x$



**15.** $m=\frac{0-6}{-1-2}=\frac{-6}{-3}=2$

**16.** $m=\frac{-5-2}{-3-7}=\frac{-7}{-10}=\frac{7}{10}$

**17.** $m=\frac{2-2}{3-8}=\frac{0}{-5}=0$

**18.** $m=\frac{1-\frac{1}{2}}{-4-(-4)}=\frac{\frac{1}{2}}{0}$ Undefined

**19.** $m_1=\frac{-2-(-6)}{3-4}=\frac{4}{-1}=-4$

$m_2=\frac{0-(-1)}{7-3}=\frac{1}{4}$

The lines are perpendicular.

**20.** The lines are perpendicular.

**21.** The lines are neither parallel nor perpendicular.

**22.** The lines are parallel.

**23.** **a.** $m=\frac{3080-2020}{2010-1990}=\frac{1060}{20}=53$

**b.** The enrollment increases at a rate of 53 students per year.

**24.** $m=\frac{36}{48}=\frac{3}{4}$

## Section 2.3

**25.** **a.** $y=k$

**b.** $y-y_1=m(x-x_1)$

**c.** $Ax+By=C$

**d.** $x=k$

**e.** $y=mx+b$

**26.** $m=\frac{1}{9}$, $y$-intercept: $(0, 6)$

$y=\frac{1}{9}x+6$ or $\frac{1}{9}x-y=-6$

$x-9y=-54$

**27.** $m = -\frac{2}{3}$, $x$-intercept: $(3, 0)$

$y - 0 = -\frac{2}{3}(x - 3)$

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

$2x + 3y = 6$

**28.** $m = \frac{9 - (-1)}{-5 - (-8)} = \frac{10}{3}$

$y - (-1) = \frac{10}{3}(x - (-8))$

$y + 1 = \frac{10}{3}x + \frac{80}{3}$

$y = \frac{10}{3}x + \frac{77}{3}$ or $\frac{10}{3}x - y = -\frac{77}{3}$

$10x - 3y = -77$

**29.** $y = -\frac{1}{3}x + 2$

$m_{\perp} = 3$, point: $(6, -2)$

$y - (-2) = 3(x - 6)$

$y + 2 = 3x - 18$

$y = 3x - 20$ or $3x - y = 20$

**30.** $4x + 3y = -1$

$3y = -4x - 1$

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

$m_{\parallel} = -\frac{4}{3}$, point: $(0, -3)$

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

$4x + 3y = -9$

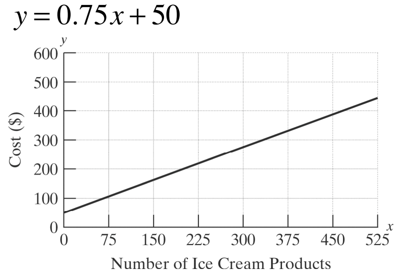
**31.** **a.** $y = -2$
**b.** $x = -3$
**c.** $x = -3$
**d.** $y = -2$

**32.** Yes; a and d are the same, b and c are the same.

## Section 2.4

**33.** **a.** $y = 0.75x + 50$

**b.**




**c.** The $y$-intercept represents the daily fixed cost of \$50 when no ice cream is sold.

**d.** $y = 0.75(450) + 50$

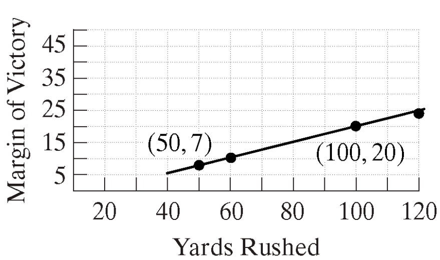
$= 337.50 + 50 = 387.50$

The cost is \$387.50 when 450 ice cream products are sold.

