Chapter 2
Functions and Linear Functions

2.1 Check Points

1. The domain is the set of all first components. The domain is {0, 10, 20, 30, 40}.
The range is the set of all second components. The range is {9.1, 6.7, 10.7, 13.2, 21.2}.

2. **a.** The relation is not a function because an element, 5, in the domain corresponds to two elements in the range.

   b. The relation is a function.

3. **a.** $f(x) = 4x + 5$
$f(6) = 4(6) + 5$
$f(6) = 29$

   b. $g(x) = 3x^2 - 10$
$g(-5) = 3(-5)^2 - 10$
$g(-5) = 65$

   c. $h(r) = r^2 - 7r + 2$
$h(-4) = (-4)^2 - 7(-4) + 2$
$h(-4) = 46$

   d. $F(x) = 6x + 9$
$F(a+h) = 6(a+h) + 9$
$F(a+h) = 6a + 6h + 9$

4. **a.** Every element in the domain corresponds to exactly one element in the range.

   b. The domain is {0, 1, 2, 3, 4}.
The range is {3, 0, 1, 2}.

   c. $g(1) = 0$

   d. $g(3) = 2$

   e. $x = 0$ and $x = 4$.

2.1 Concept and Vocabulary Check

1. relation; domain; range

2. function

3. f, x

4. r, -2

2.1 Exercise Set

1. The relation is a function.
The domain is {1, 3, 5}.
The range is {2, 4, 5}.

2. The relation is a function.
The domain is {4,6,8}.
The range is {5,7,8}.

3. The relation is not a function.
The domain is {3, 4}.
The range is {4, 5}.

4. The relation is not a function.
The domain is {5, 6}.
The range is {6, 7}.

5. The relation is a function.
The domain is {-3, -2, -1, 0}.
The range is {-3, -2, -1, 0}.

6. The relation is a function.
The domain is {–7, –5, –3, 0}.
The range is {–7, –5, –3, 0}.

7. The relation is not a function.
The domain is {1}.
The range is {4, 5, 6}.

8. The relation is a function.
The domain is {4, 5, 6}.
The range is {1}.

9. **a.** $f(0) = 0 + 1 = 1$

   b. $f(5) = 5 + 1 = 6$

   c. $f(-8) = -8 + 1 = -7$

   d. $f(2a) = 2a + 1$

   e. $f(a+2) = (a+2) + 1$
$= a + 2 + 1 = a + 3$

10. $f(x) = x + 3$

a. $f(0) = 0 + 3 = 3$

b. $f(5) = 5 + 3 = 8$

c. $f(-8) = -8 + 3 = -5$

d. $f(2a) = 2a + 3$

e. $f(a+2) = (a+2) + 3$
$= a + 2 + 3 = a + 5$

11. a. $g(0) = 3(0) - 2 = 0 - 2 = -2$

b. $g(-5) = 3(-5) - 2$
$= -15 - 2 = -17$

c. $g\left(\frac{2}{3}\right) = 3\left(\frac{2}{3}\right) - 2 = 2 - 2 = 0$

d. $g(4b) = 3(4b) - 2 = 12b - 2$

e. $g(b+4) = 3(b+4) - 2$
$= 3b + 12 - 2 = 3b + 10$

12. $g(x) = 4x - 3$

a. $g(0) = 4(0) - 3 = 0 - 3 = -3$

b. $g(-5) = 4(-5) - 3 = -20 - 3 = -23$

c. $g\left(\frac{3}{4}\right) = 4\left(\frac{3}{4}\right) - 3 = 3 - 3 = 0$

d. $g(5b) = 4(5b) - 3 = 20b - 3$

e. $g(b+5) = 4(b+5) - 3$
$= 4b + 20 - 3 = 4b + 17$

13. a. $h(0) = 3(0)^2 + 5 = 3(0) + 5$
$= 0 + 5 = 5$

b. $h(-1) = 3(-1)^2 + 5 = 3(1) + 5$
$= 3 + 5 = 8$

c. $h(4) = 3(4)^2 + 5 = 3(16) + 5$
$= 48 + 5 = 53$

d. $h(-3) = 3(-3)^2 + 5 = 3(9) + 5$
$= 27 + 5 = 32$

e. $h(4b) = 3(4b)^2 + 5 = 3(16b^2) + 5$
$= 48b^2 + 5$

14. $h(x) = 2x^2 - 4$

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

b. $h(-1) = 2(-1)^2 - 4 = 2(1) - 4$
$= 2 - 4 = -2$

c. $h(5) = 2(5)^2 - 4 = 2(25) - 4$
$= 50 - 4 = 46$

d. $h(-3) = 2(-3)^2 - 4 = 2(9) - 4$
$= 18 - 4 = 14$

e. $h(5b) = 2(5b)^2 - 4 = 2(25b^2) - 4$
$= 50b^2 - 4$

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

b. $f(3) = 2(3)^2 + 3(3) - 1$
$= 2(9) + 9 - 1$
$= 18 + 9 - 1 = 26$

c. $f(-4) = 2(-4)^2 + 3(-4) - 1$
$= 2(16) - 12 - 1$
$= 32 - 12 - 1 = 19$

d. $f(b) = 2(b)^2 + 3(b) - 1$
$= 2b^2 + 3b - 1$

e. $f(5a) = 2(5a)^2 + 3(5a) - 1$
$= 2(25a^2) + 15a - 1$
$= 50a^2 + 15a - 1$

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

a. $f(0) = 3(0)^2 + 4(0) - 2$
$= 3(0) + 0 - 2$
$= 0 + 0 - 2 = -2$

b. $f(3) = 3(3)^2 + 4(3) - 2$
$= 3(9) + 12 - 2$
$= 27 + 12 - 2 = 37$

c. $f(-5) = 3(-5)^2 + 4(-5) - 2$
$= 3(25) - 20 - 2$
$= 75 - 20 - 2 = 53$

d. $f(b) = 3(b)^2 + 4(b) - 2$
$= 3b^2 + 4b - 2$

e. $f(5a) = 3(5a)^2 + 4(5a) - 2$
$= 3(25a^2) + 20a - 2$
$= 75a^2 + 20a - 2$

17. a. $f(0) = (-0)^3 - (0)^2 - (0) + 7$
$= 7$

b. $f(2) = (-2)^3 - (2)^2 - (2) + 7$
$= -7$

c. $f(-2) = (-(-2))^3 - (-2)^2 - (-2) + 7$
$= 13$

d. $f(1) + f(-1) = \left[(-1)^3 - (1)^2 - (1) + 7\right] + \left[(-(-1))^3 - (-1)^2 - (-1) + 7\right]$
$= 4 + 8$
$= 12$

18. a. $f(0) = (-0)^3 - (0)^2 - (0) + 10$
$= 10$

b. $f(2) = (-2)^3 - (2)^2 - (2) + 10$
$= -4$

c. $f(-2) = (-(-2))^3 - (-2)^2 - (-2) + 10$
$= 16$

d. $f(1)+f(-1)=\left[(-1)^3-(1)^2-(1)+10\right]+\left[\left(-(-1)\right)^3-(-1)^2-(-1)+10\right]$
$=7+11$
$=18$

19. a. $f(0)=\dfrac{2(0)-3}{(0)-4}=\dfrac{0-3}{0-4}$
$=\dfrac{-3}{-4}=\dfrac{3}{4}$

b. $f(3)=\dfrac{2(3)-3}{(3)-4}=\dfrac{6-3}{3-4}$
$=\dfrac{3}{-1}=-3$

c. $f(-4)=\dfrac{2(-4)-3}{(-4)-4}=\dfrac{-8-3}{-8}$
$=\dfrac{-11}{-8}=\dfrac{11}{8}$

d. $f(-5)=\dfrac{2(-5)-3}{(-5)-4}=\dfrac{-10-3}{-9}$
$=\dfrac{-13}{-9}=\dfrac{13}{9}$

e. $f(a+h)=\dfrac{2(a+h)-3}{(a+h)-4}$
$=\dfrac{2a+2h-3}{a+h-4}$

f. Four must be excluded from the domain, because four would make the denominator zero. Division by zero is undefined.

20. $f(x)=\dfrac{3x-1}{x-5}$

a. $f(0)=\dfrac{3(0)-1}{(0)-5}=\dfrac{0-1}{-5}=\dfrac{-1}{-5}=\dfrac{1}{5}$

b. $f(3)=\dfrac{3(3)-1}{3-5}=\dfrac{9-1}{-2}=\dfrac{8}{-2}=-4$

c. $f(-3)=\dfrac{3(-3)-1}{-3-5}=\dfrac{-9-1}{-8}$
$=\dfrac{-10}{-8}=\dfrac{5}{4}$

d. $f(10)=\dfrac{3(10)-1}{10-5}=\dfrac{30-1}{5}=\dfrac{29}{5}$

e. $f(a+h)=\dfrac{3(a+h)-1}{a+h-5}$
$=\dfrac{3a+3h-1}{a+h-5}$

f. Five must be excluded from the domain, because 5 would make the denominator zero. Division by zero is undefined.

21. a. $f(-2)=6$

b. $f(2)=12$

c. $x=0$

22. a. $f(-3)=8$

b. $f(3)=16$

c. $x=0$

23. a. $h(-2)=2$

b. $h(1)=1$

c. $x=-1$ and $x=1$

24. a. $h(-2)=-2$

b. $h(1)=-1$

c. $x=-1$ and $x=1$

25. $g(1)=3(1)-5=3-5=-2$
$f(g(1))=f(-2)=(-2)^2-(-2)+4$
$=4+2+4=10$

26. $g(-1)=3(-1)-5=-3-5=-8$
$f(g(-1))=f(-8)=(-8)^2-(-8)+4$
$=64+8+4=76$

27. $\sqrt{3-(-1)}-(-6)^2+6\div -6\cdot 4$
$=\sqrt{3+1}-36+-1\cdot 4$
$=\sqrt{4}-36+-4=2-36-4=-38$

28. $|-4-(-1)|-(-3)^2+-3\div 3\cdot -6$
$=|-4+1|-9+-3\div 3\cdot -6$
$=|-3|-9+-1\cdot -6$
$=3-9+6=-6+6=0$

29. $f(-x)-f(x)$
$=(-x)^3+(-x)-5-\left[x^3+x-5\right]$
$=-x^3-x-5-x^3-x+5$
$=-2x^3-2x$

30. $f(-x)-f(x)$
$=(-x)^2-3(-x)+7-\left(x^2-3x+7\right)$
$=x^2+3x+7-x^2+3x-7$
$=6x$

31. a. $f(-2)=3(-2)+5=-6+5=-1$

b. $f(0)=4(0)+7=0+7=7$

c. $f(3)=4(3)+7=12+7=19$

d. $f(-100)+f(100)$
$=3(-100)+5+4(100)+7$
$=-300+5+400+7=112$

32. a. $f(-3)=6(-3)-1=-18-1=-19$

b. $f(0)=7(0)+3=0+3=3$

c. $f(4)=7(4)+3=28+3=31$

d. $f(-100)+f(100)$
$=6(-100)-1+7(100)+3$
$=-600-1+700+3$
$=100+2=102$

33. a. {(Iceland, 9.7), (Finland, 9.6), (New Zealand, 9.6), (Denmark, 9.5)}

b. Yes, the relation is a function because each country in the domain corresponds to exactly one corruption rating in the range.

c. {(9.7, Iceland), (9.6, Finland), (9.6, New Zealand), (9.5, Denmark)}

d. No, the relation is not a function because 9.6 in the domain corresponds to two countries in the range, Finland and New Zealand.

34. **a.** {(Bangladesh, 1.7), (Chad, 1.7), (Haiti, 1.8), (Myanmar, 1.8)}

b. Yes, the relation is a function because each country in the domain corresponds to exactly one corruption rating in the range.

c. {(1.7, Bangladesh), (1.7, Chad), (1.8, Haiti), (1.8, Myanmar)}

d. No, the relation is not a function because 1.7 in the domain corresponds to two countries in the range, Bangladesh and Chad.

35. – 38. Answers will vary.

39. makes sense

40. makes sense

41. makes sense

42. does not make sense; Explanations will vary. Sample explanation: The range is the chance of divorce.

43. false; Changes to make the statement true will vary. A sample change is: All functions are relations.

44. false; Changes to make the statement true will vary. A sample change is: Functions can have ordered pairs with the same second component. It is the first component that cannot be duplicated.

45. true

46. true

47. true

48. false; $g(-4)+f(-4)$
$= (-1)+(-1)$
$= -2$

49. $f(a+h) = 3(a+h)+7 = 3a+3h+7$
$f(a) = 3a+7$
$$\frac{f(a+h)-f(a)}{h}$$
$$= \frac{(3a+3h+7)-(3a+7)}{h}$$
$$= \frac{3a+3h+7-3a-7}{h} = \frac{3h}{h} = 3$$

50. Answers will vary. An example is {(1, 1), (2, 1)}.

51. It is given that $f(x+y) = f(x)+f(y)$ and $f(1)=3$.
To find $f(2)$, rewrite 2 as 1 + 1.
$f(2) = f(1+1) = f(1)+f(1)$
$= 3+3 = 6$
Similarly:
$f(3) = f(2+1) = f(2)+f(1)$
$= 6+3 = 9$
$f(4) = f(3+1) = f(3)+f(1)$
$= 9+3 = 12$
While $f(x+y) = f(x)+f(y)$ is true for this function, it is not true for all functions. It is not true for $f(x) = x^2$, for example.

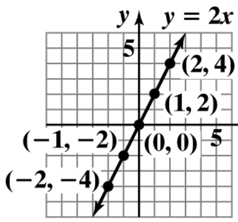
52. $24 \div 4\left[2-(5-2)\right]^2 - 6$
$= 24 \div 4\left[2-(3)\right]^2 - 6$
$= 24 \div 4(-1)^2 - 6$
$= 24 \div 4(1) - 6$
$= 6(1) - 6 = 6 - 6 = 0$

53. $$\left(\frac{3x^2y^{-2}}{y^3}\right)^{-2} = \left(\frac{3x^2}{y^5}\right)^{-2} = \left(\frac{y^5}{3x^2}\right)^2 = \frac{y^{10}}{9x^4}$$

54. $\frac{x}{3} = \frac{3x}{5} + 4$
$15\left(\frac{x}{3}\right) = 15\left(\frac{3x}{5}+4\right)$
$15\left(\frac{x}{3}\right) = 15\left(\frac{3x}{5}\right) + 15(4)$
$5x = 3(3x)+60$
$5x = 9x+60$
$5x-9x = 9x-9x+60$
$-4x = 60$
$\frac{-4x}{-4} = \frac{60}{-4}$
$x = -15$
The solution set is $\{-15\}$.

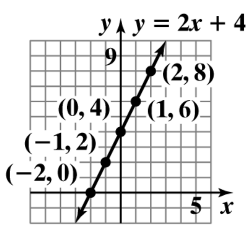
55.

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



56.

x	$f(x)=2x+4$	(x,y)
–2	$f(-2)=2(-2)+4=0$	$(-2,0)$
–1	$f(-1)=2(-1)+4=2$	$(-1,2)$
0	$f(0)=2(0)+4=4$	$(0,4)$
1	$f(1)=2(1)+4=6$	$(1,6)$
2	$f(2)=2(2)+4=8$	$(2,8)$



57. **a.** When the x-coordinate is 2, the y-coordinate is 3.

b. When the y-coordinate is 4, the x-coordinates are –3 and 3.

c. $(-\infty,\infty)$

d. $[1,\infty)$

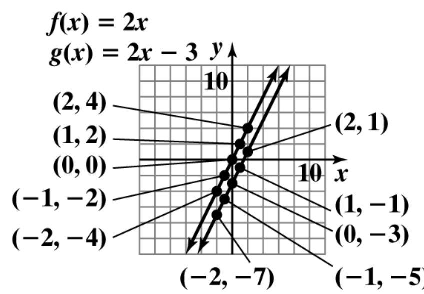
2.2 Check Points

1. $f(x)=2x$

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

$g(x)=2x-3$

x	$g(x)=2x-3$	(x,y)
–2	$g(-2)=2(-2)-3=-7$	$(-2,-7)$
–1	$g(-1)=2(-1)-3=-5$	$(-1,-5)$
0	$g(0)=2(0)-3=-3$	$(0,-3)$
1	$g(1)=2(1)-3=-1$	$(1,-1)$
2	$g(2)=2(2)-3=1$	$(2,1)$



The graph of g is the graph of f shifted down by 3 units.

2. **a.** The graph represents a function. It passes the vertical line test.

b. The graph represents a function. It passes the vertical line test.

c. The graph does not represent a function. It fails the vertical line test.

3. **a.** $f(5)=400$

b. When x is 9, the function's value is 100. i.e. $f(9)=100$

c. The minimum T cell count during the asymptomatic stage is approximately 425.

4. a. The domain is $[-2,1]$.
The range is $[0,3]$.

b. The domain is $(-2,1]$.
The range is $[-1,2)$.

c. The domain is $[-3,0)$.
The range is $\{-3,-2,-1\}$.

2.2 Concept and Vocabulary Check

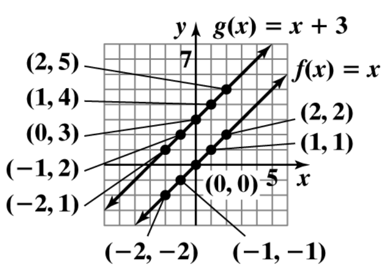
1. ordered pairs
2. more than once; function
3. $[1,3)$; domain
4. $[1,\infty)$; range

2.2 Exercise Set

1.

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

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

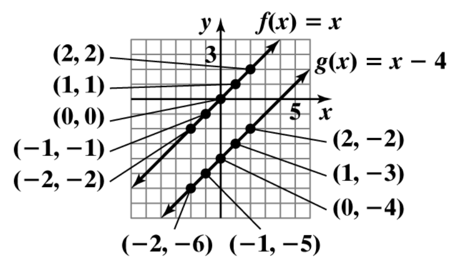


The graph of g is the graph of f shifted up 3 units.

2.

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

x	$g(x)=x-4$	(x,y)
-2	$g(-2)=-2-4=-6$	$(-2,-6)$
-1	$g(-1)=-1-4=-5$	$(-1,-5)$
0	$g(0)=0-4=-4$	$(0,-4)$
1	$g(1)=1-4=-3$	$(1,-3)$
2	$g(2)=2-4=-2$	$(2,-2)$

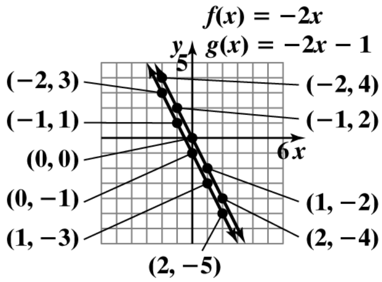


The graph of g is the graph of f shifted down 4 units.

3.

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

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

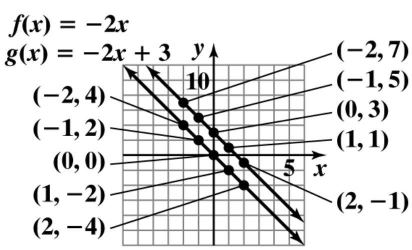


The graph of g is the graph of f shifted down 1 unit.

