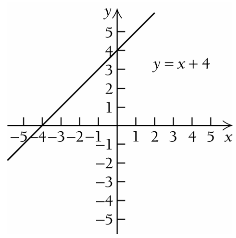
Chapter R
Functions, Graphs, and Models

Exercise Set R.1

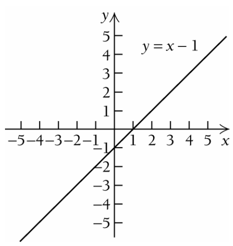
1. Graph $y = x + 4$.

We choose some x-values and calculate the corresponding y-values to find some ordered pairs that are solutions of the equation. Then we plot the points and connect them with a smooth curve.

x	y	(x, y)
-2	2	$(-2, 2)$
0	4	$(0, 4)$
3	7	$(3, 7)$



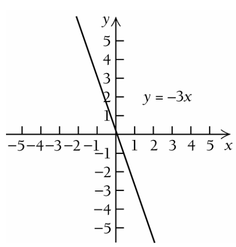
2. Graph $y = x - 1$.



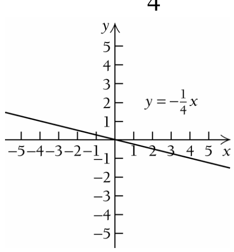
3. Graph $y = -3x$.

We choose some x-values and calculate the corresponding y-values to find some ordered pairs that are solutions of the equation. Then we plot the points and connect them with a smooth curve.

x	y	(x, y)
-1	3	$(-1, 3)$
0	0	$(0, 0)$
2	-6	$(2, -6)$



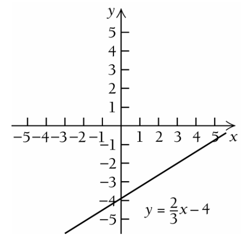
4. Graph $y = -\frac{1}{4}x$.



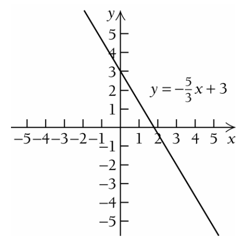
5. Graph $y = \frac{2}{3}x - 4$.

We choose some x-values and calculate the corresponding y-values to find some ordered pairs that are solutions of the equation. Then we plot the points and connect them with a smooth curve.

x	y	(x, y)
-3	-6	$(-3, -6)$
0	-4	$(0, -4)$
3	-2	$(3, -2)$



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



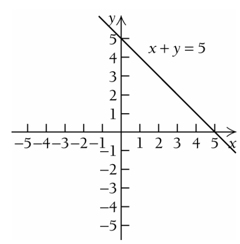
7. Graph $x + y = 5$.

We solve for y first.

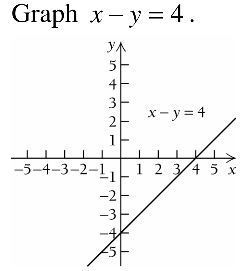
$$x + y = 5$$
$$y = 5 - x \qquad \text{subtract } x \text{ from both sides}$$
$$y = -x + 5 \qquad \text{commutative property}$$

Next, we choose some x-values and calculate the corresponding y-values to find some ordered pairs that are solutions of the equation. Then we plot the points and connect them with a smooth curve.

x	y	(x, y)
-1	6	$(-1, 6)$
0	5	$(0, 5)$
2	3	$(2, 3)$



8. Graph $x - y = 4$.



9. Graph $8y-2x=4$.

We solve for y first.

$8y-2x=4$

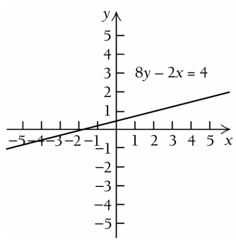
$8y=2x+4$ add $2x$ to both sides

$y=\frac{2}{8}x+\frac{4}{8}$ divide both sides by 8

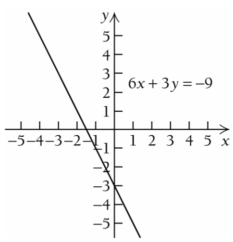
$y=\frac{1}{4}x+\frac{1}{2}$

Next, we choose some x-values and calculate the corresponding y-values to find some ordered pairs that are solutions of the equation. Then we plot the points and connect them with a smooth curve.

x	y	(x,y)
-2	0	$(-2,0)$
2	1	$(2,1)$
6	2	$(6,2)$



10. Graph $6x+3y=-9$.



11. Graph $5x-6y=12$.

We solve for y first.

$5x-6y=12$

$-6y=12-5x$ subtract $5x$ from both sides

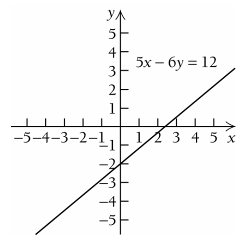
$y=\frac{1}{-6}(12-5x)$ divide both sides by -6

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

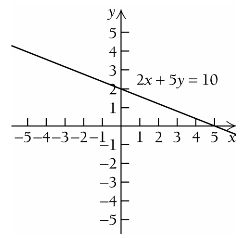
$y=\frac{5}{6}x-2$

We choose some x-values and calculate the corresponding y-values to find some ordered pairs that are solutions of the equation. Then we plot the points and connect them with a smooth curve.

x	y	(x,y)
-6	-7	$(-6,7)$
0	-2	$(0,-2)$
6	3	$(6,3)$



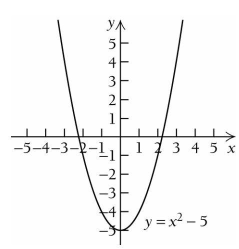
12. Graph $2x+5y=10$.



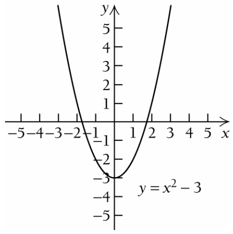
13. Graph $y=x^2-5$.

We choose some x-values and calculate the corresponding y-values to find some ordered pairs that are solutions of the equation. Then we plot the points and connect them with a smooth curve.

x	y	(x,y)
-2	-1	$(-2,-1)$
-1	-4	$(-1,-4)$
0	-5	$(0,-5)$
1	-4	$(1,-4)$
2	-1	$(2,-1)$



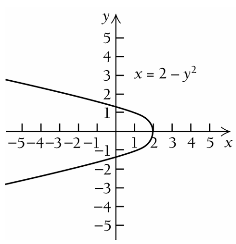
14. Graph $y = x^2 - 3$.



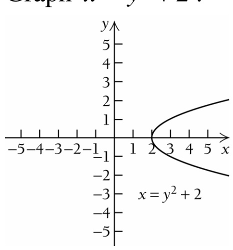
15. Graph $x = 2 - y^2$.

Since x is expressed in terms of y we first choose values for y and then compute x. Then we plot the points that are found and connect them with a smooth curve.

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



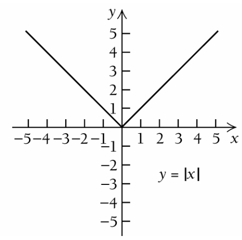
16. Graph $x = y^2 + 2$.



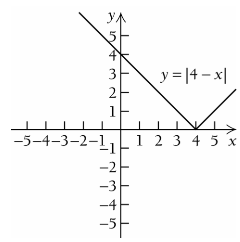
17. Graph $y = |x|$.

We choose some x-values and calculate the corresponding y-values to find some ordered pairs that are solutions of the equation. Then we plot the points and connect them with a smooth curve.

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



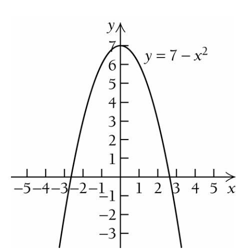
18. Graph $y = |4 - x|$.



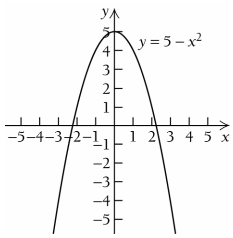
19. Graph $y = 7 - x^2$.

We choose some x-values and calculate the corresponding y-values to find some ordered pairs that are solutions of the equation. Then we plot the points and connect them with a smooth curve.

x	y	(x, y)
-2	3	$(-2,3)$
-1	6	$(-1,6)$
0	7	$(0,7)$
1	6	$(1,6)$
2	3	$(2,3)$



20. Graph $y = 5 - x^2$.



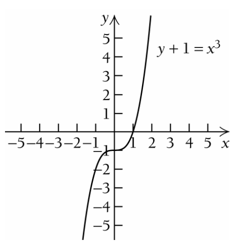
21. Graph $y + 1 = x^3$.

First we solve for y.

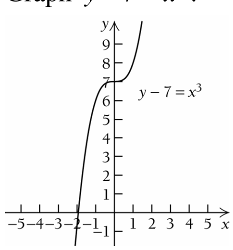
$$y + 1 = x^3$$
$$y = x^3 - 1$$

Next, we choose some x-values and calculate the corresponding y-values to find some ordered pairs that are solutions of the equation. Then we plot the points and connect them with a smooth curve.

x	y	(x, y)
-2	-9	$(-2, -9)$
-1	-2	$(-1, -2)$
0	-1	$(0, -1)$
1	0	$(1, 0)$
2	7	$(2, 7)$



22. Graph $y - 7 = x^3$.



23. $R = -0.00582x + 15.3476$

We substitute 1954 in for x to get

$$R = -0.00582(1954) + 15.3476$$
$$= 3.97532$$

According to this model, the world record for the mile in 1954 is approximately 3.97532 minutes. To convert this to traditional minutes-seconds we multiply the decimal part by 60 seconds.

$$0.97532(60) = 58.5192$$

Therefore the world record for the mile in 1954 was 3:58.5.

Likewise, we substitute 2008 in for x to get

$$R = -0.00582(2008) + 15.3476$$
$$= 3.66104$$

According to the model, the world record for the mile in 2008 will be approximately 3.66104 minutes or 3:39.7.

24. $A = 0.5t^4 + 3.45t^3 - 96.65t^2 + 347.7t,\ 0 \le t \le 6$

We substitute $t = 2$

$$A = 0.5(2)^4 + 3.45(2)^3 - 96.65(2)^2 + 347.7(2)$$
$$= 344.4$$

Approximately 344.4 milligrams of ibuprofen will remain in the blood stream 2 hours after 400 mg have been swallowed.

25. $v(t) = 10.9t$

We substitute 2.34 in for t to get

$$v(2.34) = 10.9(2.34)$$
$$= 25.506$$
$$\approx 25.5$$

Durmont was traveling at 25.5 miles per hour when he reentered the halfpipe.

26. $s(t) = 16t^2$

$$s(1.36) = 16(1.36)^2$$
$$= 16(1.8496)$$
$$= 29.5936$$
$$\approx 29.6$$

Dyani dropped about 29.6 feet into the quarterpipe.

27. a) Locate 20 on the horizontal axis and go directly up to the graph. Then move left to the vertical axis and read the value there. We estimate the number of hearing-impaired Americans of age 20 is about 1.8 million.

Follow the same process for 40, 50, and 60 to determine the number of hearing-impaired Americans at each of those ages.

We estimate the number of hearing-impaired Americans of age 40 is about 3.7 million.

We estimate the number of hearing-impaired Americans of age 50 is about 4.4 million.

We estimate the number of hearing-impaired Americans of age 60 is about 4.5 million.

b) Locate 4 on the vertical axis and move horizontally across to the graph. There are two x-values that correspond to the y-value of 4. They are 44 and 67, so there are approximately 4 million Americans age 44 who are hearing-impaired and approximately 4 million Americans age 67 who are hearing-impaired.

c) The highest point on the graph appears to correspond to the x-value of 58. Therefore, age 58 appears to be the age at which the greatest number of Americans are hearing-impaired.

d) $\boxed{tw}$ Visually, we cannot tell precisely which point is the highest point on the graph or which x-value corresponds exactly to that point. The graph is not detailed enough to make that determination.

28. a) We estimate the incidence of breast cancer in 40-yr-old women is about 100 per 100,000 women.

b) We estimate that at age 67 and at age 88 the incidence of breast cancer is about 400 per 100,000 women.

c) The largest incidence of breast cancer occurs in woman who are approximately 79 years of age.

d) $\boxed{tw}$ Visually, we cannot tell precisely which point is the highest point on the graph or which x-value corresponds exactly to that point. The graph is not detailed enough to make that determination.

29. a) $A = P(1+i)^t$

$$A = 1000(1+0.06)^1$$
$$= 1000(1.06)$$
$$= 1060$$

At the end of 1 year, \$1060 is in the account.

b) $A = P\left(1+\frac{i}{n}\right)^{nt}$

$$A = 1000\left(1+\frac{0.06}{2}\right)^{2\cdot 1}$$
$$= 1000(1+0.03)^2$$
$$= 1000(1.03)^2$$
$$A = 1000(1.0609)$$
$$= 1060.90$$

At the end of 1 year, \$1060.90 is in the account.

c) $A = P\left(1+\frac{i}{n}\right)^{nt}$

$$A = 1000\left(1+\frac{0.06}{4}\right)^{4\cdot 1}$$
$$= 1000(1+0.015)^4$$
$$= 1000(1.015)^4$$
$$= 1000(1.061363551)$$
$$= 1061.363551$$
$$\approx 1061.36$$

At the end of 1 year, approximately \$1061.36 is in the account.

d) $A = P\left(1+\frac{i}{n}\right)^{nt}$

$$A = 1000\left(1+\frac{0.06}{365}\right)^{365\cdot 1}$$
$$= 1000(1+0.000164384)^{365}$$
$$= 1000(1.000164384)^{365}$$
$$= 1000(1.06183131)$$
$$= 1061.83131$$
$$\approx 1061.83$$

At the end of 1 year, approximately \$1061.83 is in the account.

e) There are $24\cdot 365 = 8760$ hours in one year.

$$A = P\left(1+\frac{i}{n}\right)^{nt}$$
$$A = 1000\left(1+\frac{0.06}{8760}\right)^{8760\cdot 1}$$
$$= 1000(1+0.000006849)^{8760}$$
$$= 1000(1.000006849)^{8760}$$
$$= 1000(1.061836329)$$
$$= 1061.836329$$
$$\approx 1061.84$$

At the end of 1 year, approximately \$1061.84 is in the account.

30. a) $A = P(1+i)^t$

$A = 1000(1+0.085)^1 = 1000(1.085) = 1085$

At the end of 1 year, \$1085 is in the account.

b) $A = P\left(1+\frac{i}{n}\right)^{nt}$

$A = 1000\left(1+\frac{0.085}{2}\right)^{2\cdot 1}$

$= 1000(1.0425)^2$

$= 1086.81$

At the end of 1 year, \$1086.81 is in the account.

c) $A = P\left(1+\frac{i}{n}\right)^{nt}$

$A = 1000\left(1+\frac{0.085}{4}\right)^{4\cdot 1}$

$= 1000(1.02125)^4$

≈ 1087.75

At the end of 1 year, approximately \$1087.75 is in the account.

d) $A = P\left(1+\frac{i}{n}\right)^{nt}$

$A = 1000\left(1+\frac{0.085}{365}\right)^{365\cdot 1}$

$= 1000(1.000232877)^{365}$

≈ 1088.71

At the end of 1 year, approximately \$1088.71 is in the account.

e) There are $24\cdot 365 = 8760$ hours in one year.