**e.** The slope of the line is 0.75.

**f.** The cost increases at a rate of \$0.75 per ice cream product.

**34.** **a.**




**b.** $m = \frac{20 - 7}{100 - 50} = \frac{13}{50} = 0.26$

$y - 7 = 0.26(x - 50)$

$y - 7 = 0.26x - 13$

$y = 0.26x - 6$

**c.** The margin of victory would be –6 points which means they would lose by 6 points.

## Section 2.5

**35.** Domain: $\left\{\frac{1}{3}, 6, \frac{1}{4}, 7\right\}$

Range: $\left\{10, -\frac{1}{2}, 4, \frac{2}{5}\right\}$

**36.** Domain: $\{-3, -1, 0, 2, 3\}$

Range: $\{-2, 0, 1, \frac{5}{2}\}$

**37.** Domain: $[-3, 9]$

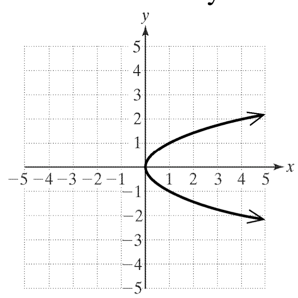
Range: $[0, 60]$

**38.** Domain: $[-4, 4]$

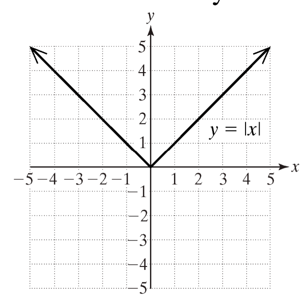
Range: $[1, 3]$

## Section 2.6

**39.** Answers will vary. For example:




**40.** Answers will vary. For example:




**41.** **a.** Not a function
**b.** $[1, 3]$
**c.** $[-4, 4]$

**42.** **a.** A function
**b.** $(-\infty, \infty)$
**c.** $(-\infty, 0.35]$

**43.** **a.** A function
**b.** $\{1, 2, 3, 4\}$
**c.** $\{3\}$

**44.** **a.** Not a function
**b.** $\{0, 4\}$
**c.** $\{2, 3, 4, 5\}$

**45.** **a.** Not a function
**b.** $\{4, 9\}$
**c.** $\{2, -2, 3, -3\}$

**46.** **a.** A function
**b.** $\{6, 7, 8, 9\}$
**c.** $\{9, 10, 11, 12\}$

**47.** $f(0)=6(0)^2-4=6(0)-4=0-4=-4$

**48.** $f(1)=6(1)^2-4=6(1)-4=6-4=2$

**49.** $f(-1)=6(-1)^2-4=6(1)-4=6-4=2$

**50.** $f(t)=6(t)^2-4=6t^2-4$

**51.** $f(b)=6(b)^2-4=6b^2-4$

**52.** $f(\pi)=6(\pi)^2-4=6\pi^2-4$

**53.** $f(\square)=6(\square)^2-4=6\square^2-4$

**54.** $f(-2)=6(-2)^2-4=6(4)-4=24-4=20$

**55.** $g(x)=7x^3+1$

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

**56.** $h(x)=\dfrac{x+10}{x-11}$

$x-11=0$

$x=11$

Domain: $(-\infty,\ 11)\cup(11,\ \infty)$

**57.** $k(x)=\sqrt{x-8}$

$x-8\ge 0$

$x\ge 8$

Domain: $[8,\ \infty)$

**58.** $w(x)=\sqrt{x+2}$

$x+2\ge 0$

$x\ge -2$