4.

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

x	$g(x) = -2x + 3$	(x, y)
–2	$g(-2) = -2(-2) + 3 = 7$	$(-2, 7)$
–1	$g(-1) = -2(-1) + 3 = 5$	$(-1, 5)$
0	$g(0) = -2(0) + 3 = 3$	$(0, 3)$
1	$g(1) = -2(1) + 3 = 1$	$(1, 1)$
2	$g(2) = -2(2) + 3 = -1$	$(2, -1)$

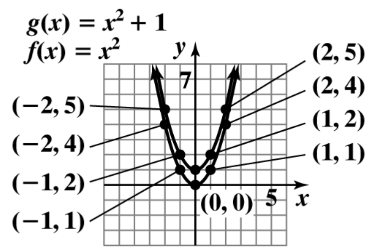


The graph of g is the graph of f shifted up 3 units.

5.

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

x	$g(x) = x^2 + 1$	(x, y)
-2	$g(-2) = (-2)^2 + 1 = 5$	$(-2, 5)$
-1	$g(-1) = (-1)^2 + 1 = 2$	$(-1, 2)$
0	$g(0) = (0)^2 + 1 = 1$	$(0, 1)$
1	$g(1) = (1)^2 + 1 = 2$	$(1, 2)$
2	$g(2) = (2)^2 + 1 = 5$	$(2, 5)$

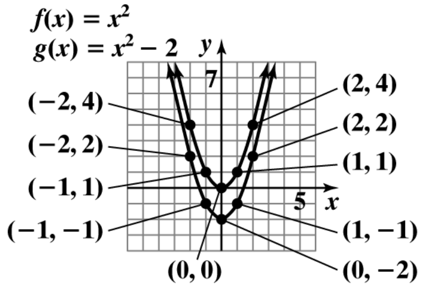


The graph of g is the graph of f shifted up 1 unit.

6.

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

x	$g(x) = x^2 - 2$	(x, y)
–2	$g(-2) = (-2)^2 - 2 = 2$	$(-2, 2)$
–1	$g(-1) = (-1)^2 - 2 = -1$	$(-1, -1)$
0	$g(0) = (0)^2 - 2 = -2$	$(0, -2)$
1	$g(1) = (1)^2 - 2 = -1$	$(1, -1)$
2	$g(2) = (2)^2 - 2 = 2$	$(2, 2)$

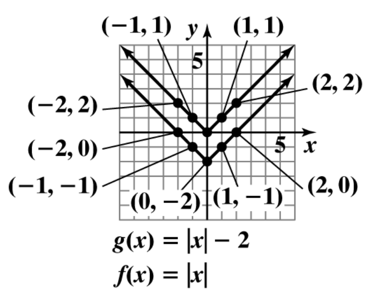


The graph of g is the graph of f shifted down 2 units.

7.

x	$f(x)=\|x\|$	(x, y)
–2	$f(-2)=\|-2\|=2$	$(-2,2)$
–1	$f(-1)=\|-1\|=1$	$(-1,1)$
0	$f(0)=\|0\|=0$	$(0,0)$
1	$f(1)=\|1\|=1$	$(1,1)$
2	$f(2)=\|2\|=2$	$(2,2)$

x	$g(x)=\|x\|-2$	(x, y)
–2	$g(-2)=\|-2\|-2=0$	$(-2,0)$
–1	$g(-1)=\|-1\|-2=-1$	$(-1,-1)$
0	$g(0)=\|0\|-2=-2$	$(0,-2)$
1	$g(1)=\|1\|-2=-1$	$(1,-1)$
2	$g(2)=\|2\|-2=0$	$(2,0)$

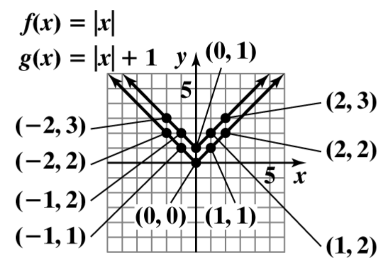


The graph of g is the graph of f shifted down 2 units.

8.

x	$f(x)=\|x\|$	(x, y)
–2	$f(-2)=\|-2\|=2$	$(-2,2)$
–1	$f(-1)=\|-1\|=1$	$(-1,1)$
0	$f(0)=\|0\|=0$	$(0,0)$
1	$f(1)=\|1\|=1$	$(1,1)$
2	$f(2)=\|2\|=2$	$(2,2)$

x	$g(x)=\|x\|+1$	(x, y)
–2	$g(-2)=\|-2\|+1=3$	$(-2,3)$
–1	$g(-1)=\|-1\|+1=2$	$(-1,2)$
0	$g(0)=\|0\|+1=1$	$(0,1)$
1	$g(1)=\|1\|+1=2$	$(1,2)$
2	$g(2)=\|2\|+1=3$	$(2,3)$

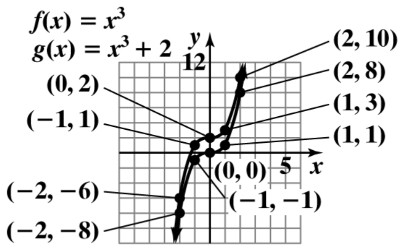


The graph of g is the graph of f shifted up 1 unit.

9.

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

x	$g(x)=x^3+2$	(x, y)
–2	$g(-2)=(-2)^3+2=-6$	$(-2,-6)$
–1	$g(-1)=(-1)^3+2=1$	$(-1,1)$
0	$g(0)=(0)^3+2=2$	$(0,2)$
1	$g(1)=(1)^3+2=3$	$(1,3)$
2	$g(2)=(2)^3+2=10$	$(2,10)$

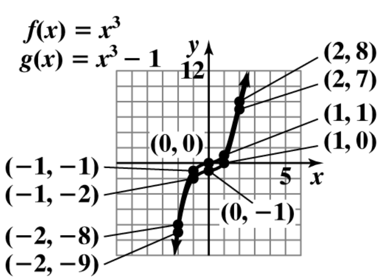


The graph of g is the graph of f shifted up 2 units.

10.

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

x	$g(x) = x^3 - 1$	(x, y)
−2	$g(-2) = (-2)^3 - 1 = -9$	$(-2, -9)$
−1	$g(-1) = (-1)^3 - 1 = -2$	$(-1, -2)$
0	$g(0) = (0)^3 - 1 = -1$	$(0, -1)$
1	$g(1) = (1)^3 - 1 = 0$	$(1, 0)$
2	$g(2) = (2)^3 - 1 = 7$	$(2, 7)$



The graph of g is the graph of f shifted down 1 unit.

11. The graph represents a function. It passes the vertical line test.

12. The graph represents a function. It passes the vertical line test.

13. The graph does not represent a function. It fails the vertical line test.

14. The graph does not represent a function. It fails the vertical line test.

15. The graph represents a function. It passes the vertical line test.

16. The graph does not represent a function. It fails the vertical line test.

17. The graph does not represent a function. It fails the vertical line test.

18. The graph represents a function. It passes the vertical line test.

19. $f(-2) = -4$

20. $f(2) = -4$

21. $f(4) = 4$

22. $f(-4) = 4$

23. $f(-3) = 0$

24. $f(-1) = 0$

25. $g(-4) = 2$

26. $g(2) = -2$

27. $g(-10) = 2$

28. $g(10) = -2$

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

30. When $x = 1$, $g(x) = -1$.

31. The domain is $[0, 5)$.
The range is $[-1, 5)$.

32. The domain is $(-5, 0]$.
The range is $[-3, 3)$.

33. The domain is $[0, \infty)$.
The range is $[1, \infty)$.

34. The domain is $[0, \infty)$.
The range is $[0, \infty)$.

35. The domain is $[-2,6]$.
The range is $[-2,6]$.

36. The domain is $[-3,2]$.
The range is $[-5,5]$.

37. The domain is $(-\infty,\infty)$
The range is $(-\infty,-2]$

38. The domain is $(-\infty,\infty)$.
The range is $[0,\infty)$.

39. The domain is $\{-5,-2,0,1,3\}$.
The range is $\{2\}$.

40. The domain is $\{-5,-2,0,1,4\}$.
The range is $\{-2\}$.

41. **a.** The domain is $(-\infty,\infty)$.

b. The range is $[-4,\infty)$

c. $f(-3)=4$

d. 2 and 6; i.e. $f(2)=f(6)=-2$

e. f crosses the x-axis at $(1,0)$ and $(7,0)$.

f. f crosses the y-axis at $(0,4)$.

g. $f(x)<0$ on the interval $(1,7)$.

h. $f(-8)$ is positive.

42. **a.** The domain is $(-\infty,6]$.

b. The range is $(-\infty,1]$.

c. $f(-4)=-1$

d. –6 and 6; i.e. $f(-6)=f(6)=-3$

e. f crosses the x-axis at $(-3,0)$ and $(3,0)$.

f. f crosses the y-axis at $(0,1)$.

g. $f(x)>0$ on the interval $(-3,3)$.

h. $f(-2)$ is positive.

43. **a.** $G(30)=-0.01(30)^2+(30)+60=81$
In 2010, the wage gap was 81%. This is represented as $(30,81)$ on the graph.

b. $G(30)$ underestimates the actual data shown by the bar graph by 2%.

44. **a.** $G(10)=-0.01(10)^2+(10)+60=69$
In 1990, the wage gap was 69%. This is represented as $(10,69)$ on the graph.

b. $G(10)$ underestimates the actual data shown by the bar graph by 2%.

45.
$$\begin{aligned}f(20)&=0.4(20)^2-36(20)+1000\\&=0.4(400)-720+1000\\&=160-720+1000\\&=-560+1000=440\end{aligned}$$
Twenty-year-old drivers have 440 accidents per 50 million miles driven.
This is represented on the graph by point (20,440).

46.
$$\begin{aligned}f(50)&=0.4(50)^2-36(50)+1000\\&=0.4(2500)-1800+1000\\&=1000-1800+1000=200\end{aligned}$$
Fifty-year-old drivers have 200 accidents per 50 million miles driven.
This is represented on the graph by point (50,200).

47. The graph reaches its lowest point at $x=45$.
$$\begin{aligned}f(45)&=0.4(45)^2-36(45)+1000\\&=0.4(2025)-1620+1000\\&=810-1620+1000\\&=-810+1000\\&=190\end{aligned}$$
Drivers at age 45 have 190 accidents per 50 million miles driven. This is the least number of accidents for any driver between ages 16 and 74.

48. Answers will vary.
One possible answer is age 16 and age 74.
$$\begin{aligned}f(16)&=0.4(16)^2-36(16)+1000\\&=0.4(256)-576+1000\\&=102.4-576+1000=526.4\end{aligned}$$
$$\begin{aligned}f(74)&=0.4(74)^2-36(74)+1000\\&=0.4(5476)-2664+1000\\&=2190.4-2664+1000=526.4\end{aligned}$$
Both 16-year-olds and 74-year-olds have approximately 526.4 accidents per 50 million miles driven.

49. $f(3) = 0.91$
The cost of mailing a first-class letter weighing 3 ounces is \$0.91.

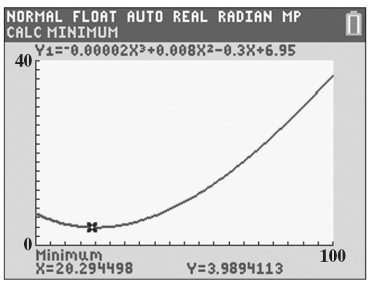
50. $f(3.5) = 1.12$
The cost of mailing a first-class letter weighing 3.5 ounces is \$1.12.

51. The cost to mail a letter weighing 1.5 ounces is \$0.70.

52. The cost to mail a letter weighing 1.8 ounces is \$0.70.

53. – 56. Answers will vary.

57. The number of physician's visits per year based on age first decreases and then increases over a person's lifetime.



These are the approximate coordinates of the point (20.3, 4.0). The means that the minimum number of physician's visits per year is approximately 4. This occurs around age 20.

58. makes sense

59. makes sense

60. does not make sense; Explanations will vary. Sample explanation: The domain is the set of number of years that people work for a company.

61. does not make sense; Explanations will vary. Sample explanation: The domain is the set of the various ages of the people.

62. false; Changes to make the statement true will vary. A sample change is: The graph of a vertical line is not a function.

63. true

64. true

65. false; Changes to make the statement true will vary. A sample change is: The range of *f* is $[-2, 2)$.

66. true

67. false; Changes to make the statement true will vary. A sample change is: $f(0) = 0.6$

68. $\sqrt{f(-1.5)+f(-0.9)}-[f(\pi)]^2+f(-3)\div f(1)\cdot f(-\pi)$
$=\sqrt{1+0}-[-4]^2+2\div(-2)(3)$
$=\sqrt{1}-16+(-1)(3)$
$=1-16-3$
$=-15-3$
$=-18$

69. $\sqrt{f(-2.5)-f(1.9)}-[f(-\pi)]^2+f(-3)\div f(1)\cdot f(\pi)$
$=\sqrt{2-(-2)}-[3]^2+2\div(-2)(-4)$
$=\sqrt{4}-9+(-1)(-4)$
$=2-9+4$
$=-3$

70. The relation is a function. Every element in the domain corresponds to exactly one element in the range.

71. $12-2(3x+1)=4x-5$
$12-6x-2=4x-5$
$10-6x=4x-5$
$-6x-4x=-5-10$
$-10x=-15$
$\frac{-10x}{-10}=\frac{-15}{-10}$
$x=\frac{3}{2}$
The solution set is $\left\{\frac{3}{2}\right\}$.

72. Let x = the width of the rectangle.
Let $3x+8=$ length of the rectangle.
$P=2l+2w$
$624=2(3x+8)+2x$
$624=6x+16+2x$
$624=8x+16$
$-8x=-608$
$x=76$
$3x+8=236$
The dimensions of the rectangle are 76 yards by 236 yards.

73. 3 must be excluded from the domain of *f* because it would cause the denominator, $x-3$, to be equal to zero. Division by 0 is undefined.

74. $f(4)+g(4)=\overbrace{(4^2+4)}^{f(4)}+\overbrace{(4-5)}^{g(4)}$
$=20+(-1)$
$=19$

75. $-2.6x^2+49x+3994-(-0.6x^2+7x+2412)$
$=-2.6x^2+49x+3994+0.6x^2-7x-2412$
$=-2x^2+42x+1582$

2.3 Check Points

1. a. The function contains neither division nor a square root. For every real number, x, the algebraic expression $\frac{1}{2}x+3$ is a real number. Thus, the domain of f is the set of all real numbers.
Domain of f is $(-\infty,\infty)$.

b. The function $g(x)=\dfrac{7x+4}{x+5}$ contains division. Because division by 0 is undefined, we must exclude from the domain the value of x that causes $x+5$ to be 0. Thus, x cannot equal –5.
Domain of g is $(-\infty,-5)$ or $(-5,\infty)$.

2. a.
$$\begin{aligned}(f+g)(x) &= f(x)+g(x)\\ &= \left(3x^2+4x-1\right)+\left(2x+7\right)\\ &= 3x^2+4x-1+2x+7\\ &= 3x^2+6x+6\end{aligned}$$

b.
$$(f+g)(x)=3x^2+6x+6$$
$$\begin{aligned}(f+g)(4) &= 3(4)^2+6(4)+6\\ &= 78\end{aligned}$$

3. a. $(f-g)(x)=\dfrac{5}{x}-\dfrac{7}{x-8}$

b. The domain of f - g is the set of all real numbers that are common to the domain of f and the domain of g. Thus, we must find the domains of f and g.

Note that $f(x)=\dfrac{5}{x}$ is a function involving division. Because division by 0 is undefined, x cannot equal 0.

The function $g(x)=\dfrac{7}{x-8}$ is also a function involving division. Because division by 0 is undefined, x cannot equal 8.
To be in the domain of f - g, x must be in both the domain of f and the domain of g.

This means that $x\neq 0$ and $x\neq 8$.
Domain of $f-g=(-\infty,0)$ or $(0,8)$ or $(8,\infty)$.

4. a. $(f+g)(5)=f(5)+g(5)=[5^2-2\cdot 5]+[5+3]=23$

b. $(f-g)(x)=f(x)-g(x)=[x^2-2x]-[x+3]=x^2-3x-3$
$(f-g)(-1)=(-1)^2-3(-1)-3=1$

c. $\left(\dfrac{f}{g}\right)(x)=\dfrac{f(x)}{g(x)}=\dfrac{x^2-2x}{x+3}$
$\left(\dfrac{f}{g}\right)(7)=\dfrac{(7)^2-2(7)}{(7)+3}=\dfrac{35}{10}=\dfrac{7}{2}$

d. $(fg)(-4) = f(-4) \cdot g(-4)$

$= \left((-4)^2 - 2(-4)\right)\left((-4)+3\right)$

$= (24)(-1)$

$= -24$

5. **a.** $(B+D)(x) = B(x) + D(x)$

$= (-2.6x^2 + 49x + 3994) + (-0.6x^2 + 7x + 2412)$

$= -2.6x^2 + 49x + 3994 - 0.6x^2 + 7x + 2412$

$= -3.2x^2 + 56x + 6406$

b. $(B+D)(x) = -3.2x^2 + 56x + 6406$

$(B+D)(5) = -3.2(3)^2 + 56(3) + 6406$

$= 6545.2$

The number of births and deaths in the U.S. in 2003 was 6545.2 thousand.

c. $(B+D)(x)$ overestimates the actual number of births and deaths in 2003 by 7.2 thousand.