$A = P\left(1+\frac{i}{n}\right)^{nt}$

$A = 1000\left(1+\frac{0.085}{8760}\right)^{8760\cdot 1}$

$= 1000(1.000009703)^{8760}$

≈ 1088.72

At the end of 1 year, approximately \$1088.72 is in the account.

31. a) $A = P(1+i)^t$

$A = 2000(1+0.04)^3$

$= 2000(1.04)^3$

$= 2249.728$

≈ 2249.73

At the end of 3 years, approximately \$2249.73 is in the account.

b) $A = P\left(1+\frac{i}{n}\right)^{nt}$

$A = 2000\left(1+\frac{0.04}{2}\right)^{2\cdot 3}$

$= 2000(1.02)^6$

$= 2000(1.126162419)$

$= 2252.324839$

≈ 2252.32

At the end of 3 years, \$2252.32 is in the account.

c) $A = P\left(1+\frac{i}{n}\right)^{nt}$

$A = 2000\left(1+\frac{0.04}{4}\right)^{4\cdot 3}$

$= 2000(1.01)^{12}$

$= 2000(1.12682503)$

$= 2253.65006$

≈ 2253.65

At the end of 3 years, approximately \$2253.65 is in the account.

d) $A = P\left(1+\frac{i}{n}\right)^{nt}$

$A = 2000\left(1+\frac{0.04}{365}\right)^{365\cdot 3}$

$= 2000(1.000109589)^{1095}$

$= 2000(1.127489438)$

$= 2254.978877$

≈ 2254.98

At the end of 3 years, approximately \$2254.98 is in the account.

e) There are $24\cdot 365 = 8760$ hours in one year.

$A = P\left(1+\frac{i}{n}\right)^{nt}$

$A = 2000\left(1+\frac{0.04}{8760}\right)^{8760\cdot 3}$

$= 2000(1.000004566210046)^{26280}$

$= 2000(1.127496543)$

$= 2254.993083$

≈ 2254.99

At the end of 3 years, approximately \$2254.99 is in the account.

32. a) $A = P(1+i)^t$

$A = 3000(1+0.05)^4$

$= 3000(1.05)^4$

≈ 3646.52

At the end of 4 years, approximately \$3646.52 is in the account.

b) $A = P\left(1+\frac{i}{n}\right)^{nt}$

$A = 3000\left(1+\frac{0.05}{2}\right)^{2\cdot 4}$

$= 3000(1.025)^8$

≈ 3655.21

At the end of 4 years, approximately \$3655.21 is in the account.

c) $A = P\left(1+\frac{i}{n}\right)^{nt}$

$A = 3000\left(1+\frac{0.05}{4}\right)^{4\cdot 4}$

$= 3000(1.0125)^{16}$

≈ 3659.67

At the end of 4 years, approximately \$3659.67 is in the account.

d) $A = P\left(1+\frac{i}{n}\right)^{nt}$

$A = 3000\left(1+\frac{0.05}{365}\right)^{365\cdot 4}$

$= 3000(1.000136986)^{1460}$

≈ 3664.16

At the end of 4 years, approximately \$3664.16 is in the account.

e) There are $24\cdot 365 = 8760$ hours in one year.

$A = P\left(1+\frac{i}{n}\right)^{nt}$

$A = 3000\left(1+\frac{0.05}{8760}\right)^{8760\cdot 4}$

$= 3000(1.000005708)^{35040}$

≈ 3664.21

At the end of 4 years, approximately \$3664.21 is in the account.

33. Using the formula:

$$M = P\left[\frac{\frac{i}{12}\left(1+\frac{i}{12}\right)^n}{\left(1+\frac{i}{12}\right)^n - 1}\right]$$

We substitute 18,000 for P, 0.0975 $\left(9\frac{3}{4}\% = 0.0975\right)$ for *i*, and 36 $(3\cdot 12 = 36)$ for *n*. Then we use a calculator to perform the computation.

$$M = 18{,}000\left[\frac{\frac{0.0975}{12}\left(1+\frac{0.0975}{12}\right)^{36}}{\left(1+\frac{0.0975}{12}\right)^{36} - 1}\right]$$

≈ 578.70

The monthly payment on the loan will be approximately \$578.70.

34. 30 years $= 30\cdot 12 = 360$ months

$P = 100{,}000; i = 0.0675$

$$M = 100{,}000\left[\frac{\frac{0.0675}{12}\left(1+\frac{0.0675}{12}\right)^{360}}{\left(1+\frac{0.0675}{12}\right)^{360} - 1}\right]$$

≈ 648.60

The monthly payment on the loan will be approximately \$648.60.

35. $W = P\left[\frac{(1+i)^n - 1}{i}\right]$

We substitute 3000 for *P*, 0.08 $(8\% = 0.08)$ for *i*, and 18 for *n*.

$$W = 3000\left[\frac{(1+0.08)^{18} - 1}{0.08}\right]$$

$\approx 112{,}351$

Rounded to the nearest dollar, the annuity will be worth \$112,351 after 18 years.

36. We substitute 50,000 for *W*, 0.0725 $\left(7\frac{1}{4}\% = 0.0725\right)$ in for *i*, and 20 for *n*. Then we proceed to solve for *P* on the next page.

$$50{,}000 = P\left[\frac{(1+0.0725)^{20}-1}{0.0725}\right]$$

$$\frac{50{,}000}{\left[\frac{(1+0.0725)^{20}-1}{0.0725}\right]} = P$$

$$1186.74 \approx P$$

You will need to invest \$1186.74 annually to reach a goal of \$50,000 after 20 years.

37. a) Locate 400,000 and 700,000 on the vertical axis and then think of horizontal lines extending across the graph from these points. The years for which the graph lies between these two lines are the years for which the population was common. Those time periods are 1800 – 1858, 1862 – 1888, 1900 – 1937, 1975 – 1984, and 1987 – 2000.

b) Locate 700,000 on the vertical axis and then think of a horizontal line extending across the graph from this point. The years for which the graph lies above this line are the years for which the population was abundant. Those time periods are 1937 – 1975 and 1984 – 1987.

c) Locate 400,000 on the vertical axis and then think of a horizontal line extending across the graph from this point. The years for which the graph lies below this line are the years for which the population was scarce. Those time periods are 1858 – 1862 and 1888 – 1900.

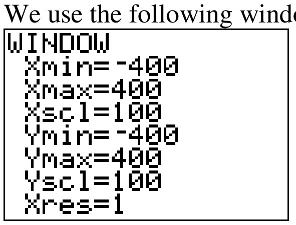
38. a) The highest point on the graph corresponds to the year 1962

b) The lowest point on the graph corresponds to the year 1890.

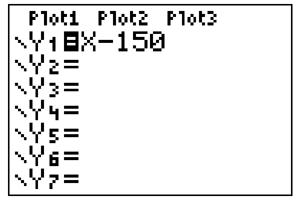
c) $\boxed{tw}$ The graph shows a dramatic decrease in the deer population in the years following the discovery of gold in California.

39. Graph $y = x - 150$

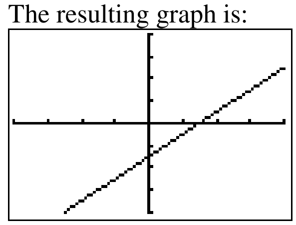
We use the following window.



Next, we type the equation into the calculator.

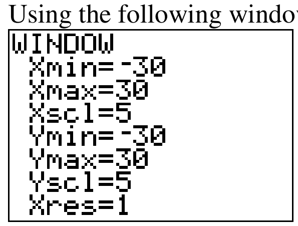


The resulting graph is:

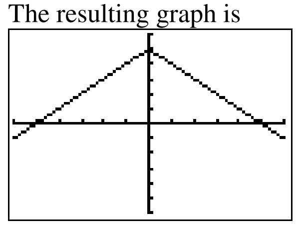


40. Graph $y = 25 - |x|$

Using the following window:

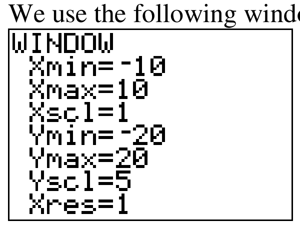


The resulting graph is

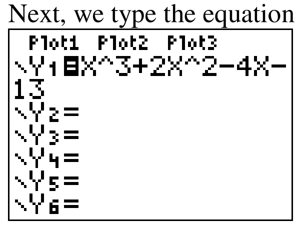


41. Graph $y = x^3 + 2x^2 - 4x - 13$

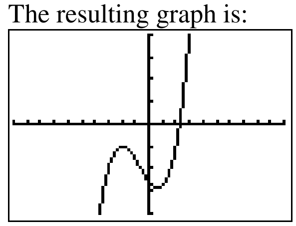
We use the following window:



Next, we type the equation in to the calculator.

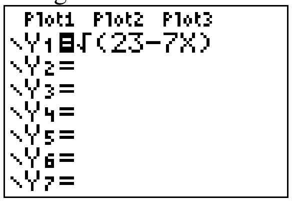


The resulting graph is:

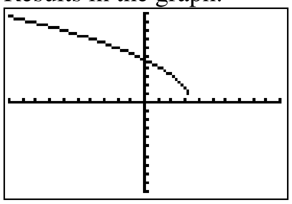


42. Graph $y=\sqrt{23-7x}$.

Using a standard window.



Results in the graph:



43. Graph $9.6x+4.2y=-100$.

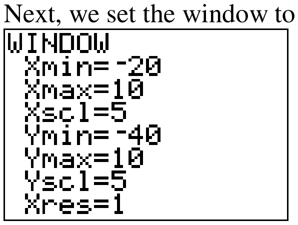
First, we solve for y.

$$9.6x+4.2y=-100$$

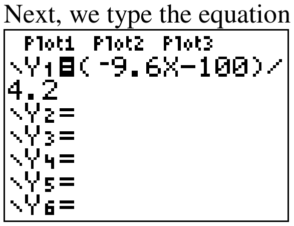
$$4.2y=-100-9.6x \quad \text{subtract } 9.6x \text{ from both sides}$$

$$y=\frac{-9.6x-100}{4.2}$$

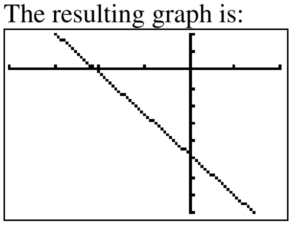
Next, we set the window to be:



Next, we type the equation into the calculator.

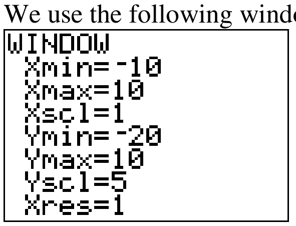


The resulting graph is:

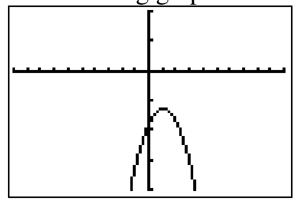


44. Graph $y=-2.3x^2+4.8x-9$.

We use the following window:



The resulting graph is:



45. Graph $x=4+y^2$.

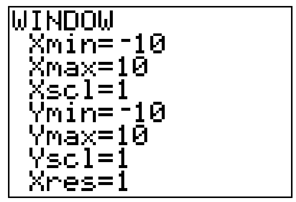
First we solve for y.

$$x=4+y^2$$

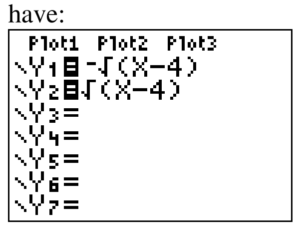
$$x-4=y^2 \quad \text{subtracting 4 from both sides}$$

$$\pm\sqrt{x-4}=y \quad \text{taking the square root of both sides}$$

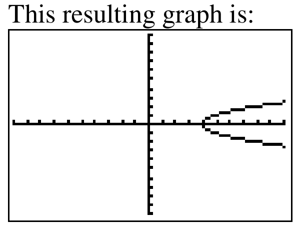
Next, we set the window to the standard window:



It is important to remember that we must graph both the positive root and the negative root. Typing both equations into the calculator we have:



This resulting graph is:



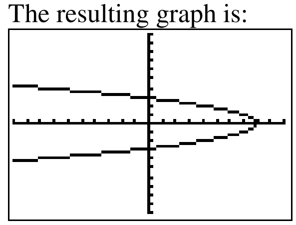
46. Graph $x=8-y^2$.

Solving for y yields:

$y=\pm\sqrt{8-x}$

We use the standard window.

The resulting graph is:



Exercise Set R.2

1. The correspondence is a function because each member of the domain corresponds to only one member of the range.

2. The correspondence is a function because each member of the domain corresponds to only one member of the range.

3. The correspondence is *not* a function because one member of the domain, 6, corresponds to two members of the range, -6 and -7.

4. The correspondence is a function because each member of the domain corresponds to only one member of the range.

5. The correspondence is a function because each member of the domain corresponds to only one member of the range, even though two members of the domain, Quarter Pounder ® and Big N' Tasty ® correspond to $2.29.

6. The correspondence is a function because each member of the domain corresponds to only one member of the range.

7. The correspondence is a function because each student has exactly one ID number.

8. The correspondence is a function because each student has exactly one registration form.

9. The correspondence is a function because each student has exactly one shoe size.

10. The correspondence is a function because each student has exactly one height.

11. The correspondence is a function because any number squared and then increased by 8, corresponds to exactly one number greater than or equal to 8.

12. The correspondence is a function because any number raised to the fourth power corresponds to exactly one nonnegative number.

13. The correspondence is a function because every male has exactly one biological father.

14. The correspondence is a function because every female has exactly one biological mother.

15. This correspondence is *not* a function, because it is reasonable to assume at least one avenue is intersected by more than one cross street.

16. This correspondence is *not* a function, because it is reasonable to assume that a textbook has more than one even-numbered page.