Domain: $[-2,\ \infty)$

**59.** $p(x)=48+5x$

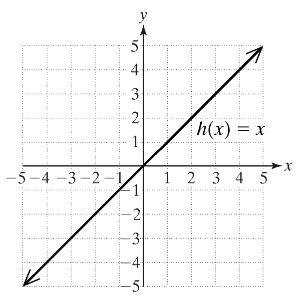
**a.** $p(10)=48+5(10)=48+50=\$98$

**b.** $p(15)=48+5(15)=48+75=\$123$

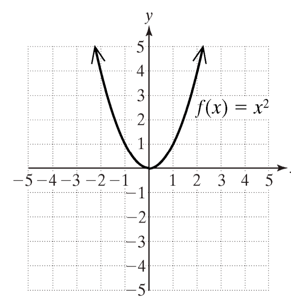
**c.** $p(20)=48+5(20)=48+100=\$148$

## Section 2.7

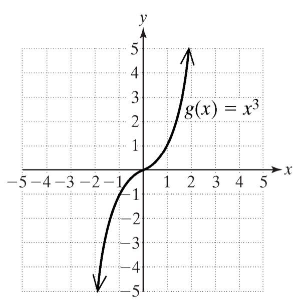
**60.** $h(x)=x$



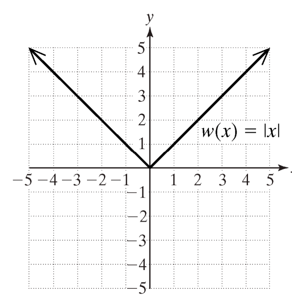

**61.** $f(x)=x^2$



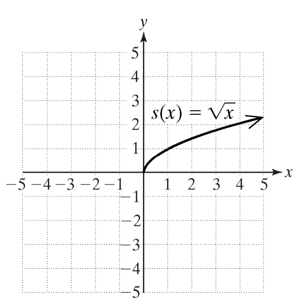

**62.** $g(x)=x^3$



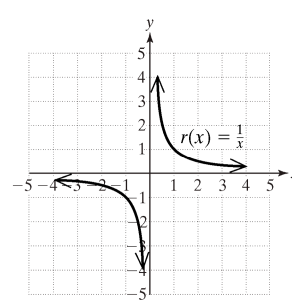

**63.** $w(x)=|x|$



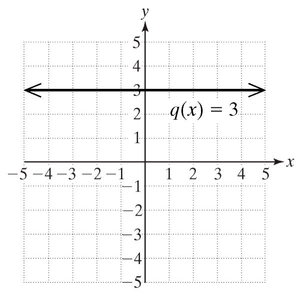

**64.** $s(x)=\sqrt{x}$



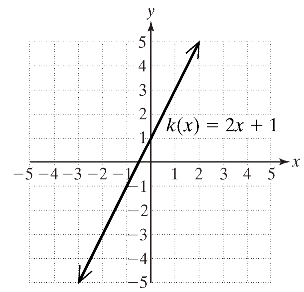

**65.** $r(x)=\dfrac{1}{x}$



**66.** $q(x) = 3$




**67.** $k(x) = 2x + 1$




**68.** $s(x) = (x-2)^2$

**a.** $s(4) = (4-2)^2 = 2^2 = 4$

$s(-3) = (-3-2)^2 = (-5)^2 = 25$

$s(2) = (2-2)^2 = 0^2 = 0$

$s(1) = (1-2)^2 = (-1)^2 = 1$

$s(0) = (0-2)^2 = (-2)^2 = 4$

**b.** Domain: $(-\infty, \infty)$

**69.** $r(x) = 2\sqrt{x-4}$

**a.** $r(2) = 2\sqrt{2-4} = 2\sqrt{-2}$ not a real number

$r(4) = 2\sqrt{4-4} = 2\sqrt{0} = 2\cdot 0 = 0$

$r(5) = 2\sqrt{5-4} = 2\sqrt{1} = 2\cdot 1 = 2$

$r(8) = 2\sqrt{8-4} = 2\sqrt{4} = 2\cdot 2 = 4$

**b.** $x - 4 \ge 0$

$x \ge 4$

Domain: $[4, \infty)$

**70.** $h(x) = \dfrac{3}{x-3}$

**a.** $h(-3) = \dfrac{3}{-3-3} = \dfrac{3}{-6} = -\dfrac{1}{2}$

$h(0) = \dfrac{3}{0-3} = \dfrac{3}{-3} = -1$

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

$h(5) = \dfrac{3}{5-3} = \dfrac{3}{2}$

**b.** $x - 3 = 0$

$x = 3$

Domain: $(-\infty, 3)\cup(3, \infty)$

**71.** $k(x) = -|x+3|$

**a.** $k(-5) = -|-5+3| = -|-2| = -2$

$k(-4) = -|-4+3| = -|-1| = -1$

$k(-3) = -|-3+3| = -|0| = 0$

$k(2) = -|2+3| = -|5| = -5$

**b.** Domain: $(-\infty, \infty)$

**72.** $p(x) = 4x - 7$

$4x - 7 = 0$

$4x = 7$

$x = \dfrac{7}{4}$ $x$-intercept: $\left(\dfrac{7}{4}, 0\right)$

$f(0) = 4(0) - 7 = 0 - 7 = -7$

$y$-intercept: $(0, -7)$