2.3 Concept and Vocabulary Check

1. zero

2. negative

3. $f(x) + g(x)$

4. $f(x) - g(x)$

5. $f(x) \cdot g(x)$

6. $\dfrac{f(x)}{g(x)}$; $g(x)$

7. $(-\infty, \infty)$

8. $(2, \infty)$

9. $(0, 3)$; $(3, \infty)$

2.3 Exercise Set

1. Domain of *f* is $(-\infty, \infty)$.

2. Domain of *f* is $(-\infty, \infty)$.

3. Domain of *g* is $(-\infty, -4)$ or $(-4, \infty)$.

4. Domain of g is $(-\infty,-5)$ or $(-5,\infty)$.

5. Domain of f is $(-\infty,3)$ or $(3,\infty)$.

6. Domain of f is $(-\infty,2)$ or $(2,\infty)$.

7. Domain of g is $(-\infty,5)$ or $(5,\infty)$.

8. Domain of g is $(-\infty,6)$ or $(6,\infty)$.

9. Domain of f is $(-\infty,-7)$ or $(-7,9)$ or $(9,\infty)$.

10. Domain of f is $(-\infty,-8)$ or $(-8,10)$ or $(10,\infty)$.

11. $$\begin{aligned}(f+g)(x) &= (3x+1)+(2x-6)\\ &= 3x+1+2x-6\\ &= 5x-5\end{aligned}$$

$$\begin{aligned}(f+g)(5) &= 5(5)-5\\ &= 25-5=20\end{aligned}$$

12. $$\begin{aligned}(f+g)(x) &= (4x+2)+(2x-9)\\ &= 4x+2+2x-9\\ &= 6x-7\end{aligned}$$

$$(f+g)(5) = 6(5)-7 = 30-7 = 23$$

13. $$\begin{aligned}(f+g)(x) &= (x-5)+(3x^2)\\ &= x-5+3x^2\\ &= 3x^2+x-5\end{aligned}$$

$$\begin{aligned}(f+g)(5) &= 3(5)^2+5-5\\ &= 3(25)=75\end{aligned}$$

14. $$\begin{aligned}(f+g)(x) &= (x-6)+(2x^2)\\ &= x-6+2x^2\\ &= 2x^2+x-6\end{aligned}$$

$$\begin{aligned}(f+g)(5) &= 2(5)^2+5-6\\ &= 2(25)+5-6\\ &= 50+5-6=49\end{aligned}$$

15. $(f+g)(x)$

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

$$\begin{aligned}(f+g)(5) &= 2(5)^2 - 2\\ &= 2(25) - 2\\ &= 50 - 2 = 48\end{aligned}$$

16. $$\begin{aligned}(f+g)(x) &= \left(4x^2 - x - 3\right) + (x+1)\\ &= 4x^2 - x - 3 + x + 1\\ &= 4x^2 - 2\end{aligned}$$

$$\begin{aligned}(f+g)(5) &= 4(5)^2 - 2 = 4(25) - 2\\ &= 100 - 2 = 98\end{aligned}$$

17. $$\begin{aligned}(f+g)(x) &= (5x) + (-2x-3)\\ &= 5x - 2x - 3\\ &= 3x - 3\end{aligned}$$

$$\begin{aligned}(f-g)(x) &= (5x) - (-2x-3)\\ &= 5x + 2x + 3\\ &= 7x + 3\end{aligned}$$

$$\begin{aligned}(fg)(x) &= (5x)(-2x-3)\\ &= -10x^2 - 15x\end{aligned}$$

$$\left(\frac{f}{g}\right)(x) = \frac{5x}{-2x-3}$$

18. $$\begin{aligned}(f+g)(x) &= (-4x) + (-3x+5)\\ &= -4x - 3x + 5\\ &= -7x + 5\end{aligned}$$

$$\begin{aligned}(f-g)(x) &= (-4x) - (-3x+5)\\ &= -4x + 3x - 5\\ &= -x - 5\end{aligned}$$

$$\begin{aligned}(fg)(x) &= (-4x)(-3x+5)\\ &= 12x^2 - 20x\end{aligned}$$

$$\left(\frac{f}{g}\right)(x) = \frac{-4x}{-3x+5}$$

19. Domain of $f + g = (-\infty, \infty)$.

20. Domain of $f + g = (-\infty, \infty)$.

21. Domain of $f + g = (-\infty, 5)$ or $(5, \infty)$.

22. Domain of $f + g = (-\infty, 6)$ or $(6, \infty)$.

23. Domain of $f+g = (-\infty, 0)$ or $(0, 5)$ or $(5, \infty)$.

24. Domain of $f+g = (-\infty, 0)$ or $(0, 6)$ or $(6, \infty)$.

25. Domain of $f+g = f+g = (-\infty, -3)$ or $(-3, 2)$ or $(2, \infty)$.

26. Domain of $f+g = f+g = (-\infty, -8)$ or $(-8, 4)$ or $(4, \infty)$.

27. Domain of $f+g = (-\infty, 2)$ or $(2, \infty)$.

28. Domain of $f+g = (-\infty, 4)$ or $(4, \infty)$.

29. Domain of $f+g = (-\infty, \infty)$.

30. Domain of $f+g = (-\infty, \infty)$.

31.
$$\begin{aligned}(f+g)(x) &= f(x)+g(x)\\ &= x^2+4x+2-x\\ &= x^2+3x+2\end{aligned}$$
$$(f+g)(3) = (3)^2+3(3)+2 = 20$$

32.
$$\begin{aligned}(f+g)(x) &= f(x)+g(x)\\ &= x^2+4x+2-x\\ &= x^2+3x+2\end{aligned}$$
$$(f+g)(4) = (4)^2+3(4)+2 = 30$$

33. $f(-2)+g(-2) = \left((-2)^2+4(-2)\right)+\left(2-(-2)\right) = -4+4 = 0$

34. $f(-3)+g(-3) = \left((-3)^2+4(-3)\right)+\left(2-(-3)\right) = -3+5 = 2$

35.
$$\begin{aligned}(f-g)(x) &= f(x)-g(x)\\ &= \left(x^2+4x\right)-(2-x)\\ &= x^2+4x-2+x\\ &= x^2+5x-2\\ (f-g)(5) &= (5)^2+5(5)-2\\ &= 25+25-2 = 48\end{aligned}$$

36.
$$\begin{aligned}(f-g)(x) &= f(x)-g(x)\\ &= \left(x^2+4x\right)-(2-x)\\ &= x^2+4x-2+x\\ &= x^2+5x-2\\ (f-g)(6) &= (6)^2+5(6)-2\\ &= 36+30-2 = 64\end{aligned}$$

37. $f(-2)-g(-2)=\left((-2)^2+4(-2)\right)-\left(2-(-2)\right)=-4-4=-8$

38. $f(-3)-g(-3)=\left((-3)^2+4(-3)\right)-\left(2-(-3)\right)=-3-5=-8$

39. $(fg)(-2)=f(-2)\cdot g(-2)=\left((-2)^2+4(-2)\right)\cdot\left(2-(-2)\right)=-4(4)=-16$

40. $(fg)(-3)=f(-3)\cdot g(-3)=\left((-3)^2+4(-3)\right)\cdot\left(2-(-3)\right)=-3(5)=-15$

41. $(fg)(5)=f(5)\cdot g(5)=\left((5)^2+4(5)\right)\cdot\left(2-(5)\right)=45(-3)=-135$

42. $(fg)(6)=f(6)\cdot g(6)=\left((6)^2+4(6)\right)\cdot\left(2-(6)\right)=60(-4)=-240$

43. $\left(\frac{f}{g}\right)(x)=\frac{f(x)}{g(x)}=\frac{x^2+4x}{2-x}$

$\left(\frac{f}{g}\right)(1)=\frac{(1)^2+4(1)}{2-(1)}=\frac{1+4}{1}=\frac{5}{1}=5$

44. $\left(\frac{f}{g}\right)(x)=\frac{f(x)}{g(x)}=\frac{x^2+4x}{2-x}$

$\left(\frac{f}{g}\right)(3)=\frac{(3)^2+4(3)}{2-3}=\frac{9+12}{-1}=\frac{21}{-1}=-21$

45. $\left(\frac{f}{g}\right)(x)=\frac{f(x)}{g(x)}=\frac{x^2+4x}{2-x}$

$\left(\frac{f}{g}\right)(-1)=\frac{(-1)^2+4(-1)}{2-(-1)}$

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

46. $\left(\frac{f}{g}\right)(x)=\frac{f(x)}{g(x)}=\frac{x^2+4x}{2-x}$

$\left(\frac{f}{g}\right)(0)=\frac{(0)^2+4(0)}{2-0}=\frac{0+0}{2}=\frac{0}{2}=0$

47. Domain of $f+g=(-\infty,\infty)$.

48. Domain of $f+g=(-\infty,\infty)$.

49. $\left(\frac{f}{g}\right)(x)=\frac{f(x)}{g(x)}=\frac{x^2+4x}{2-x}$

Domain of $\frac{f}{g}=(-\infty,2)$ or $(2,\infty)$.

50. $(fg)(x) = f(x) \cdot g(x) = (x^2 + 4x)(2 - x)$

Domain of $fg = (-\infty, \infty)$.

51. $(f + g)(-3) = f(-3) + g(-3) = 4 + 1 = 5$

52. $(g - f)(-2) = g(-2) - f(-2) = 2 - 3 = -1$

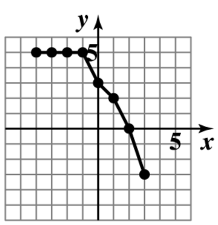
53. $(fg)(2) = f(2)g(2) = (-1)(1) = -1$

54. $\left(\frac{g}{f}\right)(3) = \frac{g(3)}{f(3)} = \frac{0}{-3} = 0$

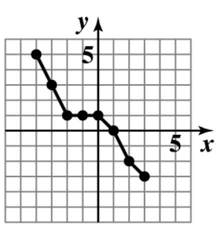
55. The domain of $f + g$ is $[-4, 3]$.

56. The domain of $\frac{f}{g}$ is $(4, 3)$.

57. The graph of $f + g$



58. The graph of $f - g$



59. $(f + g)(1) - (g - f)(-1)$
$= f(1) + g(1) - [g(-1) - f(-1)]$
$= f(1) + g(1) - g(-1) + f(-1)$
$= -6 + -3 - (-2) + 3$
$= -6 + -3 + 2 + 3 = -4$

60. $(f + g)(-1) - (g - f)(0)$
$= f(-1) + g(-1) - [g(0) - f(0)]$
$= 3 + (-2) - [4 - (-2)]$
$= 3 + -2 - (4 + 2) = 3 + -2 - 6 = -5$

61. $(fg)(-2)-\left[\left(\frac{f}{g}\right)(1)\right]^2$

$= f(-2)g(-2)-\left[\frac{f(1)}{g(1)}\right]^2$

$= 5\cdot 0-\left[\frac{-6}{-3}\right]^2 = 0-2^2 = 0-4=-4$

62. $(fg)(2)-\left[\left(\frac{g}{f}\right)(0)\right]^2$

$= f(2)g(2)-\left[\frac{g(0)}{f(0)}\right]^2$

$= 0(1)-\left(\frac{4}{-2}\right)^2 = 0-(-2)^2$

$= 0-4=-4$

63. **a.** $(M+F)(x) = M(x)+F(x) = (1.5x+115)+(1.4x+121) = 2.9x+236$

b. $(M+F)(x) = 2.9x+236$

$(M+F)(20) = 2.9(25)+236 = 308.5$

The total U.S. population in 2010 was 308.5 million.

c. The result in part (b) underestimates the actual total by 0.5 million.

64. **a.** $(F-M)(x) = F(x)-M(x) = (1.4x+121)-(1.5x+115) = -0.1x+6$

b. $(F-M)(x) = -0.1x+6$

$(F-M)(20) = -0.1(20)+6 = 4$

In 2005 there were 4 million more women than men.

c. The result in part (b) is the same as the actual difference.

65. **a.** $\left(\frac{M}{F}\right)(x) = \left(\frac{M(x)}{F(x)}\right) = \frac{1.5x+115}{1.4x+121}$

b. $\left(\frac{M}{F}\right)(x) = \frac{1.5x+115}{1.4x+121}$

$\left(\frac{M}{F}\right)(15) = \frac{1.5(15)+115}{1.4(15)+121} \approx 0.968$

In 2000 the ratio of men to women was 0.968.

c. The result in part (b) underestimates the actual ratio of $\frac{138}{143} \approx 0.965$ by about 0.003.

66. First, find $(R-C)(x)$.

$$(R-C)(x) = 65x-(600{,}000+45x)$$
$$= 65x-600{,}000-45x$$
$$= 20x-600{,}000$$

$(R-C)(20{,}000)$

$= 20(20{,}000)-600{,}000$

$= 400{,}000-600{,}000 = -200{,}000$

This means that if the company produces and sells 20,000 radios, it will lose $200,000.

$(R-C)(30{,}000)$

$= 20(30{,}000)-600{,}000$

$= 600{,}000-600{,}000 = 0$

If the company produces and sells 30,000 radios, it will break even with its costs equal to its revenue.

$(R-C)(40{,}000)$

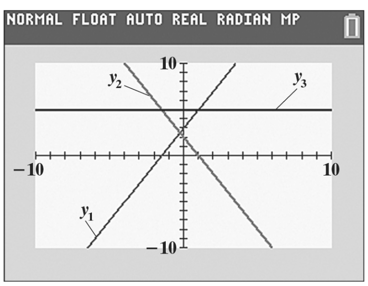
$= 20(40{,}000)-600{,}000$

$= 800{,}000-600{,}000 = 200{,}000$

This means that if the company produces and sells 40,000 radios, it will make a profit of $200,000.

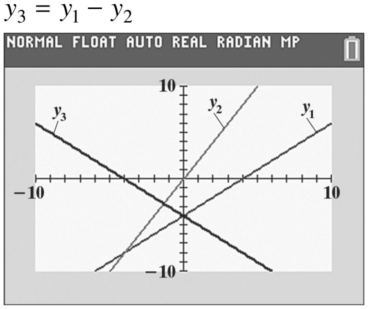
67. – 70. Answers will vary.

71. $y_1 = 2x+3$ $\quad y_2 = 2-2x$ $\quad y_3 = y_1 + y_2$

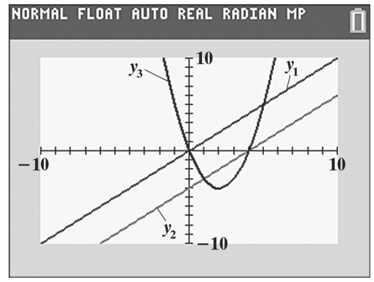


72. $y_1 = x-4$ $\quad y_2 = 2x$

$y_3 = y_1 - y_2$



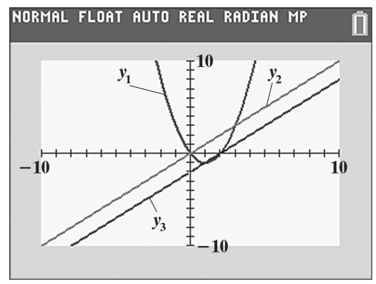
73. $y_1 = x$ $\quad y_2 = x-4$ $\quad y_3 = y_1 \cdot y_2$



74. $y_1 = x^2-2x$ $\quad y_2 = x$

$$y_3 = \frac{y_1}{y_2}$$

75.



No y-value is displayed because y_3 is undefined at $x = 0$.

76. makes sense

77. makes sense

78. makes sense

79. makes sense

80. true

81. true

82. true

83. false; Changes to make the statement true will vary. A sample change is: $f(a)$ or $f(b)$ is 0.

84.
$$R = 3(a+b)$$
$$R = 3a+3b$$
$$R-3a = 3b$$
$$b = \frac{R-3a}{3} \text{ or } b = \frac{R}{3}-a$$

85. $3(6-x)=3-2(x-4)$

$18-3x=3-2x+8$

$18-3x=11-2x$

$18=11+x$

$7=x$

The solution set is $\{7\}$.

86. $f(b+2)=6(b+2)-4$

$=6b+12-4=6b+8$

87. **a.** $4x-3y=6$

$4x-3(0)=6$

$4x=6$

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

b. $4x-3y=6$

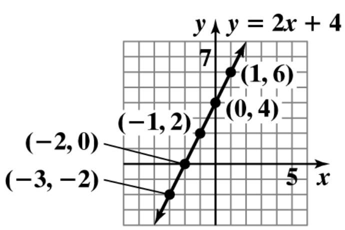
$4(0)-3y=6$

$-3y=6$

$y=-2$

88. **a.**

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



b. The graph crosses the x-axis at the point $(-2,0)$.

c. The graph crosses the y-axis at the point $(0,4)$.

89. $5x+3y=-12$

$3y=-5x-12$

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

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

Mid-Chapter Check Point – Chapter 2

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

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

3. The relation is a function.
The domain is $[-2,2)$.
The range is $[0,3]$.

4. The relation is not a function.
The domain is $(-3,4]$.
The range is $[-1,2]$.

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

6. The relation is a function.
The domain is $(-\infty,1]$.
The range is $[-1,\infty)$.

7. The graph of f represents the graph of a function because every element in the domain corresponds to exactly one element in the range. It passes the vertical line test.

8. $f(-4)=3$

9. The function $f(x)=4$ when $x=-2$.

10. The function $f(x)=0$ when $x=2$ and $x=-6$.

11. The domain of f is $(-\infty,\infty)$.

12. The range of f is $(-\infty,4]$.

13. The domain is $(-\infty,\infty)$.

14. The domain of g is $(-\infty,-2)$ or $(-2,2)$ or $(2,\infty)$.

15. $f(0)=0^2-3(0)+8=8$

$g(-10)=-2(-10)-5=20-5=15$

$f(0)+g(-10)=8+15=23$

16. $f(-1) = (-1)^2 - 3(-1) + 8 = 1 + 3 + 8 = 12$
$g(3) = -2(3) - 5 = -6 - 5 = -11$
$f(-1) - g(3) = 12 - (-11) = 12 + 11 = 23$

17. $f(a) = a^2 - 3a + 8$
$g(a+3) = -2(a+3) - 5$
$= -2a - 6 - 5 = -2a - 11$
$f(a) + g(a+3) = a^2 - 3a + 8 + -2a - 11$
$= a^2 - 5a - 3$

18. $(f+g)(x) = x^2 - 3x + 8 + -2x - 5$
$= x^2 - 5x + 3$
$(f+g)(-2) = (-2)^2 - 5(-2) + 3$
$= 4 + 10 + 3 = 17$

19. $(f-g)(x) = x^2 - 3x + 8 - (-2x - 5)$
$= x^2 - 3x + 8 + 2x + 5$
$= x^2 - x + 13$
$(f-g)(5) = (5)^2 - 5 + 13$
$= 25 - 5 + 13 = 33$

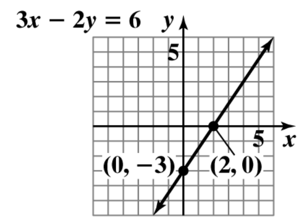
20. $f(-1) = (-1)^2 - 3(-1) + 8$
$= 1 + 3 + 8 = 12$
$g(-1) = -2(-1) - 5 = 2 - 5 = -3$
$(fg)(-1) = 12(-3) = -36$

21. $\left(\frac{f}{g}\right)(x) = \frac{x^2 - 3x + 8}{-2x - 5}$
$\left(\frac{f}{g}\right)(-4) = \frac{(-4)^2 - 3(-4) + 8}{-2(-4) - 5}$
$= \frac{16 + 12 + 8}{8 - 5} = \frac{36}{3} = 12$

22. The domain of $\frac{f}{g}$ is $\left(-\infty, -\frac{5}{2}\right)$ or $\left(-\frac{5}{2}, \infty\right)$.

2.4 Check Points

1. $3x - 2y = 6$
Find the x–intercept by setting $y = 0$.
$3x - 2y = 6$
$3x - 2(0) = 6$
$3x = 6$
$x = 2$
Find the y–intercept by setting $x = 0$.
$3x - 2y = 6$
$3(0) - 2y = 6$
$-2y = 6$
$y = -3$

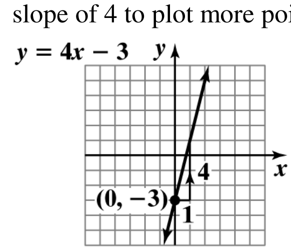


2. **a.** $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-2 - 4}{-4 - (-3)} = \frac{-6}{-1} = 6$

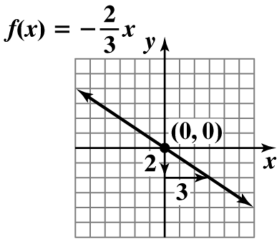
b. $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{5 - (-2)}{-1 - 4} = \frac{7}{-5} = -\frac{7}{5}$

3. First, convert the equation to slope-intercept form by solving the equation for y.
$8x - 4y = 20$
$-4y = -8x + 20$
$\frac{-4y}{-4} = \frac{-8x + 20}{-4}$
$y = 2x - 5$
In this form, the coefficient of x is the line's slope and the constant term is the y-intercept.
The slope is 2 and the y-intercept is –5.