17. The correspondence is a function because each shape has exactly one area.

18. The correspondence is a function because each shape has exactly one perimeter.

19. a) $f(x)=3x+2$

$$f(4.1)=3(4.1)+2=14.3$$
$$f(4.01)=3(4.01)+2=14.03$$
$$f(4.001)=3(4.001)+2=14.003$$
$$f(4)=3(4)+2=14$$

x	4.1	4.01	4.001	4
$f(x)$	14.3	14.03	14.003	14

b) $f(x)=3x+2$

$$f(5)=3(5)+2=17$$
$$f(-1)=3(-1)+2=-1$$
$$f(k)=3(k)+2=3k+2$$
$$f(1+t)=3(1+t)+2=3+3t+2=3t+5$$
$$f(x+h)=3(x+h)+2=3x+3h+2$$

20. a) $f(x)=4x-3$

x	5.1	5.01	5.001	5
$f(x)$	17.4	17.04	17.004	17

b) $f(x)=4x-3$

$$f(4)=4(4)-3=13$$
$$f(3)=4(3)-3=9$$
$$f(-2)=4(-2)-3=-11$$
$$f(k)=4(k)-3=4k-3$$
$$f(1+t)=4(1+t)-3=4+4t-3=4t+1$$
$$f(x+h)=4(x+h)-3=4x+4h-3$$

21. $g(x)=x^2-3$

$$g(-1)=(-1)^2-3=1-3=-2$$
$$g(0)=(0)^2-3=0-3=-3$$
$$g(1)=(1)^2-3=1-3=-2$$
$$g(5)=(5)^2-3=25-3=22$$
$$g(u)=(u)^2-3=u^2-3$$
$$g(a+h)=(a+h)^2-3=a^2+2ah+h^2-3$$
$$\begin{aligned}\frac{g(a+h)-g(a)}{h}&=\frac{(a+h)^2-3-\left[(a)^2-3\right]}{h}\\&=\frac{a^2+2ah+h^2-3-\left[a^2-3\right]}{h}\\&=\frac{2ah+h^2}{h}\\&=\frac{h(2a+h)}{h}\\&=2a+h\end{aligned}$$

22. $g(x)=x^2+4$

$$g(-3)=(-3)^2+4=13$$
$$g(0)=(0)^2+4=4$$
$$g(-1)=(-1)^2+4=5$$
$$g(7)=(7)^2+4=53$$
$$g(v)=(v)^2+4=v^2+4$$
$$g(a+h)=(a+h)^2+4=a^2+2ah+h^2+4$$
$$\begin{aligned}\frac{g(a+h)-g(a)}{h}&=\frac{a^2+2ah+h^2+4-(a^2+4)}{h}\\&=\frac{2ah+h^2}{h}\\&=2a+h\end{aligned}$$

23. $f(x)=\dfrac{1}{(x+3)^2}$

a) $f(4)=\dfrac{1}{((4)+3)^2}=\dfrac{1}{(7)^2}=\dfrac{1}{49}$

$f(-3)=\dfrac{1}{((-3)+3)^2}=\dfrac{1}{(0)^2}$, Output is undefined.

$f(0)=\dfrac{1}{((0)+3)^2}=\dfrac{1}{(3)^2}=\dfrac{1}{9}$

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

$f(t+4)=\dfrac{1}{((t+4)+3)^2}=\dfrac{1}{(t+7)^2}$

$f(x+h)=\dfrac{1}{((x+h)+3)^2}=\dfrac{1}{(x+h+3)^2}$

$$\begin{aligned}&\frac{f(x+h)-f(x)}{h}\\&=\frac{\dfrac{1}{(x+h+3)^2}-\dfrac{1}{(x+3)^2}}{h}\\&=\frac{\dfrac{(x+3)^2}{(x+h+3)^2(x+3)^2}-\dfrac{(x+h+3)^2}{(x+h+3)^2(x+3)^2}}{h}\\&=\frac{x^2+6x+9-(x^2+2hx+6x+h^2+6h+9)}{h(x+h+3)^2(x+3)^2}\\&=\frac{-2hx-h^2-6h}{h(x+h+3)^2(x+3)^2}\\&=\frac{h(-2x-h-6)}{h(x+h+3)^2(x+3)^2}\\&=\frac{-2x-h-6}{(x+h+3)^2(x+3)^2},\quad h\neq 0\end{aligned}$$

b) The function squares the input, then it adds six times the input, then it adds 9 and then it takes the reciprocal of the result.

24. $f(x)=\dfrac{1}{(x-5)^2}$

a) $f(3)=\dfrac{1}{(3-5)^2}=\dfrac{1}{(-2)^2}=\dfrac{1}{4}$

$f(-1)=\dfrac{1}{(-1-5)^2}=\dfrac{1}{(-6)^2}=\dfrac{1}{36}$

$f(5)=\dfrac{1}{(5-5)^2}=\dfrac{1}{(0)^2}$, Output is undefined.

$f(k)=\dfrac{1}{(k-5)^2}$

$f(t-1)=\dfrac{1}{((t-1)-5)^2}=\dfrac{1}{(t-6)^2}$

$f(t-4)=\dfrac{1}{((t-4)-5)^2}=\dfrac{1}{(t-9)^2}$

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

b) The function squares the input, then subtracts 10 times the input, then adds 25, and then it takes the reciprocal of the result.

25. Graph $f(x)=2x-5$.

First, we choose some values for x and compute the values for $f(x)$, in order to form the ordered pairs that we will plot on the graph.

$f(-1)=2(-1)-5=-7$

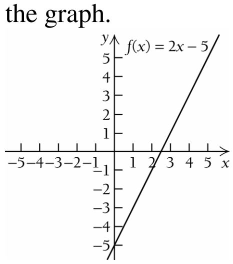
$f(0)=2(0)-5=-5$

$f(1)=2(1)-5=-3$

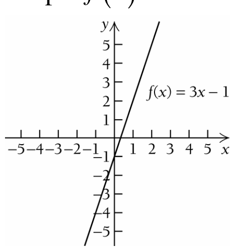
$f(2)=2(2)-5=-1$

x	$f(x)$	$(x,f(x))$
-1	-7	$(-1,-7)$
0	-5	$(0,-5)$
1	-3	$(1,-3)$
2	-1	$(2,-1)$

Next we plot the input – output pairs from the table and, in this case, draw the line to complete the graph.



26. Graph $f(x)=3x-1$.



27. Graph $g(x)=-4x$.

First, we choose some values for x and compute the values for $g(x)$, in order to form the ordered pairs that we will plot on the graph.

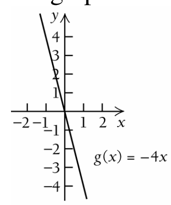
$g(-1)=-4(-1)=4$

$g(0)=-4(0)=0$

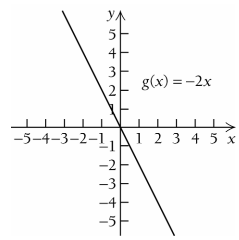
$g(1)=-4(1)=-4$.

x	$g(x)$	$(x,g(x))$
-1	4	$(-1,4)$
0	0	$(0,0)$
1	-4	$(0,-4)$

Next we plot the input – output pairs from the table and, in this case, draw the line to complete the graph.



28. Graph $g(x)=-2x$.



29. Graph $f(x)=x^2-2$.

First, we choose some values for x and compute the values for $f(x)$, in order to form the ordered pairs that we will plot on the graph.

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

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

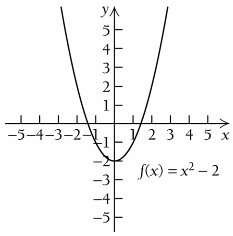
$f(0)=(0)^2-2=-2$

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

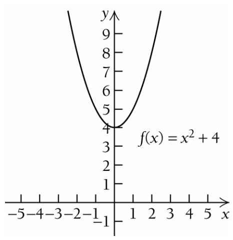
$f(2)=(2)^2-2=2$

x	$f(x)$	$(x,f(x))$
-2	2	$(-2,2)$
-1	-1	$(-1,-1)$
0	-2	$(0,-2)$
1	-1	$(1,-1)$
2	2	$(2,2)$

Next we plot the input – output pairs from the table on the previous page and, in this case, draw the curve to complete the graph.



30. Graph $f(x) = x^2 + 4$.



31. Graph $f(x) = 6 - x^2$.

First, we choose some values for x and compute the values for $f(x)$, in order to form the ordered pairs that we will plot on the graph.

$f(-2) = 6 - (-2)^2 = 2$

$f(-1) = 6 - (-1)^2 = 5$

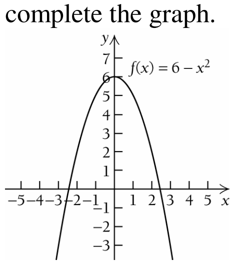
$f(0) = 6 - (0)^2 = 6$

$f(1) = 6 - (1)^2 = 5$

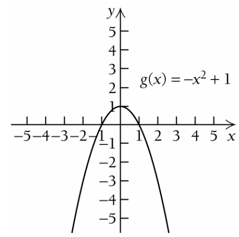
$f(2) = 6 - (2)^2 = 2$

x	$f(x)$	$(x, f(x))$
–2	2	$(-2,2)$
–1	5	$(-1,5)$
0	6	$(0,6)$
1	5	$(1,5)$
2	2	$(2,2)$

Next we plot the input – output pairs from the table and, in this case, draw the curve to complete the graph.



32. Graph $g(x) = -x^2 + 1$.



33. Graph $g(x) = x^3$.

First, we choose some values for x and compute the values for $g(x)$, in order to form the ordered pairs that we will plot on the graph.

$g(-2) = (-2)^3 = -8$

$g(-1) = (-1)^3 = -1$

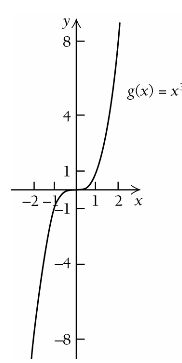
$g(0) = (0)^3 = 0$

$g(1) = (1)^3 = 1$

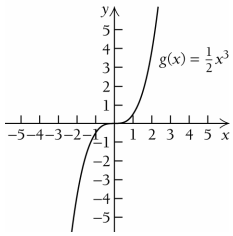
$g(2) = (2)^3 = 8$

x	$f(x)$	$(x, f(x))$
–2	–8	$(-2,-8)$
–1	–1	$(-1,-1)$
0	0	$(0,0)$
1	1	$(1,1)$
2	8	$(2,8)$

Next we plot the input – output pairs from the table and, in this case, draw the curve to complete the graph.



34. Graph $g(x)=\frac{1}{2}x^3$.



35. The graph is a function, it is impossible to draw a vertical line that intersects the graph more than once.

36. The graph is a function, it is impossible to draw a vertical line that intersects the graph more than once.

37. The graph is a function, it is impossible to draw a vertical line that intersects the graph more than once.

38. The graph is not that of a function. A vertical line can intersect the graph more than once.

39. The graph is not that of a function. A vertical line can intersect the graph more than once.

40. The graph is a function, it is impossible to draw a vertical line that intersects the graph more than once.

41. The graph is not that of a function. A vertical line can intersect the graph more than once.

42. The graph is a function, it is impossible to draw a vertical line that intersects the graph more than once.

43. The graph is a function, it is impossible to draw a vertical line that intersects the graph more than once.

44. The graph is a function, it is impossible to draw a vertical line that intersects the graph more than once.

45. The graph is a function, it is impossible to draw a vertical line that intersects the graph more than once.

46. The graph is a function, it is impossible to draw a vertical line that intersects the graph more than once.

47. Graph $x=y^2-2$.

a) First, we choose some values for y (since x is expressed in terms of y) and compute the values for x, in order to form the ordered pairs that we will plot on the graph.

For $y=-2; x=(-2)^2-2=2$

For $y=-1; x=(-1)^2-2=-1$

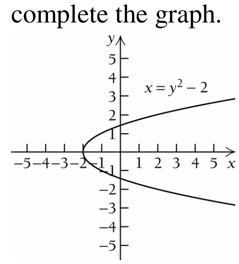
For $y=0; x=(0)^2-2=-2$

For $y=1; x=(1)^2-2=-1$

For $y=2; x=(2)^2-2=2$

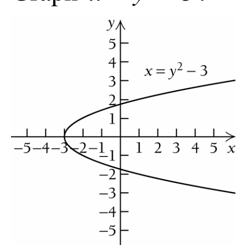
x	y	(x,y)
2	–2	$(2,-2)$
–1	–1	$(-1,-1)$
–2	0	$(-2,0)$
–1	1	$(-1,1)$
2	2	$(2,2)$

Next we plot the input – output pairs from the table and, in this case, draw the curve to complete the graph.



b) The graph is not that of a function. A vertical line can intersect the graph more than once.

48. a) Graph $x=y^2-3$.



b) The graph is not that of a function. A vertical line can intersect the graph more than once.

49. $f(x) = x^2 - 3x$

$$\frac{f(x+h) - f(x)}{h}$$
$$= \frac{(x+h)^2 - 3(x+h) - [x^2 - 3x]}{h}$$
$$= \frac{x^2 + 2xh + h^2 - 3x - 3h - [x^2 - 3x]}{h}$$
$$= \frac{2xh + h^2 - 3h}{h} \quad \text{combining like terms}$$
$$= \frac{h(2x + h - 3)}{h} \quad \text{Factoring}$$
$$= 2x + h - 3, \quad h \neq 0$$

50. $f(x) = x^2 + 4x$

$$\frac{f(x+h) - f(x)}{h}$$
$$= \frac{(x+h)^2 + 4(x+h) - [x^2 + 4x]}{h}$$
$$= \frac{x^2 + 2xh + h^2 + 4x + 4h - [x^2 + 4x]}{h}$$
$$= \frac{2xh + h^2 + 4h}{h}$$
$$= \frac{h(2x + h + 4)}{h}$$
$$= 2x + h + 4, \quad h \neq 0$$

51. To find $f(-1)$ we need to locate which piece defines the function on the domain that contains $x = -1$. When $x = -1$, the function is defined by $f(x) = -2x + 1;\quad \text{for } x < 0$; therefore, $f(-1) = -2(-1) + 1 = 2 + 1 = 3$.

To find $f(1)$ we need to locate which piece defines the function on the domain that contains $x = 1$. When $x = 1$, the function is defined by $f(x) = x^2 - 3;\quad \text{for } 0 < x < 4$; therefore, $f(1) = (1)^2 - 3 = 1 - 3 = -2$.

52. When $x = -3$, the function is defined by $f(x) = -2x + 1;\quad \text{for } x < 0$; therefore, $f(-3) = -2(-3) + 1 = 6 + 1 = 7$.
When $x = 3$, the function is defined by $f(x) = x^2 - 3;\quad \text{for } 0 < x < 4$; therefore, $f(3) = (3)^2 - 3 = 9 - 3 = 6$.

53. To find $f(0)$ we need to locate which piece defines the function on the domain that contains $x = 0$.
When $x = 0$, the function is defined by $f(x) = 17;\quad \text{for } x = 0$; therefore, $f(0) = 17$.

To find $f(10)$ we need to locate which piece defines the function on the domain that contains $x = 10$. When $x = 10$, the function is defined by $f(x) = \frac{1}{2}x + 1;\quad \text{for } x \geq 4$; therefore, $f(10) = \frac{1}{2}(10) + 1 = 5 + 1 = 6$.

54. When $x = -5$, the function is defined by $f(x) = -2x + 1;\quad \text{for } x < 0$; therefore, $f(-5) = -2(-5) + 1 = 10 + 1 = 11$.
When $x = 5$, the function is defined by $f(x) = \frac{1}{2}x + 1;\quad \text{for } x \geq 4$; therefore, $f(5) = \frac{1}{2}(5) + 1 = \frac{5}{2} + 1 = \frac{7}{2} = 3.5$.

55. Graph $f(x)=\begin{cases} 1 & \text{for } x<0 \\ -1 & \text{for } x\ge 0 \end{cases}$.

First, we graph $f(x)=1$ for inputs less than 0. We note for any x-value less than 0, the graph is the horizontal line $y=1$. Note that for

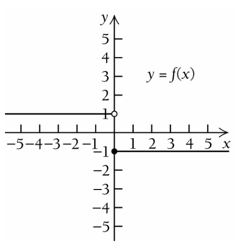
$f(x)=1$
$f(-3)=1$
$f(-2)=1$
$f(-1)=1$

The open circle indicates that $(0,1)$ is not part of the graph.