**73.** $q(x) = -2x + 9$

$-2x + 9 = 0$

$-2x = -9$

$x = \dfrac{9}{2}$ $x$-intercept: $\left(\dfrac{9}{2}, 0\right)$

$f(0) = -2(0) + 9 = 0 + 9 = 9$

$y$-intercept: $(0, 9)$

**74.** $b(t)=0.7t+4.5$

**a.** $b(0)=0.7(0)+4.5=0+4.5=4.5$

$b(7)=0.7(7)+4.5=4.9+4.5=9.4$

In 1985 consumption was 4.5 gal of bottled water per capita. In 1992 consumption was 9.4 gal of bottled water per capita.

**b.** $m=0.7$

Consumption increased by 0.7 gal/year.

**75.** $g(-2)=-1$

**76.** $g(4)=0$

**77.** $g(x)=0$ when $x=0$ and $x=4$.

**78.** There are no values of $x$ for which $g(x)=4$ on this graph.

**79.** Domain: $(-4, \infty)$

**80.** Range: $(-\infty, 1]$

## Chapter 2 Test

**1.**

$x-\frac{2}{3}y=6$

$0-\frac{2}{3}y=6$

$y=-\frac{3}{2}(6)=-9$

$(0, -9)$

$x-\frac{2}{3}(0)=6$

$x=6$

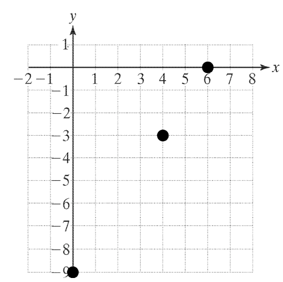
$(6, 0)$

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

$x+2=6$

$x=4$

$(4, -3)$




**2.** **a.** False; the product is positive in quadrants I and III. In quadrant III both $x$ and $y$ are negative, so their product is positive.

**b.** False; the quotient is negative in quadrants II and IV. Each of these quadrants contains points in which one coordinate is positive and one is negative.

**c.** True

**d.** True

**3.**

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

$-1=-\frac{1}{2}(-4)-3=2-3-1$

(–4, –1) is a solution of the equation.

**4.** To find the $x$-intercept, let $y = 0$ and solve for $x$. To find the $y$-intercept, let $x = 0$ and solve for $y$.

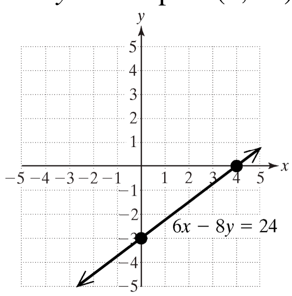
**5.** $6x - 8y = 24$

$6x - 8(0) = 24$ $\qquad$ $6(0) - 8y = 24$

$6x = 24$ $\qquad$ $-8y = 24$

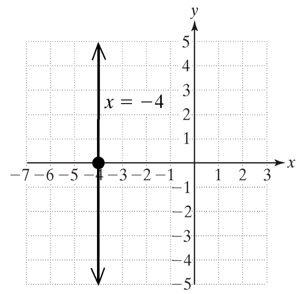
$x = 4$ $\qquad$ $y = -3$

The $x$-intercept is (4, 0).
The $y$-intercept is (0, –3).




**6.** $x = -4$

The $x$-intercept is (–4, 0).
There is no $y$-intercept.



