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INSTRUCTOR'S SOLUTIONS MANUAL

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INTERMEDIATE ALGEBRA FOR COLLEGE STUDENTS

SEVENTH EDITION

Robert Blitzer
Miami Dade College

PEARSON

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ISBN-13: 978-0-13-418015-1
ISBN-10: 0-13-418015-1

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INTERMEDIATE ALGEBRA FOR COLLEGE STUDENTS 7E

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Chapter 1
Algebra, Mathematical Models, and Problem Solving

1.1 Check Points

1. **a.** $\overbrace{8x}^{\boxed{\text{eight times a number}}} \overbrace{+ \quad 5}^{\boxed{\text{five more}}} = 8x+5$

b. $\overbrace{\frac{x}{7}}^{\boxed{\text{the quotient of a number and seven}}} \overbrace{- \quad 2x}^{\boxed{\text{decreased by twice the number}}} = \frac{x}{7}-2x$

2. $\overbrace{23-0.12x}^{\text{replace } x \text{ with } 10}$

$= 23-0.12(10)$

$= 23-1.2$

$= 21.8$

At age 10, the average neurotic level is 21.8.

3. $\overbrace{8+6(x-3)^2}^{\text{replace } x \text{ with } 13}$

$= 8+6(13-3)^2$

$= 8+6(10)^2$

$= 8+6(100)$

$= 8+600$

$= 608$

4. **a.** 2010 is 10 years after 2000.

$D = \overbrace{46x^2+541x+17{,}650}^{\text{replace } x \text{ with } 10}$

$D = 46(10)^2+541(10)+17{,}650$

$= 46(100)+541(10)+17{,}650$

$= 4600+5410+17{,}650$

$= 27{,}660$

The formula indicates that the mean student-loan debt for college students who graduated in 2010 was \$27,660.

b. The model value, \$27,660, is more than the actual data value, \$26,682. Thus, the mathematical model overestimates by \$978.

5. **a.** true; Because the number 13 is an element of the set of integers.

b. true; Because 6 is not an element of $\{7, 8, 9, 10\}$, the statement is true.

6. **a.** -8 is less than -2; true

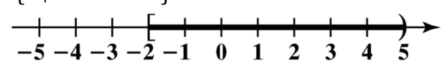
b. 7 is greater than -3; true

c. -1 is less than or equal to -4; false

d. 5 is greater than or equal to 5; true

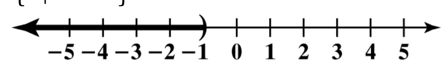
e. 2 is greater than or equal to -14; true

7. **a.** $\{x \mid -2 \le x < 5\}$



b. $\{x \mid 1 \le x \le 3.5\}$

c. $\{x \mid x < -1\}$



1.1 Concept and Vocabulary Check

1. variable
2. expression
3. *b*th to the *n*th power; base; exponent
4. formula; modeling; models
5. natural
6. whole
7. integers
8. rational
9. irrational
10. rational; irrational
11. left
12. 2; 5; 2; 5
13. greater than
14. less than or equal to

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1.1 Exercise Set

1. $x+5$

2. $x+6$

3. $x-4$

4. $x-9$

5. $4x$

6. $2x$

7. $2x+10$

8. $5x+4$

9. $6-\frac{1}{2}x$

10. $3-\frac{1}{2}x$

11. $\frac{4}{x}-2$

12. $\frac{5}{x}-3$

13. $\frac{3}{5-x}$

14. $\frac{6}{10-x}$

15. $7+5(10)=7+50=57$

16. $8+6(5)=8+30=38$

17. $6(3)-8=18-8=10$

18. $8(3)-4=24-4=20$

19. $\left(\frac{1}{3}\right)^2+3\left(\frac{1}{3}\right)=\frac{1}{9}+1=1\frac{1}{9}$

20. $\left(\frac{1}{2}\right)^2+2\left(\frac{1}{2}\right)=\frac{1}{4}+1=1\frac{1}{4}$

21. $7^2-6(7)+3=49-42+3=7+3=10$

22. $8^2-7(8)+4=64-56+4=8+4=12$

23. $$\begin{aligned}4+5(9-7)^3 &= 4+5(2)^3\\ &= 4+5(8)=4+40=44\end{aligned}$$

24. $$\begin{aligned}6+5(8-6)^3 &= 6+5(2)^3\\ &= 6+5(8)\\ &= 6+40=46\end{aligned}$$

25. $$\begin{aligned}8^2-3(8-2) &= 64-3(6)\\ &= 64-18=46\end{aligned}$$

26. $8^2-4(8-3)=64-4(5)=64-20=44$

27. $\{1, 2, 3, 4\}$

28. $\{1, 2, 3\}$

29. $\{-7, -6, -5, -4\}$

30. $\{-6, -5, -4, -3\}$

31. $\{8, 9, 10, \ldots\}$

32. $\{10, 11, 12, \ldots\}$

33. $\{1, 3, 5, 7, 9\}$

34. $\{1, 3, 5, 7\}$

35. true; Seven is an integer.

36. true; Nine is an integer.

37. true; Seven is a rational number.

38. true; Nine is a rational number.

39. false; Seven is a rational number.

40. false; Nine is not an irrational number.

41. true; Three is not an irrational number.

42. true; Five is not an irrational number.

43. false; $\frac{1}{2}$ is a rational number.

44. false; $\frac{1}{4}$ is a rational number.

45. true; $\sqrt{2}$ is not a rational number.

46. true; π is not a rational number.

47. false; $\sqrt{2}$ is a real number.

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48. false; π is a real number.

49. –6 is less than –2; true

50. –7 is less than –3; true

51. 5 is greater than –7; true

52. 3 is greater than –8; true

53. 0 is less than –4; false. 0 is greater than –4.

54. 0 is less than –5; false. 0 is greater than –5.

55. –4 is less than or equal to 1; true

56. –5 is less than or equal to 1; true

57. –2 is less than or equal to –6; false. –2 is greater than –6.

58. –3 is less than or equal to –7; false. –3 is greater than –7.

59. –2 is less than or equal to –2; true

60. –3 is less than or equal to –3; true

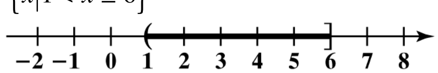
61. –2 is greater than or equal to –2; true

62. –3 is greater than or equal to –3; true

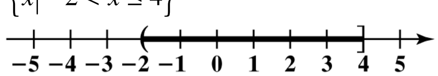
63. 2 is less than or equal to $-\frac{1}{2}$; false. 2 is greater than $-\frac{1}{2}$.

64. 4 is less than or equal to $-\frac{1}{2}$; false. 4 is greater than $-\frac{1}{2}$.

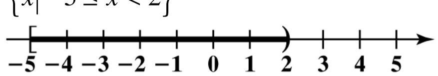
65. $\{x|1 < x \leq 6\}$



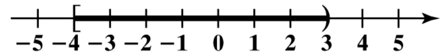
66. $\{x|-2 < x \leq 4\}$



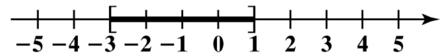
67. $\{x|-5 \leq x < 2\}$



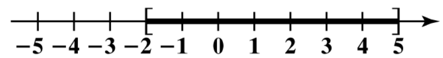
68. $\{x|-4 \leq x < 3\}$



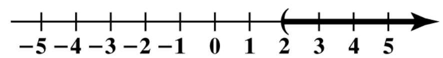
69. $\{x|-3 \leq x \leq 1\}$



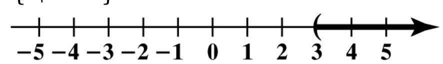
70. $\{x|-2 \leq x \leq 5\}$



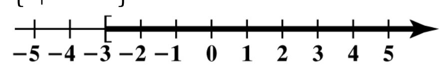
71. $\{x|x > 2\}$



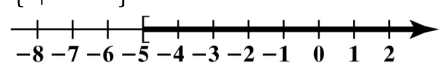
72. $\{x|x > 3\}$



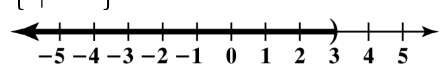
73. $\{x|x \geq -3\}$



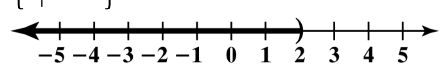
74. $\{x|x \geq -5\}$



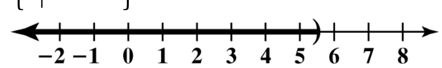
75. $\{x|x < 3\}$



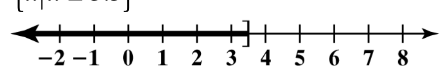
76. $\{x|x < 2\}$



77. $\{x|x < 5.5\}$



78. $\{x|x \leq 3.5\}$



79. true

80. true

81. false; $\{3\} \not\subseteq \{1,2,3,4\}$.

82. false; $\{4\} \not\subseteq \{1,2,3,4,5\}$.

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83. true

84. true

85. false; The value of $\{x \mid x$ is an integer between -3 and $0\} = \{-2,-1\}$, not $\{-3,-2,-1,0\}$.

86. false; The value of $\{x \mid x$ is an integer between -4 and $0\} = \{-3,-2,-1\}$, not $\{-4,-3,-2,-1,0\}$.

87. false; Twice the sum of a number and three is represented by $2(x+3)$, not $2x+3$.

88. false; Three times the sum of a number and five is represented by $3(x+5)$, not $3x+5$.

89. $R = 4.6 - 0.02x$
$= 4.6 - 0.02(20)$
$= 4.2$
The average resistance to happiness at age 20 is 4.2.

90. $R = 4.6 - 0.02x$
$= 4.6 - 0.02(30)$
$= 4.0$
The average resistance to happiness at age 30 is 4.0.

91. $[4.6 - 0.02(30)] - [4.6 - 0.02(50)]$
$= 4.0 - 3.6$
$= 0.4$
The difference between the average resistance to happiness at age 30 and at age 50 is 0.4.

92. $[4.6 - 0.02(20)] - [4.6 - 0.02(70)]$
$= 4.2 - 3.2$
$= 1.0$
The difference between the average resistance to happiness at age 20 and at age 70 is 0.4.