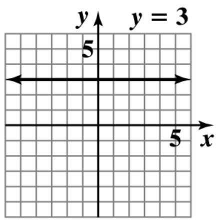
4. Begin by plotting the y-intercept of –3. Then use the slope of 4 to plot more points.



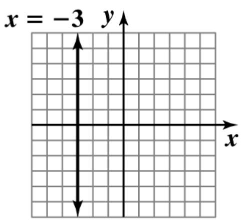
5. Begin by plotting the y-intercept of 0. Then use the slope of $\frac{-2}{3}$ to plot more points.



6. $y = 3$ is a horizontal line.



7. $x = -3$ is a vertical line.



8. $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4.4 - 4.65}{2010 - 2005} = \frac{-0.25}{5} = -0.05$

From 2005 through 2010, the average waste produced per person in the U.S. decreased by 0.05 pound per day each year.

9. $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{0.05 - 0.03}{3 - 1} = \frac{0.02}{2} \approx 0.01$

The average rate of change between 1 hour and 3 hours is 0.01. This means that the drug's concentration is increasing at an average rate of 0.01 milligram per 100 milliliters per hour.

10. a. We will use the line segment passing through $(60, 390)$ and $(0, 310)$ to obtain a model. We need values for m, the slope, and b, the y-intercept.

$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{390 - 310}{60 - 0} = \frac{80}{60} \approx 1.33$

The point $(0, 310)$ gives us the y-intercept of 310.

Thus, $C(x) = mx + b$

$C(x) = 1.33x + 310$

b. $C(x) = 1.33x + 310$

$C(100) = 1.33(100) + 310$

$= 443$

The model predicts the average atmospheric concentration of carbon dioxide will be 443 parts per million in 2050.

2.4 Concept and Vocabulary Check

1. scatterplot; regression

2. standard

3. x-intercept; zero

4. y-intercept; zero

5. $\frac{y_2 - y_1}{x_2 - x_1}$

6. positive

7. negative

8. zero

9. undefined

10. $y = mx + b$

11. $(0, 3)$; 2; 5

12. horizontal

13. vertical

14. y; x

2.4 Exercise Set

1. $x+y=4$

Find the x–intercept by setting $y = 0$.

$x+y=4$

$x+0=4$

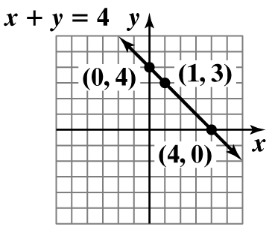
$x=4$

Find the y–intercept by setting $x = 0$.

$x+y=4$

$0+y=4$

$y=4$



2. $x+y=2$

Find the x–intercept by setting $y = 0$.

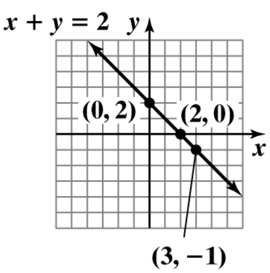
$x+0=2$

$x=2$

Find the y–intercept by setting $x = 0$.

$0+y=2$

$y=2$



3. $x+3y=6$

Find the x–intercept by setting $y = 0$.

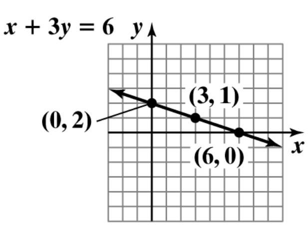
$x+3(0)=6$

$x=6$

Find the y–intercept by setting $x = 0$.

$(0)+3y=6$

$y=2$



4. $2x+y=4$

Find the x–intercept by setting $y = 0$.

$2x+0=4$

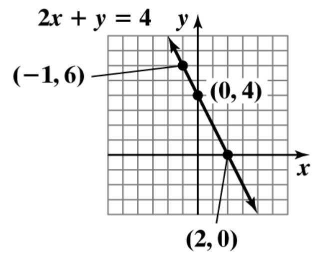
$2x=4$

$x=2$

Find the y–intercept by setting $x = 0$.

$2(0)+y=4$

$y=4$



5. $6x-2y=12$

Find the x–intercept by setting $y = 0$.

$6x-2(0)=12$

$6x=12$

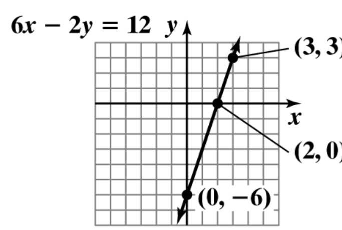
$x=2$

Find the y–intercept by setting $x = 0$.

$6(0)-2y=12$

$-2y=12$

$y=-6$



6. $6x-9y=18$

Find the x–intercept by setting $y=0$.

$6x-9(0)=18$

$6x=18$

$x=3$

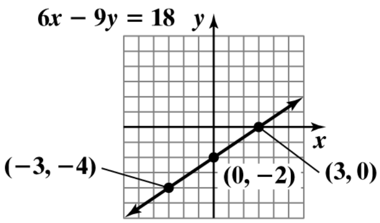
Find the y–intercept by setting $x=0$.

$6(0)-9y=18$

$0-9y=18$

$-9y=18$

$y=-2$



7. $3x-y=6$

Find the x–intercept by setting $y=0$.

$3x-0=6$

$3x=6$

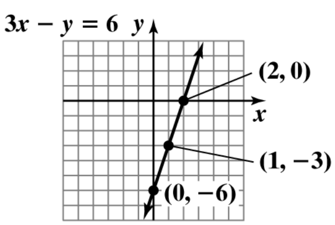
$x=2$

Find the y–intercept by setting $x=0$.

$3(0)-y=6$

$-y=6$

$y=-6$



8. $x-4y=8$

Find the x–intercept by setting $y=0$.

$x+4(0)=8$

$x+0=8$

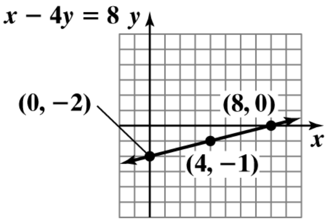
$x=8$

Find the y–intercept by setting $x=0$.

$0-4y=8$

$-4y=8$

$y=-2$



9. $x-3y=9$

Find the x–intercept by setting $y=0$.

$x-3(0)=9$

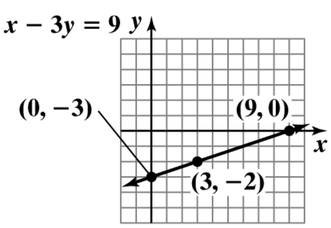
$x=9$

Find the y–intercept by setting $x=0$.

$(0)-3y=9$

$-3y=9$

$y=-3$



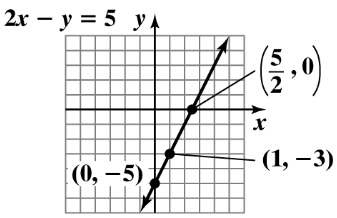
10. $2x - y = 5$

Find the x–intercept by setting $y = 0$.

$$2x - 0 = 5$$
$$2x = 5$$
$$x = \frac{5}{2}$$

Find the y–intercept by setting $x = 0$.

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



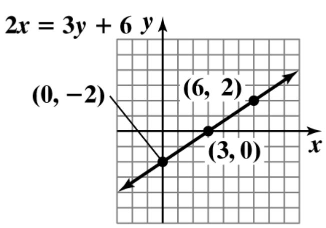
11. $2x = 3y + 6$

Find the x–intercept by setting $y = 0$.

$$2x = 3(0) + 6$$
$$2x = 6$$
$$x = 3$$

Find the y–intercept by setting $x = 0$.

$$2(0) = 3y + 6$$
$$0 = 3y + 6$$
$$-6 = 3y$$
$$-2 = y$$



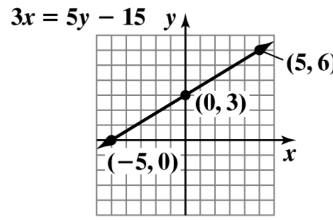
12. $3x = 5y - 15$

Find the x–intercept by setting $y = 0$.

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

Find the y–intercept by setting $x = 0$.

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



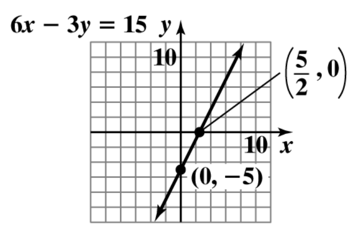
13. $6x - 3y = 15$

Find the x–intercept by setting $y = 0$.

$$6x - 3(0) = 15$$
$$6x = 15$$
$$x = \frac{15}{6} = \frac{5}{2}$$

Find the y–intercept by setting $x = 0$.

$$6(0) - 3y = 15$$
$$-3y = 15$$
$$y = -5$$



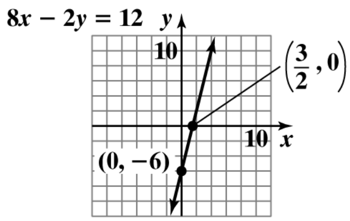
14. $8x - 2y = 12$

Find the x–intercept by setting $y = 0$.

$$8x - 2(0) = 12$$
$$8x = 12$$
$$x = \frac{12}{8}$$
$$x = \frac{3}{2}$$

Find the y–intercept by setting $x = 0$.

$$8(0) - 2y = 12$$
$$-2y = 12$$
$$y = -6$$



15. $m = \frac{8-4}{3-2} = \frac{4}{1} = 4$

The line rises.

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

The line rises.

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

The line rises.

18. $m = \frac{5-(-2)}{2-(-3)} = \frac{5+2}{2+3} = \frac{7}{5}$

The line rises.

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

The line is horizontal.

20. $m = \frac{-3-(-3)}{4-(-6)} = \frac{-3+3}{4+6} = \frac{0}{10} = 0$

The line is horizontal.

21. $m = \frac{-3-1}{-4-(-7)} = \frac{-4}{-4+7} = \frac{-4}{3} = -\frac{4}{3}$

The line falls.

22. $m = \frac{3-(-1)}{-6-2} = \frac{3+1}{-8} = \frac{4}{-8} = -\frac{1}{2}$

The line falls.

23. $m = \frac{6-(-4)}{-3-(-7)} = \frac{10}{4} = \frac{5}{2}$

The line rises.

24. $m = \frac{6-(-4)}{-1-(-3)} = \frac{10}{2} = 5$

The line rises.

25. $m = \frac{\frac{1}{4}-(-2)}{\frac{7}{2}-\frac{7}{2}} = \frac{\frac{1}{4}+2}{0} = \text{undefined}$

undefined slope; The line is vertical.

26. $m = \frac{\frac{1}{6}-(-6)}{\frac{3}{2}-\frac{3}{2}} = \frac{\frac{1}{6}+6}{0} = \text{undefined}$

undefined sl $m = \frac{5-(-2)}{2-(-3)} = \frac{5+2}{2+3} = \frac{7}{5}$ ope; The line is vertical.

27. Line 1 goes through $(-3,0)$ and $(0,2)$.

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

Line 2 goes through $(2,0)$ and $(0,4)$.

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

Line 3 goes through $(0,-3)$ and $(2,-4)$.

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

28. L_1 passes through $(1,0)$ and $(0,-1)$.

$$m = \frac{-1-0}{0-1} = \frac{-1}{-1} = 1$$

L_2 passes through $(4,-2)$ and $(1,-4)$.

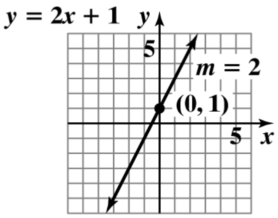
$$m = \frac{-4-(-2)}{1-4} = \frac{-4+2}{-3} = \frac{-2}{-3} = \frac{2}{3}$$

L_3 passes through $(-4,2)$ and $(-3,0)$.

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

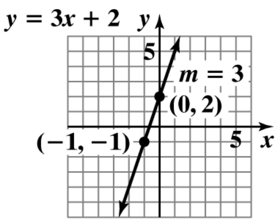
29. $y = 2x + 1$

$m = 2 \qquad y - \text{intercept} = 1$



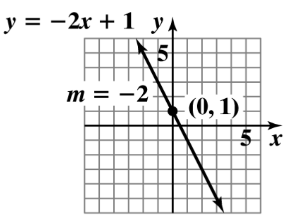
30. $y = 3x + 2$

$m = 3 \qquad y - \text{intercept} = 2$



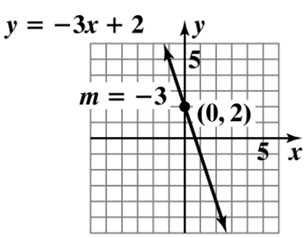
31. $y = -2x + 1$

$m = -2 \qquad y - \text{intercept} = 1$



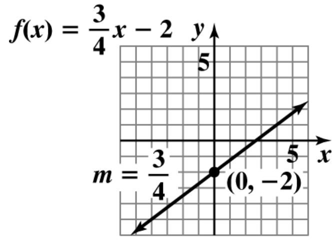
32. $f(x) = -3x + 2$

$m = -3 \qquad y - \text{intercept} = 2$



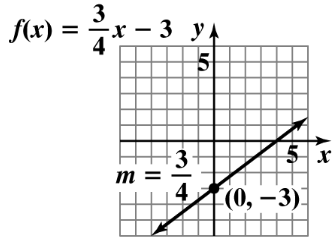
33. $f(x) = \frac{3}{4}x - 2$

$m = \frac{3}{4} \qquad y - \text{intercept} = -2$



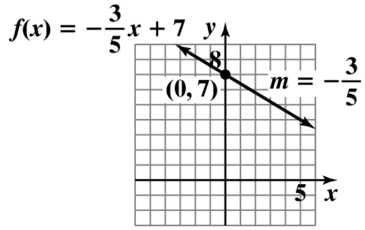
34. $f(x) = \frac{3}{4}x - 3$

$m = \frac{3}{4} \qquad y - \text{intercept} = -3$



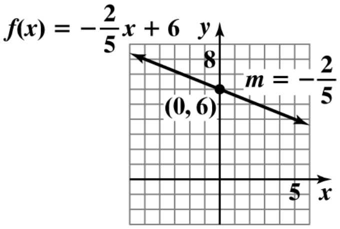
35. $f(x) = -\frac{3}{5}x + 7$

$m = -\frac{3}{5} \qquad y - \text{intercept} = 7$



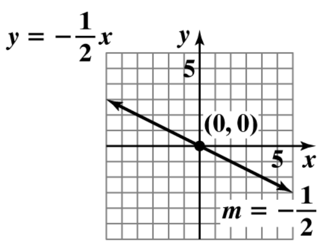
36. $f(x) = -\frac{2}{5}x + 6$

$m = -\frac{2}{5}$ $\quad y - \text{intercept} = 6$



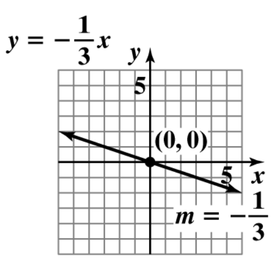
37. $y = -\frac{1}{2}x$

$m = -\frac{1}{2}$ $\quad y - \text{intercept} = 0$



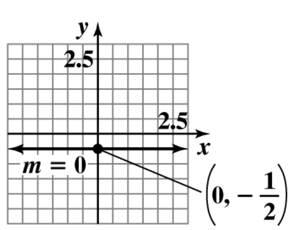
38. $y = -\frac{1}{3}x$

$m = -\frac{1}{3}$ $\quad y - \text{intercept} = 0$



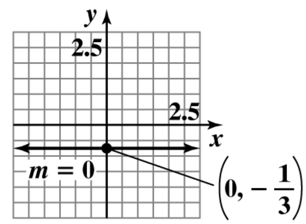
39. $y = -\frac{1}{2}$

$m = 0$ $\quad y - \text{intercept} = -\frac{1}{2}$



40. $y = -\frac{1}{3}$

$m = 0$ $\quad y - \text{intercept} = -\frac{1}{3}$

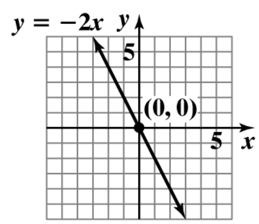


41. **a.** $2x + y = 0$

$y = -2x$

b. $m = -2$ $\quad y - \text{intercept} = 0$

c.

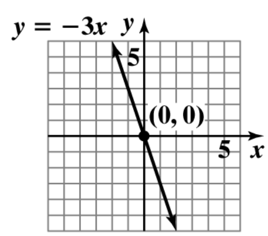


42. **a.** $3x + y = 0$

$y = -3x$

b. $m = -3$ $\quad y - \text{intercept} = 0$

c.

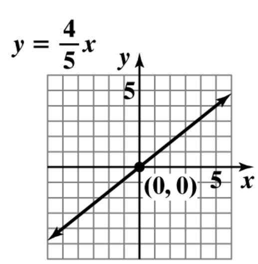


43. **a.** $5y = 4x$

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

b. $m = \frac{4}{5}$ $\quad y - \text{intercept} = 0$

c.

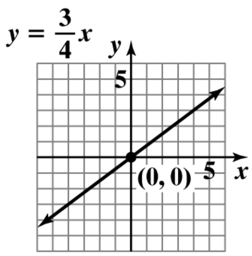


44. a. $4y = 3x$

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

b. $m = \frac{3}{4}$ $\quad$ $y - \text{intercept} = 0$

c.

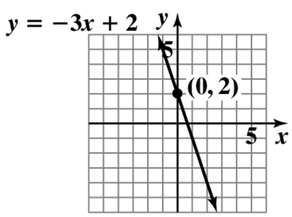


45. a. $3x + y = 2$

$y = -3x + 2$

b. $m = -3$ $\quad$ $y - \text{intercept} = 2$

c.

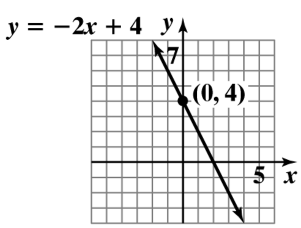


46. a. $2x + y = 4$

$y = -2x + 4$

b. $m = -2$ $\quad$ $y - \text{intercept} = 4$

c.



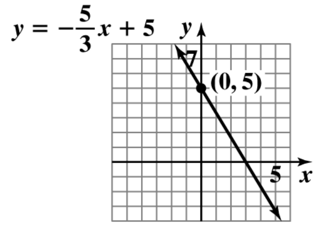
47. a. $5x + 3y = 15$

$3y = -5x + 15$

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

b. $m = -\frac{5}{3}$ $\quad$ $y - \text{intercept} = 5$

c.