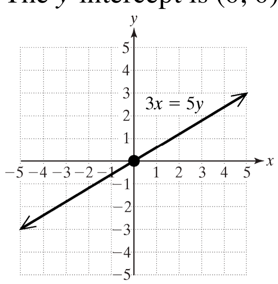

**7.** $3x = 5y$

$3x = 5(0)$ $\qquad$ $3(0) = 5y$

$3x = 0$ $\qquad$ $0 = 5y$

$x = 0$ $\qquad$ $0 = y$

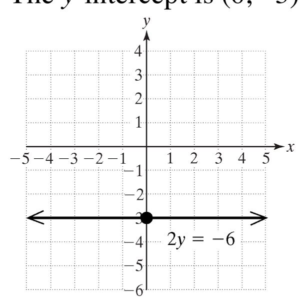
The $x$-intercept is (0, 0).
The $y$-intercept is (0, 0).




**8.** $2y = -6$

$y = -3$

There is no $x$-intercept.
The $y$-intercept is (0, –3).




**9.** **a.** $m = \dfrac{-8-(-3)}{-1-7} = \dfrac{-5}{-8} = \dfrac{5}{8}$

**b.** $6x - 5y = 1$

$-5y = -6x + 1$

$y = \dfrac{-6}{-5}x + \dfrac{1}{-5}$

$y = \dfrac{6}{5}x - \dfrac{1}{5}$

$m = \dfrac{6}{5}$

**10.** **a.** The slopes of parallel lines are the same.
**b.** The slope of one line is the opposite of the reciprocal of the slope of the other line.

**11.** **a.** $m = -7$
**b.** $m = \dfrac{1}{7}$

**12.** $m_1 = \dfrac{-6-(-4)}{1-4} = \dfrac{-2}{-3} = \dfrac{2}{3}$

$m_2 = \dfrac{3-0}{0-(-2)} = \dfrac{3}{2}$

The lines are neither parallel nor perpendicular.

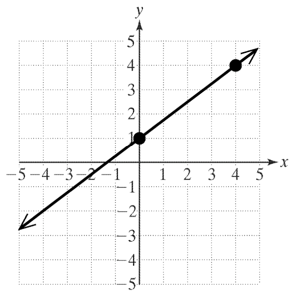
**13. a.** $-3x+4y=4$

$4y=3x+4$

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

**b.** $m=\frac{3}{4}$, $y$-intercept: $(0, 1)$

**c.**




**14. a.** $y=-x+4$ $m=-1$

$y=x-3$ $m=1$

The lines are perpendicular.

**b.** $9x-3y=1$

$-3y=-9x+1$

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

$m=3$

$15x-5y=10$

$-5y=-15x+10$

$y=3x-2$

$m=3$

The lines are parallel.

**c.** $3y=6$ horizontal

$x=0.5$ vertical

The lines are perpendicular.

**d.** $5x-3y=9$

$-3y=-5x+9$

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

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

$3x-5y=10$

$-5y=-3x+10$

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

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

The lines are neither parallel nor perpendicular.

**15. a.** For example: $y=3x+2$

**b.** For example: $x=2$

**c.** For example: $y=3$ $m=0$

**d.** For example: $y=-2x$

**16.** $m=-2$, point: $\left(8, -\frac{1}{2}\right)$

$y-\left(-\frac{1}{2}\right)=-2(x-8)$

$y+\frac{1}{2}=-2x+16$

$y=-2x+\frac{31}{2}$

**17.** $m=\frac{0-(-3)}{4-2}=\frac{3}{2}$

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

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

$y=\frac{3}{2}x-6$ or $\frac{3}{2}x-y=6$

$3x-2y=12$

**18.** $6x-3y=1$

$-3y=-6x+1$

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

$m_{\parallel}=2$ point: $(4, -3)$

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

$y+3=2x-8$

$y=2x-11$ or $2x-y=11$

**19.** $3x + y = 7$

$y = -3x + 7$

$m_{\perp} = \frac{1}{3}$ point: $(-10, -3)$

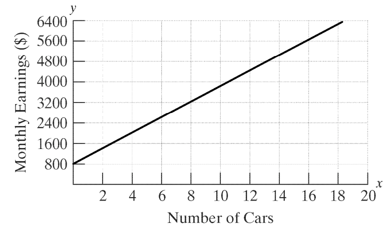
$y - (-3) = \frac{1}{3}(x - (-10))$

$y + 3 = \frac{1}{3}x + \frac{10}{3}$

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

**20.** **a.** $y = 300x + 800$

**b.**




**c.** The $y$-intercept represents Jack's base salary of $800.

**d.** $y = 300(17) + 800$

$= 5100 + 800 = 5900$

Jack earns $5900 when he sells 17 automobiles.