93. $S = 32 + 8.7x - 0.3x^2$
$= 32 + 8.7(4) - 0.3(4)^2$
$= 32 + 34.8 - 4.8$
$= 62$
According to the formula, 67% of American adults used smartphones to go online in 2013. The formula underestimated the actual value by 1%.

94. $S = 32 + 8.7x - 0.3x^2$
$= 32 + 8.7(3) - 0.3(3)^2$
$= 32 + 26.1 - 2.7$
$= 55.4$
According to the formula, 55.4% of American adults used smartphones to go online in 2012. The formula overestimated the actual value by 0.4%.

95. $C = \frac{5}{9}(50-32) = \frac{5}{9}(18) = 10$

10°C is equivalent to 50°F.

96. $C = \frac{5}{9}(F-32) = \frac{5}{9}(86-32) = \frac{5}{9}(54) = 30$
30°C is equivalent to 86°F.

97. $h = 4 + 60t - 16t^2 = 4 + 60(2) - 16(2)^2$
$= 4 + 120 - 16(4) = 4 + 120 - 64$
$= 124 - 64 = 60$

Two seconds after it was kicked, the ball's height was 60 feet.

98. $h = 4 + 60t - 16t^2$
$= 4 + 60(3) - 16(3)^2$
$= 4 + 180 - 16(9)$
$= 4 + 180 - 144$
$= 184 - 144 = 40$
Three seconds after it was kicked, the ball's height was 40 feet.

99. – 116. Answers will vary.

117. does not make sense; Explanations will vary. Sample explanation: Many models work for a while and then no longer are valid beyond a certain point.

118. does not make sense; Explanations will vary. Sample explanation: Though this value is beyond the capabilities of a calculator, it still exists. This particular expression can be obtained via several software applications.

119. makes sense

120. does not make sense; Explanations will vary. Sample explanation: The model can be used to estimate the number in 2000 by letting $x = 0$.

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121. false; Changes to make the statement true will vary. A sample change is: Every integer is a rational number.

122. false; Changes to make the statement true will vary. A sample change is: Some integers are not whole numbers.

123. true

124. true

125. Evaluate the two expressions.
$2(4+20)=2(24)=48$
$2\cdot 4+20=8+20=28$
Since the bird lover purchases $\frac{1}{7}$ of the birds, the expression has to be a multiple of 7. Since 48 in not a multiple of 7 and 28 is a multiple of 7, we know that the correct expression is $2\cdot 4+20.$

126. $(2\cdot 3+3)\cdot 5=45$

127. $(8+2)\cdot(4-3)=10$ or $8+2\cdot(4-3)=10$

128. 26 is not a perfect square and $\sqrt{26}$ cannot be simplified. Consider the numbers closest to 26, both smaller and larger, which are perfect squares. The first perfect square smaller than 26 is 25. The first perfect square larger than 26 is 36. We know that the square root of 26 will lie between these numbers. We have $-\sqrt{36}<-\sqrt{26}<-\sqrt{25}.$ If we simplify, we have $-6<-\sqrt{26}<-5.$ Therefore, $-\sqrt{26}$ lies between –6 and –5.

129. –5 and 5 are both a distance of five units from zero on a real number line.

130. $\dfrac{16+3(2)^4}{12-(10-6)}=\dfrac{16+3(16)}{12-(4)}=\dfrac{16+48}{8}=\dfrac{64}{8}=8$

131. $2(3x+5)$
$=2(3(4)+5)$
$=2(12+5)$
$=2(17)$
$=34$

$6x+10$
$=6(4)+10$
$=24+10$
$=34$

1.2 Check Points

1. a. $|-6|=6$ because -6 is 6 units from 0.

b. $|4.5|=4.5$ because 4.5 is 4.5 units from 0.

c. $|0|=0$ because 0 is 0 units from 0.

2. a. $-10+(-18)=-28$

b. $-0.2+0.9=0.7$

c. $-\frac{3}{5}+\frac{1}{2}=-\frac{6}{10}+\frac{5}{10}=-\frac{1}{10}$

3. a. If $x=-8,$ then $-x=-(-8)=8.$

b. If $x=\frac{1}{3},$ then $-x=-\frac{1}{3}.$

4. a. $7-10=7+(-10)=-3$

b. $4.3-(-6.2)=4.3+6.2=10.5$

c. $-\frac{4}{5}-\left(-\frac{1}{5}\right)=-\frac{4}{5}+\frac{1}{5}=-\frac{3}{5}$

5. a. $(-5)^2=(-5)(-5)=25$

b. $-5^2=-(5\cdot 5)=-25$

c. $(-4)^3=(-4)(-4)(-4)=-64$

d. $\left(-\frac{3}{5}\right)^4=\left(-\frac{3}{5}\right)\left(-\frac{3}{5}\right)\left(-\frac{3}{5}\right)\left(-\frac{3}{5}\right)=\frac{81}{625}$

6. a. $\frac{32}{-4}=-8$

b. $-\frac{2}{3}\div\left(-\frac{5}{4}\right)=-\frac{2}{3}\cdot\left(-\frac{4}{5}\right)=\frac{8}{15}$

7. $3-5^2+12\div 2(-4)^2$
$=3-25+12\div 2(16)$
$=3-25+6(16)$
$=3-25+96$
$=-22+96$
$=74$

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8. $\dfrac{4+3(-2)^3}{2-(6-9)}$
$=\dfrac{4+3(-8)}{2-(-3)}$
$=\dfrac{4-24}{2+3}$
$=\dfrac{-20}{5}$
$=-4$

9. Commutative Property of Addition: $4x+9=9+4x$
Commutative Property of Multiplication:
$4x+9=x\cdot 4+9$

10. **a.** $6+(12+x)=(6+12)+x=18+x$

b. $-7(4x)=(-7\cdot 4)x=-28x$

11. $-4(7x+2)=-28x-8$

12. $3x+14x^2+11x+x^2$
$=(14x^2+x^2)+(3x+11x)$
$=(14+1)x^2+(3+11)x$
$=15x^2+14x$

13. $8(2x-5)-4x$
$=16x-40-4x$
$=16x-4x-40$
$=12x-40$

14. $6+4[7-(x-2)]$
$=6+4[7-x+2]$
$=6+4[9-x]$
$=6+36-4x$
$=42-4x$

1.2 Concept and Vocabulary Check

1. negative number

2. 0

3. positive number

4. positive number

5. positive number

6. negative number

7. positive number

8. divide

9. subtract

10. absolute value; 0; a

11. a; $-a$

12. 0; inverse; 0; identity

13. $b+a$

14. $(ab)c$

15. $ab+ac$

16. simplified

1.2 Exercise Set

1. $|-7|=7$

2. $|-10|=10$

3. $|4|=4$

4. $|13|=13$

5. $|-7.6|=7.6$

6. $|-8.3|=8.3$

7. $\left|\dfrac{\pi}{2}\right|=\dfrac{\pi}{2}$

8. $\left|\dfrac{\pi}{3}\right|=\dfrac{\pi}{3}$

9. $\left|-\sqrt{2}\right|=\sqrt{2}$

10. $\left|-\sqrt{3}\right|=\sqrt{3}$

11. $-\left|-\dfrac{2}{5}\right|=-\dfrac{2}{5}$

12. $-\left|-\dfrac{7}{10}\right|=-\dfrac{7}{10}$

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13. $-3+(-8)=-11$

14. $-5+(-10)=-15$

15. $-14+10=-4$

16. $-15+6=-9$

17. $-6.8+2.3=-4.5$

18. $-7.9+2.4=-5.5$

19. $\frac{11}{15}+\left(-\frac{3}{5}\right)=\frac{11}{15}+\left(-\frac{9}{15}\right)=\frac{2}{15}$

20. $\frac{7}{10}+\left(-\frac{4}{5}\right)=\frac{7}{10}+\left(-\frac{4}{5}\right)\left(\frac{2}{2}\right)$
$=\frac{7}{10}+\left(-\frac{8}{10}\right)=-\frac{1}{10}$

21. $-\frac{2}{9}-\frac{3}{4}=-\frac{2}{9}+\left(-\frac{3}{4}\right)$
$=-\frac{8}{36}+\left(-\frac{27}{36}\right)=-\frac{35}{36}$

22. $-\frac{3}{5}-\frac{4}{7}=-\frac{3}{5}+\left(-\frac{4}{7}\right)$
$=-\frac{21}{35}+\left(-\frac{20}{35}\right)=-\frac{41}{35}$

23. $-3.7+(-4.5)=-8.2$

24. $-6.2+(-5.9)=-12.1$

25. $0+(-12.4)=-12.4$

26. $0+(-15.3)=-15.3$

27. $12.4+(-12.4)=0$

28. $15.3+(-15.3)=0$

29. $x=11$
$-x=-11$

30. $x=13$
$-x=-13$

31. $x=-5$
$-x=5$

32. $x=-9$
$-x=9$

33. $x=0$
$-x=0$

34. $x=-\sqrt{2}$
$-x=\sqrt{2}$

35. $3-15=3+(-15)=-12$

36. $4-20=4+(-20)=-16$

37. $8-(-10)=8+10=18$

38. $7-(-13)=7+13=20$

39. $-20-(-5)=-20+5=-15$

40. $-30-(-10)=-30+10=-20$

41. $\frac{1}{4}-\frac{1}{2}=\frac{1}{4}+\left(-\frac{1}{2}\right)=\frac{1}{4}+\left(-\frac{2}{4}\right)=-\frac{1}{4}$

42. $\frac{1}{10}-\frac{2}{5}=\frac{1}{10}+\left(-\frac{2}{5}\right)=\frac{1}{10}+\left(-\frac{2}{5}\right)\left(\frac{2}{2}\right)$
$=\frac{1}{10}+\left(-\frac{4}{10}\right)=-\frac{3}{10}$