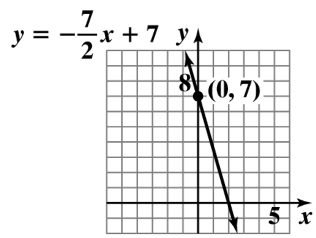
48. a. $7x + 2y = 14$

$2y = -7x + 14$

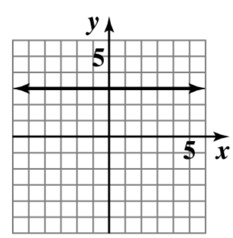
$y = -\frac{7}{2}x + 7$

b. $m = -\frac{7}{2}$ $\quad$ $y - \text{intercept} = 7$

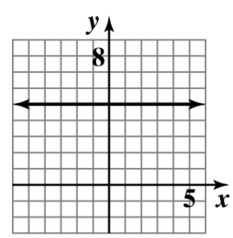
c.



49. $y = 3$

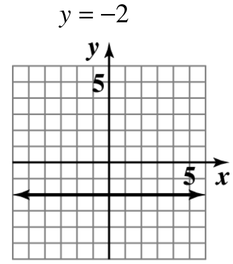


50. $y = 5$

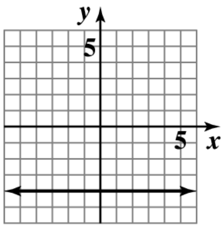


51. $f(x) = -2$

$y = -2$

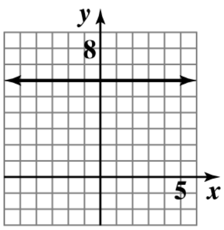


52. $f(x) = -4$ which is the same as $y = -4$



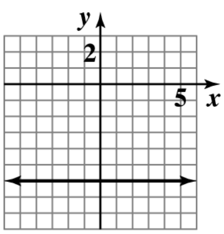
53. $3y = 18$

$y = 6$



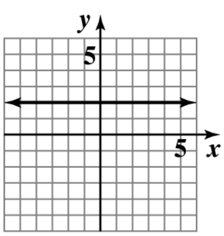
54. $5y = -30$

$y = -6$

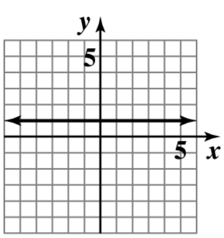


55. $f(x) = 2$

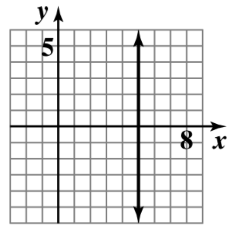
$y = 2$



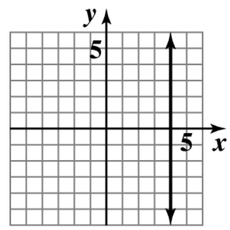
56. $f(x) = 1$ or $y = 1$



57. $x = 5$

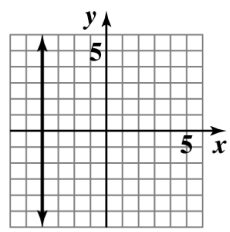


58. $x = 4$



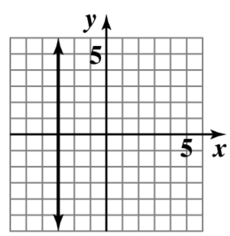
59. $3x = -12$

$x = -4$



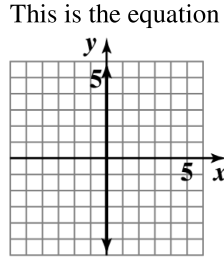
60. $4x = -12$

$x = -3$



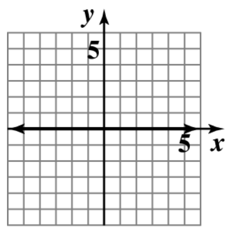
61. $x = 0$

This is the equation of the y–axis.



62. $y = 0$

This is the equation of the x–axis.



63. $m = \frac{0-a}{b-0} = \frac{-a}{b} = -\frac{a}{b}$

Since a and b are both positive, $-\frac{a}{b}$ is negative.

Therefore, the line falls.

64. $m = \frac{-b-0}{0-(-a)} = \frac{-b}{a} = -\frac{b}{a}$

The line falls.

65. $m = \frac{(b+c)-b}{a-a} = \frac{c}{0}$

The slope is undefined.
The line is vertical.

66. $m = \frac{(a+c)-c}{a-(a-b)} = \frac{a}{b}$

The line rises.

67.
$$Ax + By = C$$
$$By = -Ax + C$$
$$y = -\frac{A}{B}x + \frac{C}{B}$$

The slope is $-\frac{A}{B}$ and the $y-$intercept is $\frac{C}{B}$.

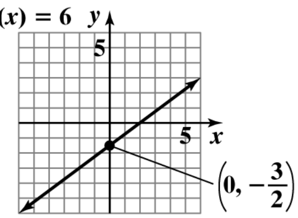
68.
$$Ax = By - C$$
$$Ax + C = By$$
$$\frac{A}{B}x + \frac{C}{B} = y$$

The slope is $\frac{A}{B}$ and the $y-$intercept is $\frac{C}{B}$.

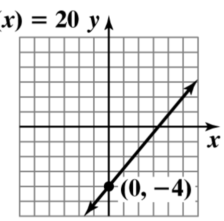
69.
$$-3 = \frac{4-y}{1-3}$$
$$-3 = \frac{4-y}{-2}$$
$$6 = 4 - y$$
$$2 = -y$$
$$-2 = y$$

70.
$$\frac{1}{3} = \frac{-4-y}{4-(-2)}$$
$$\frac{1}{3} = \frac{-4-y}{4+2}$$
$$\frac{1}{3} = \frac{-4-y}{6}$$
$$6 = 3(-4-y)$$
$$6 = -12 - 3y$$
$$18 = -3y$$
$$-6 = y$$

71.
$$3x - 4f(x) = 6$$
$$-4f(x) = -3x + 6$$
$$f(x) = \frac{3}{4}x - \frac{3}{2}$$



72.
$$6x - 5f(x) = 20$$
$$-5f(x) = -6x + 20$$
$$f(x) = \frac{6}{5}x - 4$$



73. Using the slope-intercept form for the equation of a line:
$$-1 = -2(3) + b$$
$$-1 = -6 + b$$
$$5 = b$$

74.
$$-6 = -\frac{3}{2}(2) + b$$
$$-6 = -3 + b$$
$$-3 = b$$

75. The line with slope m_1 is the steepest rising line so its slope is the biggest positive number. Then the line with slope m_3 is next because it is the only other line whose slope is positive. Since the line with slope m_2 is less steep but decreasing, it is next. The slope m_4 is the smallest because it is negative and the line with slope m_4 is steeper than the line with slope m_3, so its slope is more negative.
Decreasing order: m_1, m_3, m_2, m_4

76. Decreasing order: b_2, b_1, b_4, b_3

77. The slope is 55.7. This means Smartphone sales are increasing by 55.7 million each year.

78. The slope is 2. This means the amount spent by the drug industry to market drugs to doctors is increasing by $2 billion each year.

79. The slope is –0.52. This means the percentage of U.S. adults who smoke cigarettes is decreasing by 0.52% each year.

80. The slope is –0.28. This means the percentage of U.S. taxpayers audited by the IRS is decreasing by 0.28% each year.

81. **a.** 30% of marriages in which the wife is under 18 when she marries end in divorce within the first five years.

b. 50% of marriages in which the wife is under 18 when she marries end in divorce within the first ten years.

c. $m = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{50-30}{10-5} = \dfrac{20}{5} = 4$
There is an average increase of 4% of marriages ending in divorce per year.

82. **a.** 15% of marriages in which the wife is over age 25 when she marries end in divorce within the first five years.

b. 25% of marriages in which the wife is over age 25 when she marries end in divorce within the first ten years.

c. $m = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{25-15}{10-5} = \dfrac{10}{5} = 2$
There is an average increase of 2% of marriages ending in divorce per year.

83. **a.** The y-intercept is 254. This represents if no women in a country are literate, the mortality rate of children under five is 254 per thousand.

b. $m = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{110-254}{60-0} = \dfrac{-144}{60} = -2.4$
For each 1% of adult females who are literate, the mortality rate of children under five decreases by 2.4 per thousand.

c. $f(x) = -2.4x + 254$

d. $f(50) = -2.4(50) + 254 = 134$
A country where 50% of adult females are literate is predicted to have a mortality rate of children under five of 134 per thousand.

84. **a.** $m = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{6.7-3.1}{20-0} = \dfrac{3.6}{20} = 0.18$
The percentage of America's black population that is foreign-born is increasing by 0.18 each year. The rate of change is 0.18% per year..

b. $C(x) = 0.18x + 3.1$

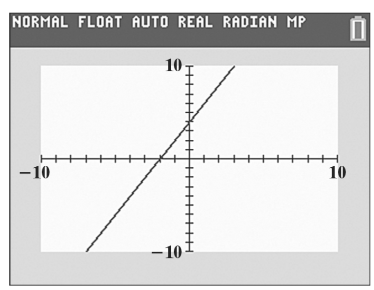
c.
$$\begin{aligned} C(x) &= 0.18x + 3.1 \\ C(80) &= 0.18(80) + 3.1 \\ &= 17.5 \end{aligned}$$
The percentage of America's black population that will be foreign-born in 2060 is 17.5%..

85. $P(x) = 0.24x + 29$

86. $P(x) = 0.24x + 30$

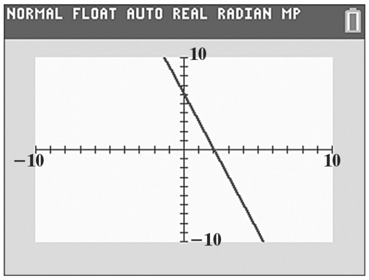
87. – 104. Answers will vary.

105. $y = 2x + 4$



Two points found using [TRACE] are $(0,4)$ and $(2,8)$.
$m = \dfrac{8-4}{2-0} = \dfrac{4}{2} = 2$
This is the same as the coefficient of x in the line's equation.

106. $y = -3x + 6$

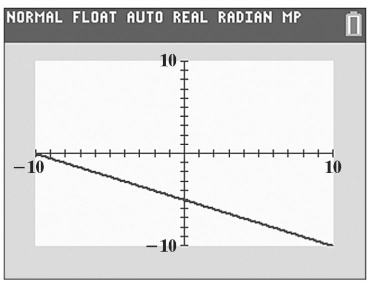


Two points found using [TRACE] are (0, 6) and (2, 0). Based on these points, the slope is:

$$m = \frac{6-0}{0-2} = \frac{6}{-2} = -3.$$

This is the same as the coefficient of *x* in the line's equation.

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

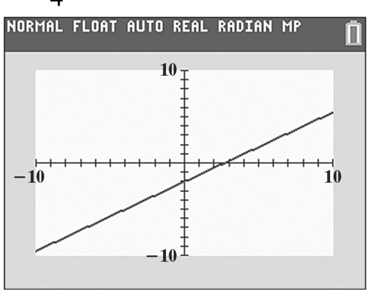


Two points found using [TRACE] are $(0,-5)$ and $(1,-5.5)$. Based on these points, the slope is:

$$m = \frac{-5.5-(-5)}{1-0} = \frac{-5.5+5}{1} = \frac{-0.5}{1} = -0.5.$$

This is the same as the coefficient of *x* in the line's equation.

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



Two points found using [TRACE] are $(0,-2)$ and $(1,-1.25)$. Based on these points, the slope is:

$$m = \frac{-2-(-1.25)}{0-1} = \frac{-0.75}{-1} = 0.75.$$

This is equivalent to the coefficient of *x* in the line's equation.

109. does not make sense; Explanations will vary. Sample explanation: Linear functions never change from rising to falling.

110. does not make sense; Explanations will vary. Sample explanation: Since this value is increasing, it will have a positive slope.

111. does not make sense; Explanations will vary. Sample explanation: This function suggests that the average salary in 2000 was $1700, and that there is an annual raise of $49,100. The function would make sense if the *x* was with the 1700. i.e. $S(x) = 1700x + 49{,}100$

112. makes sense

113. false; Changes to make the statement true will vary. A sample change is: One nonnegative slope is 0. A line with slope equal to zero does not rise from left to right.

114. false; Changes to make the statement true will vary. A sample change is: Slope-intercept form is $y = mx + b$. Vertical lines have equations of the form $x = a$. Equations of this form have undefined slope and cannot be written in slope-intercept form.

115. true

116. false; Changes to make the statement true will vary. A sample change is: The graph of $x = 7$ is a vertical line that passes through the point $(7,0)$.

117. We are given that the $x-$intercept is -2 and the $y-$intercept is 4. We can use the points $(-2,0)$ and $(0,4)$ to find the slope.

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

Using the slope and one of the intercepts, we can write the line in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 0 = 2(x-(-2))$$
$$y = 2(x+2)$$
$$y = 2x + 4$$
$$-2x + y = 4$$

Find the x– and y–coefficients for the equation of the line with right-hand-side equal to 12. Multiply both sides of $-2x+y=4$ by 3 to obtain 12 on the right-hand-side.

$$-2x+y=4$$
$$3(-2x+y)=3(4)$$
$$-6x+3y=12$$

The coefficients are –6 and 3.

118. We are given that the $y-$intercept is -6 and the slope is $\frac{1}{2}$.

So the equation of the line is $y=\frac{1}{2}x-6$.

We can put this equation in the form $ax+by=c$ to find the missing coefficients.

$$y=\frac{1}{2}x-6$$
$$y-\frac{1}{2}x=-6$$
$$2\left(y-\frac{1}{2}x\right)=2(-6)$$
$$2y-x=-12$$
$$x-2y=12$$

Therefore, the coefficient of x is 1 and the coefficient of y is -2.

119. a. $f(x_1+x_2)=m(x_1+x_2)+b$
$=mx_1+mx_2+b$

b. $f(x_1)+f(x_2)$
$=mx_1+b+mx_2+b$
$=mx_1+mx_2+2b$

c. no

120. $\left(\frac{4x^2}{y^{-3}}\right)^2=\left(4x^2y^3\right)^2=4^2\left(x^2\right)^2\left(y^3\right)^2$
$=16x^4y^6$

121. $\left(8\times10^{-7}\right)\left(4\times10^3\right)=32\times10^{-4}$
$=\left(3.2\times10^1\right)\times10^{-4}$
$=3.2\times10^{-3}$

122. $5-\left[3(x-4)-6x\right]=5-\left[3x-12-6x\right]$
$=5-3x+12+6x$
$=3x+17$

123.
$$y-5=7(x+4)$$
$$y-5=7x+28$$
$$y=7x+33$$

124.
$$y+3=-\frac{7}{3}(x-1)$$
$$y+3=-\frac{7}{3}x+\frac{7}{3}$$
$$y+3-3=-\frac{7}{3}x+\frac{7}{3}-3$$
$$y=-\frac{7}{3}x-\frac{2}{3}$$

125. a. $x+4y-8=0$
$$4y=-x+8$$
$$\frac{4y}{4}=\frac{-x+8}{4}$$
$$y=-\frac{1}{4}x+2$$

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

b. $-\frac{1}{4}\cdot m_2=-1$
$$\frac{1}{4}\cdot m_2=1$$
$$m_2=4$$

The slope of the second line is 4.

2.5 Check Points

1. Slope $= -2$, passing through $(4,-3)$

Point-Slope Form

$$y - y_1 = m(x - x_1)$$
$$y - (-3) = -2(x - 4)$$
$$y + 3 = -2(x - 4)$$

Slope-Intercept Form

$$y + 3 = -2(x - 4)$$
$$y + 3 = -2x + 8$$
$$y = -2x + 5$$
$$f(x) = -2x + 5$$

2. a. Passing through $(6,-3)$ and $(2,5)$

First, find the slope.

$$m = \frac{5-(-3)}{2-6} = \frac{8}{-4} = -2$$

Then use the slope and one of the points to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 5 = -2(x - 2)$$

or

$$y - y_1 = m(x - x_1)$$
$$y - (-3) = -2(x - 6)$$
$$y + 3 = -2(x - 6)$$

b. Slope-Intercept Form

$$y - 5 = -2(x - 2)$$
$$y - 5 = -2x + 4$$
$$y = -2x + 9$$
$$f(x) = -2x + 9$$

3. First, find the slope.

$$m = \frac{79.7 - 74.7}{40 - 10} = \frac{5}{30} \approx 0.17$$

Then use the slope and one of the points to write the equation in point-slope form.

Using the point (10, 74.7):

$$y - y_1 = m(x - x_1)$$
$$y - 74.7 = 0.17(x - 10)$$
$$y = 0.17x + 73$$
$$f(x) = 0.17x + 73$$

Next, since 2020 is 60 years after 1960, substitute 60 into the function: $f(60) = 0.17(60) + 73 = 83.2$.

This means that the life expectancy of American women in 2020 is predicted to be 83.2 years.

Answers vary due to rounding and choice of point. If point (40, 79.7) is chosen, $f(x) = 0.17x + 72.9$ and the life expectancy of American women in 2020 is predicted to be 83.1 years.

4. Since the line is parallel to $y = 3x + 1$, we know it will have slope $m = 3$. We are given that it passes through $(-2,5)$. We use the slope and point to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 5 = 3(x - (-2))$$
$$y - 5 = 3(x + 2)$$

Solve for y to obtain slope-intercept form.

$$y - 5 = 3(x + 2)$$
$$y - 5 = 3x + 6$$
$$y = 3x + 11$$
$$f(x) = 3x + 11$$

5. a. Solve the given equation for y to obtain slope-intercept form.