**21.** **a.** (0, 66) For a woman born in 1940, the life expectancy was about 66 years.

**b.** $m = \frac{75 - 66}{30 - 0} = \frac{9}{30} = \frac{3}{10}$

Life expectancy increases by 3 years for every 10 years that elapse.

**c.** $y = \frac{3}{10}x + 66$

**d.** 1994 corresponds to $x = 54$.

$y = \frac{3}{10}(54) + 66 = 16.2 + 66 = 82.2$

Life expectancy is 82.2 years for a woman born in 1994. This is 3.2 years longer than 79 years reported.

**22.** **a.** Not a function. $x$ is paired with two different values of $y$.

**b.** Domain: $\{-3, -1, 1, 3\}$

**c.** Range: $\{-2, -1, 1, 3\}$

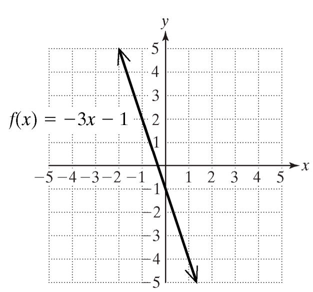
**23.** **a.** A function.

**b.** Domain: $(-\infty, \infty)$

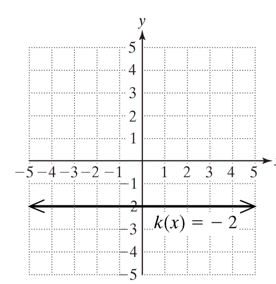
**c.** Range: $(-\infty, 0]$

**24.** To find the $x$-intercept(s), solve for the real solutions of the equation $f(x) = 0$. To find the $y$-intercept, find $f(0)$.

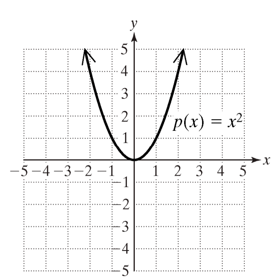
**25.** $f(x) = -3x - 1$



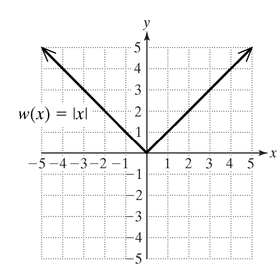

**26.** $k(x) = -2$




**27.** $p(x) = x^2$




**28.** $w(x) = |x|$



**29.** $f(x) = \frac{x-5}{x+7}$

$x + 7 = 0$

$x = -7$

Domain: $(-\infty, -7) \cup (-7, \infty)$

**30.** $f(x) = \sqrt{x+7}$

$x + 7 \geq 0$

$x \geq -7$

Domain: $[-7, \infty)$

**31.** $h(x) = (x+7)(x-5)$ Domain: $(-\infty, \infty)$

**32.** $r(x) = x^2 - 2x + 1$

**a.** $r(-2) = (-2)^2 - 2(-2) + 1 = 4 + 4 + 1 = 9$

$r(0) = (0)^2 - 2(0) + 1 = 0 - 0 + 1 = 1$

$r(3) = (3)^2 - 2(3) + 1 = 9 - 6 + 1 = 4$

**b.** Domain: $(-\infty, \infty)$

**33.** $s(t) = 1.6t + 36$

**a.** $s(0) = 1.6(0) + 36 = 0 + 36 = 36$

$s(7) = 1.6(7) + 36 = 11.2 + 36 = 47.2$

In 1985, the per capita consumption was 36 gal. In 1992, the per capita consumption was 47.2 gal.