43. $-2.3-(-7.8)=-2.3+7.8=5.5$

44. $-4.3-(-8.7)=-4.3+8.7=4.4$

45. $0-\left(-\sqrt{2}\right)=0+\sqrt{2}=\sqrt{2}$

46. $0-\left(-\sqrt{3}\right)=0+\sqrt{3}=\sqrt{3}$

47. $9(-10)=-90$

48. $8(-10)=-80$

49. $(-3)(-11)=33$

50. $(-7)(-11)=77$

51. $\frac{15}{13}(-1)=-\frac{15}{13}$

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52. $\frac{11}{13}(-1) = -\frac{11}{13}$

53. $-\sqrt{2} \cdot 0 = 0$

54. $-\sqrt{3} \cdot 0 = 0$

55. $(-4)(-2)(-1) = (8)(-1) = -8$

56. $(-5)(-3)(-2) = (15)(-2) = -30$

57.
$$\begin{aligned} 2(-3)(-1)(-2)(-4) &= (-6)(-1)(-2)(-4) \\ &= (6)(-2)(-4) \\ &= (-12)(-4) \\ &= 48 \end{aligned}$$

58.
$$\begin{aligned} 3(-2)(-1)(-5)(-3) &= -6(-1)(-5)(-3) \\ &= 6(-5)(-3) \\ &= -30(-3) = 90 \end{aligned}$$

59. $(-10)^2 = (-10)(-10) = 100$

60. $(-8)^2 = (-8)(-8) = 64$

61. $-10^2 = -(10)(10) = -100$

62. $-8^2 = -(8)(8) = -64$

63. $(-2)^3 = (-2)(-2)(-2) = -8$

64. $(-3)^3 = (-3)(-3)(-3) = -27$

65. $(-1)^4 = (-1)(-1)(-1)(-1) = 1$

66. $(-4)^4 = (-4)(-4)(-4)(-4) = 256$

67. Since a product with an odd number of negative factors is negative, $(-1)^{33} = -1$.

68. A product with an odd number of negative factors is negative.
$(-1)^{35} = -1$

69. $-\left(-\frac{1}{2}\right)^3 = -\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right) = \frac{1}{8}$

70. $-\left(-\frac{1}{4}\right)^3 = -\left(-\frac{1}{4}\right)\left(-\frac{1}{4}\right)\left(-\frac{1}{4}\right) = \frac{1}{64}$

71. $\frac{12}{-4} = -3$

72. $\frac{30}{-5} = -6$

73. $\frac{-90}{-2} = 45$

74. $\frac{-55}{-5} = 11$

75. $\frac{0}{-4.6} = 0$

76. $\frac{0}{-5.3} = 0$

77. $-\frac{4.6}{0}$ is undefined.

78. $-\frac{5.3}{0}$ is undefined.

79. $-\frac{1}{2} \div \left(-\frac{7}{9}\right) = -\frac{1}{2} \cdot \left(-\frac{9}{7}\right) = \frac{9}{14}$

80. $-\frac{1}{2} \div \left(-\frac{3}{5}\right) = -\frac{1}{2} \cdot \left(-\frac{5}{3}\right) = \frac{5}{6}$

81. $6 \div \left(-\frac{2}{5}\right) = \frac{6}{1} \cdot \left(-\frac{5}{2}\right) = -\frac{30}{2} = -15$

82. $8 \div \left(-\frac{2}{9}\right) = \frac{8}{1} \cdot \left(-\frac{9}{2}\right) = -\frac{72}{2} = -36$

83.
$$\begin{aligned} 4(-5) - 6(-3) &= -20 - (-18) \\ &= -20 + 18 = -2 \end{aligned}$$

84. $8(-3) - 5(-6) = -24 - (-30) = -24 + 30 = 6$

85.
$$\begin{aligned} 3(-2)^2 - 4(-3)^2 &= 3(4) - 4(9) \\ &= 12 - 36 = -24 \end{aligned}$$

86. $5(-3)^2 - 2(-2)^2 = 5(9) - 2(4) = 45 - 8 = 37$

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87. $8^2 - 16 \div 2^2 \cdot 4 - 3 = 64 - 16 \div 4 \cdot 4 - 3$
$= 64 - 4 \cdot 4 - 3$
$= 64 - 16 - 3$
$= 48 - 3$
$= 45$

88. $10^2 - 100 \div 5^2 \cdot 2 - 3$
$= 100 - 100 \div 25 \cdot 2 - 3$
$= 100 - 4 \cdot 2 - 3 = 100 - 8 - 3$
$= 92 - 3 = 89$

89. $\dfrac{5 \cdot 2 - 3^2}{\left[3^2 - (-2)\right]^2} = \dfrac{5 \cdot 2 - 9}{\left[9 - (-2)\right]^2}$
$= \dfrac{10 - 9}{(9+2)^2}$
$= \dfrac{1}{11^2}$
$= \dfrac{1}{121}$

90. $\dfrac{10 \div 2 + 3 \cdot 4}{(12 - 3 \cdot 2)^2} = \dfrac{5 + 3 \cdot 4}{(12-6)^2} = \dfrac{5+12}{(6)^2} = \dfrac{17}{36}$

91. $8 - 3[-2(2-5) - 4(8-6)]$
$= 8 - 3[-2(-3) - 4(2)]$
$= 8 - 3[6 - 8] = 8 - 3[-2] = 8 + 6 = 14$

92. $8 - 3[-2(5-7) - 5(4-2)]$
$= 8 - 3[-2(-2) - 5(2)] = 8 - 3[4 - 10]$
$= 8 - 3[4 + (-10)] = 8 - 3[-6]$
$= 8 + 18 = 26$

93. $\dfrac{2(-2) - 4(-3)}{5-8} = \dfrac{-4+12}{-3} = \dfrac{8}{-3} = -\dfrac{8}{3}$

94. $\dfrac{6(-4) - 5(-3)}{9-10} = \dfrac{-24+15}{-1} = \dfrac{-9}{-1} = 9$

95. $\dfrac{(5-6)^2 - 2|3-7|}{89 - 3 \cdot 5^2} = \dfrac{(-1)^2 - 2|-4|}{89 - 3 \cdot 25}$
$= \dfrac{1 - 2(4)}{89 - 75}$
$= \dfrac{1-8}{14} = \dfrac{-7}{14} = -\dfrac{1}{2}$

96. $\dfrac{12 \div 3 \cdot 5\left|2^2 + 3^2\right|}{7 + 3 - 6^2} = \dfrac{12 \div 3 \cdot 5|4+9|}{7+3-36}$
$= \dfrac{12 \div 3 \cdot 5|13|}{10 - 36}$
$= \dfrac{12 \div 3 \cdot 5(13)}{-26} = \dfrac{4 \cdot 5(13)}{-26}$
$= \dfrac{20(13)}{-26} = \dfrac{260}{-26} = -10$

97. $15 - \sqrt{3-(-1)} + 12 \div 2 \cdot 3$
$= 15 - \sqrt{4} + 12 \div 2 \cdot 3$
$= 15 - 2 + 12 \div 2 \cdot 3$
$= 15 - 2 + 6 \cdot 3$
$= 15 - 2 + 18 = 13 + 18 = 31$

98. $17 - |5 - (-2)| + 12 \div 2 \cdot 3$
$= 17 - |7| + 12 \div 2 \cdot 3 = 17 - 7 + 12 \div 2 \cdot 3$
$= 17 - 7 + 6 \cdot 3 = 17 - 7 + 18$
$= 10 + 18 = 28$

99. $20 + 1 - \sqrt{10^2 - (5+1)^2}\,(-2)$
$= 20 + 1 - \sqrt{10^2 - 6^2}\,(-2)$
$= 20 + 1 - \sqrt{100 - 36}\,(-2)$
$= 20 + 1 - \sqrt{64}\,(-2)$
$= 20 + 1 - 8(-2) = 20 + 1 + 16 = 37$

100. $24 \div \sqrt{3 \cdot (5-2)} \div \left[-1 - (-3)\right]^2$
$= 24 \div \sqrt{3(3)} \div [-1+3]^2$
$= 24 \div \sqrt{9} \div [2]^2$
$= 24 \div 3 \div 4 = 8 \div 4$
$= 2$

101. Commutative Property of Addition
$4x + 10 = 10 + 4x$
Commutative Property of Multiplication
$4x + 10 = x \cdot 4 + 10$

102. Commutative Property of Addition
$5x + 30 = 30 + 5x$
Commutative Property of Multiplication
$5x + 30 = x \cdot 5 + 30$

103. Commutative Property of Addition
$7x - 5 = -5 + 7x$
Commutative Property of Multiplication
$7x - 5 = x \cdot 7 - 5$

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104. Commutative Property of Addition
$3x-7=-7+3x$
Commutative Property of Multiplication
$3x-7=x\cdot 3-7$

105. $4+(6+x)=(4+6)+x=10+x$

106. $12+(3+x)=(12+3)+x=15+x$

107. $-7(3x)=(-7\cdot 3)x=-21x$

108. $-10(5x)=(-10\cdot 5)x=-50x$

109. $-\frac{1}{3}(-3y)=\left(-\frac{1}{3}\cdot -3\right)y=y$

110. $-\frac{1}{4}(-4y)=\left(-\frac{1}{4}\cdot -4\right)y=y$

111. $3(2x+5)=3\cdot 2x+3\cdot 5=6x+15$

112. $5(4x+7)=5\cdot 4x+5\cdot 7=20x+35$

113. $-7(2x+3)=-7\cdot 2x+(-7)3$
$=-14x-21$

114. $-9(3x+2)=-9\cdot 3x+(-9)2=-27x-18$

115. $-(3x-6)=-1\cdot 3x-(-1)6=-3x+6$

116. $-(6x-3)=-1(6x)-(-1)3=-6x+3$

117. $7x+5x=(7+5)x=12x$

118. $8x+10x=(8+10)x=18x$

119. $6x^2-x^2=(6-1)x^2=5x^2$

120. $9x^2-x^2=(9-1)x^2=8x^2$

121. $6x+10x^2+4x+2x^2$
$=6x+4x+10x^2+2x^2$
$=(6+4)x+(10+2)x^2=10x+12x^2$

122. $9x+5x^2+3x+4x^2=(9+3)x+(5+4)x^2$
$=12x+9x^2$

123. $8(3x-5)-6x$
$=8\cdot 3x-8\cdot 5-6x$
$=24x-40-6x$
$=24x-6x-40$
$=(24-6)x-40=18x-40$