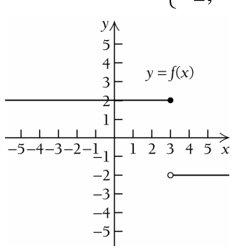
Next, we graph $f(x)=-1$ for inputs greater than or equal to 0. We note for any x-value less than 0, the graph is the horizontal line $y=-1$. Note that for $f(x)=-1$.

$f(0)=-1$
$f(1)=-1$
$f(2)=-1$

The solid dot indicates that $(0,-1)$ is part of the graph.



56. Graph $f(x)=\begin{cases} 2, & \text{for } x\le 3 \\ -2, & \text{for } x>3 \end{cases}$.



57. Graph $f(x)=\begin{cases} 6, & \text{for } x=-2 \\ x^2, & \text{for } x\ne -2 \end{cases}$.

First, we graph $f(x)=6$ for $x=-2$.

This graph consists of only one point, $(-2,6)$.

The solid dot indicates that $(-2,6)$ is part of the graph.

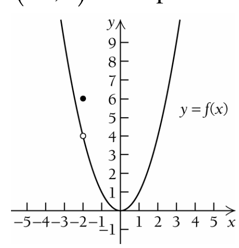
Next, we graph $f(x)=x^2$ for inputs $x\ne -2$.

Note that for $f(x)=x^2$

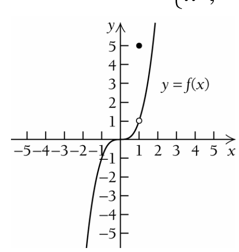
$f(-3)=(-3)^2=9$
$f(-1)=(-1)^2=1$
$f(0)=(0)^2=0$
$f(1)=(1)^2=1$
$f(2)=(2)^2=4$

x	$f(x)$	$(x,f(x))$
-3	9	$(-3,9)$
-1	1	$(-1,1)$
0	0	$(0,0)$
1	1	$(1,1)$
2	4	$(2,4)$

Since the input $x=-2$ is not defined on this part of the graph, the point $(-2,4)$ is not part of the graph. The open circle indicates that $(-2,4)$ is not part of the graph.



58. Graph $f(x)=\begin{cases} 5, & \text{for } x=1 \\ x^3, & \text{for } x\ne 1 \end{cases}$.



59. Graph $g(x)=\begin{cases}-x, & \text{for } x<0\\ 4, & \text{for } x=0\\ x+2, & \text{for } x>0\end{cases}$.

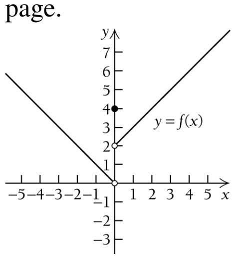
First, we graph $g(x)=-x$ for inputs $x<0$.
Creating the input – output table, we have:

x	$g(x)$	$(x,g(x))$
–3	3	$(-3,3)$
–2	2	$(-2,2)$
–1	1	$(-1,1)$

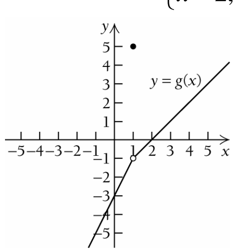
The open circle indicates that $(0,0)$ is not part of the graph. The graph is shown on the next page.
Next, we graph $g(x)=4$ for $x=0$. This part of the graph consists of a single point. The solid dot indicates that $(0,4)$ is part of the graph.
Next, we graph $g(x)=x+2$ for inputs $x>0$.
Creating the input – output table, we have:

x	$g(x)$	$(x,g(x))$
1	3	$(1,3)$
2	4	$(2,4)$
3	5	$(3,5)$

The open circle indicates that $(0,2)$ is not part of the graph. The graph is shown on the next page.



60. Graph $g(x)=\begin{cases}2x-3, & \text{for } x<1\\ 5, & \text{for } x=1\\ x-2, & \text{for } x>1\end{cases}$.



61. Graph $g(x)=\begin{cases}\frac{1}{2}x-1, & \text{for } x<2\\ -4, & \text{for } x=2\\ x-3, & \text{for } x>2\end{cases}$.

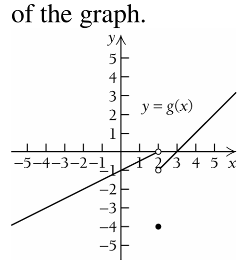
First, we graph $g(x)=\frac{1}{2}x-1$ for inputs $x<2$.
Creating the input – output table, we have:

x	$g(x)$	$(x,g(x))$
–2	–2	$(-2,-2)$
0	–1	$(0,-1)$
1	$-\frac{1}{2}$	$(1,-\frac{1}{2})$

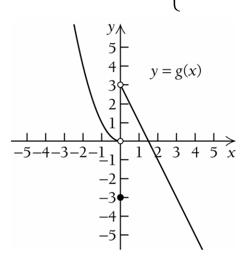
The open circle indicates that $(2,0)$ is not part of the graph.
Next, we graph $g(x)=-4$ for $x=2$. This part of the graph consists of a single point. The solid dot indicates that $(2,-4)$ is part of the graph.
Next, we graph $g(x)=x-3$ for inputs $x>2$.
Creating the input – output table, we have:

x	$g(x)$	$(x,g(x))$
3	0	$(3,0)$
4	1	$(4,1)$
5	2	$(5,2)$

The open circle indicates that $(2,-1)$ is not part of the graph.



62. Graph $g(x)=\begin{cases}x^2, & \text{for } x<0\\ -3, & \text{for } x=0\\ -2x+3, & \text{for } x>0\end{cases}$.



63. Graph $f(x)=\begin{cases}-7, & \text{for } x=2\\ x^2-3, & \text{for } x\neq 2\end{cases}$.

First, we graph $f(x)=-7$ for $x=2$.

This graph consists of only one point, $(2,-7)$.

The solid dot indicates that $(2,-7)$ is part of the graph.

Next, we graph $f(x)=x^2-3$ for inputs $x\neq -2$. Note that for $f(x)=x^2-3$

$f(-3)=(-3)^2-3=6$

$f(-1)=(-1)^2-3=-2$

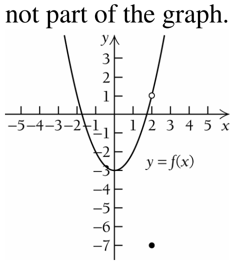
$f(0)=(0)^2-3=-3$

$f(1)=(1)^2-3=-2$

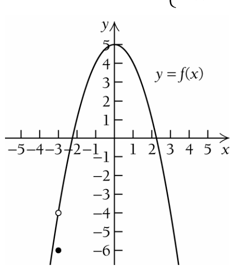
$f(3)=(3)^2-3=6$

x	$f(x)$	$(x,f(x))$
-3	6	$(-3,6)$
-1	-2	$(-1,-2)$
0	-3	$(0,-3)$
1	-2	$(1,-2)$
3	6	$(3,6)$

Since the input $x=2$ is not defined on this part of the graph, the point $(2,1)$ is not part of the graph. The open circle indicates that $(2,1)$ is not part of the graph.



64. Graph $f(x)=\begin{cases}-6, & \text{for } x=-3\\ -x^2+5, & \text{for } x\neq -3\end{cases}$.



65. a) Locate 5 on the horizontal axis and move directly up to the graph. Then move across to the vertical axis and read the value there. We estimate that approximately 600 million CD's were sold in 2005.

b) Locate 710 (million) on the vertical axis and move horizontally across to the graph. The input that corresponds to 710 is approximately 1. Therefore, we estimate that in 2001 approximately 710 million CD's were sold.

66. a) The average ticket price in 2003 is approximately \$20.

b) The average ticket price first hit \$14 during 1998.

67. a) Yes, each graph is a function. We can test this by applying the vertical line test. We see that every vertical line will intersect both graphs exactly once.

b) Locate 1990 on the horizontal axis and move directly up to the blue graph (gross receipts). Then move across to the vertical axis and read the value there. We estimate that the gross receipts of the federal government in 1990 were approximately \$1050 billion.

c) Locate 800 (billion) on the vertical axis and move horizontally across to the red graph (gross outlays). Then move down to the horizontal axis and read the value of the input there. We estimate that gross federal outlays were \$800 billion around 1982 or 1983.

68. a) In 1997 and 2002 the gross receipts and outlays were approximately the same.

b) Gross receipts were the least in 1980.

c) Gross outlays were the greatest in 2005.

69. $A(t)=P\left(1+\frac{0.06}{4}\right)^{4t}$

We substitute 500 in for P and 2 in for t.

$$A(t)=500\left(1+\frac{0.06}{4}\right)^{4\cdot 2}$$
$$=500(1.015)^8$$
$$=500(1.126492587)$$
$$=563.2462933$$
$$\approx 563.25$$

The investment will be worth approximately \$563.25 after 2 years.

70. $A(t) = P\left(1+\dfrac{0.06}{4}\right)^{4t}$

$$A(t) = 800\left(1+\frac{0.06}{4}\right)^{4\cdot 3}$$
$$= 800(1.015)^{12}$$
$$\approx 956.49$$

The investment will be worth approximately \$956.49 after 3 years.

71. $s = \sqrt{\dfrac{hw}{3600}}$

a) We substitute 170 for h and 70 for w.

$$s = \sqrt{\frac{(170)(70)}{3600}} \approx 1.818$$

The patient's approximate surface area is $1.818\,m^2$

b) We substitute 170 for h and 100 for w.

$$s = \sqrt{\frac{(170)(100)}{3600}} \approx 2.173$$

The patient's approximate surface area is $2.173\,m^2$

c) We substitute 170 for h and 50 for w.

$$s = \sqrt{\frac{(170)(50)}{3600}} \approx 1.537$$

The patient's approximate surface area is $1.537\,m^2$

72. $s = \sqrt{\dfrac{hw}{3600}}$

a) $s = \sqrt{\dfrac{(150)(70)}{3600}} \approx 1.708$

The patient's approximate surface area is $1.708\,m^2$.

b) $s = \sqrt{\dfrac{(180)(70)}{3600}} \approx 1.871$

The patient's approximate surface area is $1.871\,m^2$.

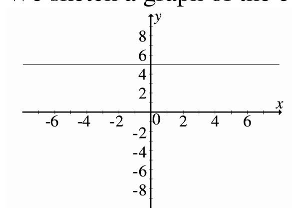
73. a) Yes, the table represents a function. Each event is assigned exactly one scale of impact number.

b) The inputs are the events; the outputs are the scale of impact numbers.

74. Solve the equation for y.

$$2x + y - 16 = 4 - 3y + 2x$$
$$y - 16 = 4 - 3y$$
$$4y = 20$$
$$y = 5$$

We sketch a graph of the equation.

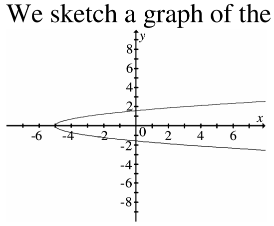


No vertical line meets the graph more than once. Thus, the equation represents a function.

75. First we solve the equation for y.

$$2y^2 + 3x = 4x + 5$$
$$2y^2 = x + 5 \quad \text{subtract } 3x \text{ from both sides}$$
$$y^2 = \frac{x+5}{2} \quad \text{divide both sides by 2}$$
$$y = \pm\sqrt{\frac{x+5}{2}} \quad \text{take the square root of both sides}$$

We sketch a graph of the equation.

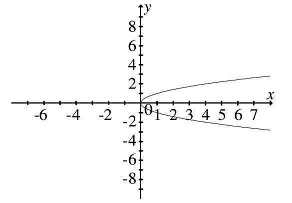


We can see that a vertical line will intersect the graph more than once; therefore, this is not a function.

76. First we solve the equation for y.

$$\left(4y^{2/3}\right)^3 = 64x$$
$$4^3\left(y^{2/3}\right)^3 = 4^3 x$$
$$y^2 = x$$
$$y = \pm\sqrt{x}$$

Next, we sketch a graph:



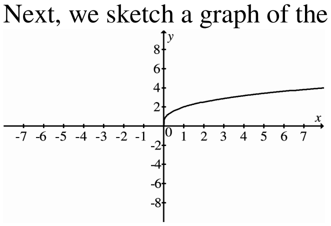
We can see that a vertical line will intersect the graph more than once; therefore, this is not a function.

77. First, we solve the equation for *y*.

$$\left(3y^{3/2}\right)^2 = 72x$$
$$9y^3 = 72x$$
$$y^3 = 8x$$
$$y = \sqrt[3]{8x}$$
$$y = 2\sqrt[3]{x} \qquad [y \geq 0]$$

Note: since *y* must be non-negative to satisfy the original equation, we only graph the points for which *y* is non-negative.

Next, we sketch a graph of the equation:

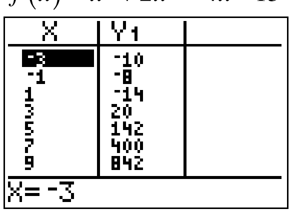


No vertical line meets the graph more than once. Thus, the equation represents a function.

78. $\boxed{tw}$ Answers will vary. The vertical line test works, because you are locating the values to which each input corresponds. For a relation to be a function, each input must correspond with exactly one output. Therefore, if a vertical line intersect the graph in more than one point, that means that particular input corresponds to more than one output and the graph is not a function.

79. $\boxed{tw}$ Yes, $x = 4$ is in the domain of *f* in Exercises 51-54. The function is defined for all values of *x*.

80. $f(x) = x^3 + 2x^2 - 4x - 13$

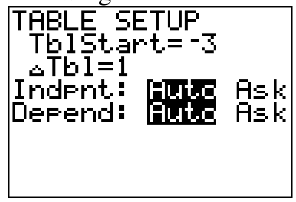


X	Y1
-3	-10
-1	-8
1	-14
3	20
5	142
7	400
9	842

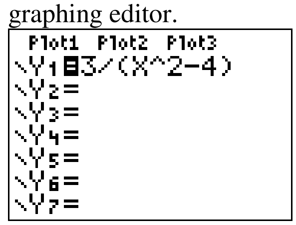
X=-3

81. $f(x) = \dfrac{3}{x^2 - 4}$

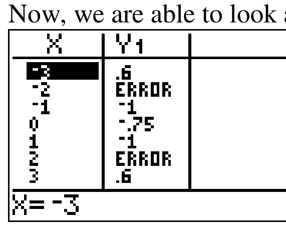
We begin by setting up the table in the following manner:



Next, we will type in the equation into the graphing editor.



Now, we are able to look at the table:

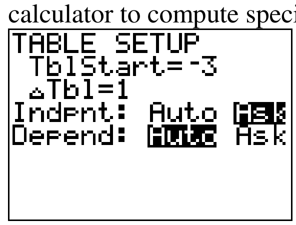


X	Y1
-3	.6
-2	ERROR
-1	-1
0	-.75
1	-1
2	ERROR
3	.6

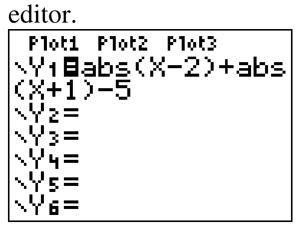
X=-3

82. $f(x) = |x-2| + |x+1| - 5$

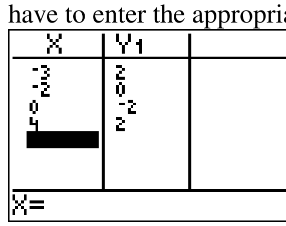
First, we set up the table to allow us to ask the calculator to compute specific values.