**b.** $m = 1.6$.

Consumption increases by 1.6 gal/year.

**34.** $f(1) = 1$

**35.** $f(4) = 2$

**36.** Domain: $(-1, 7]$

**37.** Range: $[-1, 4)$

**38.** False

**39.** $x$-intercept: $(6, 0)$

**40.** $f(x) = 0$ when $x = 6$

**41.** All $x$ in the interval $[1, 3]$ and $x = 5$.

**42.** $f(x) = -3x^2$ Quadratic function

**43.** $g(x) = -3x$ Linear function

**44.** $h(x) = -3$ Constant function

**45.** $k(x) = -\frac{3}{x}$ None of these

**46.** $f(x) = \frac{3}{4}x + 9$

$\frac{3}{4}x + 9 = 0$

$\frac{3}{4}x = -9$

$3x = -36$

$x = -12$ $x$-intercept: $(-12, 0)$

$f(0) = \frac{3}{4}(0) + 9 = 0 + 9 = 9$

$y$-intercept: $(0, 9)$

## Chapters 1 – 2 Cumulative Review Exercises

**1.** $\dfrac{5-2^3 \div 4+7}{-1-3(4-1)}=\dfrac{5-8\div 4+7}{-1-3(3)}$
$=\dfrac{5-2+7}{-1-9}=\dfrac{10}{-10}=-1$

**2.** $3+\sqrt{25}-8\left(\sqrt{9}\right)\div 6=3+5-8(3)\div 6$
$=3+5-24\div 6$
$=3+5-4$
$=4$

**3.** $4\left[-3x-5(y-2x)+3\right]-7(6y+x)$
$=4\left[-3x-5y+10x+3\right]-42y-7x$
$=4\left[7x-5y+3\right]-42y-7x$
$=28x-20y+12-42y-7x$
$=21x-62y+12$

**4.** $\dfrac{2x-3}{6}-\dfrac{x+1}{4}=-2$
$24\left(\dfrac{2x-3}{6}-\dfrac{x+1}{4}\right)=24(-2)$
$4(2x-3)-6(x+1)=-48$
$8x-12-6x-6=-48$
$2x-18=-48$
$2x=-30$
$x=-15 \quad \{-15\}$

**5.** $z-(3+2z)+5=-z-5$
$z-3-2z+5=-z-5$
$-z+2=-z-5$
$-z+z+2=-z+z-5$
$2=-5 \quad \{\ \}$

**6.** $|x-5|+7=10$
$|x-5|=3$
$x-5=3$ or $x-5=-3$
$x=8$ or $x=2 \quad \{8, 2\}$

**7.** $-4\le\dfrac{x-1}{2}<3$
$-8\le x-1<6$
$-7\le x<7 \quad [-7, 7)$

**8.** $3x+2<11$ and $-4<2x$
$3x<9$ and $-2<x$
$x<3$ and $x>-2 \quad (-2, 3)$

**9.** $3x+2<11$ or $-4<2x$
$3x<9$ or $-2<x$
$x<3$ or $x>-2 \quad (-\infty, \infty)$

**10.** $|2x-1|+3<12$
$|2x-1|<9$
$-9<2x-1<9$
$-8<2x<10$
$-4<x<5 \quad (-4, 5)$

**11.** $\left|\dfrac{x-3}{5}\right|\ge 2$
$\dfrac{x-3}{5}\ge 2$ or $\dfrac{x-3}{5}\le -2$
$x-3\ge 10$ or $x-3\le -10$
$x\ge 13$ or $x\le -7 \quad (-\infty, -7]\cup[13, \infty)$

**12.**
**a.** $f(4)=\dfrac{1}{2}(4)-1=2-1=1$

**b.** $g(-3)=3(-3)^2-2(-3)=3(9)-2(-3)$
$=27+6=33$

**13.** $m = \frac{-3-(-5)}{-6-4} = \frac{2}{-10} = -\frac{1}{5}$

**14.** $y = 6x - 5$

$7 = 6\left(\frac{1}{3}\right) - 5 = 2 - 5 = -3$

$\left(\frac{1}{3}, 7\right)$ is not a solution.