124. $7(4x-5)-8x$
$=7\cdot 4x-7\cdot 5-8x=28x-35-8x$
$=(28-8)x-35=20x-35$

125. $5(3y-2)-(7y+2)$
$=5\cdot 3y-5\cdot 2-1\cdot 7y+(-1)2$
$=15y-10-7y-2$
$=15y-7y-10-2$
$=(15-7)y-12=8y-12$

126. $4(5y-3)-(6y+3)$
$=4\cdot 5y-4\cdot(3)-1(6y)+(-1)3$
$=20y-12-6y-3$
$=(20-6)y-15$
$=14y-15$

127. $7-4[3-(4y-5)]$
$=7-4[3-4y+5]$
$=7-12+16y-20$
$=16y-25$

128. $6-5[8-(2y-4)]=6-5[8-2y+4]$
$=6-5[12-2y]$
$=6-5\cdot 12-(-5)(2y)$
$=6-60+10y$
$=10y-54$

129. $18x^2+4-\left[6\left(x^2-2\right)+5\right]$
$=18x^2+4-\left[6x^2-12+5\right]$
$=18x^2+4-\left[6x^2-7\right]$
$=18x^2+4-6x^2+7$
$=18x^2-6x^2+4+7$
$=(18-6)x^2+11=12x^2+11$

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130. $14x^2+5-\left[7\left(x^2-2\right)+4\right]$
$=14x^2+5-\left[7x^2-14+4\right]$
$=14x^2+5-\left[7x^2-10\right]$
$=14x^2+5-7x^2+10$
$=14x^2-7x^2+5+10$
$=\left(14-7\right)x^2+15$
$=7x^2+15$

131. $x-\left(x+4\right)=x-x-4=-4$

132. $x-\left(8-x\right)=x-8+x=2x-8$

133. $6\left(-5x\right)=-30x$

134. $10\left(-4x\right)=-40x$

135. $5x-2x=3x$

136. $6x-\left(-2x\right)=6x+2x=8x$

137. $8x-\left(3x+6\right)=8x-3x-6=5x-6$

138. $8-3\left(x+6\right)=8-3x-18=-3x-10$

139. $21+(-29)=-8$

140. $4+(-10)=-6$

141. $21-(-29)=21+29$
$=50$

142. $4-(-10)=4+10$
$=14$

143. $-3-(-10)=-3+10$
$=7$
The approval rating of France exceeds the approval rating of China by 7.

144. $-3-(-29)=-3+29$
$=26$
The approval rating of France exceeds the approval rating of Iran by 26.

145. $\dfrac{-10+(-3)+4}{3}=\dfrac{-9}{3}$
$=-3$
The average approval rating of China, France, and Israel is -3.

146. $\dfrac{-29+(-10)+21}{3}=\dfrac{-18}{3}$
$=-6$
The average approval rating of Iran, China, and the UK is -6.

147. $D=1.2x^2+1.6(x+40)$
$=1.2\left(6\right)^2+1.6(6+40)$
$=116.8$
According to the model, college students spent \$116.8 billion in 2013.
The model underestimates the actual value displayed in the graph by \$0.2 billion.

148. $D=1.2x^2+1.6(x+40)$
$=1.2\left(4\right)^2+1.6(4+40)$
$=89.6$
According to the model, college students spent \$89.6 billion in 2011.
The model overestimates the actual value displayed in the graph by \$2.6 billion.

149. **a.** $0.05x+0.12\left(10{,}000-x\right)$
$=0.05x+1200-0.12x$
$=1200-0.07x$

b. $0.05\left(6000\right)+0.12\left(10{,}000-6000\right)$
$=0.05\left(6000\right)+0.12\left(4000\right)$
$=300+480=780$
$1200-0.07\left(6000\right)=1200-420$
$=780$
The total interest will be \$780.

150. **a.** $0.06t+0.5(50-t)$
$=0.06t+25-0.5t$
$=25-0.44t$

b. $0.06(20)+0.5(50-20)$
$=0.06(20)+0.5(30)$
$=1.2+15=16.2$

$25-0.44(20)=25-8.8=16.2$

The total distance will be 16.2 miles.

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151. – 167. Answers will vary.

168. makes sense

169. makes sense

170. does not make sense; Explanations will vary. Sample explanation: For terms to be considered like terms they must have the same variables and the same powers.

171. does not make sense; Explanations will vary. Sample explanation: When there is no number in front of a variable, the coefficient has a value of 1.

172. false; Changes to make the statement true will vary. A sample change is: $16 \div 4 \cdot 2 = 4 \cdot 2 = 8$

173. false; Changes to make the statement true will vary. A sample change is:
$6 - 2(4+3) = 6 - 2(7) = 6 - 14 = -8$

174. false; Changes to make the statement true will vary. A sample change is:
$5 + 3(x-4) = 5 + 3x - 12 = 3x - 7$

175. false; Changes to make the statement true will vary. A sample change is: $-x - x = -2x$

176. true

177. $(8-2) \cdot 3 - 4 = 14$

178. $\left(2 \cdot 5 - \frac{1}{2} \cdot 10\right) \cdot 9 = 45$

179.
$$\begin{aligned}
\frac{9[4-(1+6)]-(3-9)^2}{5+\frac{12}{5-\frac{6}{2+1}}} &= \frac{9[4-7]-(-6)^2}{5+\frac{12}{5-\frac{6}{3}}} \\
&= \frac{9[-3]-36}{5+\frac{12}{5-2}} \\
&= \frac{-27-36}{5+\frac{12}{3}} \\
&= \frac{-63}{5+4} \\
&= \frac{-63}{9} \\
&= -7
\end{aligned}$$

180. $\frac{10}{x} - 4x$

181.
$$\begin{aligned}
10 + 2(x-5)^4 &= 10 + 2(7-5)^4 \\
&= 10 + 2(2)^4 = 10 + 2(16) \\
&= 10 + 32 = 42
\end{aligned}$$

182. true; $\frac{1}{2}$ is not an irrational number.

183.

x	$y = 4 - x^2$
-3	$y = 4 - (-3)^2 = 4 - 9 = -5$
-2	$y = 4 - (-2)^2 = 4 - 4 = 0$
-1	$y = 4 - (-1)^2 = 4 - 1 = 3$
0	$y = 4 - (0)^2 = 4 - 0 = 4$
1	$y = 4 - (1)^2 = 4 - 1 = 3$
2	$y = 4 - (2)^2 = 4 - 4 = 0$
3	$y = 4 - (3)^2 = 4 - 9 = -5$

184.

x	$y = 1 - x^2$
-3	$y = 1 - (-3)^2 = 1 - 9 = -8$
-2	$y = 1 - (-2)^2 = 1 - 4 = -3$
-1	$y = 1 - (-1)^2 = 1 - 1 = 0$
0	$y = 1 - (0)^2 = 1 - 0 = 1$
1	$y = 1 - (1)^2 = 1 - 1 = 0$
2	$y = 1 - (2)^2 = 1 - 4 = -3$
3	$y = 1 - (3)^2 = 1 - 9 = -8$

185.

x	$y = \lvert x+1 \rvert$
-4	$y = \lvert -4+1 \rvert = \lvert -3 \rvert = 3$
-3	$y = \lvert -3+1 \rvert = \lvert -2 \rvert = 2$
-2	$y = \lvert -2+1 \rvert = \lvert -1 \rvert = 1$
-1	$y = \lvert -1+1 \rvert = \lvert 0 \rvert = 0$
0	$y = \lvert 0+1 \rvert = \lvert 1 \rvert = 1$
1	$y = \lvert 1+1 \rvert = \lvert 2 \rvert = 2$
2	$y = \lvert 2+1 \rvert = \lvert 3 \rvert = 3$

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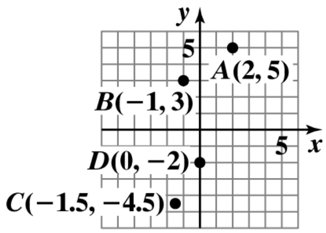
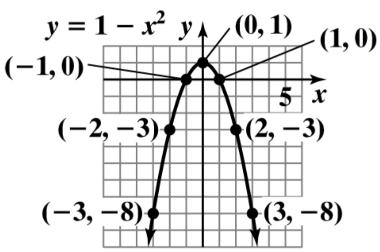
1.3 Check Points

1.



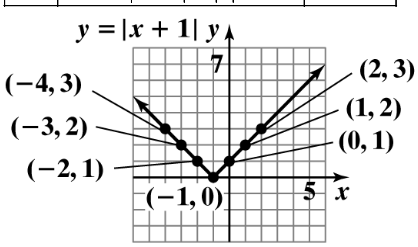
2. Make a table:

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



3. Make a table:

x	$y=\lvert x+1\rvert$	(x, y)
–4	$y=\lvert -4+1\rvert=\lvert -3\rvert=3$	$(-4,3)$
–3	$y=\lvert -3+1\rvert=\lvert -2\rvert=2$	$(-3,2)$
–2	$y=\lvert -2+1\rvert=\lvert -1\rvert=1$	$(-2,1)$
–1	$y=\lvert -1+1\rvert=\lvert 0\rvert=0$	$(-1,0)$
0	$y=\lvert 0+1\rvert=\lvert 1\rvert=1$	$(0,1)$
1	$y=\lvert 1+1\rvert=\lvert 2\rvert=2$	$(1,2)$
2	$y=\lvert 2+1\rvert=\lvert 3\rvert=3$	$(2,3)$



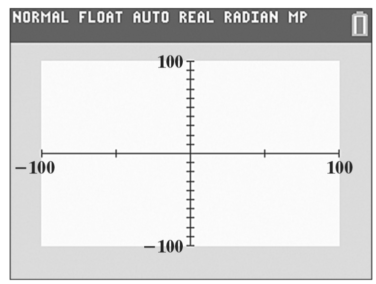
4. a. The drug concentration is increasing from 0 to 3 hours.

b. The drug concentration is decreasing from 3 to 13 hours.

c. The drug's maximum concentration is 0.05 milligram per 100 milliliters, which occurs after 3 hours.

d. None of the drug is left in the body.