Next, we type the equation into the graphing editor.



Now, we are able to look at the table. We will have to enter the appropriate values of *x*.



X	Y1
-3	2
-2	0
0	-2
4	2

X=

From the table on the previous page we conclude:

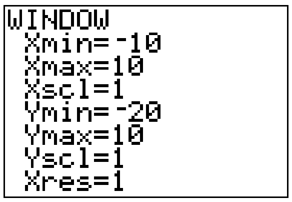
$f(-3)=2$

$f(-2)=0$

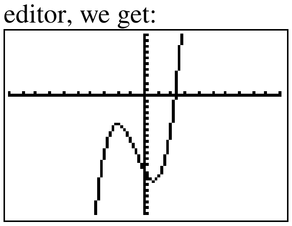
$f(0)=-2$

$f(4)=2$

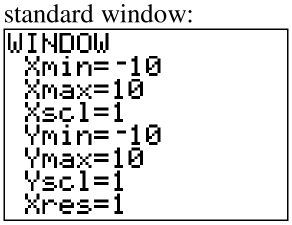
83. Each graph is shown below.
In order to graph $f(x)=x^3+2x^2-4x-13$, we use the window:



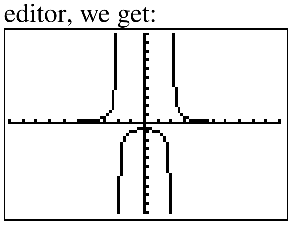
After entering the function into the graphing editor, we get:



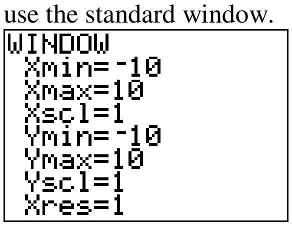
In order to graph $f(x)=\dfrac{3}{x^2-4}$, we use the standard window:



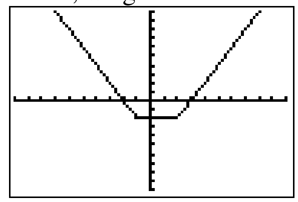
After entering the function into the graphing editor, we get:



In order to graph $f(x)=|x-2|+|x+1|-5$, we use the standard window.



After entering the function into the graphing editor, we get:



84. Answers will vary. Some ordered pairs are $(-2.978723, 1.0617)$, $(-1.382979, 2.8438301)$, $(0, 3.1622777)$, $(1.7021277, 2.6651006)$, and $(2.6595745, 1.7107494)$.

Exercise Set R.3

1. $[-2,4]$

2. $(-1,3)$

3. $(0,5)$

4. $[-1,2]$

5. $[-9,-4)$

6. $(-9,-5]$

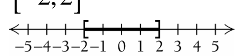
7. $[x, x+h]$

8. $(x, x+h]$

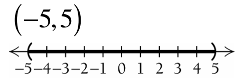
9. (p,∞)

10. $(-\infty,q]$

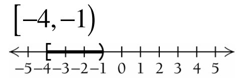
11. $[-2,2]$



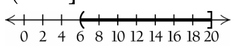
12. $(-5,5)$



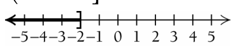
13. $[-4,-1)$



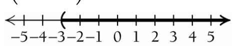
14. $(6, 20]$



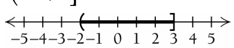
15. $(-\infty, -2]$



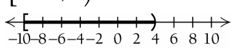
16. $(-3, \infty)$



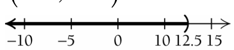
17. $(-2, 3]$



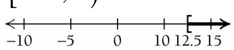
18. $[-10, 4)$



19. $(-\infty, 12.5)$



20. $[12.5, \infty)$



21. a) First, we locate 1 on the horizontal axis and then we look vertically to find the point on the graph for which 1 is the first coordinate. From that point, we look to the vertical axis to find the corresponding *y*-coordinate, 3. Thus, $f(1) = 3$.

b) The domain is the set of all *x*-values of the points on the graph. The domain is $\{-3, -1, 1, 3, 5\}$.

c) First, we locate 2 on the vertical axis and then we look horizontally to find any points on the graph for which 2 is the second coordinate. One such point exists, $(3, 2)$. Thus the *x*-value for which $f(x) = 2$ is $x = 3$.

d) The range is the set of all *y*-values of the points on the graph. The range is $\{-2, 0, 2, 3, 4\}$.

22. a) $f(1) = -1$.

b) The domain is $\{-4, -3, -2, -1, 0, 1, 2\}$.

c) The point on the graph with the second coordinate 2 is $(-2, 2)$. Thus the *x*-value for which $f(x) = 2$ is $x = -2$.

d) The range is $\{-2, -1, 0, 1, 2, 3, 4\}$.

23. a) First, we locate 1 on the horizontal axis and then we look vertically to find the point on the graph for which 1 is the first coordinate. From that point, we look to the vertical axis to find the corresponding *y*-coordinate, 4. Thus, $f(1) = 4$.

b) The domain is the set of all *x*-values of the points on the graph. The domain is $\{-5, -3, 1, 2, 3, 4, 5\}$.

c) First, we locate 2 on the vertical axis and then we look horizontally to find any points on the graph for which 2 is the second coordinate. Three such point exists, $(-5, 2); (-3, 2);$ and $(4, 2)$. Thus the *x*-values for which $f(x) = 2$ are $\{-5, -3, 4\}$.

d) The range is the set of all *y*-values of the points on the graph. The range is $\{-3, 2, 4, 5\}$

24. a) $f(1) = 2$.

b) The domain is $\{-6, -4, -2, 0, 1, 3, 4\}$.

c) The points on the graph with the second coordinate 2 are $(1, 2)$ and $(3, 2)$. Thus the *x*-values for which $f(x) = 2$ are $\{1, 3\}$.

d) The range is $\{-5, -2, 0, 2, 5\}$.

25. a) First, we locate 1 on the horizontal axis and then we look vertically to find the point on the graph for which 1 is the first coordinate. From that point, we look to the vertical axis to find the corresponding *y*-coordinate, -1. Thus, $f(1) = -1$.

b) The domain is the set of all *x*-values of the points on the graph. These extend from -2 to 4. Thus, the domain is $\{x \mid -2 \le x \le 4\}$, or in interval notation $[-2, 4]$.

c) First, we locate 2 on the vertical axis and then we look horizontally to find any points on the graph for which 2 is the second coordinate. One such point exists, $(3, 2)$. Thus the *x*-value for which $f(x) = 2$ is $x = 3$.

d) The range is the set of all *y*-values of the points on the graph. These extend from -3 to 3. Thus, the range is $\{y \mid -3 \le y \le 3\}$, or, in interval notation $[-3, 3]$.

26. a) $f(1) \approx 2.5$.

b) The domain is $\{x \mid -3 \le x \le 5\}$ or $[-3,5]$.

c) The point on the graph with the second coordinate 2 appears to be $(2.25,2)$. Thus the x-value for which $f(x) = 2$ is $x = 2.25$.

d) The range is $\{y \mid 1 \le y \le 4\}$, or, $[1,4]$.

27. a) First, we locate 1 on the horizontal axis and then we look vertically to find the point on the graph for which 1 is the first coordinate. From that point, we look to the vertical axis to find the corresponding y-coordinate, -2. Thus, $f(1) = -2$.

b) The domain is the set of all x-values of the points on the graph. These extend from -4 to 2. Thus, the domain is $\{x \mid -4 \le x \le 2\}$, or, in interval notation $[-4,2]$.

c) First, we locate 2 on the vertical axis and then we look horizontally to find any points on the graph for which 2 is the second coordinate. One such point exists, $(-2,2)$. Thus the x-value for which $f(x) = 2$ are $x = -2.$

d) The range is the set of all y-values of the points on the graph. These extend from -3 to 3. Thus, the range is $\{y \mid -3 \le y \le 3\}$, or in interval notation $[-3,3]$.

28. a) $f(1) \approx 2.25$.

b) The domain is $\{x \mid -4 \le x \le 3\}$ or $[-4,3]$.

c) The point on the graph with the second coordinate 2 appears to be $(0,2)$. Thus the x-value for which $f(x) = 2$ is $x = 0.$.

d) The range is $\{y \mid -5 \le y \le 4\}$, or, $[-5,4]$.

29. a) First, we locate 1 on the horizontal axis and then we look vertically to find the point on the graph for which 1 is the first coordinate. From that point, we look to the vertical axis to find the corresponding y-coordinate, 3. Thus, $f(1) = 3$.

b) The domain is the set of all x-values of the points on the graph. These extend from -3 to 3. Thus, the domain is $\{x \mid -3 \le x \le 3\}$, or, in interval notation $[-3,3]$.

c) First, we locate 2 on the vertical axis and then we look horizontally to find any points on the graph for which 2 is the second coordinate. Two such point exists, $(-1.4,2)$ and $(1.4,2)$. Thus the x-values for which $f(x) = 2$ are $\{-1.4,1.4\}$.

d) The range is the set of all y-values of the points on the graph. These extend from -5 to 4. Thus, the range is $\{y \mid -5 \le y \le 4\}$, or in interval notation $[-5,4]$.

30. a) $f(1) \approx 2$.

b) The domain is $\{x \mid -5 \le x \le 4\}$ or $[-5,4]$.

c) The points on the graph with the second coordinate 2 are all the points with the x-value in the set $\{x \mid 1 \le x \le 4\}$. Thus the x-values for which $f(x) = 2$ are $\{x \mid 1 \le x \le 4\}$, or $[1,4]$.

d) The range is $\{y \mid -3 \le y \le 2\}$, or $[-3,2]$.

31. a) First, we locate 1 on the horizontal axis and then we look vertically to find the point on the graph for which 1 is the first coordinate. From that point, we look to the vertical axis to find the corresponding y-coordinate, 1. Thus, $f(1) = 1$.

b) The domain is the set of all x-values of the points on the graph. These extend from -5 to 5. However, the open circle at the point $(5,2)$ indicates that 5 is not in the domain. Thus, the domain is $\{x \mid -5 \le x < 5\}$, or in interval notation $[-5,5)$.

c) First, we locate 2 on the vertical axis and then we look horizontally to find any points on the graph for which 2 is the second coordinate. We notice all the points with x-values in the set $\{x \mid 3 \le x < 5\}$ Thus the x-values for which $f(x) = 2$ are $\{x \mid 3 \le x < 5\}$, or $[3,5)$.

d) The range is the set of all y-values of the points on the graph. The range is $\{-2,-1,0,1,2\}$

32. a) $f(1) = 2$.

b) The domain is $\{x \mid -4 \le x \le 4\}$ or $[-4,4]$.

c) The points on the graph with the second coordinate 2 are all the points with the x-value in the set $\{x \mid 0 < x \le 2\}$. Thus the x-values for which $f(x) = 2$ are $\{x \mid 0 < x \le 2\}$, or $(0,2]$.

d) The range is $\{1,2,3,4\}$.

33. $f(x) = \dfrac{6}{2-x}$

Since the function value cannot be calculated when the denominator is equal to 0, we solve the following equation to find those real numbers that must be excluded from the domain of *f*.

$2 - x = 0$ setting the denominator equal to 0

$2 = x$ adding x to both sides

Thus, 2 is not in the domain of *f*, while all other real numbers are. The domain of *f* is $\{x \mid x \text{ is a real number and } x \ne 2\}$; or, in interval notation, $(-\infty,2)\cup(2,\infty)$

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

Set the denominator equal to 0 and solve.

$x + 3 = 0$

$x = -3$

The domain is $\{x \mid x \text{ is a real number and } x \ne -3\}$, or, in interval notation, $(-\infty,-3)\cup(-3,\infty)$

35. $f(x) = \sqrt{2x}$

Since the function value cannot be calculated when the radicand is negative, the domain is all real numbers for which $2x \ge 0$. We find them by solving the inequality.

$2x \ge 0$ setting the radicand $\ge$ 0

$x \ge 0$ dividing both sides by 2

The domain of *f* is $\{x \mid x \text{ is a real number and } x \ge 0\}$; or, in interval notation, $[0,\infty)$.

36. $f(x) = \sqrt{x-2}$

Solve $x - 2 \ge 0$

$x \ge 2$

The domain of *f* is $\{x \mid x \text{ is a real number and } x \ge 2\}$; or, in interval notation, $[2,\infty)$.

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

We can calculate the function value for all values of x, so the domain is the set of all real numbers $\mathbb{R}$.

38. $f(x) = x^2 + 3$

We can calculate the function value for all values of x, so the domain is the set of all real numbers $\mathbb{R}$.

39. $f(x) = \dfrac{x-2}{6x-12}$

Since the function value cannot be calculated when the denominator is equal to 0, we solve the following equation to find those real numbers that must be excluded from the domain of *f*.

$6x - 12 = 0$ setting the denominator equal to 0

$6x = 12$ adding 12 to both sides

$x = 2$ dividing both sides by 6

Thus, 2 is not in the domain of *f*, while all other real numbers are. The domain of *f* is $\{x \mid x \text{ is a real number and } x \ne 2\}$; or, in interval notation, $(-\infty,2)\cup(2,\infty)$

40. $f(x) = \dfrac{8}{3x-6}$

Solve $3x - 6 = 0$

$x = 2$.

The domain of *f* is $\{x \mid x \text{ is a real number and } x \ne 2\}$; or, in interval notation, $(-\infty,2)\cup(2,\infty)$.

41. $f(x) = |x-4|$

We can calculate the function value for all values of x, so the domain is the set of all real numbers $\mathbb{R}$.

42. $f(x) = |x| - 4$

We can calculate the function value for all values of x, so the domain is the set of all real numbers $\mathbb{R}$.

43. $f(x) = \dfrac{3x-1}{7-2x}$

Since the function value cannot be calculated when the denominator is equal to 0, we solve the equation on the following page to find those real numbers that must be excluded from the domain of *f*.

$7-2x=0$ setting the denominator equal to 0

$7=2x$ adding $2x$ to both sides

$\frac{7}{2}=x$ dividing both sides by 2

Thus, $\frac{7}{2}$ is not in the domain of *f*, while all other real numbers are. The domain of *f* is $\left\{x \mid x \text{ is a real number and } x \neq \frac{7}{2}\right\}$; or, in interval notation, $\left(-\infty, \frac{7}{2}\right) \cup \left(\frac{7}{2}, \infty\right)$.

44. $f(x)=\frac{2x-1}{9-2x}$

Solve $9-2x=0$

$x=\frac{9}{2}$

Thus, $\frac{9}{2}$ is not in the domain of *f*, while all other real numbers are. The domain of *f* is $\left\{x \mid x \text{ is a real number and } x \neq \frac{9}{2}\right\}$; or, in interval notation, $\left(-\infty, \frac{9}{2}\right) \cup \left(\frac{9}{2}, \infty\right)$.