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

Since the slope of the given line is $-\frac{1}{3}$, the slope of any line perpendicular to the given line is 3.

b. We use the slope of 3 and the point $(-2,-6)$ to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - (-6) = 3(x - (-2))$$
$$y + 6 = 3(x + 2)$$

Solve for y to obtain slope-intercept form.

$$y + 6 = 3(x + 2)$$
$$y + 6 = 3x + 6$$
$$y = 3x$$
$$f(x) = 3x$$

2.5 Concept and Vocabulary Check

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

2. equal/the same

3. -1

4. $-\frac{1}{5}$

5. $\frac{5}{3}$

6. -4; -4

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

2.5 Exercise Set

1. Slope $= 3$, passing through $(2,5)$

Point-Slope Form

$$y - y_1 = m(x - x_1)$$
$$y - 5 = 3(x - 2)$$

Slope-Intercept Form

$$y - 5 = 3(x - 2)$$
$$y - 5 = 3x - 6$$
$$y = 3x - 1$$
$$f(x) = 3x - 1$$

2. Slope $= 4$, passing through $(3,1)$

Point-Slope Form

$$y - 1 = 4(x - 3)$$

Slope-Intercept Form

$$y - 1 = 4(x - 3)$$
$$y - 1 = 4x - 12$$
$$y = 4x - 11$$
$$f(x) = 4x - 11$$

3. Slope $= 5$, passing through $(-2,6)$

Point-Slope Form

$$y - y_1 = m(x - x_1)$$
$$y - 6 = 5(x - (-2))$$
$$y - 6 = 5(x + 2)$$

Slope-Intercept Form

$$y - 6 = 5(x + 2)$$
$$y - 6 = 5x + 10$$
$$y = 5x + 16$$
$$f(x) = 5x + 16$$

4. Slope $= 8$, passing through $(-4,1)$

Point-Slope Form

$$y - 1 = 8(x - (-4))$$
$$y - 1 = 8(x + 4)$$

Slope-Intercept Form

$$y - 1 = 8x + 32$$
$$y = 8x + 33$$
$$f(x) = 8x + 33$$

5. Slope $= -4$, passing through $(-3,-2)$

Point-Slope Form

$$y - y_1 = m(x - x_1)$$
$$y - (-2) = -4(x - (-3))$$
$$y + 2 = -4(x + 3)$$

Slope-Intercept Form

$$y + 2 = -4(x + 3)$$
$$y + 2 = -4x - 12$$
$$y = -4x - 14$$
$$f(x) = -4x - 14$$

6. Slope $= -6$, passing through $(-2,-4)$

Point-Slope Form

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

Slope-Intercept Form

$$y + 4 = -6x - 12$$
$$y = -6x - 16$$
$$f(x) = -6x - 16$$

7. Slope $= -5$, passing through $(-2,0)$

Point-Slope Form

$$y - y_1 = m(x - x_1)$$
$$y - 0 = -5(x - (-2))$$
$$y - 0 = -5(x + 2)$$

Slope-Intercept Form

$$y - 0 = -5(x + 2)$$
$$y = -5(x + 2)$$
$$y = -5x - 10$$
$$f(x) = -5x - 10$$

8. Slope $= -4$, passing through $(0,-3)$

Point-Slope Form

$$y-(-3)=-4(x-0)$$
$$y+3=-4(x-0)$$

Slope-Intercept Form

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

9. Slope $= -1$, passing through $\left(-2,-\frac{1}{2}\right)$

Point-Slope Form

$$y-y_1=m(x-x_1)$$
$$y-\left(-\tfrac{1}{2}\right)=-1(x-(-2))$$
$$y+\tfrac{1}{2}=-1(x+2)$$

Slope-Intercept Form

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

10. Slope $= -1$, passing through $\left(-\frac{1}{4},-4\right)$

Point-Slope Form

$$y-(-4)=-1\left(x-\left(-\tfrac{1}{4}\right)\right)$$
$$y+4=-1\left(x+\tfrac{1}{4}\right)$$

Slope-Intercept Form

$$y+4=-x-\tfrac{1}{4}$$
$$y=-x-\tfrac{1}{4}-4$$
$$y=-x-\tfrac{17}{4}$$
$$f(x)=-x-\tfrac{17}{4}$$

11. Slope $= \frac{1}{4}$, passing through $(0,0)$

Point-Slope Form

$$y-y_1=m(x-x_1)$$
$$y-0=\tfrac{1}{4}(x-0)$$

Slope-Intercept Form

$$y-0=\tfrac{1}{4}(x-0)$$
$$y=\tfrac{1}{4}x$$
$$f(x)=\tfrac{1}{4}x$$

12. Slope $= \frac{1}{5}$, passing through $(0,0)$

Point-Slope Form

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

Slope-Intercept Form

$$y=\tfrac{1}{5}x$$
$$f(x)=\tfrac{1}{5}x$$

13. Slope $= -\frac{2}{3}$, passing through $(6,-4)$

Point-Slope Form

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

Slope-Intercept Form

$$y+4=-\tfrac{2}{3}(x-6)$$
$$y+4=-\tfrac{2}{3}x+4$$
$$y=-\tfrac{2}{3}x$$
$$f(x)=-\tfrac{2}{3}x$$

14. Slope $= -\frac{2}{5}$, passing through $(15,-4)$

Point-Slope Form

$$y-(-4)=-\tfrac{2}{5}(x-15)$$
$$y+4=-\tfrac{2}{5}(x-15)$$

Slope-Intercept Form

$$y+4=-\tfrac{2}{5}x+6$$
$$y=-\tfrac{2}{5}x+2$$
$$f(x)=-\tfrac{2}{5}x+2$$

15. Passing through $(6,3)$ and $(5,2)$

First, find the slope.

$$m=\frac{2-3}{5-6}=\frac{-1}{-1}=1$$

Then use the slope and one of the points to write the equation in point-slope form.

$$y-y_1=m(x-x_1)$$
$$y-3=1(x-6)$$

or

$$y-2=1(x-5)$$

Slope-Intercept Form

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

16. Passing through $(1,3)$ and $(2,4)$

First, find the slope.

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

Then use the slope and one of the points to write the equation in point-slope form.

$$y-4=1(x-2) \quad \text{or} \quad y-3=1(x-1)$$

Slope-Intercept Form

$$y-4=1x-2$$
$$y=x+2$$
$$f(x)=x+2$$

17. Passing through $(-2,0)$ and $(0,4)$

First, find the slope.

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

Then use the slope and one of the points to write the equation in point-slope form.

$$y-y_1=m(x-x_1)$$
$$y-4=2(x-0)$$

or

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

Slope-Intercept Form

$$y-0=2(x+2)$$
$$y=2x+4$$
$$f(x)=2x+4$$

18. Passing through $(2,0)$ and $(0,-1)$

First, find the slope.

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

Then use the slope and one of the points to write the equation in point-slope form.

$$y-0=\frac{1}{2}(x-2) \quad \text{or} \quad y-(-1)=\frac{1}{2}(x-0)$$
$$y+1=\frac{1}{2}(x-0)$$

Slope-Intercept Form

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

19. Passing through $(-6,13)$ and $(-2,5)$

First, find the slope.

$$m=\frac{5-13}{-2-(-6)}=\frac{-8}{-2+6}=\frac{-8}{4}=-2$$

Then use the slope and one of the points to write the equation in point-slope form.

$$y-y_1=m(x-x_1)$$
$$y-5=-2(x-(-2))$$
$$y-5=-2(x+2)$$

or

$$y-13=-2(x-(-6))$$
$$y-13=-2(x+6)$$

Slope-Intercept Form

$$y-13=-2(x+6)$$
$$y-13=-2x-12$$
$$y=-2x+1$$
$$f(x)=-2x+1$$

20. Passing through $(-3,2)$ and $(2,-8)$

First, find the slope.

$$m=\frac{-8-2}{2-(-3)}=\frac{-10}{2+3}=\frac{-10}{5}=-2$$

Then use the slope and one of the points to write the equation in point-slope form.

$$y-(-8)=-2(x-2)$$
$$y+8=-2(x-2)$$

or

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

Slope-Intercept Form

$$y-(-8)=-2(x-2)$$
$$y+8=-2x+4$$
$$y=-2x-4$$
$$f(x)=-2x-4$$

21. Passing through $(1,9)$ and $(4,-2)$

First, find the slope.

$$m=\frac{-2-9}{4-1}=\frac{-11}{3}=-\frac{11}{3}$$

Then use the slope and one of the points to write the equation in point-slope form.

$$y-y_1=m(x-x_1)$$
$$y-(-2)=-\frac{11}{3}(x-4)$$
$$y+2=-\frac{11}{3}(x-4)$$

or

$$y-9=-\frac{11}{3}(x-1)$$

Slope-Intercept Form

$$y-9=-\frac{11}{3}(x-1)$$
$$y-9=-\frac{11}{3}x+\frac{11}{3}$$
$$y=-\frac{11}{3}x+\frac{38}{3}$$
$$f(x)=-\frac{11}{3}x+\frac{38}{3}$$

22. Passing through $(4,-8)$ and $(8,-3)$

First, find the slope.

$$m=\frac{-3-(-8)}{8-4}=\frac{-3+8}{4}=\frac{5}{4}$$

Then use the slope and one of the points to write the equation in point-slope form.

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

or

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

Slope-Intercept Form

$$y+3=\frac{5}{4}x-10$$
$$y=\frac{5}{4}x-13$$
$$f(x)=\frac{5}{4}x-13$$

23. Passing through $(-2,-5)$ and $(3,-5)$

First, find the slope.

$$m=\frac{-5-(-5)}{3-(-2)}=\frac{0}{5}=0$$

Then use the slope and one of the points to write the equation in point-slope form.

$$y-y_1=m(x-x_1)$$
$$y-(-5)=0(x-3)$$
$$y+5=0(x-3)$$

or

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

Slope-Intercept Form

$$y+5=0(x+2)$$
$$y+5=0$$
$$y=-5$$
$$f(x)=-5$$

24. Passing through $(-1,-4)$ and $(3,-4)$

First, find the slope.

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

Then use the slope and one of the points to write the equation in point-slope form.

$$y-(-4)=0(x-(-1))$$
$$y+4=0(x+1)$$

or

$$y-(-4)=0(x-3)$$
$$y+4=0(x-3)$$

Slope-Intercept Form

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

25. Passing through $(7,8)$ with $x-$intercept $= 3$

If the line has an $x-$intercept $= 3$, it passes through the point $(3,0)$.

First, find the slope.

$$m = \frac{8-0}{7-3} = \frac{8}{4} = 2$$

Then use the slope and one of the points to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 0 = 2(x-3)$$
$$y - 0 = 2(x-3)$$

or

$$y - 8 = 2(x-7)$$

Slope-Intercept Form

$$y - 8 = 2(x-7)$$
$$y - 8 = 2x - 14$$
$$y = 2x - 6$$
$$f(x) = 2x - 6$$

26. Passing through $(-4,5)$ and with y-intercept $= -3$

If the line has a y-intercept $= -3$, it passes through $(0,-3)$.

First, find the slope.

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

Then use the slope and one of the points to write the equation in point-slope form.

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

or

$$y - 5 = -2(x-(-4))$$
$$y - 5 = -2(x+4)$$

Slope-Intercept Form

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

27. x-intercept $= 2$ and y-intercept $= -1$

If the line has an x-intercept $= 2$, it passes through the point $(2,0)$. If the line has a y-intercept $= -1$, it passes through $(0,-1)$.

First, find the slope.

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

Then use the slope and one of the points to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 0 = \frac{1}{2}(x-2)$$

or

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

Slope-Intercept Form

$$y - (-1) = \frac{1}{2}(x-0)$$
$$y + 1 = \frac{1}{2}x$$
$$y = \frac{1}{2}x - 1$$
$$f(x) = \frac{1}{2}x - 1$$

28. x-intercept $= -2$ and y-intercept $= 4$

If the line has an x-intercept $= -2$, it passes through the point $(-2,0)$. If the line has a y-intercept $= 4$, it passes through $(0,4)$.

First, find the slope.

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

Then use the slope and one of the points to write the equation in point-slope form.

$$y - 4 = 2(x-0)$$

or

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

Slope-Intercept Form

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

29. For $y = 5x$, $m = 5$.

a. A line parallel to this line would have the same slope, $m = 5$.

b. A line perpendicular to it would have slope $m = -\frac{1}{5}$.

30. **a.** Parallel: $m = 3$

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

31. For $y = -7x$, $m = -7$.

a. A line parallel to this line would have the same slope, $m = -7$.

b. A line perpendicular to it would have slope $m = \frac{1}{7}$.

32. **a.** Parallel: $m = -9$

b. Perpendicular: $m = \frac{1}{9}$

33. For $y = \frac{1}{2}x + 3$, $m = \frac{1}{2}$.

a. A line parallel to this line would have the same slope, $m = \frac{1}{2}$.

b. A line perpendicular to it would have slope $m = -2$.

34. **a.** Parallel: $m = \frac{1}{4}$

b. Perpendicular: $m = -4$

35. For $y = -\frac{2}{5}x - 1$, $m = -\frac{2}{5}$.

a. A line parallel to this line would have the same slope, $m = -\frac{2}{5}$.

b. A line perpendicular to it would have slope $m = \frac{5}{2}$.

36. **a.** Parallel: $m = -\frac{3}{7}$

b. Perpendicular: $m = \frac{7}{3}$

37. To find the slope, we rewrite the equation in slope-intercept form.

$$4x + y = 7$$
$$y = -4x + 7$$

So, $m = -4$.

a. A line parallel to this line would have the same slope, $m = -4$.

b. A line perpendicular to it would have slope $m = \frac{1}{4}$.

38.

$$8x + y = 11$$
$$y = -8x + 11$$

a. Parallel: $m = -8$

b. Perpendicular: $m = \frac{1}{8}$

39. To find the slope, we rewrite the equation in slope-intercept form.

$$2x + 4y = 8$$
$$4y = -2x + 8$$
$$y = -\frac{1}{2}x + 2$$

So, $m = -\frac{1}{2}$.

a. A line parallel to this line would have the same slope, $m = -\frac{1}{2}$.

b. A line perpendicular to it would have slope $m = 2$.

40.

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

a. Parallel: $m = -\frac{3}{2}$

b. Perpendicular: $m = \frac{2}{3}$

41. To find the slope, we rewrite the equation in slope-intercept form.

$2x-3y=5$

$-3y=-2x+5$

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

So, $m=\frac{2}{3}$.

a. A line parallel to this line would have the same slope, $m=\frac{2}{3}$.

b. A line perpendicular to it would have slope $m=-\frac{3}{2}$.

42. $3x-4y=-7$

$-4y=-3x-7$

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

a. Parallel: $m=\frac{3}{4}$

b. Perpendicular: $m=-\frac{4}{3}$

43. We know that $x=6$ is a vertical line with undefined slope.

a. A line parallel to it would also be vertical with undefined slope.

b. A line perpendicular to it would be horizontal with slope $m=0$.

44. $y=9$ is a horizontal line with slope $m=0$.

a. Parallel: $m=0$

b. Perpendicular: m is undefined

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

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

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

Solve for *y* to obtain slope-intercept form.

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

$y-2=2x-8$

$y=2x-6$

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

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

$y-4=-2x+6$

$y=-2x+10$

$f(x)=-2x+10$

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

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

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

Solve for *y* to obtain slope-intercept form.

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

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

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

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

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

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

Solve for y to obtain slope-intercept form.

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

49. Since the line is parallel to $y = -4x + 3$, we know it will have slope $m = -4$. We are given that it passes through (–8, –10). We use the slope and point to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - (-10) = -4\left(x - (-8)\right)$$
$$y + 10 = -4(x + 8)$$

Solve for y to obtain slope-intercept form.

$$y + 10 = -4(x + 8)$$
$$y + 10 = -4x - 32$$
$$y = -4x - 42$$

In function notation, the equation of the line is $f(x) = -4x - 42$.

50. L will have slope $m = -5$. The line passes through (–2, –7). Use the slope and point to write the equation in point-slope form.

$$y - (-7) = -5\left(x - (-2)\right)$$
$$y + 7 = -5(x + 2)$$

Solve for y to obtain slope-intercept form.

$$y + 7 = -5x - 10$$
$$y = -5x - 17$$
$$f(x) = -5x - 17$$

51. Since the line is perpendicular to $y = \frac{1}{5}x + 6$, we know it will have slope $m = -5$. We are given that it passes through (2, –3). We use the slope and point to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - (-3) = -5(x - 2)$$
$$y + 3 = -5(x - 2)$$

Solve for y to obtain slope-intercept form.

$$y + 3 = -5(x - 2)$$
$$y + 3 = -5x + 10$$
$$y = -5x + 7$$

In function notation, the equation of the line is $f(x) = -5x + 7$.

52. L will have slope $m = -3$. The line passes through (–4, 2). We use the slope and point to write the equation in point-slope form.

$$y - 2 = -3\left(x - (-4)\right)$$
$$y - 2 = -3(x + 4)$$

Solve for y to obtain slope-intercept form.

$$y - 2 = -3x - 12$$
$$y = -3x - 10$$
$$f(x) = -3x - 10$$

53. To find the slope, we rewrite the equation in slope-intercept form.

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

Since the line is parallel to $y = \frac{2}{3}x - \frac{7}{3}$, we know it will have slope $m = \frac{2}{3}$. We are given that it passes through (–2, 2). We use the slope and point to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 2 = \frac{2}{3}\left(x - (-2)\right)$$
$$y - 2 = \frac{2}{3}(x + 2)$$

Solve for y to obtain slope-intercept form.

$$y - 2 = \frac{2}{3}(x + 2)$$
$$y - 2 = \frac{2}{3}x + \frac{4}{3}$$
$$y = \frac{2}{3}x + \frac{10}{3}$$

In function notation, the equation of the line is $f(x) = \frac{2}{3}x + \frac{10}{3}$.

54. Find the slope.

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

Since the lines are parallel, it will have slope $m = \frac{3}{2}$. The line passes through $(-1, 3)$. Use the slope and point to write the equation in point-slope form.

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

Solve for *y* to obtain slope-intercept form.

$$y - 3 = \frac{3}{2}x + \frac{3}{2}$$
$$y = \frac{3}{2}x + \frac{3}{2} + 3$$
$$y = \frac{3}{2}x + \frac{9}{2}$$
$$f(x) = \frac{3}{2}x + \frac{9}{2}$$

55. To find the slope, we rewrite the equation in slope-intercept form.

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

Since the line is perpendicular to $y = \frac{1}{2}x - \frac{3}{2}$, we know it will have slope $m = -2$. We are given that it passes through $(4, -7)$. We use the slope and point to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - (-7) = -2(x - 4)$$
$$y + 7 = -2(x - 4)$$

Solve for *y* to obtain slope-intercept form.

$$y + 7 = -2(x - 4)$$
$$y + 7 = -2x + 8$$
$$y = -2x + 1$$

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

56. Find the slope.

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

Since the lines are perpendicular, the slope is $m = 7$. The line passes through $(5, -9)$. Use the slope and point to write the equation in point-slope form.

$$y - (-9) = 7(x - 5)$$
$$y + 9 = 7(x - 5)$$

Solve for *y* to obtain slope-intercept form.

$$y + 9 = 7(x - 5)$$
$$y + 9 = 7x - 35$$
$$y = 7x - 44$$
$$f(x) = 7x - 44$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

63. The graph of f is just the graph of g shifted down 2 units. So subtract 2 from the equation of $g(x)$ to obtain the equation of $f(x)$.

$$f(x) = g(x) - 2 = 4x - 3 - 2 = 4x - 5$$

64. The graph of f is just the graph of g shifted up 3 units. So add 3 to the equation of $g(x)$ to obtain the equation of $f(x)$.

$$f(x) = g(x) + 3 = 2x - 5 + 3 = 2x - 2$$

65. To find the slope of the line whose equation is $Ax + By = C$, put this equation in slope-intercept form by solving for y.

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

The slope of this line is $m = -\frac{A}{B}$ so the slope of the line that is parallel to it is the same, $-\frac{A}{B}$.

66. From exercise 65, we know the slope of the line is $-\frac{A}{B}$. So the slope of the line that is perpendicular would be $\frac{B}{A}$.