5. The minimum *x*-value is –100, the maximum *x*-value is 100, and the distance between consecutive tick marks is 50. The minimum *y*-value is –100, the maximum *y*-value is 100, and the distance between consecutive tick marks is 10.



1.3 Concept and Vocabulary Check

1. *x*-axis

2. *y*-axis

3. origin

4. quadrants; four

5. *x*-coordinate; *y*-coordinate

6. solution; satisfies

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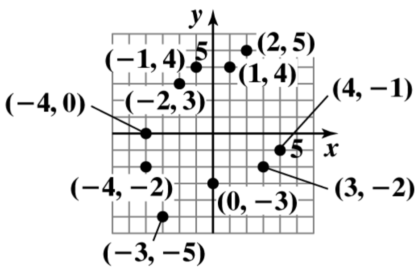
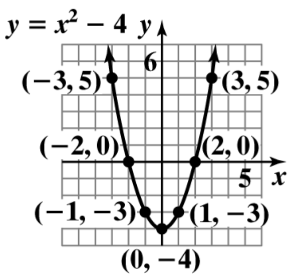
1.3 Exercise Set

1. – 10.



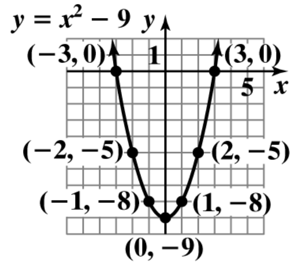
11.

x	(x, y)
−3	$(-3, 5)$
−2	$(-2, 0)$
−1	$(-1, -3)$
0	$(0, -4)$
1	$(1, -3)$
2	$(2, 0)$
3	$(3, 5)$



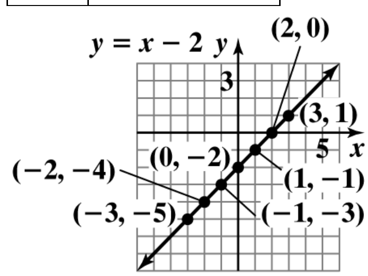
12.

x	(x, y)
−3	$(-3, 0)$
−2	$(-2, -5)$
−1	$(-1, -8)$
0	$(0, -9)$
1	$(1, -8)$
2	$(2, -5)$
3	$(3, 0)$



13.

x	(x, y)
−3	$(-3, -5)$
−2	$(-2, -4)$
−1	$(-1, -3)$
0	$(0, -2)$
1	$(1, -1)$
2	$(2, 0)$
3	$(3, 1)$



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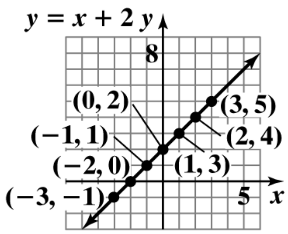
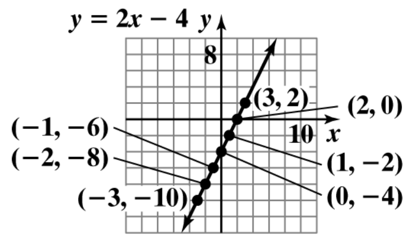
14.

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



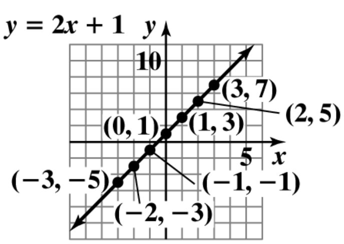
16.

x	(x, y)
-3	$(-3,-10)$
-2	$(-2,-8)$
-1	$(-1,-6)$
0	$(0,-4)$
1	$(1,-2)$
2	$(2,0)$
3	$(3,2)$



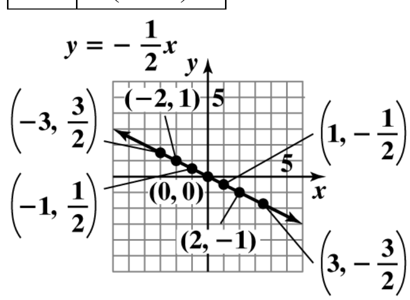
15.

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



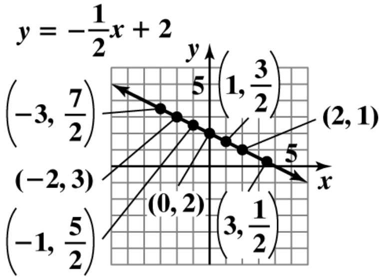
17.

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



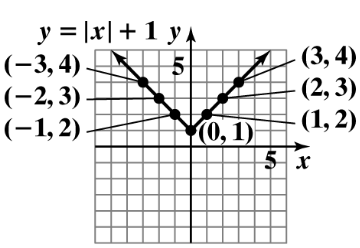
18.

x	(x, y)
-3	$\left(-3, \frac{7}{2}\right)$
-2	$(-2, 3)$
-1	$\left(-1, \frac{5}{2}\right)$
0	$(0, 2)$
1	$\left(1, \frac{3}{2}\right)$
2	$(2, 1)$
3	$\left(3, \frac{1}{2}\right)$



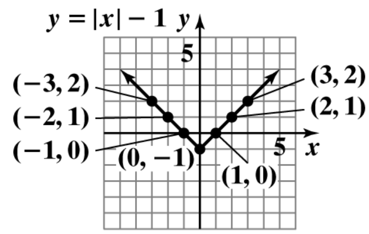
19.

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



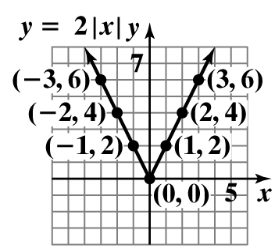
20.

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



21.

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



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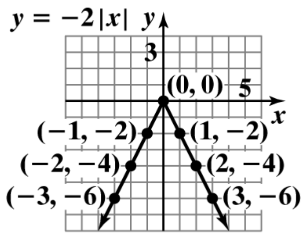
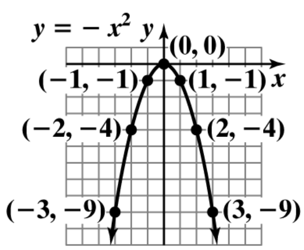
22.

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



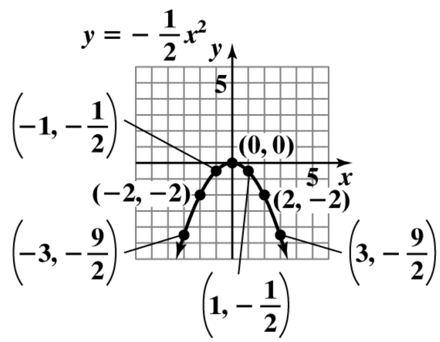
23.

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



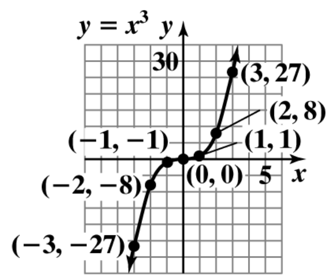
24.

x	(x, y)
-3	$(-3,-\frac{9}{2})$
-2	$(-2,-2)$
-1	$(-1,-\frac{1}{2})$
0	$(0,0)$
1	$(1,-\frac{1}{2})$
2	$(2,-2)$
3	$(3,-\frac{9}{2})$



25.

x	(x, y)
-3	$(-3,-27)$
-2	$(-2,-8)$
-1	$(-1,-1)$
0	$(0,0)$
1	$(1,1)$
2	$(2,8)$
3	$(3,27)$



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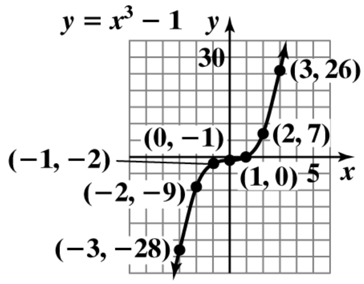
26.

x	(x, y)
–3	$(-3,-28)$
–2	$(-2,-9)$
–1	$(-1,-2)$
0	$(0,-1)$
1	$(1,0)$
2	$(2,7)$
3	$(3,26)$



27. [–5, 5, 1] by [–5, 5, 1]
This matches graph c.

28. [–10, 10, 2] by [– 4, 4, 2]
This matches graph d.

29. [–20, 80, 10] by [–30, 70, 10]
This matches graph b.

30. [–40, 40, 20] by [–1000, 1000, 100]
This matches graph a.

31. The equation that corresponds to Y_2 in the table is (c), $y_2 = 2 - x$. We can tell because all of the points $(-3,5)$, $(-2,4)$, $(-1,3)$, $(0,2)$, $(1,1)$, $(2,0)$, and $(3,-1)$ are on the line $y = 2 - x$, but all are not on any of the others.

32. The equation that corresponds to Y_1 in the table is (b), $y_1 = x^2$. We can tell because all of the points $(-3,9)$, $(-2,4)$, $(-1,1)$, $(0,0)$, $(1,1)$, $(2,4)$, and $(3,9)$ are on the graph $y = x^2$, but all are not on any of the others.

33. No. It passes through the point $(0,2)$.

34. Yes. It passes through the point $(0,0)$.

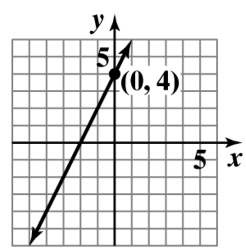
35. $(2,0)$

36. $(0,2)$

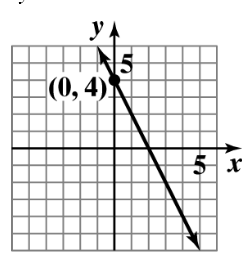
37. The graphs of Y_1 and Y_2 intersect at the points $(-2,4)$ and $(1,1)$.