45. $g(x)=\sqrt{4+5x}$

Since the function value cannot be calculated when the radicand is negative, the domain is all real numbers for which $4+5x \geq 0$. We find them by solving the inequality.

$4+5x \geq 0$ setting the radicand ≥ 0

$5x \geq -4$ subtracting 4 from both sides

$x \geq -\frac{4}{5}$ dividing both sides by 5

The domain of *g* is $\left\{x \mid x \text{ is a real number and } x \geq -\frac{4}{5}\right\}$; or, in interval notation, $\left[-\frac{4}{5}, \infty\right)$.

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

Solve $2-3x \geq 0$

$2 \geq 3x$

$\frac{2}{3} \geq x$

The domain of *g* is $\left\{x \mid x \text{ is a real number and } x \leq \frac{2}{3}\right\}$; or, in interval notation, $\left(-\infty, \frac{2}{3}\right]$.

47. $g(x)=x^2-2x+1$

We can calculate the function value for all values of *x*, so the domain is the set of all real numbers $\mathbb{R}$.

48. $g(x)=4x^3+5x^2-2x$

We can calculate the function value for all values of *x*, so the domain is the set of all real numbers $\mathbb{R}$.

49. $g(x)=\frac{2x}{x^2-25}$

Since the function value cannot be calculated when the denominator is equal to 0, we solve the following equation to find those real numbers that must be excluded from the domain of *g*.

$x^2-25=0$ setting the denominator equal to 0

$x^2=25$ adding 25 to both sides

$x=\pm\sqrt{25}$ taking the square root or both sides

$x=\pm 5$

Thus, -5 and 5 are not in the domain of *g*, while all other real numbers are. The domain of *g* is $\{x \mid x \text{ is a real number and } x \neq -5,\ x \neq 5\}$; or, in interval notation, $(-\infty,-5) \cup (-5,5) \cup (5,\infty)$.

50. $g(x)=\frac{x-1}{x^2-36}$

Solve $x^2-36=0$

$x^2=36$

$x=\pm 6$

The domain of *g* is $\{x \mid x \text{ is a real number and } x \neq -6, x \neq 6\}$; or, in interval notation, $(-\infty,-6) \cup (-6,6) \cup (6,\infty)$.

51. $g(x)=|x|+1$

We can calculate the function value for all values of *x*, so the domain is the set of all real numbers $\mathbb{R}$.

52. $g(x)=|x+7|$

We can calculate the function value for all values of x, so the domain is the set of all real numbers $\mathbb{R}$.

53. $g(x)=\dfrac{2x-6}{x^2-6x+5}$

Since the function value cannot be calculated when the denominator is equal to 0, we solve the following equation to find those real numbers that must be excluded from the domain of *f*.

$x^2-6x+5=0$ setting the denominator equal to 0

$(x-5)(x-1)=0$ factoring the quadratic equation

$x-5=0$ or $x-1=0$ Using the principle of zero products

$x=5$ or $x=1$

Thus, 1 and 5 are not in the domain of *g*, while all other real numbers are. The domain of *g* is $\{x \mid x \text{ is a real number and } x\neq 1, x\neq 5\}$; or, in interval notation, $(-\infty,1)\cup(1,5)\cup(5,\infty)$.

54. $g(x)=\dfrac{3x-10}{x^2-4x-5}$

Solve $x^2-4x-5=0$

$(x+1)(x-5)=0$

$x+1=0$ or $x-5=0$

$x=-1$ or $x=5$

The domain of *g* is

$\{x \mid x \text{ is a real number and } x\neq -1, x\neq 5\}$; or, in interval notation, $(-\infty,-1)\cup(-1,5)\cup(5,\infty)$.

55. The graph of *f* lies on or below the *x*-axis when $f(x)\leq 0$, so we scan the graph from left to right looking for the values of *x* for which the graph lies on or below the *x* axis. Those values extend from -1 to 2. So the set of *x*-values for which $f(x)\leq 0$ is $\{x \mid -1\leq x\leq 2\}$, or, in interval notation, $[-1,2]$.

56. The graph crosses the line $y=1$ at every integer value of *x*. Therefore, the set of *x*-values for which $g(x)=1$ is $\{x \mid x \text{ is an integer}\}$.

57. a) We use the compound interest formula from Theorem 2 in section R.1 and substitute 5000 for *P*, 2 for *n* and 0.08 (8%) for *i*. The equation for this function is:

$$A=P\left(1+\frac{i}{n}\right)^{nt}$$

$$A=5000\left(1+\frac{0.08}{2}\right)^{2t}$$

$$A=5000(1.04)^{2t}$$

b) The independent variable *t* is the time in years the principal has been invested in the account. It would not make sense to have time be a negative number in this case. Therefore, the domain is the set of all non-negative real numbers. $\{t \mid 0\leq t<\infty\}$.

58. a) We use the compound interest formula from Theorem 2 in section R.1 and substitute 3000 for *P*, 365 for *n* and 0.05 (5%) for *i*. The equation for this function is:

$$A=P\left(1+\frac{i}{n}\right)^{nt}$$

$$A=3000\left(1+\frac{0.05}{365}\right)^{365t}$$

$$A=3000(1.000136986)^{365t}$$

b) The independent variable *t* is the time in years the principal has been invested in the account. It would not make sense to have time be a negative number in this case. Therefore, the domain is the set of all non-negative real numbers. $\{t \mid 0\leq t<\infty\}$.

59. a) The graph extends from $x=0$ to $x=84.7$, so the domain, in interval notation, of the function *N* is $[0,84.7]$

b) The graph extends from $N(x)=0$ to $N(x)=4.6$ million. Therefore, the range, in interval notation, of the function *N* is $[0, 4{,}600{,}000]$.

c) $\boxed{tw}$ Answers will vary. We would target the 50 year old to 60 year old age group, because that is the age group that has the most number of hearing-impaired Americans.

60. a) The domain in interval notation is $[25,102]$.

b) The range in interval notation is $[0,455]$.

c) $\boxed{tw}$ Answers will vary. Since we are looking for the greatest increase in the incidence of breast cancer, we are looking for the steepest portion of the graph. It appears that the greatest increase occurs from age 50 to age 60.

61. a) The graph extends from $t = 0$ to $t = 65$, so the domain, in interval notation, of the function L is $[0,65]$.

b) The graph extends from $L(x) = 8$ to $L(x) = 75$, so the range, in interval notation, of the function L is $[8,75]$.

62. a) The x-value where the cancer rate is 50 per 100,000 is approximately $x = 26$ or the year 1966.

b) There are two x-values where the cancer rate is 70 per 100,000. The first x-value is $x = 41$ or the year 1981, and the second x-value is $x = 60$ or the year 2000.

c) In 2005, $t = 2005 - 1940 = 65$

$$\begin{aligned} L(65) &= -0.00054(65)^3 + 0.02917(65)^2 + \\ &\qquad 1.2329(65) + 8 \\ &= 63.08425 \\ &\approx 63 \end{aligned}$$

The lung and bronchus cancer rate in 2005 is approximately 63 per 100,000.

63. $\boxed{tw}$ Answers may vary. Some possible answers are. The output -5 corresponds with the input 2. The point $(2,-5)$ is on the graph of the function. The value $x = 2$ is the solution to the equation $f(x) = -5$.

64. $\boxed{tw}$ Answers may vary. Given a domain each value in the domain corresponds to exactly one value in the range. It is certainly possible for each member of the domain to correspond with itself. Consider the function: $y = x$. Here the domain and the range are the same set.

65. $\boxed{tw}$ Answers may vary. Consider the function $f(x) = \dfrac{1}{x-3}$. Here the number 3 is not in the domain of f because replacing x with 3 results in division by zero.

66. The range in interval notation for each function is:

Exercise 33: $(-\infty,0)\cup(0,\infty)$

Exercise 35: $[0,\infty)$

Exercise 39: $\left\{\frac{1}{6}\right\}$

Exercise 40: $(-\infty,0)\cup(0,\infty)$

Exercise 47: $[0,\infty)$

67. The range in interval notation for each function is:

Exercise 34: $(-\infty,0)\cup(0,\infty)$

Exercise 36: $[0,\infty)$

Exercise 48: $\mathbb{R}$

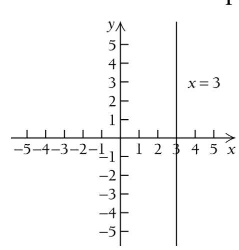
Exercise 51: $[1,\infty)$

Exercise 54: $\mathbb{R}$

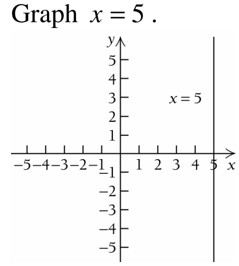
Exercise Set R.4

1. Graph $x = 3$.

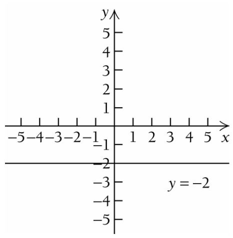
The graph consists of all ordered pairs whose first coordinate is 3. This results in a vertical line whose x-intercept is the point $(3,0)$



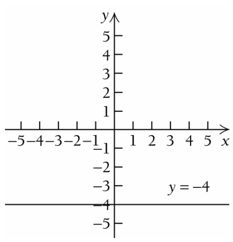
2. Graph $x = 5$.



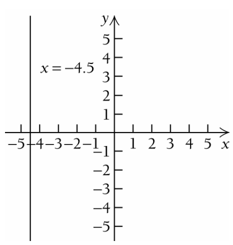
3. Graph $y = -2$.
The graph consists of all ordered pairs whose second coordinate is -2. This results in a horizontal line whose y-intercept is the point $(0,-2)$.



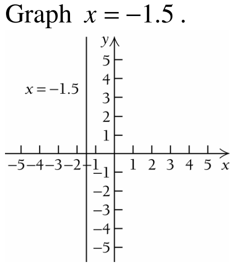
4. Graph $y = -4$.



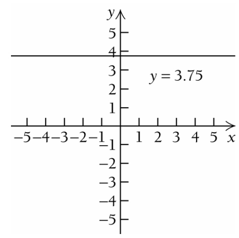
5. Graph $x = -4.5$.
The graph consists of all ordered pairs whose first coordinate is – 4.5. This results in a vertical line whose x-intercept is the point $(-4.5,0)$.



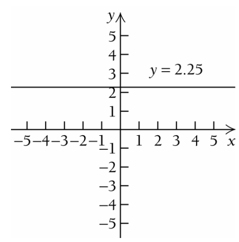
6. Graph $x = -1.5$.



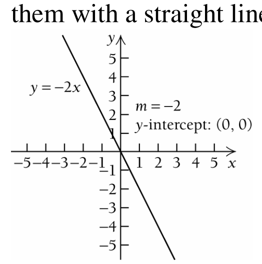
7. Graph $y = 3.75$.
The graph consists of all ordered pairs whose second coordinate is 3.75. This results in a horizontal line whose y-intercept is the point $(0,3.75)$.



8. Graph $y = 2.25$.

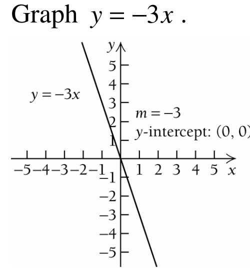


9. Graph $y = -2x$.
Using Theorem 4, The graph of y is the straight line through the origin $(0,0)$ and the point $(1,-2)$. We plot these two points and connect them with a straight line.



The function $y = -2x$ has slope –2, and y-intercept $(0,0)$.

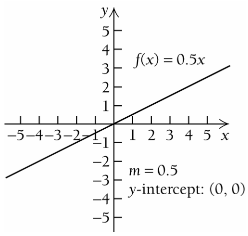
10. Graph $y = -3x$.



The function $y = -3x$ has slope –3, and y-intercept $(0,0)$.

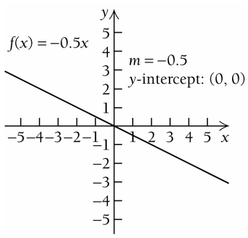
11. Graph $f(x) = 0.5x$.

Using Theorem 4, The graph of $f(x)$ is the straight line through the origin $(0,0)$ and the point $(1,0.5)$. We plot these two points and connect them with a straight line.



The function $f(x) = 0.5x$ has slope 0.5, and y-intercept $(0,0)$.

12. Graph $f(x) = -0.5x$



The function $f(x) = -0.5x$ has slope –0.5, and y-intercept $(0,0)$.

13. Graph $y = 3x - 4$

First, we make a table of values. We choose any number for x and then determine y by substitution.

When $x = -1, y = 3(-1) - 4 = -7$.

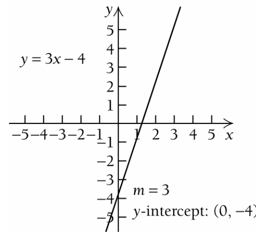
When $x = 0, y = 3(0) - 4 = -4$.

When $x = 2, y = 3(2) - 4 = 2$.

We organize these values into an input – output table.

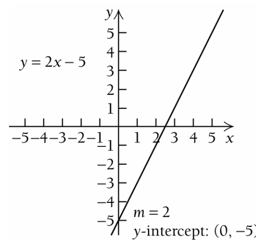
x	y	(x,y)
-1	-7	$(-1,-7)$
0	-4	$(0,-4)$
2	2	$(2,2)$

Next, we plot these ordered pairs and connect them with a straight line.



The function $y = 3x - 4$ has slope 3, and y-intercept $(0,-4)$.

14. Graph $y = 2x - 5$.



The function $y = 2x - 5$ has slope 2, and y-intercept $(0,-5)$.

15. Graph $g(x) = -x + 3$.

First, we make a table of values. We choose any number for x and then determine y by substation. Because the function is linear, we save ourselves some work by only plotting two points.

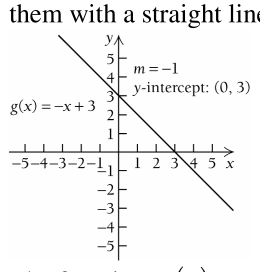
When $x = 0, g(0) = -(0) + 3 = 3$.

When $x = 1, g(1) = -(1) + 3 = 2$.

We organize these values into an input – output table.

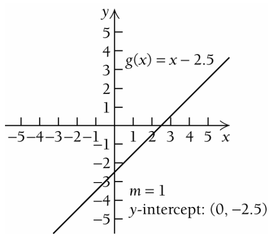
x	$g(x)$	$(x,g(x))$
0	3	$(0,3)$
1	2	$(1,2)$

Next, we plot these ordered pairs and connect them with a straight line.



The function $g(x) = -x + 3$ has slope – 1, and y-intercept $(0,3)$.

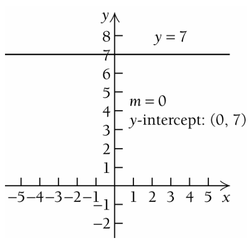
16. Graph $g(x) = x - 2.5$.



The function $g(x) = x - 2.5$ has slope 1, and y-intercept $(0, -2.5)$.