67. a. First, find the slope using $(20, 38.9)$ and $(30, 47.8)$.

$$m = \frac{47.8 - 38.9}{30 - 20} = \frac{8.9}{10} = 0.89$$

Then use the slope and one of the points to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 47.8 = 0.89(x - 30)$$
or
$$y - 38.9 = 0.89(x - 20)$$

b.
$$y - 47.8 = 0.89(x - 30)$$
$$y - 47.8 = 0.89x - 26.7$$
$$y = 0.89x + 21.1$$
$$f(x) = 0.89x + 21.1$$

c. $f(40) = 0.89(40) + 21.1 = 56.7$

The linear function predicts the percentage of never- married American females, ages 25 – 29, to be 56.7% in 2020.

68. a. First, find the slope using $(20, 51.7)$ and $(30, 62.6)$.

$$m = \frac{62.6 - 51.7}{30 - 20} = 10.9 = 1.09$$

Then use the slope and one of the points to write the equation in point-slope form.

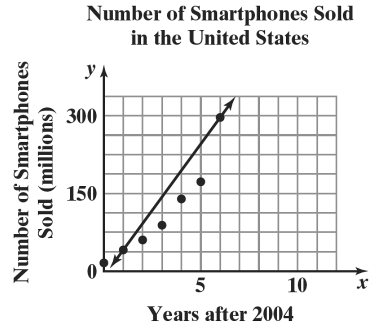
$$y - y_1 = m(x - x_1)$$
$$y - 62.6 = 1.09(x - 30)$$
or
$$y - 51.7 = 1.09(x - 20)$$

b.
$$y - 62.6 = 1.09(x - 30)$$
$$y - 62.6 = 1.09x - 32.7$$
$$y = 1.09x + 29.9$$
$$f(x) = 1.09x + 29.9$$

c. $f(35) = 1.09(35) + 29.9 = 68.05$

The linear function predicts the percentage of never-married American males, ages 25 – 29, to be 68.05% in 2015.

69. a/b.



Use the two points $(1, 40.8)$ and $(6, 296.6)$ to find the slope.

$$m = \frac{296.6 - 40.8}{6 - 1} = \frac{255.8}{5} = 51.16$$

Then use the slope and one of the points to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 40.8 = 51.16(x - 1)$$
or
$$y - 296.6 = 51.16(x - 6)$$

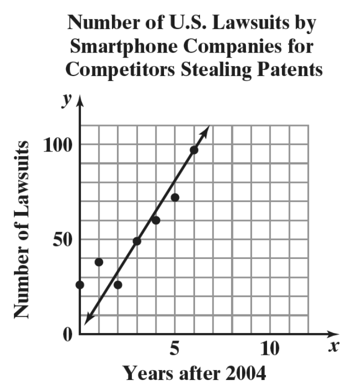
Solve for y to obtain slope-intercept form.

$$y - 40.8 = 51.16(x - 1)$$
$$y - 40.8 = 51.16x - 51.16$$
$$y = 51.16x - 10.36$$
$$f(x) = 51.16x - 10.36$$

c.
$$f(x) = 51.16x - 10.36$$
$$f(11) = 51.16(11) - 10.36$$
$$= 552.4$$

The function predicts that 552.4 million smartphones will be sold in 2015.

70. a/b.



Use the two points $(3, 49)$ and $(6, 97)$ to find the slope.

$$m = \frac{97-49}{6-3} = \frac{48}{3} = 16$$

Then use the slope and one of the points to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 49 = 16(x - 3)$$

or

$$y - 97 = 16(x - 6)$$

Solve for y to obtain slope-intercept form.

$$y - 49 = 16(x - 3)$$
$$y - 49 = 16x - 48$$
$$y = 16x + 1$$
$$f(x) = 16x + 1$$

c. $f(x) = 16x + 1$

$$f(12) = 16(12) + 1$$
$$= 193$$

The function predicts that there will be 193 lawsuits by Smartphone companies for patent infringement in 2016.

71. a. $m = \dfrac{970-582}{2016-2007} = \dfrac{388}{9} \approx 43.1$

The cost of Social Security is projected to increase at a rate of approximately $43.1 billion per year.

b. $m = \dfrac{909-446}{2016-2007} = \dfrac{463}{9} \approx 51.4$

The cost of Medicare is projected to increase at a rate of approximately $51.4 billion per year.

c. No, the slopes are not the same. This means that the cost of Medicare is projected to increase at a faster rate than the cost of Social Security.

72. a. $m = \dfrac{970-582}{2016-2007} = \dfrac{388}{9} \approx 43.1$

The cost of Social Security is projected to increase at a rate of approximately $43.1 billion per year.

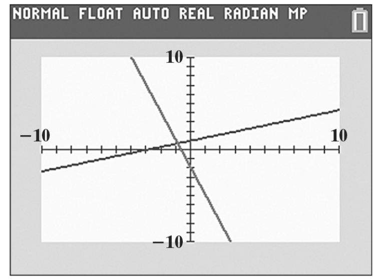
b. $m = \dfrac{392-195}{2016-2007} = \dfrac{197}{9} \approx 21.9$

The cost of Medicaid is projected to increase at a rate of approximately $21.9 billion per year.

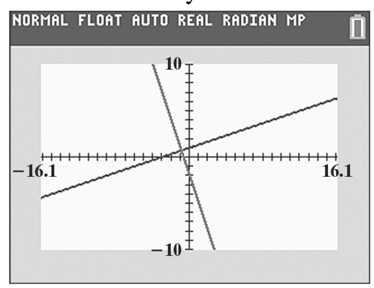
c. No, the slopes are not the same. This means that the cost of Social Security is projected to increase at a faster rate than the cost of Medicaid.

73. – 79. Answers will vary.

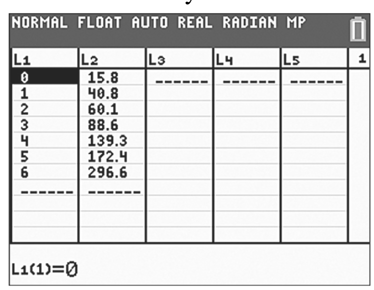
80. a. Answers will vary.



b. Answers will vary.

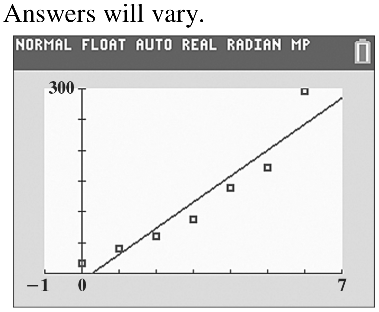


81. a. Answers will vary.

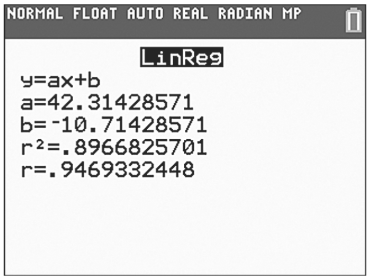


L1	L2	L3	L4	L5
0	15.8	------	------	------
1	40.8			
2	60.1			
3	88.6			
4	139.3			
5	172.4			
6	296.6			
------	------			

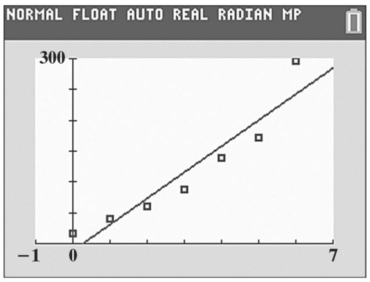
b. Answers will vary.



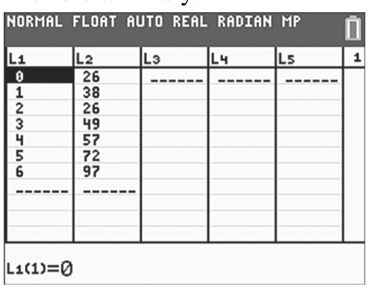
c. Answers will vary.



d. Answers will vary.



82. **a.** Answers will vary.

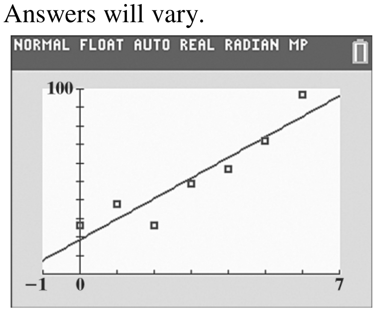


NORMAL FLOAT AUTO REAL RADIAN MP

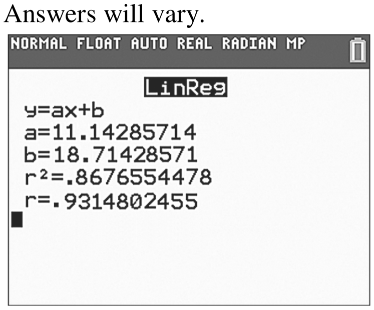
L1	L2	L3	L4	L5	1
0	26	------	------	------	
1	38				
2	26				
3	49				
4	57				
5	72				
6	97				
------	------				

L1(1)=0

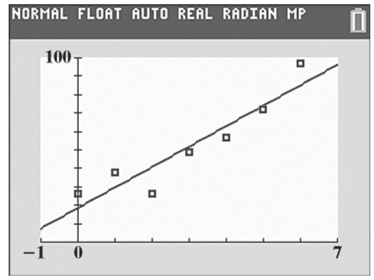
b. Answers will vary.



c. Answers will vary.



d. Answers will vary.



83. makes sense

84. makes sense

85. makes sense

86. does not make sense; Explanations will vary. Sample explanation: If we know the slope and the *y*-intercept, it may be easier to write the slope-intercept form of the equation.

87. true

88. true

89. true

90. true

91. $By = 8x - 1$

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

Since $\frac{8}{B}$ is the slope, $\frac{8}{B}$ must equal -2.

$$\frac{8}{B} = -2$$

$$8 = -2B$$

$$-4 = B$$

92. The slope of the line containing $(1,-3)$ and $(-2,4)$ has slope

$$m = \frac{4-(-3)}{-2-1} = \frac{4+3}{-3} = \frac{7}{-3} = -\frac{7}{3}.$$

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

$$Ax + y = 2$$

$$y = -Ax + 2$$

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

93. Find the slope of the line by using the two points, $(-3,0)$, the $x-$intercept and $(0,-6)$, the $y-$intercept.

$m=\dfrac{-6-0}{0-(-3)}=\dfrac{-6}{3}=-2$

So the equation of the line is $y=-2x-6$.

Substitute -40 for x:

$y=-2(-40)-6=80-6=74$

This is the $y-$coordinate of the first ordered pair.

Substitute -200 for y:

$-200=-2x-6$

$-194=-2x$

$97=x$

This is the $x-$coordinate of the second ordered pair.

Therefore, the two ordered pairs are $(-40,74)$ and $(97,-200)$.

94. First find the slope.

$m=\dfrac{b-0}{0-a}=\dfrac{b}{-a}=-\dfrac{b}{a}$

Use the slope and point to write the equation in point-slope form.

$y-b=-\dfrac{b}{a}(x-0)$

Solve this equation for y to obtain slope-intercept form.

$y-b=-\dfrac{b}{a}x$

$y=-\dfrac{b}{a}x+b$

Divide both sides by b.

$\dfrac{y}{b}=-\dfrac{x}{a}+1$

$\dfrac{x}{a}+\dfrac{y}{b}=1$

This is called *intercept form* because the variable x is being divided by the $x-$intercept, a, and the variable y is being divided by the $y-$intercept, b.

95. $f(-2)=3(-2)^2-8(-2)+5$

$=3(4)+16+5$

$=12+16+5=33$

96. $f(-1)=(-1)^2-3(-1)+4=1+3+4=8$

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

$(fg)(-1)=(f)(-1)\cdot(g)(-1)=8(-7)=-56$

97. Let x = the measure of the smallest angle.
$x + 20$ = the measure of the second angle.
$2x$ = the measure of the third angle.

$x+(x+20)+2x=180$

$x+x+20+2x=180$

$4x+20=180$

$4x=160$

$x=40$

Find the other angles.
$x + 20 = 40 + 20 = 60$
$2x = 2(40) = 80$
The angles are $40°$, $60°$, and $80°$.

98. **a.**

$2x-y=-4$

$2(-5)-(-6)=-4$

$-10+6=-4$

$-4=-4$, true

The point satisfies the equation.

b.

$3x-5y=15$

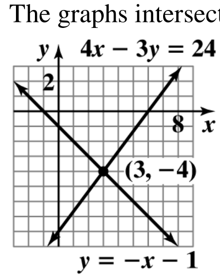
$3(-5)-5(-6)=15$

$-15+30=15$

$15=15$, true

The point satisfies the equation.

99. The graphs intersect at $(3,-4)$.



100. $7x-2(-2x+4)=3$

$7x+4x-8=3$

$11x-8=3$

$11x=11$

$x=1$

The solution set is $\{1\}$.

Chapter 2 Review

1. The relation is a function.
Domain {3, 4, 5}
Range {10}

2. The relation is a function.
Domain {1, 2, 3, 4}
Range {–6, π, 12, 100}

3. The relation is not a function.
Domain {13, 15}
Range {14, 16, 17}

4. **a.** $f(0)=7(0)-5=0-5=-5$

b. $f(3)=7(3)-5=21-5=16$

c. $f(-10)=7(-10)-5=-75$

d. $f(2a)=7(2a)-5=14a-5$

e. $f(a+2)=7(a+2)-5$
$=7a+14-5=7a+9$

5. **a.** $g(0)=3(0)^2-5(0)+2=2$

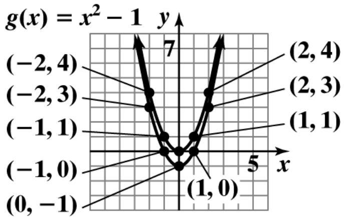
b. $g(5)=3(5)^2-5(5)+2$
$=3(25)-25+2$
$=75-25+2=52$

c. $g(-4)=3(-4)^2-5(-4)+2=70$

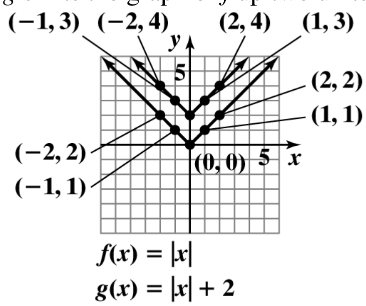
d. $g(b)=3(b)^2-5(b)+2$
$=3b^2-5b+2$

e. $g(4a)=3(4a)^2-5(4a)+2$
$=3(16a^2)-20a+2$
$=48a^2-20a+2$

6. *g* shifts the graph of *f* down one unit.



7. *g* shifts the graph of *f* up two units.



8. The vertical line test shows that this is not the graph of a function.

9. The vertical line test shows that this is the graph of a function.

10. The vertical line test shows that this is the graph of a function.

11. The vertical line test shows that this is not the graph of a function.

12. The vertical line test shows that this is not the graph of a function.

13. The vertical line test shows that this is the graph of a function.

14. $f(-2)=-3$

15. $f(0)=-2$

16. When $x=3$, $f(x)=-5$.

17. The domain of f is $[-3,5)$.

18. The range of f is $[-5,0]$.

19. **a.** The eagle's height is a function of its time in flight because every time, *t*, is associated with at most one height.

b. $f(15)=0$
At time $t = 15$ seconds, the eagle is at height zero. This means that after 15 seconds, the eagle is on the ground.

c. The eagle's maximum height is 45 meters.

d. For $x = 7$ and 22, $f(x)=20$. This means that at times 7 seconds and 22 seconds, the eagle is at a height of 20 meters.

e. The eagle began the flight at 45 meters and remained there for approximately 3 seconds. At that time, the eagle descended for 9 seconds. It landed on the ground and stayed there for 5 seconds. The eagle then began to climb back up to a height of 44 meters.

20. The domain of f is $(-\infty,\infty)$.

21. The domain of f is $(-\infty,-8)$ or $(-8,\infty)$.

22. The domain of f is $(-\infty,5)$ or $(5,\infty)$.

23. a. $(f+g)(x)=(4x-5)+(2x+1)$
$=4x-5+2x+1$
$=6x-4$

b. $(f+g)(3)=6(3)-4$
$=18-4=14$

24. a. $(f+g)(x)$
$=(5x^2-x+4)+(x-3)$
$=5x^2-x+4+x-3=5x^2+1$

b. $(f+g)(3)=5(3)^2+1=5(9)+1$
$=45+1=46$

25. The domain of $f+g$ is $(-\infty,4)$ or $(4,\infty)$.

26. The domain of $f+g$ is $(-\infty,-6)$ or $(-6,-1)$ or $(-1,\infty)$.

27. $f(x)=x^2-2x,\quad g(x)=x-5$
$(f+g)(x)=(x^2-2x)+(x-5)$
$=x^2-2x+x-5$
$=x^2-x-5$
$(f+g)(-2)=(-2)^2-(-2)-5$
$=4+2-5=1$

28. From Exercise 27 we know $(f+g)(x)=x^2-x-5$. We can use this to find $f(3)+g(3)$.
$f(3)+g(3)=(f+g)(3)$
$=(3)^2-(3)-5$
$=9-3-5=1$

29. $f(x)=x^2-2x,\quad g(x)=x-5$
$(f-g)(x)=(x^2-2x)-(x-5)$
$=x^2-2x-x+5$
$=x^2-3x+5$
$(f-g)(x)=x^2-3x+5$
$(f-g)(1)=(1)^2-3(1)+5$
$=1-3+5=3$

30. From Exercise 29 we know $(f-g)(x)=x^2-3x+5$. We can use this to find $f(4)-g(4)$.
$f(4)-g(4)=(f-g)(4)$
$=(4)^2-3(4)+5$
$=16-12+5=9$

31. Since $(fg)(-3)=f(-3)\cdot g(-3)$, find $f(-3)$ and $g(-3)$ first.
$f(-3)=(-3)^2-2(-3)$
$=9+6=15$
$g(-3)=-3-5=-8$
$(fg)(-3)=f(-3)\cdot g(-3)$
$=15(-8)=-120$

32. $f(x)=x^2-2x,\quad g(x)=x-5$
$\left(\frac{f}{g}\right)(x)=\frac{x^2-2x}{x-5}$
$\left(\frac{f}{g}\right)(4)=\frac{(4)^2-2(4)}{4-5}=\frac{16-8}{-1}$
$=\frac{8}{-1}=-8$

33. $(f-g)(x)=x^2-3x+5$
The domain of $f-g$ is $(-\infty,\infty)$.

34. $\left(\frac{f}{g}\right)(x)=\frac{x^2-2x}{x-5}$
The domain of $\frac{f}{g}$ is $(-\infty,5)$ or $(5,\infty)$.

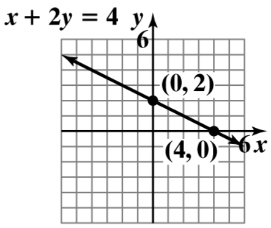
35. $x+2y=4$

Find the *x*–intercept by setting $y = 0$ and the *y*–intercept by setting $x = 0$.

$$x+2(0)=4 \qquad 0+2y=4$$
$$x+0=4 \qquad 2y=4$$
$$x=4 \qquad y=2$$

Choose another point to use as a check.
Let $x = 1$.