38. The values of Y_1 and Y_2 are the same when $x = -2$ and $x = 1$.

39. $y = 2x + 4$



40. $y = 4 - 2x$



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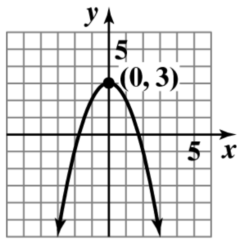
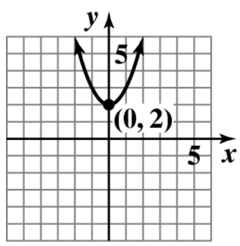
41. $y = 3 - x^2$

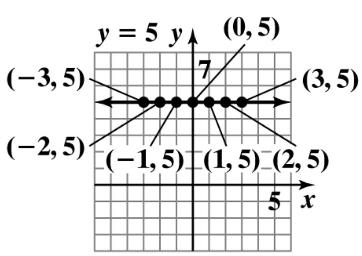


42. $y = x^2 + 2$



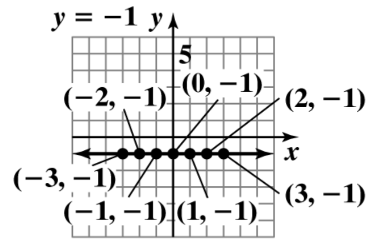
43.

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



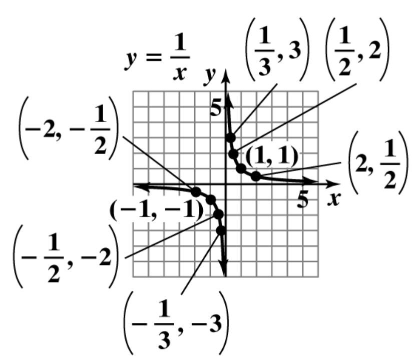
44.

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



45.

x	(x, y)
-2	$\left(-2, -\frac{1}{2}\right)$
-1	$(-1, -1)$
$-\frac{1}{2}$	$\left(-\frac{1}{2}, -2\right)$
$-\frac{1}{3}$	$\left(-\frac{1}{3}, -3\right)$
$\frac{1}{3}$	$\left(\frac{1}{3}, 3\right)$
$\frac{1}{2}$	$\left(\frac{1}{2}, 2\right)$
1	$(1, 1)$
2	$\left(2, \frac{1}{2}\right)$



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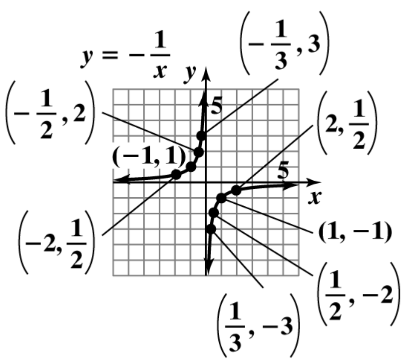
46.

x	(x, y)
-2	$\left(-2, \frac{1}{2}\right)$
-1	$(-1, 1)$
$-\frac{1}{2}$	$\left(-\frac{1}{2}, 2\right)$
$-\frac{1}{3}$	$\left(-\frac{1}{3}, 3\right)$
$\frac{1}{3}$	$\left(\frac{1}{3}, -3\right)$
$\frac{1}{2}$	$\left(\frac{1}{2}, -2\right)$
1	$(1, -1)$
2	$\left(2, -\frac{1}{2}\right)$



47. The greatest percentage of the U.S. population that used the internet was 84%, in 2013.

48. The least percentage of the U.S. population that used the internet was 70%, in 2011.

49. The percentage of the U.S. population that used the internet remained constant in 2009 and 2010 at 71%.

50. The percentage of the U.S. population that used the internet increased most rapidly between 2011 and 2012. It increased by 9%.

51. The percentage of the U.S. population that used the internet decreased most rapidly between 2008 and 2009. It decreased by 3%.

52. Between 2007 to 2013, the increase was 9%.

53. At age 8, women have the least number of awakenings, averaging about 1 awakening per night.

54. At age 65, men have the greatest number of awakenings, averaging about 8 awakenings per night.

55. The difference between the number of awakenings for 25-year-old men and women is about 1.9.

56. The difference between the number of awakenings for 18-year-old men and women is about 1.1.

57. graph a

58. graph d

59. graph b

60. graph c

61. graph b

62. graph a

63. graph c

64. graph b

65. – 72. Answers will vary.

73. makes sense

74. does not make sense; Explanations will vary. Sample explanation: Most graphing utilities do not display numbers on the axes.

75. makes sense

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76. does not make sense; Explanations will vary. Sample explanation: There may or may not be a mathematical model that perfectly describes the graph's data.

77. false; Changes to make the statement true will vary. A sample change is: If the product of a point's coordinates is positive, the point could be in quadrant I <u>or</u> III.

78. false; Changes to make the statement true will vary. A sample change is: When a point lies on the x-axis, $y = 0$.

79. true

80. false; Changes to make the statement true will vary. A sample change is: Substituting the coordinates of $(2,5)$ into $3y - 2x = -4$ gives $3(5) - 2(2) = -4$ which simplifies to $11 = -4$ which is false.

81. The four hour day costs \$6 and the five hour day costs \$9. Thus the total cost for the two days is \$15.

82. Your car was parked more than six hours, but not exceeding eight hours.

83. $|-14.3| = 14.3$

84.
$$\begin{aligned}&\left[12-(13-17)\right]-\left[9-(6-10)\right]\\ &=\left[12-(-4)\right]-\left[9-(-4)\right]\\ &=\left[12+4\right]-\left[9+4\right]=16-13=3\end{aligned}$$

85.
$$\begin{aligned}6x-5(4x+3)-10 &= 6x-20x-15-10\\ &=(6-20)x-(15+10)\\ &=-14x-25\end{aligned}$$

86.
$$\begin{aligned}4x-3 &= 5x+6\\ 4(-9)-3 &= 5(-9)+6\\ -36-3 &= -45+6\\ -39 &= -39\end{aligned}$$
The statement is true for $x = -9$.

87.
$$\begin{aligned}&13-3(x+2)\\ &=13-3x-6\\ &=7-3x\end{aligned}$$

88.
$$\begin{aligned}&10\left(\frac{3x+1}{2}\right)\\ &=\frac{10}{1}\cdot\frac{3x+1}{2}\\ &=5(3x+1)\\ &=15x+5\end{aligned}$$

1.4 Check Points

1.
$$\begin{aligned}4x+5 &= 29\\ 4x+5-5 &= 29-5\\ 4x &= 24\\ \frac{4x}{4} &= \frac{24}{4}\\ x &= 6\end{aligned}$$
The solution set is $\{6\}$.
Check:
$$\begin{aligned}4x+5 &= 29\\ 4(6)+5 &= 29\\ 24+5 &= 29\\ 29 &= 29\end{aligned}$$

2.
$$\begin{aligned}2x-12+x &= 6x-4+5x\\ 3x-12 &= 11x-4\\ 3x-11x &= -4+12\\ -8x &= 8\\ \frac{-8x}{-8} &= \frac{8}{-8}\\ x &= -1\end{aligned}$$
The solution set is $\{-1\}$.
Check:
$$\begin{aligned}2x-12+x &= 6x-4+5x\\ 2(-1)-12+(-1) &= 6(-1)-4+5(-1)\\ -2-12-1 &= -6-4-5\\ -15 &= -15\end{aligned}$$

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3.
$$\begin{aligned} 2(x-3)-17 &= 13-3(x+2) \\ 2x-6-17 &= 13-3x-6 \\ 2x-23 &= 7-3x \\ 2x+3x &= 7+23 \\ 5x &= 30 \\ \frac{5x}{5} &= \frac{30}{5} \\ x &= 6 \end{aligned}$$

The solution set is $\{6\}$.

Check:
$$\begin{aligned} 2(x-3)-17 &= 13-3(x+2) \\ 2(6-3)-17 &= 13-3(6+2) \\ 2(3)-17 &= 13-3(8) \\ 6-17 &= 13-24 \\ -11 &= -11 \end{aligned}$$

4.
$$\begin{aligned} \frac{x+5}{7}+\frac{x-3}{4} &= \frac{5}{14} \\ 28\left(\frac{x+5}{7}+\frac{x-3}{4}\right) &= 28\left(\frac{5}{14}\right) \\ \frac{28}{1}\left(\frac{x+5}{7}\right)+\frac{28}{1}\left(\frac{x-3}{4}\right) &= \frac{28}{1}\left(\frac{5}{14}\right) \\ 4(x+5)+7(x-3) &= 2(5) \\ 4x+20+7x-21 &= 10 \\ 11x-1 &= 10 \\ 11x &= 10+1 \\ 11x &= 11 \\ \frac{11x}{11} &= \frac{11}{11} \\ x &= 1 \end{aligned}$$

The solution set is $\{1\}$.

Check:
$$\begin{aligned} \frac{x+5}{7}+\frac{x-3}{4} &= \frac{5}{14} \\ \frac{1+5}{7}+\frac{1-3}{4} &= \frac{5}{14} \\ \frac{6}{7}+\frac{-2}{4} &= \frac{5}{14} \\ \frac{24}{28}+\frac{-14}{28} &= \frac{10}{28} \\ \frac{10}{28} &= \frac{10}{28} \end{aligned}$$

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

This equation is an inconsistent equation and thus has no solution.
The solution set is $\{\ \}$.

6.
$$\begin{aligned} 7x+9 &= 9(x+1)-2x \\ 7x+9 &= 9x+9-2x \\ 7x+9 &= 7x+9 \\ 9 &= 9 \end{aligned}$$

This equation is an identity and all real numbers are solutions.
The solution set is $\{x \mid x \text{ is a real number}\}$ or $(-\infty,\infty)$ or $\mathbb{R}$.

7.
$$\begin{aligned} T &= 394x+3123 \\ 11{,}397 &= 394x+3123 \\ 11{,}397-3123 &= 394x \\ 8274 &= 394x \\ \frac{8274}{394} &= \frac{394x}{394} \\ 21 &= x \end{aligned}$$

The average cost of tuition and fees at public colleges will reach \$11,397 in the school year ending 21 years after 2000, or 2021.