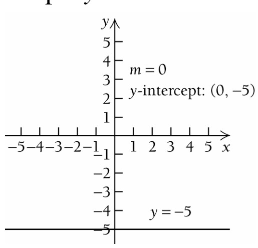
17. Graph $y = 7$.

The graph consists of all ordered pairs whose second coordinate is 7. This results in a horizontal line, whose y-intercept is the point $(0, 7)$.



Since the graph is horizontal, the slope is 0 and the y-intercept is $(0, 7)$.

18. Graph $y = -5$.



Since the graph is horizontal, the slope is 0 and the y-intercept is $(0, -5)$.

19. First, we solve the equation for y.

$$y - 3x = 6$$
$$y = 3x + 6 \quad \text{adding } 3x \text{ to both sides}$$

The slope is 3.

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

20. First, we solve the equation for y.

$$y - 4x = 1$$
$$y = 4x + 1$$

The slope is 4.

The y-intercept is $(0, 1)$.

21. First, we solve the equation for y.

$$2x + y - 3 = 0$$
$$2x + y = 3 \quad \text{adding 3 to both sides}$$
$$y = -2x + 3 \quad \text{subtracting } 2x \text{ from both sides}$$

The slope is –2.

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

22. First, we solve the equation for y.

$$2x - y + 3 = 0$$
$$y = 2x + 3$$

The slope is 2.

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

23. First, we solve the equation for y.

$$2x + 2y + 8 = 0$$
$$2x + 2y = -8 \quad \text{subtracting 8}$$
$$2y = -2x - 8 \quad \text{subtracting } 2x$$
$$y = \frac{-2x - 8}{2} \quad \text{dividing both sides by 2}$$
$$y = -x - 4 \quad \text{simplifying}$$

The slope is –1.

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

24. First, we solve the equation for y.

$$3x - 3y + 6 = 0$$
$$y = x + 2$$

The slope is 1.

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

25. First, we solve the equation for y.

$$x = 3y + 7$$
$$3y + 7 = x \quad \text{commutative property of equality}$$
$$3y = x - 7 \quad \text{subtracting 7}$$
$$y = \frac{x - 7}{3} \quad \text{dividing by 3}$$
$$y = \frac{1}{3}x - \frac{7}{3} \quad \text{simplifying}$$

The slope is $\frac{1}{3}$.

The y-intercept is $\left(0, -\frac{7}{3}\right)$.

26. First, we solve the equation for *y*.

$x = -4y + 3$

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

The slope is $-\frac{1}{4}$.

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

27.
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - (-3) &= -5(x - (-2)) && \text{Substituting} \\ y + 3 &= -5(x + 2) && \text{Simplifying} \\ y + 3 &= -5x - 10 \\ y &= -5x - 13 && \text{Subtracting 3} \end{aligned}$$

28.
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - (7) &= 7(x - (1)) \\ y - 7 &= 7x - 7 \\ y &= 7x \end{aligned}$$

29.
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - (3) &= -2(x - (2)) && \text{Substituting} \\ y - 3 &= -2x + 4 \\ y &= -2x + 7 && \text{Adding 3} \end{aligned}$$

30.
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - (-2) &= -3(x - (5)) \\ y + 2 &= -3x + 15 \\ y &= -3x + 13 \end{aligned}$$

31.
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - (0) &= 2(x - (3)) && \text{Substituting} \\ y &= 2x - 6 \end{aligned}$$

32.
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - (0) &= -5(x - (5)) \\ y &= -5x + 25 \end{aligned}$$

33.
$$\begin{aligned} y &= mx + b \\ y &= \frac{1}{2}x + (-6) && \text{Substituting} \\ y &= \frac{1}{2}x - 6 && \text{Simplifying} \end{aligned}$$

34.
$$\begin{aligned} y &= mx + b \\ y &= \frac{4}{3}x + 7 && \text{Substituting} \end{aligned}$$

35.
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - (3) &= 0(x - (2)) && \text{Substituting} \\ y - 3 &= 0 && \text{Simplifying} \\ y &= 3 && \text{Adding 3} \end{aligned}$$

36.
$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - (8) &= 0(x - (4)) \\ y - 8 &= 0 \\ y &= 8 \end{aligned}$$

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

Substituting, we have:

$$\begin{aligned} m &= \frac{1 - (-3)}{-2 - 5} \\ &= \frac{1 + 3}{-2 - 5} \\ &= \frac{4}{-7} \\ &= -\frac{4}{7} \end{aligned}$$

Note: it does not matter which point is taken first, as long as we subtract coordinates in the same order. We could also find the slope as follows.

$$\begin{aligned} m &= \frac{(-3) - 1}{5 - (-2)} \\ &= \frac{-3 - 1}{5 + 2} \\ &= \frac{-4}{7} \\ &= -\frac{4}{7} \end{aligned}$$

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

$$\begin{aligned} m &= \frac{3 - 1}{6 - (-2)} \\ &= \frac{2}{8} \\ &= \frac{1}{4} \end{aligned}$$

39. $m=\dfrac{y_2-y_1}{x_2-x_1}$

Substituting, we have:

$$m=\frac{-4-(-3)}{-1-2}=\frac{-4+3}{-1-2}=\frac{-1}{-3}=\frac{1}{3}$$

40. $m=\dfrac{y_2-y_1}{x_2-x_1}$

$$m=\frac{-6-(-5)}{1-(-3)}=-\frac{1}{4}$$

41. $m=\dfrac{y_2-y_1}{x_2-x_1}$

Substituting, we have:

$$m=\frac{-9-(-7)}{3-3}=\frac{-9+7}{3-3}=\frac{-2}{0}$$

Since we cannot divide by 0, the slope is undefined.

42. $m=\dfrac{y_2-y_1}{x_2-x_1}$

$$m=\frac{10-(2)}{-4-(-4)}=\frac{8}{0}$$

Since we cannot divide by 0, the slope is undefined.

43. $m=\dfrac{y_2-y_1}{x_2-x_1}$

Substituting, we have:

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

$$=\frac{\frac{2}{5}-\left(-\frac{15}{5}\right)}{\frac{5}{10}-\frac{8}{10}} \quad \text{finding a common denominator}$$

$$=\frac{\frac{17}{5}}{-\frac{3}{10}} \quad \text{adding fractions}$$

$$=\frac{17}{5}\cdot\left(-\frac{10}{3}\right) \quad \text{Multiplying by the reciprical}$$

$$=-\frac{34}{3}$$

44. $m=\dfrac{y_2-y_1}{x_2-x_1}$

$$m=\frac{-\frac{3}{4}-\left(-\frac{1}{2}\right)}{\frac{5}{8}-\left(-\frac{3}{16}\right)}=\frac{\frac{-3}{4}+\frac{2}{4}}{\frac{10}{16}+\frac{3}{16}}=\frac{-\frac{1}{4}}{\frac{13}{16}}$$

$$=-\frac{4}{13}$$

45. $m=\dfrac{y_2-y_1}{x_2-x_1}$

Substituting, we have:

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

46. $m=\dfrac{y_2-y_1}{x_2-x_1}$

$$m=\frac{\frac{1}{2}-\left(\frac{1}{2}\right)}{-7-(-6)}=\frac{0}{-1}=0$$

47. $m = \dfrac{y_2 - y_1}{x_2 - x_1}$

Substituting, we have:

$$\begin{aligned} m &= \frac{3(x+h)-(3x)}{(x+h)-x} \\ &= \frac{3x+3h-3x}{x+h-x} \\ &= \frac{3h}{h} \\ &= 3 \end{aligned}$$

48. $m = \dfrac{y_2 - y_1}{x_2 - x_1}$

$$\begin{aligned} m &= \frac{4(x+h)-(4x)}{(x+h)-x} \\ &= \frac{4x+4h-4x}{x+h-x} \\ &= \frac{4h}{h} \\ &= 4 \end{aligned}$$

49. $m = \dfrac{y_2 - y_1}{x_2 - x_1}$

Substituting, we have:

$$\begin{aligned} m &= \frac{[2(x+h)+3]-(2x+3)}{(x+h)-x} \\ &= \frac{2x+2h+3-(2x+3)}{x+h-x} \\ &= \frac{2h}{h} \\ &= 2 \end{aligned}$$

50. $m = \dfrac{y_2 - y_1}{x_2 - x_1}$

Substituting, we have:

$$\begin{aligned} m &= \frac{[3(x+h)-1]-(3x-1)}{(x+h)-x} \\ &= \frac{3x+3h-1-(3x-1)}{x+h-x} \\ &= \frac{3h}{h} \\ &= 3 \end{aligned}$$

51. From Exercise 37, we know that the slope is $-\dfrac{4}{7}$. Using the point $(5,-3)$, we substitute into the point-slope equation.

$$\begin{aligned} y-(-3) &= -\frac{4}{7}(x-5) \\ y+3 &= -\frac{4}{7}x+\frac{20}{7} \\ y &= -\frac{4}{7}x+\frac{20}{7}-3 \\ y &= -\frac{4}{7}x-\frac{1}{7} \end{aligned}$$

Note: We could have found the equation of the line using the point $(-2,1)$.

$$\begin{aligned} y-(1) &= -\frac{4}{7}(x-(-2)) \\ y-1 &= -\frac{4}{7}x-\frac{8}{7} \\ y &= -\frac{4}{7}x-\frac{8}{7}+1 \\ y &= -\frac{4}{7}x-\frac{1}{7} \end{aligned}$$

52. From Exercise 38, we know that the slope is $\dfrac{1}{4}$. Using the point $(-2,1)$, we substitute into the point-slope equation.

$$\begin{aligned} y-(1) &= \frac{1}{4}(x-(-2)) \\ y-1 &= \frac{1}{4}x+\frac{1}{2} \\ y &= \frac{1}{4}x+\frac{3}{2} \end{aligned}$$

Alternatively, using the point $(6,3)$ we get:

$$\begin{aligned} y-(3) &= \frac{1}{4}(x-6) \\ y-3 &= \frac{1}{4}x-\frac{3}{2} \\ y &= \frac{1}{4}x+\frac{3}{2} \end{aligned}$$

53. From Exercise 39, we know that the slope is $\frac{1}{3}$. Using the point $(2,-3)$, we substitute into the point-slope equation.

$$\begin{aligned} y-(-3) &= \frac{1}{3}(x-2) \\ y+3 &= \frac{1}{3}x-\frac{2}{3} \\ y &= \frac{1}{3}x-\frac{2}{3}-3 \\ y &= \frac{1}{3}x-\frac{11}{3} \end{aligned}$$

Note: We could have found the equation of the line using the point $(-1,-4)$.

$$\begin{aligned} y-(-4) &= \frac{1}{3}(x-(-1)) \\ y+4 &= \frac{1}{3}x+\frac{1}{3} \\ y &= \frac{1}{3}x+\frac{1}{3}-4 \\ y &= \frac{1}{3}x-\frac{11}{3} \end{aligned}$$

54. From Exercise 40, we know that the slope is $-\frac{1}{4}$. Using the point $(-3,-5)$, we substitute into the point-slope equation.

$$\begin{aligned} y-(-5) &= -\frac{1}{4}(x-(-3)) \\ y+5 &= -\frac{1}{4}x-\frac{3}{4} \\ y &= -\frac{1}{4}x-\frac{23}{4} \end{aligned}$$

Alternatively, using the point $(1,-6)$ we get:

$$\begin{aligned} y-(-6) &= -\frac{1}{4}(x-(1)) \\ y+6 &= -\frac{1}{4}x+\frac{1}{4} \\ y &= -\frac{1}{4}x-\frac{23}{4} \end{aligned}$$

55. From Exercise 41, we know that the slope is undefined. The graph is a line which contains all ordered pairs whose first coordinate is 3. The equation of the line is $x=3$

56. From Exercise 42, we know that the slope is undefined. Thus, it is a vertical line. The equation is $x=-4$.

57. From Exercise 43, we know that the slope is $-\frac{34}{3}$. Using the point $\left(\frac{4}{5},-3\right)$, we substitute into the point-slope equation.

$$\begin{aligned} y-(-3) &= -\frac{34}{3}\left(x-\frac{4}{5}\right) \\ y+3 &= -\frac{34}{3}x+\frac{136}{15} \\ y &= -\frac{34}{3}x+\frac{136}{15}-3 \\ y &= -\frac{34}{3}x+\frac{91}{15} \end{aligned}$$

Note: We could have found the equation of the line using the point $\left(\frac{1}{2},\frac{2}{5}\right)$.

$$\begin{aligned} y-\left(\frac{2}{5}\right) &= -\frac{34}{3}\left(x-\frac{1}{2}\right) \\ y-\frac{2}{5} &= -\frac{34}{3}x+\frac{17}{3} \\ y &= -\frac{34}{3}x+\frac{17}{3}+\frac{2}{5} \\ y &= -\frac{34}{3}x+\frac{91}{15} \end{aligned}$$

58. From Exercise 44, we know that the slope is $-\frac{4}{13}$. Using the point $\left(-\frac{3}{16},-\frac{1}{2}\right)$, we substitute into the point-slope equation.

$$\begin{aligned} y-\left(-\frac{1}{2}\right) &= -\frac{4}{13}\left(x-\left(-\frac{3}{16}\right)\right) \\ y+\frac{1}{2} &= -\frac{4}{13}x-\frac{12}{208} \\ y &= -\frac{4}{13}x-\frac{3}{52}-\frac{1}{2} \\ y &= -\frac{4}{13}x-\frac{29}{52} \end{aligned}$$

Note: We could have found the equation of the line using the point $\left(\frac{5}{8},-\frac{3}{4}\right)$.

$$\begin{aligned} y-\left(-\frac{3}{4}\right) &= -\frac{4}{13}\left(x-\left(\frac{5}{8}\right)\right) \\ y+\frac{3}{4} &= -\frac{4}{13}x+\frac{5}{26} \\ y &= -\frac{4}{13}x-\frac{29}{52} \end{aligned}$$

59. From Exercise 45, we know that the slope is 0. The line is horizontal, thus the equation is $y = 3$.

60. From Exercise 46, we know that the slope is 0. The line is horizontal, thus the equation is $y = \frac{1}{2}$.

61. $\text{Slope} = \frac{2ft}{5ft} = \frac{2}{5} = 0.4$

The slope of the skateboard ramp is 0.4.

62. $\text{Slope} = \frac{0.4ft}{5ft} = \frac{0.4}{5} = \frac{2}{25} = 0.08$.

The grade is then 8%.

63. $\text{Slope} = \frac{43.33ft}{1238ft} = \frac{43.33}{1238} = \frac{7}{200} = 0.035$

Expressing the slope as a percentage, we find the head of the river is 3.5%.

64. $\text{Slope} = \frac{8.25in}{9in} = \frac{11}{12} = 0.91\overline{6}$

The maximum grade of stairs in North Carolina is 91%. Don't round up for legal reasons!

65. The average rate of change can be found using the coordinates of any two points on the line. We use the given coordinates $(2000, 6438)$ and $(2005, 10,880)$.

$$\text{Rate of Change} = \frac{\text{change in premiums}}{\text{corresponding change in time}}$$

$$= \frac{10,880 - 6438}{2005 - 2000}$$
$$= \frac{4442}{5}$$
$$= 888.40$$

The average rate of change in annual premium for a family's health insurance was \$888 per year.