**15.** **a.**
$$3x - 5y = 10$$
$$3x - 5(0) = 10$$
$$3x = 10$$
$$x = \frac{10}{3}$$

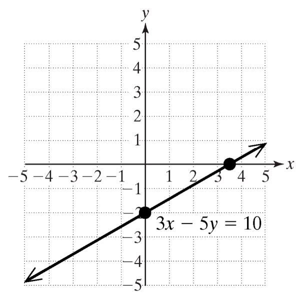
$$3(0) - 5y = 10$$
$$-5y = 10$$
$$y = -2$$

The $x$-intercept is $\left(\frac{10}{3}, 0\right)$.

The $y$-intercept is (0, –2).

**b.** $m = \frac{-2-0}{0-\frac{10}{3}} = \frac{-2}{-\frac{10}{3}} = 2\left(\frac{3}{10}\right) = \frac{6}{10} = \frac{3}{5}$

**c.**

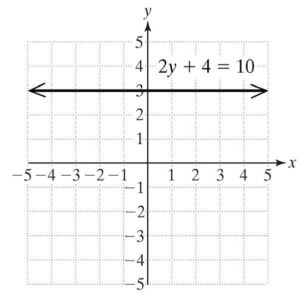



**16.** **a.**
$$2y + 4 = 10$$
$$2y = 6$$
$$y = 3$$

There is no $x$-intercept.
The $y$-intercept is (0, 3).

**b.** $m = 0$

**c.**




**17.** $x = 7$

**18.**
$$5x - 2y = -10$$
$$2y = 5x + 10$$
$$y = \frac{5}{2}x + 5$$
$$m = \frac{5}{2}$$

**19.** Domain: $\{3, 4\}$ Range: $\{-1, -5, -8\}$
This is not a function.

**20.**
$$2x + y = 6$$
$$y = -2x + 6$$

$m_{\parallel} = -2$ point: $(1, -4)$

$$y - (-4) = -2(x - 1)$$
$$y + 4 = -2x + 2$$
$$y = -2x - 2$$

**21.**
$$y = \frac{1}{4}x - 2$$
$m_{\perp} = -4$ point: $(1, -4)$
$$y - (-4) = -4(x - 1)$$
$$y + 4 = -4x + 4$$
$$y = -4x$$

**22.** Let $x$ = the amount spent on drinks
$2x$ = the amount spent on popcorn
(amt on drinks) + (amt on popcorn) = (total)
$$x + 2x = 17.94$$
$$3x = 17.94$$
$$x = 5.98$$
$$2x = 2(5.98) = 11.96$$
Laquita spent \$5.98 on drinks and \$11.96 on popcorn.

**23.** $x - 15 \neq 0$
$x \neq 15$
Domain: $(-\infty, 15) \cup (15, \infty)$

**24.**

| | 20% Salt Solution | 50% Salt Solution | 38% Salt Solution |
|---|---|---|---|
| Amount of Solution | $x$ | 15 | $x + 15$ |
| Amount of Salt | $0.20x$ | $0.50(15)$ | $0.38(x+15)$ |

(amt of 20%) + (amt of 50%) = (amt of 38%)
$$0.20x + 0.50(15) = 0.38(x + 15)$$
$$0.20x + 7.5 = 0.38x + 5.7$$
$$-0.18x + 7.5 = 5.7$$
$$-0.18x = -1.8$$
$$\frac{-0.18x}{-0.18} = \frac{-1.8}{-0.18}$$
$$x = 10$$
10 L of 20% solution must be used.

**25.** Let $x$ = the yearly rainfall in Los Angeles
$2x - 0.7$ = the yearly rainfall in Seattle
$$x + (2x - 0.7) = 50$$
$$3x - 0.7 = 50$$
$$3x = 50.7$$
$$x = 16.9$$
$$2x - 0.7 = 2(16.9) - 0.7 = 33.1$$
Los Angeles gets 16.9 in of rain per year and Seattle gets 33.1 in of rain per year.