1.4 Concept and Vocabulary Check

1. linear
2. equivalent
3. $b+c$
4. bc
5. apply the distributive property
6. least common denominator; 12
7. inconsistent; $\varnothing$
8. identity; $(-\infty,\infty)$

1.4 Exercise Set

1.
$$\begin{aligned} 5x+3 &= 18 \\ 5x+3-3 &= 18-3 \\ 5x &= 15 \\ \frac{5x}{5} &= \frac{15}{5} \\ x &= 3 \end{aligned}$$

The solution set is $\{3\}$.

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2. $$\begin{aligned} 3x+8&=50\\ 3x&=42\\ x&=14 \end{aligned}$$
The solution set is $\{14\}$.

3. $$\begin{aligned} 6x-3&=63\\ 6x-3+3&=63+3\\ 6x&=66\\ \frac{6x}{6}&=\frac{66}{6}\\ x&=11 \end{aligned}$$
The solution set is $\{11\}$.

4. $$\begin{aligned} 5x-8&=72\\ 5x&=80\\ x&=16 \end{aligned}$$
The solution set is $\{16\}$.

5. $$\begin{aligned} 14-5x&=-41\\ 14-5x-14&=-41-14\\ -5x&=-55\\ \frac{-5x}{-5}&=\frac{-55}{-5}\\ x&=11 \end{aligned}$$
The solution set is $\{11\}$.

6. $$\begin{aligned} 25-6x&=-83\\ -6x&=-108\\ x&=18 \end{aligned}$$
The solution set is $\{18\}$.

7. $$\begin{aligned} 11x-(6x-5)&=40\\ 11x-6x+5&=40\\ 5x+5&=40\\ 5x+5-5&=40-5\\ 5x&=35\\ x&=7 \end{aligned}$$
The solution set is $\{7\}$.

8. $$\begin{aligned} 5x-(2x-8)&=35\\ 5x-2x+8&=35\\ 3x+8&=35\\ 3x&=27\\ x&=9 \end{aligned}$$
The solution set is $\{9\}$.

9. $$\begin{aligned} 2x-7&=6+x\\ 2x-x-7&=6+x-x\\ x-7&=6\\ x-7+7&=6+7\\ x&=13 \end{aligned}$$
The solution set is $\{13\}$.

10. $$\begin{aligned} 3x+5&=2x+13\\ x+5&=13\\ x&=8 \end{aligned}$$
The solution set is $\{8\}$.

11. $$\begin{aligned} 7x+4&=x+16\\ 7x-x+4&=x-x+16\\ 6x+4&=16\\ 6x+4-4&=16-4\\ 6x&=12\\ \frac{6x}{6}&=\frac{12}{6}\\ x&=2 \end{aligned}$$
The solution set is $\{2\}$.

12. $$\begin{aligned} 8x+1&=x+43\\ 7x+1&=43\\ 7x&=42\\ x&=6 \end{aligned}$$
The solution set is $\{6\}$.

13. $$\begin{aligned} 8y-3&=11y+9\\ 8y-8y-3&=11y-8y+9\\ -3&=3y+9\\ -3-9&=3y+9-9\\ -12&=3y\\ \frac{-12}{3}&=\frac{3y}{3}\\ -4&=y \end{aligned}$$
The solution set is $\{-4\}$.

14. $$\begin{aligned} 5y-2&=9y+2\\ -2&=4y+2\\ -4&=4y\\ -1&=y \end{aligned}$$
The solution set is $\{-1\}$.

15. $$\begin{aligned} 3(x-2)+7&=2(x+5)\\ 3x-6+7&=2x+10\\ 3x-2x-6+7&=2x-2x+10\\ x-6+7&=10\\ x+1&=10\\ x+1-1&=10-1\\ x&=9 \end{aligned}$$
The solution set is $\{9\}$.

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16. $$\begin{aligned}2(x-1)+3&=x-3(x+1)\\2x-2+3&=x-3x-3\\2x+1&=-2x-3\\4x+1&=-3\\4x&=-4\\x&=-1\end{aligned}$$
The solution set is $\{-1\}$.

17. $$\begin{aligned}3(x-4)-4(x-3)&=x+3-(x-2)\\3x-12-4x+12&=x+3-x+2\\-x&=5\\x&=-5\end{aligned}$$
The solution set is $\{-5\}$.

18. $$\begin{aligned}2-(7x+5)&=13-3x\\2-7x-5&=13-3x\\-7x-3&=13-3x\\-4x-3&=13\\-4x&=16\\x&=-4\end{aligned}$$
The solution set is $\{-4\}$.

19. $$\begin{aligned}16&=3(x-1)-(x-7)\\16&=3x-3-x+7\\16&=2x+4\\16-4&=2x+4-4\\12&=2x\\\frac{12}{2}&=\frac{2x}{2}\\6&=x\end{aligned}$$
The solution set is $\{6\}$.

20. $$\begin{aligned}5x-(2x+2)&=x+(3x-5)\\5x-2x-2&=x+3x-5\\3x-2&=4x-5\\-2&=x-5\\3&=x\end{aligned}$$
The solution set is $\{3\}$.

21. $$\begin{aligned}7(x+1)&=4[x-(3-x)]\\7x+7&=4[x-3+x]\\7x+7&=4[2x-3]\\7x+7&=8x-12\\7x-7x+7&=8x-7x-12\\7&=x-12\\7+12&=x-12+12\\19&=x\end{aligned}$$
The solution set is $\{19\}$.

22. $$\begin{aligned}2[3x-(4x-6)]&=5(x-6)\\2[3x-4x+6]&=5x-30\\2[-x+6]&=5x-30\\-2x+12&=5x-30\\12&=7x-30\\42&=7x\\6&=x\end{aligned}$$
The solution set is $\{6\}$.

23. $$\begin{aligned}\frac{1}{2}(4z+8)-16&=-\frac{2}{3}(9z-12)\\2z+4-16&=-6z+8\\2z-12&=-6z+8\\8z-12&=8\\8z&=20\\z&=\frac{20}{8}=\frac{5}{2}\end{aligned}$$
The solution set is $\left\{\frac{5}{2}\right\}$.

24. $$\begin{aligned}\frac{3}{4}(24-8z)-16&=-\frac{2}{3}(6z-9)\\18-6z-16&=-4z+6\\2-6z&=-4z+6\\2-2z&=6\\-2z&=4\\z&=-2\end{aligned}$$
The solution set is $\{-2\}$.

25. $$\begin{aligned}\frac{x}{3}&=\frac{x}{2}-2\\6\left(\frac{x}{3}\right)&=6\left(\frac{x}{2}-2\right)\\2x&=3x-12\\2x-3x&=3x-3x-12\\-x&=-12\\x&=12\end{aligned}$$
The solution set is $\{12\}$.

26. $$\begin{aligned}\frac{x}{5}&=\frac{x}{6}+1\\30\left(\frac{x}{5}\right)&=30\left(\frac{x}{6}+1\right)\\6x&=5x+30\\x&=30\end{aligned}$$
The solution set is $\{30\}$.

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27.
$$20-\frac{x}{3}=\frac{x}{2}$$
$$6\left(20-\frac{x}{3}\right)=6\left(\frac{x}{2}\right)$$
$$120-2x=3x$$
$$120-2x+2x=3x+2x$$
$$120=5x$$
$$\frac{120}{5}=\frac{5x}{5}$$
$$24=x$$
The solution set is $\{24\}$.

28.
$$\frac{x}{5}-\frac{1}{2}=\frac{x}{6}$$
$$30\left(\frac{x}{5}-\frac{1}{2}\right)=30\left(\frac{x}{6}\right)$$
$$6x-15=5x$$
$$x-15=0$$
$$x=15$$
The solution set is $\{15\}$.

29.
$$\frac{3x}{5}=\frac{2x}{3}+1$$
$$15\left(\frac{3x}{5}\right)=15\left(\frac{2x}{3}+1\right)$$
$$9x=10x+15$$
$$9x-10x=10x-10x+15$$
$$-x=15$$
$$x=-15$$
The solution set is $\{-15\}$.

30.
$$\frac{x}{2}=\frac{3x}{4}+5$$
$$4\left(\frac{x}{2}\right)=4\left(\frac{3x}{4}+5\right)$$
$$2x=3x+20$$
$$-x=20$$
$$x=-20$$
The solution set is $\{-20\}$.

31.
$$\frac{3x}{5}-x=\frac{x}{10}-\frac{5}{2}$$
$$10\left(\frac{3x}{5}-x\right)=10\left(\frac{x}{10}-\frac{5}{2}\right)$$
$$6x-10x=x-25$$
$$-4x=x-25$$
$$-4x-x=x-x-25$$
$$-5x=-25$$
$$x=5$$
The solution set is $\{5\}$.

32.
$$2x-\frac{2x}{7}=\frac{x}{2}+\frac{17}{2}$$
$$14\left(2x-\frac{2x}{7}\right)=14\left(\frac{x}{2}+\frac{17}{2}\right)$$
$$28x-2(2x)=7x+7(17)$$
$$28x-4x=7x+119$$
$$24x=7x+119$$
$$17x=119$$
$$x=7$$
The solution set is $\{7\}$.

33.
$$\frac{x+3}{6}=\frac{2}{3}+\frac{x-5}{4}$$
$$12\left(\frac{x+3}{6}\right)=12\left(\frac{2}{3}\right)+12\left(\frac{x-5}{4}\right)$$
$$2(x+3)=4(2)+3(x-5)$$
$$2x+6=8+3x-15$$
$$2x+6=3x-7$$
$$-x+6=-7$$
$$-x=-13$$
$$x=13$$
The solution set is $\{13\}$.

34.
$$\frac{x+1}{4}=\frac{1}{6}+\frac{2-x}{3}$$
$$12\left(\frac{x+1}{4}\right)=12\left(\frac{1}{6}+\frac{2-x}{3}\right)$$
$$3(x+1)=2+4(2-x)$$
$$3x+3=2+8-4x$$
$$3x+3=10-4x$$
$$7x+3=10$$
$$7x=7$$
$$x=1$$
The solution set is $\{1\}$.