66. $$\text{Rate of Change} = \frac{4024 - 2471}{2005 - 2000} = \frac{1553}{5} = 310.60$$

The average rate of change in the annual premium for a single person is \$311 per year.

67. The average rate of change can be found using the coordinates of any two points on the line. We use the given coordinates $(1995, 1192)$ and $(2004, 1670)$.

$$\text{Rate of Change} = \frac{1670 - 1192}{2004 - 1995} = \frac{478}{9} \approx 53.11$$

The average rate of change of the tuition and fees at public two-year colleges is approximately \$53 per year.

68. $$\text{Rate of Change} = \frac{26,327 - 15,208}{2005 - 1990} = \frac{11,119}{15} \approx 741.27$$

The average rate of change of the cost of a formal wedding is approximately \$741 per year.

69. a) If R is directly proportional to T, then there is some positive constant m such that $R = mT$.

To find m, substitute 12.51 for R, and 3 for T into the equation $R = mT$ and solve for m.

$$12.51 = m \cdot 3$$
$$\frac{12.51}{3} = m$$
$$4.17 = m$$

The variation constant $m = 4.17$. The equation of variation is $R = 4.17T$.

b) Using the equation of variation found in part (a), we substitute 6 for T.

$$R = 4.17(6)$$
$$= 25.02$$

The R-Factor for insulation that is 6 inches thick is 25.02.

70. The equation of variation is $D = 293t$. The distance the impulse has to travel is 6 ft. So we solve:

$$6 = 293t$$
$$\frac{6}{293} = t$$
$$0.0204778157 = t$$
$$0.02 \approx t$$

It would take an impulse 0.02 seconds to travel from the toes of the person to the brain.

71. a) Since the muscle weight M is directly proportional to the person's body weight W, there is a positive constant m such that $M = mW$.
To find m, we substitute 80 for M and 200 for W into $M = mW$ solve for m.

$$80 = m \cdot 200$$
$$\frac{80}{200} = m$$
$$0.4 = m$$

The constant of variation $m = 0.4$. The equation of variation is $M = 0.4W$.

b) The constant of variation $m = 0.4$ is equivalent to 40%. Thus the equation of variation is $M = 40\%W$. This implies that muscle weight, M, makes up 40% of total body weight, W.

c) Substituting 120 for W into the equation of variation we have:

$$M = 0.4(120)$$
$$= 48$$

A person weighing 120 pounds has 48 pounds of muscle weight.

72. a) $B = mW$

$$3 = m \cdot 120$$
$$0.025 = m$$

The constant of variation is $m = 0.025$. The equation of variation is $B = 0.025W$.

b) The constant of variation $m = 0.025$ is equivalent to 2.5%, so we have $B = 2.5\%W$. The weight, B, of a human's brain is 2.5% of the persons total body weight, W..

c) $B = 0.025(160)$

$$= 4$$

A person weighing 160 pounds has a brain that weighs 4 pounds.

73. a) If T, the amount of the toll, is directly proportional to the weight of the vehicle, w. Then there exists a constant m such that $T = mw$.
To find m, we substitute 2.70 for T and 3350 for w into $T = mw$ and solve for m.

$$2.70 = m \cdot 3350$$
$$\frac{2.70}{3350} = m$$
$$0.0008 \approx m$$

The constant of variation is $m = 0.0008$. The equation of variation is $T = 0.0008w$.

b) Substituting 3700 for w into the equation of variation, we have:

$$T = 0.0008(3700)$$
$$= 2.96$$

The toll would be $2.96 for a Jeep Cherokee.

74. a)

$$I = ms$$
$$16 = m \cdot 2800$$
$$\frac{16}{2800} = m$$
$$0.0057 = m$$

The constant of variation is $m = 0.0057$. The equation of variation is $I = 0.0057s$

b) $I = 0.0057s$

$$= 0.0057 \cdot 3100$$
$$= 17.67$$
$$\approx 18$$

The university would need 18 inkjet cartridges if 3100 students were enrolled.

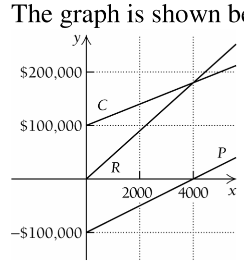
75. a) Total costs = Variables costs + Fixed Costs
To produce x calculators, it costs $20 dollars per calculator, that is the variable costs are $20x$. In addition to the variable costs the fixed costs are $100,000. The total cost is $C(x) = 20x + 100{,}000$.
The graph is shown below.

b) Revenue = Price times Quantity.
The price of the calculator is $45, therefore, the revenue from selling x calculators is given by
$R(x) = 45x$.
The graph is shown below.

c) Profit = Revenue – Cost.
Using the Cost and Revenue functions found in part (a) and (b) we have:

$$P(x) = R(x) - C(x)$$
$$= 45x - (20x + 100{,}000)$$
$$= 25x - 100{,}000$$

The graph is shown below.



d) Substituting 150,000 for x into the profit equation, we have

$$P(150{,}000) = 25(150{,}000) - 100{,}000$$
$$= 3{,}650{,}000$$

The company would realize a \$3,650,000 profit if they reach their expected sales of 150,000 calculators.

e) The break even point occurs when $P(x) = 0$. Therefore, we set the profit function equal to 0 and solve for x.

$$25x - 100{,}000 = 0$$
$$25x = 100{,}000$$
$$x = \frac{100{,}000}{25}$$
$$x = 4000$$

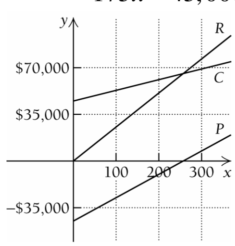
The company would need to sell 4000 calculators at \$45 each in order to break even.

76. a) $C(x) = 80x + 45{,}000$

b) $R(x) = 255x$

c) $P(x) = R(x) - C(x)$

$$P(x) = 255x - (80x + 45{,}000)$$
$$= 175x - 45{,}000$$



d) $P(3000) = 175(3000) - 45{,}000 = 480{,}000$

Total profit will be \$480,000 if they sell the expected 3000 pairs of skis.

e) $P(x) = 0$

$$175x - 45{,}000 = 0$$
$$175x = 45{,}000$$
$$x = \frac{45{,}000}{175}$$
$$x = 257.14$$
$$x \approx 258$$

They will need to sell 258 pairs of ski's in order to break even.

77. a) $V(t) = C - t\left(\frac{C - S}{N}\right)$

Substituting 5200 for C, 1100 for S, and 8 for N into the equation we have the straight line depreciation $V(t)$:

$$V(t) = 5200 - t\left(\frac{5200 - 1100}{8}\right)$$
$$= 5200 - t\left(\frac{4100}{8}\right)$$
$$= 5200 - t(512.5)$$
$$= 5200 - 512.5t$$

b) $V(t) = 5200 - 512.5t$

$$V(0) = 5200 - 512.5(0) = \$5200.00$$
$$V(1) = 5200 - 512.5(1) = \$4687.50$$
$$V(2) = 5200 - 512.5(2) = \$4175.00$$
$$V(3) = 5200 - 512.5(3) = \$3662.50$$
$$V(4) = 5200 - 512.5(4) = \$3150.00$$
$$V(7) = 5200 - 512.5(7) = \$1612.50$$
$$V(8) = 5200 - 512.5(8) = \$1100.00$$

78. a) $C(x) = 4x + 250$

b) $P(x) = R(x) - C(x)$

Substituting the profit in cost functions into the equation we have:

$$9x - 250 = R(x) - (4x + 250)$$
$$9x - 250 = R(x) - 4x - 250$$
$$13x = R(x)$$

Since Revenue is equal to price times quantity. Jimmy charges \$13 per lawn.

c) Solve $P(x) = 0$

$$9x - 250 = 0$$
$$9x = 250$$
$$x = 27.77\overline{7}$$
$$x \approx 28$$

Jimmy will need to mow 28 lawns in order to break even.

79. $V(t) = C - t\left(\frac{C - S}{N}\right)$

First, we figure the total cost of the improvements. 25,000 at \$40 per square foot gives us a total cost of $C = (40)(25{,}000) = 1{,}000{,}000$.

After 39 years, the salvage value S is 0. Therefore, we substitute 1,000,000 for C, 39 for N, and 0 for S into the straight-line depreciations formula.

$$V(t) = 1{,}000{,}000 - t\left(\frac{1{,}000{,}000 - 0}{39}\right)$$

$$V(t) = 1{,}000{,}000 - t(25{,}641.02564)$$

$$V(t) = 1{,}000{,}000 - 25{,}641.02564t$$

In order to find the depreciated value of the improvements after 10 years, we substitute 10 for t.

$$\begin{aligned} V(10) &= 1{,}000{,}000 - 25{,}641.02564(10) \\ &= 743{,}589.7436 \\ &\approx 743{,}589.74 \end{aligned}$$

The depreciated value of the improvements after 10 years is approximately \$743,590.

80. $V(t) = C - t\left(\dfrac{C - S}{N}\right)$

$$\begin{aligned} V(t) &= 60{,}000 - t\left(\frac{60{,}000 - 2000}{5}\right) \\ &= 60{,}000 - 11{,}600t \end{aligned}$$

$$V(3) = 60{,}000 - 11{,}600(3) = 25{,}200$$

The computer system will have a book value of \$25,200 after 3 years.

81. $B(t) = -700t + 3500$

a) The number –700 is the rate of change in the value of the photocopier per year. In other words, it tells us that the photocopier depreciates \$700 per year.
The number 3500 is the initial value of the photocopier. In other words, the value of the photocopier at the time of purchase was \$3500.

b) From the graph we see that $B(t) = 0$ when $t = 5$. Since we have the equation, we set $B(t) = 0$ and solve for t to double check the graph.

$$\begin{aligned} -700t + 3500 &= 0 \\ 3500 &= 700t \\ \frac{3500}{700} &= t \\ 5 &= t \end{aligned}$$

It will take 5 years for the photocopier to depreciate completely.

c) $\boxed{tw}$ The domain of B is the set of all non-negative real x-values for which B is non-negative. From the graph we see that this set is $[0,5]$.

82. a) $D(F) = 2F + 115$

$$D(0^\circ) = 2(0^\circ) + 115 = 115$$

$$D(-20^\circ) = 2(-20^\circ) + 115 = 75$$

$$D(10^\circ) = 2(10^\circ) + 115 = 135$$

$$D(32^\circ) = 2(32^\circ) + 115 = 179$$

b) $\boxed{tw}$ The domain should be restricted to the set of F –values for which D is non-negative. So we find where $D(F) = 0$.

$$\begin{aligned} 0 &= 2F + 115 \\ -2F &= 115 \\ F &= \frac{115}{-2} \\ F &= -57.5^\circ \end{aligned}$$

When the temperature is at least -57.5° the stopping distance is non-negative. Temperatures below -57.5° have negative stopping distances, which are not logical in the context of the problem. Since ice forms at 32°, for all temperatures above 32° there is no glare ice, so the formula does not apply. Therefore, the domain for D should be restricted to the interval $[-57.5^\circ, 32^\circ]$.

83. a) $D(r) = \dfrac{11r + 5}{10}$

$$D(5) = \frac{11(5) + 5}{10} = 6$$

When traveling 5 miles per hour, the car's reaction distance is 6 feet.

$$D(10) = \frac{11(10) + 5}{10} = 11.5$$

When traveling 10 miles per hour, the car's reaction distance is 11.5 feet.

$$D(20) = \frac{11(20) + 5}{10} = 22.5$$

When traveling 20 miles per hour, the car's reaction distance is 22.5 feet.

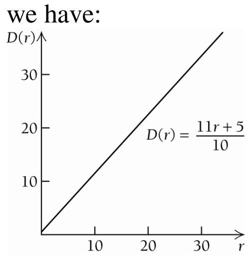
$$D(50) = \frac{11(50) + 5}{10} = 55.5$$

When traveling 50 miles per hour, the car's reaction distance is 55.5 feet.

$$D(65) = \frac{11(65)+5}{10} = 72$$

When traveling 65 miles per hour, the car's reaction distance is 72 feet.

b) Plotting the points found in part (a) and connecting the points with a smooth curve we have:



c) $\boxed{tw}$ Answers may vary. Negative speed has no meaning and when the speed is 0 mph, the car is already stopped. So theoretically, the domain would be $(0,\infty)$. However, realistically, the domain would have an upper bound that depended on the car's maximum obtainable speed.

84. a) $M(26) = 2.89(26) + 70.64 = 145.78$

The male was 145.78 cm tall.

b) $F(26) = 2.75(26) + 71.48 = 142.98$

The female was 142.98 cm tall.

85. a) We find the equation of the line that contains the points $(1999, 1873)$ and $(2006, 3116)$. First we find the slope of the line.

$$m = \frac{3116-1873}{2006-1999} = \frac{1243}{7} \approx 177.57 \approx 178$$

Next, we use the point-slope equation. We will use the point $(1999, 1873)$.

$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 1873 &= 178(x - 1999) \\ y - 1873 &= 178x - 355{,}822 \\ y &= 178x - 353{,}949 \qquad (1) \end{aligned}$$

Note: due to round off error, if we used the point $(2006, 3116)$ we would have:

$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 3116 &= 178(x - 2006) \\ y - 3116 &= 178x - 357{,}068 \\ y &= 178x - 353{,}952 \qquad (2) \end{aligned}$$

b) Using the first equation substituting 2000 for x we have:

$$y = 178(2000) - 353{,}949 = 2051$$

Approximately 2051 manatees were counted in January of 2000.

Alternatively, using the second equation and substituting 2000 for x we have:

$$y = 178(2000) - 353{,}952 = 2048$$

Approximately 2048 manatees were counted in January of 2000.

c) $\boxed{tw}$ The equation represents the 1999 and 2006 counts accurately, but overestimates the 2000 count by 422 manatees (419 when using the second equation). This would lead us to think that it is probably inaccurate for other years as well. This probably means that the growth of the manatees is not linear.

86. a) We find the equation of the line that contains the points $(1999, 215)$ and $(2003, 543)$. First we find the slope of the line.

$$m = \frac{543-215}{2003-1999} = \frac{328}{4} = 82$$

Next, we use the point-slope equation. We will use the point $(1999, 215)$.

$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 215 &= 82(x - 1999) \\ y - 215 &= 82x - 163{,}918 \\ y &= 82x - 163{,}703 \end{aligned}$$

b) Substituting 2002 for x we have

$$y = 82(2002) - 163{,}703 = 461$$

Approximately 461 mallards were counted in 2002.

c) $\boxed{tw}$ The equation represents the 1999 and 2006 counts accurately, but overestimates the 2000 count by 233 mallards. This would lead us to think that it is probably inaccurate for other years as well. This probably means that the growth of the mallards is not linear.

87. a) We know that $N = P + 0.02P = 1.02P$. Therefore the equation of variation is $N = 1.02P$.

b) Substituting 200,000 for P we have $N = 1.02(200{,}000) = 204{,}000$.

The new population is 204,000 after a growth of 2%.