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



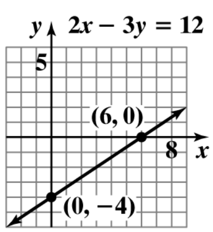
36. $2x-3y=12$

Find the *x*–intercept by setting $y = 0$ and the *y*–intercept by setting $x = 0$.

$$2x-3(0)=12 \qquad 2(0)-3y=12$$
$$2x+0=12 \qquad 0-3y=12$$
$$2x=12 \qquad -3y=12$$
$$x=6 \qquad y=-4$$

Choose another point to use as a check.
Let $x = 1$.

$$2(1)-3y=12$$
$$2-3y=12$$
$$-3y=10$$
$$y=-\frac{10}{3}$$



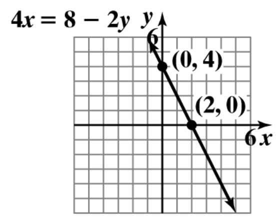
37. $4x=8-2y$

Find the *x*–intercept by setting $y = 0$ and the *y*–intercept by setting $x = 0$.

$$4x=8-2(0) \qquad 4(0)=8-2y$$
$$4x=8-0 \qquad 0=8-2y$$
$$4x=8 \qquad 2y=8$$
$$x=2 \qquad y=4$$

Choose another point to use as a check. Let $x = 1$.

$$4(1)=8-2y$$
$$4=8-2y$$
$$-4=-2y$$
$$2=y$$



38. $m=\frac{2-(-4)}{5-2}=\frac{6}{3}=2$

The line through the points rises.

39. $m=\frac{3-(-3)}{-2-7}=\frac{6}{-9}=-\frac{2}{3}$

The line through the points falls.

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

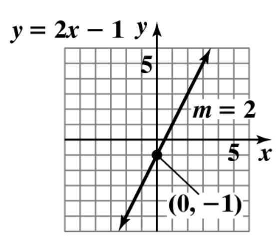
m is undefined. The line through the points is vertical.

41. $m=\frac{4-4}{-3-(-1)}=\frac{0}{-2}=0$

The line through the points is horizontal.

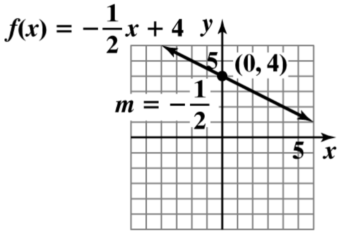
42. $y=2x-1$

$m=2 \qquad y-\text{intercept}=-1$



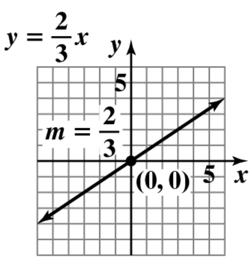
43. $f(x) = -\frac{1}{2}x + 4$

$m = -\frac{1}{2}$ $\quad y - \text{intercept} = 4$



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

$m = \frac{2}{3}$ $\quad y - \text{intercept} = 0$



45. To rewrite the equation in slope-intercept form, solve for y.

$2x + y = 4$

$y = -2x + 4$

$m = -2$ $\quad y - \text{intercept} = 4$

46. $-3y = 5x$

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

$m = -\frac{5}{3}$ $\quad y - \text{intercept} = 0$

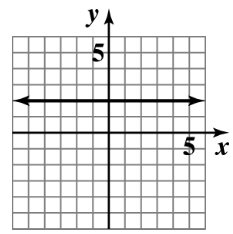
47. $5x + 3y = 6$

$3y = -5x + 6$

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

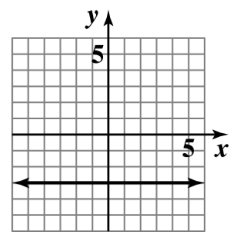
$m = -\frac{5}{3}$ $\quad y - \text{intercept} = 2$

48. $y = 2$



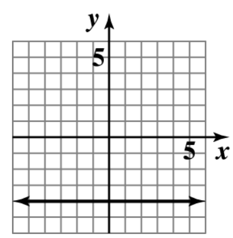
49. $7y = -21$

$y = -3$

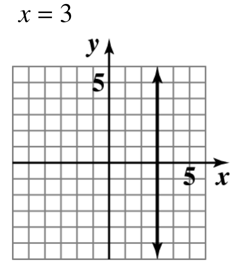


50. $f(x) = -4$

$y = -4$

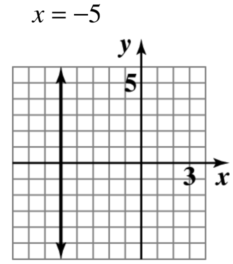


51. $x = 3$



52. $2x = -10$

$x = -5$



53. In $f(t) = -0.27t + 70.45$, the slope is -0.27. A slope of -0.27 indicates that the record time for the women's 400-meter has been decreasing by 0.27 seconds per year since 1900.

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

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

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

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

55. **a.** Find the slope of the line by using the two points (0, 32) and (100,212).

$m = \dfrac{212-32}{100-0} = \dfrac{180}{100} = \dfrac{9}{5}$

We use the slope and one of the points to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 32 = \frac{9}{5}(x-0)$$
$$y - 32 = \frac{9}{5}x$$
$$y = \frac{9}{5}x + 32$$
$$F = \frac{9}{5}C + 32$$

b. Let $C = 30$.

$F = \dfrac{9}{5}(30) + 32 = 54 + 32 = 86$

The Fahrenheit temperature is $86°$ when the Celsius temperature is $30°$.

56. Slope $= -6$, passing through $(-3, 2)$

Point-Slope Form

$$y - y_1 = m(x - x_1)$$
$$y - 2 = -6(x - (-3))$$
$$y - 2 = -6(x+3)$$

Slope-Intercept Form

$$y - 2 = -6(x+3)$$
$$y - 2 = -6x - 18$$
$$y = -6x - 16$$
$$f(x) = -6x - 16$$

57. Passing through $(1, 6)$ and $(-1, 2)$

First, find the slope.

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

Then use the slope and one of the points to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 6 = 2(x-1)$$

or

$$y - y_1 = m(x - x_1)$$
$$y - 2 = 2(x - (-1))$$
$$y - 2 = 2(x+1)$$

Slope-Intercept Form

$$y - 6 = 2(x-1)$$
$$y - 6 = 2x - 2$$
$$y = 2x + 4$$
$$f(x) = 2x + 4$$

58. Rewrite $3x + y = 9$ in slope-intercept form.

$$3x + y = 9$$
$$y = -3x + 9$$

Since the line we are concerned with is parallel to this line, we know it will have slope $m = -3$. We are given that it passes through (4, –7). We use the slope and point to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - (-7) = -3(x-4)$$
$$y + 7 = -3(x-4)$$

Solve for y to obtain slope-intercept form.

$$y + 7 = -3(x-4)$$
$$y + 7 = -3x + 12$$
$$y = -3x + 5$$

In function notation, the equation of the line is $f(x) = -3x + 5$.

59. The line is perpendicular to $y = \dfrac{1}{3}x + 4$, so the slope is –3. We are given that it passes through (–2, 6). We use the slope and point to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 6 = -3(x - (-2))$$
$$y - 6 = -3(x+2)$$

Solve for y to obtain slope-intercept form.

$$y - 6 = -3(x+2)$$
$$y - 6 = -3x - 6$$
$$y = -3x$$

In function notation, the equation of the line is $f(x) = -3x$.

60. **a.** First, find the slope using the points $(2, 28.2)$ and $(4, 28.6)$.

$$m = \frac{28.6 - 28.2}{4 - 2} = \frac{0.4}{2} = 0.2$$

Then use the slope and one of the points to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 28.2 = 0.2(x - 2)$$

or

$$y - 28.6 = 0.2(x - 4)$$

b. Solve for y to obtain slope-intercept form.

$$y - 28.2 = 0.2(x - 2)$$
$$y - 28.2 = 0.2x - 0.4$$
$$y = 0.2x + 27.8$$
$$f(x) = 0.2x + 27.8$$

c. $f(x) = 0.2x + 27.8$

$$f(7) = 0.2(12) + 27.8$$
$$= 30.2$$

The linear function predicts men's average age of first marriage will be 30.2 years in 2020.

Chapter 2 Test

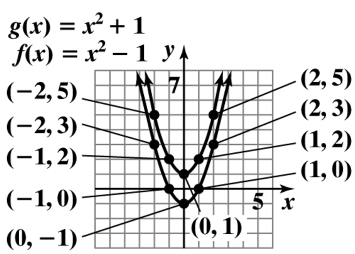
1. The relation is a function.
Domain {1, 3, 5, 6}
Range {2, 4, 6}

2. The relation is not a function.
Domain {2, 4, 6}
Range {1, 3, 5, 6}

3. $f(a+4) = 3(a+4) - 2$
$= 3a + 12 - 2 = 3a + 10$

4. $f(-2) = 4(-2)^2 - 3(-2) + 6$
$= 4(4) + 6 + 6 = 16 + 6 + 6 = 28$

5. g shifts the graph of f up 2 units.



6. The vertical line test shows that this is the graph of a function.

7. The vertical line test shows that this is not the graph of a function.

8. $f(6) = -3$

9. $f(x) = 0$ when $x = -2$ and $x = 3$.

10. The domain of f is $(-\infty, \infty)$.

11. The range of f is $(-\infty, 3]$.

12. The domain of f is $(-\infty, 10)$ or $(10, \infty)$.

13. $f(x) = x^2 + 4x$ and $g(x) = x + 2$

$$(f+g)(x) = f(x) + g(x)$$
$$= (x^2 + 4x) + (x + 2)$$
$$= x^2 + 4x + x + 2$$
$$= x^2 + 5x + 2$$
$$(f+g)(3) = (3)^2 + 5(3) + 2$$
$$= 9 + 15 + 2 = 26$$

14. $f(x) = x^2 + 4x$ and $g(x) = x + 2$

$$(f-g)(x) = f(x) - g(x)$$
$$= (x^2 + 4x) - (x + 2)$$
$$= x^2 + 4x - x - 2$$
$$= x^2 + 3x - 2$$
$$(f-g)(-1) = (-1)^2 + 3(-1) - 2$$
$$= 1 - 3 - 2 = -4$$

15. We know that $(fg)(x) = f(x) \cdot g(x)$. So, to find $(fg)(-5)$, we use $f(-5)$ and $g(-5)$.

$$f(-5) = (-5)^2 + 4(-5) = 25 - 20 = 5$$
$$g(-5) = -5 + 2 = -3$$
$$(fg)(-5) = f(-5) \cdot g(-5)$$
$$= 5(-3) = -15$$

16. $f(x) = x^2 + 4x$ and $g(x) = x + 2$

$$\left(\frac{f}{g}\right)(x) = \frac{x^2 + 4x}{x + 2}$$
$$\left(\frac{f}{g}\right)(2) = \frac{(2)^2 + 4(2)}{2 + 2} = \frac{4 + 8}{4} = \frac{12}{4} = 3$$

17. Domain of $\frac{f}{g}$ is $(-\infty,-2)$ or $(-2,\infty)$.

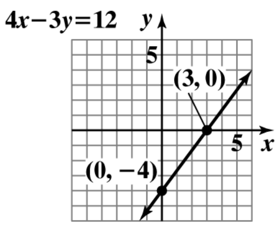
18. $4x-3y=12$

Find the x–intercept by setting $y = 0$.

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

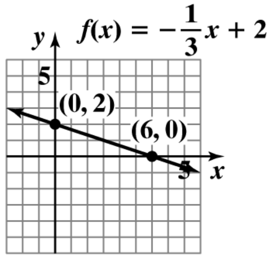
Find the y–intercept by setting $x = 0$.

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



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

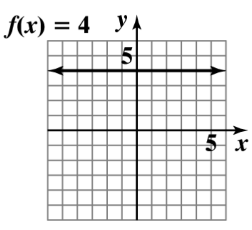
$m=-\frac{1}{3}$ $\quad$ $y-$intercept $= 2$



20. $f(x)=4$

$$y=4$$

An equation of the form $y = b$ is a horizontal line.



21. $m=\frac{4-2}{1-5}=\frac{2}{-4}=-\frac{1}{2}$

The line through the points falls.

22. $m=\frac{5-(-5)}{4-4}=\frac{10}{0}$

m is undefined

The line through the points is vertical.

23. $V(10)=3.6(10)+140$

$$=36+140=176$$

In the year 2005, there were 176 million Super Bowl viewers.

24. The slope is 3.6. This means the number of Super Bowl viewers is increasing at a rate of 3.6 million per year.

25. Passing through $(-1,-3)$ and $(4,2)$

First, find the slope.

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

Then use the slope and one of the points to write the equation in point-slope form.

$$y-y_1=m(x-x_1)$$
$$y-(-3)=1(x-(-1))$$
$$y+3=1(x+1)$$

or

$$y-2=1(x-4)$$
$$y-2=x-4$$

Slope-Intercept Form

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

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

26. The line is perpendicular to $y=-\frac{1}{2}x-4$, so the slope is 2. We are given that it passes through $(-2,3)$. We use the slope and point to write the equation in point-slope form.

$$y-y_1=m(x-x_1)$$
$$y-3=2(x-(-2))$$
$$y-3=2(x+2)$$

Solve for y to obtain slope-intercept form.

$$y-3=2(x+2)$$
$$y-3=2x+4$$
$$y=2x+7$$

In function notation, the equation of the line is $f(x)=2x+7$.

27. The line is parallel to $x+2y=5$.

Put this equation in slope-intercept form by solving for y.

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

Therefore the slopes are the same; $m=-\frac{1}{2}$.

We are given that it passes through $(6,-4)$.

We use the slope and point to write the equation in point-slope form.

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

Solve for y to obtain slope-intercept form.

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

In function notation, the equation of the line is

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

28. a. First, find the slope using the points $(3, 0.053)$ and $(7, 0.121)$.

$$m=\frac{0.121-0.053}{7-3}=\frac{0.068}{4}=0.017$$

Then use the slope and a point to write the equation in point-slope form.

$$y-y_1=m(x-x_1)$$
$$y-0.053=0.017(x-3)$$

or

$$y-0.121=0.017(x-7)$$

b.
$$y-0.053=0.017(x-3)$$
$$y-0.053=0.017x-0.051$$
$$y=0.017x+0.002$$
$$f(x)=0.017x+0.002$$

c.
$$f(x)=0.017x+0.002$$
$$f(8)=0.017(8)+0.002$$
$$=0.138$$

The function predicts that the blood alcohol concentration of an adult man who consumes 8 twelve-ounce beers in an hour will be 0.138.

Cumulative Review Exercises

1. $\{0, 1, 2, 3\}$

2. False. π is an irrational number.

3.
$$\frac{8-3^2\div 9}{|-5|-[5-(18\div 6)]^2}$$
$$=\frac{8-9\div 9}{5-[5-(3)]^2}=\frac{8-1}{5-[2]^2}$$
$$=\frac{7}{5-4}=\frac{7}{1}=7$$

4.
$$4-(2-9)^0+3^2\div 1+3$$
$$=4-(-7)^0+9\div 1+3=4-1+9\div 1+3$$
$$=4-1+9+3=3+9+3=15$$

5.
$$3-[2(x-2)-5x]$$
$$=3-[2x-4-5x]=3-[-3x-4]$$
$$=3+3x+4=3x+7$$

6.
$$2+3x-4=2(x-3)$$
$$3x-2=2x-6$$
$$x-2=-6$$
$$x=-4$$

The solution set is $\{-4\}$.

7.
$$4x+12-8x=-6(x-2)+2x$$
$$12-4x=-6x+12+2x$$
$$12-4x=-4x+12$$
$$12=12$$
$$0=0$$

The solution set is $\{x \mid x \text{ is a real number}\}$ or $(-\infty,\infty)$ or $\mathbb{R}$. The equation is an identity.

8. $\frac{x-2}{4}=\frac{2x+6}{3}$

$4(2x+6)=3(x-2)$

$8x+24=3x-6$

$5x+24=-6$

$5x=-30$

$x=-6$

The solution set is $\{-6\}$.

9. Let x = the price before reduction

$x-0.20x=1800$

$0.80x=1800$

$x=2250$

The price of the computer before the reduction was \$2250.

10. $A=p+prt$

$A-p=prt$

$\frac{A-p}{pr}=t$

11. $\left(3x^4y^{-5}\right)^{-2}=\left(\frac{3x^4}{y^5}\right)^{-2}=\left(\frac{y^5}{3x^4}\right)^2=\frac{y^{10}}{9x^8}$

12. $\left(\frac{3x^2y^{-4}}{x^{-3}y^2}\right)^2=\left(\frac{3x^2x^3}{y^2y^4}\right)^2$

$=\left(\frac{3x^5}{y^6}\right)^2=\frac{9x^{10}}{y^{12}}$

13. $\left(7\times10^{-8}\right)\left(3\times10^2\right)$

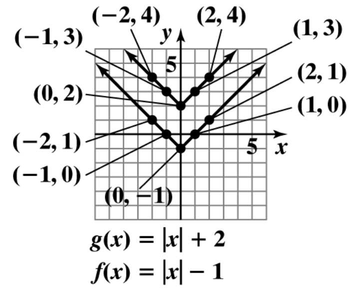
$=(7\times3)\left(10^{-8}\times10^2\right)=21\times10^{-6}$

$=(2.1\times10)\times10^{-6}=2.1\left(10\times10^{-6}\right)$

$=2.1\times10^{-5}$

14. The relation is a function.
Domain {1, 2, 3, 4, 6}
Range {5}

15. g shifts the graph of f up three units.



16. The domain of f is $(-\infty,15)$ or $(15,\infty)$.

17. $(f-g)(x)$

$=\left(3x^2-4x+2\right)-\left(x^2-5x-3\right)$

$=3x^2-4x+2-x^2+5x+3$

$=2x^2+x+5$

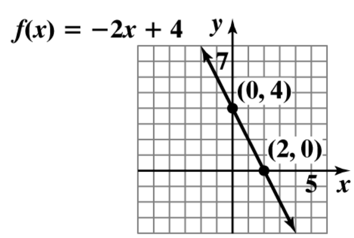
$(f-g)(-1)=2(-1)^2+(-1)+5$

$=2(1)-1+5=2-1+5=6$

18. $f(x)=-2x+4$

$y=-2x+4$

$m=-2 \qquad y-\text{intercept}=4$



19. $x-2y=6$

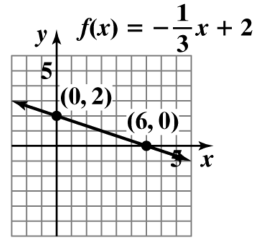
Rewrite the equation of the line in slope-intercept form.

$x-2y=6$

$-2y=-x+6$

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

$m=\frac{1}{2} \qquad y-\text{intercept}=-3$



20. The line is parallel to $y = 4x + 7$, so the slope is 4. We are given that it passes through (3, –5). We use the slope and point to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - (-5) = 4(x - 3)$$
$$y + 5 = 4(x - 3)$$

Solve for *y* to obtain slope-intercept form.

$$y + 5 = 4(x - 3)$$
$$y + 5 = 4x - 12$$
$$y = 4x - 17$$

In function notation, the equation of the line is $f(x) = 4x - 17$.