35.
$$\frac{x}{4}=2+\frac{x-3}{3}$$
$$12\left(\frac{x}{4}\right)=12\left(2+\frac{x-3}{3}\right)$$
$$3x=24+4(x-3)$$
$$3x=24+4x-12$$
$$3x=12+4x$$
$$3x-4x=12+4x-4x$$
$$-x=12$$
$$x=-12$$
The solution set is $\{-12\}$.

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36.
$$\begin{aligned}5+\frac{x-2}{3}&=\frac{x+3}{8}\\24\left(5+\frac{x-2}{3}\right)&=24\left(\frac{x+3}{8}\right)\\120+8(x-2)&=3(x+3)\\120+8x-16&=3x+9\\104+8x&=3x+9\\104+5x&=9\\5x&=-95\\x&=-19\end{aligned}$$
The solution set is $\{-19\}$.

37.
$$\begin{aligned}\frac{x+1}{3}&=5-\frac{x+2}{7}\\21\left(\frac{x+1}{3}\right)&=21\left(5-\frac{x+2}{7}\right)\\7(x+1)&=105-3(x+2)\\7x+7&=105-3x-6\\7x+3x+7&=105-3x+3x-6\\10x+7&=99\\10x&=92\\x&=\frac{92}{10}=\frac{46}{5}\end{aligned}$$
The solution set is $\left\{\frac{46}{5}\right\}$.

38.
$$\begin{aligned}\frac{3x}{5}-\frac{x-3}{2}&=\frac{x+2}{3}\\30\left(\frac{3x}{5}-\frac{x-3}{2}\right)&=30\left(\frac{x+2}{3}\right)\\6(3x)-15(x-3)&=10(x+2)\\18x-15x+45&=10x+20\\3x+45&=10x+20\\45&=7x+20\\25&=7x\\\frac{25}{7}&=x\end{aligned}$$
The solution set is $\left\{\frac{25}{7}\right\}$.

39.
$$\begin{aligned}5x+9&=9(x+1)-4x\\5x+9&=9x+9-4x\\5x+9&=5x+9\end{aligned}$$
The solution set is $\{x|x \text{ is a real number}\}$ or $(-\infty,\infty)$ or $\mathbb{R}$. The equation is an identity.

40.
$$\begin{aligned}4x+7&=7(x+1)-3x\\4x+7&=7x+7-3x\\4x+7&=4x+7\end{aligned}$$
The solution set is $\{x|x \text{ is a real number}\}$ or $(-\infty,\infty)$ or $\mathbb{R}$. The equation is an identity.

41.
$$\begin{aligned}3(y+2)&=7+3y\\3y+6&=7+3y\\3y-3y+6&=7+3y-3y\\6&=7\end{aligned}$$
There is no solution. The solution set is $\{\ \}$ or $\varnothing$. The equation is inconsistent.

42.
$$\begin{aligned}4(y+5)&=21+4y\\4y+20&=21+4y\\20&=21\end{aligned}$$
There is no solution. The solution set is $\{\ \}$ or $\varnothing$. The equation is inconsistent.

43.
$$\begin{aligned}10x+3&=8x+3\\10x-8x+3&=8x-8x+3\\2x&=0\\x&=0\end{aligned}$$
The solution set is $\{0\}$. The equation is conditional.

44.
$$\begin{aligned}5x+7&=2x+7\\3x+7&=7\\3x&=0\\x&=0\end{aligned}$$
The solution set is $\{0\}$. The equation is conditional.

45.
$$\begin{aligned}\frac{1}{2}(6z+20)-8&=2(z-4)\\3z+10-8&=2z-8\\3z+2&=2z-8\\z+2&=-8\\z&=-10\end{aligned}$$
The solution set is $\{-10\}$. The equation is conditional.

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46. $\frac{1}{3}(6z+12)=\frac{1}{5}(20z+30)-8$

$$\begin{aligned} 2z+4&=4z+6-8\\ 2z+4&=4z-2\\ -2z&=-6\\ z&=3 \end{aligned}$$

The solution set is $\{3\}$. The equation is conditional.

47. $-4x-3(2-2x)=7+2x$

$$\begin{aligned} -4x-6+6x&=7+2x\\ 2x-6&=7+2x\\ -6&=7 \end{aligned}$$

There is no solution. The solution set is $\{\ \}$ or $\varnothing$. The equation is inconsistent.

48. $3x-3(2-x)=6(x-1)$

$$\begin{aligned} 3x-6+3x&=6x-6\\ 6x-6&=6x-6 \end{aligned}$$

The solution set is $\{x|x \text{ is a real number}\}$ or $(-\infty,\infty)$ or $\mathbb{R}$. The equation is an identity.

49. $y+3(4y+2)=6(y+1)+5y$

$$\begin{aligned} y+12y+6&=6y+6+5y\\ 13y+6&=11y+6\\ 2y+6&=6\\ 2y&=0\\ y&=0 \end{aligned}$$

The solution set is $\{0\}$. The equation is conditional.

50. $9y-3(6-5y)=y-2(3y+9)$

$$\begin{aligned} 9y-18+15y&=y-6y-18\\ 24y-18&=-5y-18\\ 29y-18&=-18\\ 29y&=0\\ y&=0 \end{aligned}$$

The solution set is $\{0\}$. The equation is conditional.

51. $3(x-4)=3(2-2x)$

$x=2$

52. $3(2x-5)=5x+2$

$x=17$

53. $-3(x-3)=5(2-x)$

$x=0.5$

54. $2x-5=4(3x+1)-2$

$x=-0.7$

55. Solve: $4(x-2)+2=4x-2(2-x)$

$$\begin{aligned} 4x-8+2&=4x-4+2x\\ 4x-6&=6x-4\\ -2x-6&=-4\\ -2x&=2\\ x&=-1 \end{aligned}$$

Now, evaluate x^2-x for $x=-1$:

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

56. Solve: $2(x-6)=3x+2(2x-1)$

$$\begin{aligned} 2x-12&=3x+4x-2\\ 2x-12&=7x-2\\ -5x-12&=-2\\ -5x&=10\\ x&=-2 \end{aligned}$$

Now, evaluate x^2-x for $x=-2$:

$$\begin{aligned} x^2-x&=(-2)^2-(-2)\\ &=4-(-2)=4+2=6 \end{aligned}$$

57. Solve for x: $\frac{3(x+3)}{5}=2x+6$

$$\begin{aligned} 3(x+3)&=5(2x+6)\\ 3x+9&=10x+30\\ -7x+9&=30\\ -7x&=21\\ x&=-3 \end{aligned}$$

Solve for y: $-2y-10=5y+18$

$$\begin{aligned} -7y-10&=18\\ -7y&=28\\ y&=-4 \end{aligned}$$

Now, evaluate $x^2-(xy-y)$ for $x=-3$ and $y=-4$:

$$\begin{aligned} x^2-(xy-y)&=(-3)^2-\left[-3(-4)-(-4)\right]\\ &=(-3)^2-\left[12-(-4)\right]\\ &=9-(12+4)=9-16=-7 \end{aligned}$$

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58. Solve for x: $\dfrac{13x-6}{4}=5x+2$

$$\begin{aligned}13x-6&=4(5x+2)\\13x-6&=20x+8\\-7x-6&=8\\-7x&=14\\x&=-2\end{aligned}$$

Solve for y: $5-y=7(y+4)+1$

$$\begin{aligned}5-y&=7y+28+1\\5-y&=7y+29\\5-8y&=29\\-8y&=24\\y&=-3\end{aligned}$$

Now, evaluate $x^2-(xy-y)$ for $x=-2$ and $y=-3$:

$$\begin{aligned}x^2-(xy-y)&=(-2)^2-[-2(-3)-(-3)]\\&=(-2)^2-[6-(-3)]\\&=4-(6+3)=4-9=-5\end{aligned}$$

59. $\left[(3+6)^2\div 3\right]\cdot 4=-54x$

$$\begin{aligned}\left(9^2\div 3\right)\cdot 4&=-54x\\(81\div 3)\cdot 4&=-54x\\27\cdot 4&=-54x\\108&=-54x\\-2&=x\end{aligned}$$

The solution set is $\{-2\}$.

60. $2^3-\left[4(5-3)^3\right]=-8x$

$$\begin{aligned}8-\left[4(2)^3\right]&=-8x\\8-4\cdot 8&=-8x\\8-32&=-8x\\-24&=-8x\\3&=x\end{aligned}$$

The solution set is $\{3\}$.

61. $5-12x=8-7x-\left[6\div 3\left(2+5^3\right)+5x\right]$

$$\begin{aligned}5-12x&=8-7x-\left[6\div 3(2+125)+5x\right]\\5-12x&=8-7x-[6\div 3\cdot 127+5x]\\5-12x&=8-7x-[2\cdot 127+5x]\\5-12x&=8-7x-[254+5x]\\5-12x&=8-7x-254-5x\\5-12x&=-12x-246\\5&=-246\end{aligned}$$

The final statement is a contradiction, so the equation has no solution. The solution set is $\varnothing$.

62. $2(5x+58)=10x+4(21\div 3.5-11)$

$$\begin{aligned}10x+116&=10x+4(6-11)\\10x+116&=10x+4(-5)\\10x+116&=10x-20\\116&=-20\end{aligned}$$

The final statement is a contradiction, so the equation has no solution. The solution set is $\varnothing$.

63. $0.7x+0.4(20)=0.5(x+20)$

$$\begin{aligned}0.7x+8&=0.5x+10\\0.2x+8&=10\\0.2x&=2\\x&=10\end{aligned}$$

The solution set is $\{10\}$.

64. $0.5(x+2)=0.1+3(0.1x+0.3)$

$$\begin{aligned}0.5x+1&=0.1+0.3x+0.9\\0.5x+1&=0.3x+1\\0.2x+1&=1\\0.2x&=0\\x&=0\end{aligned}$$

The solution set is $\{0\}$.

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65. $$4x+13-\left\{2x-\left[4\left(x-3\right)-5\right]\right\}=2(x-6)$$
$$4x+13-\left\{2x-\left[4x-12-5\right]\right\}=2x-12$$
$$4x+13-\left\{2x-\left[4x-17\right]\right\}=2x-12$$
$$4x+13-\left\{2x-4x+17\right\}=2x-12$$
$$4x+13-\left\{-2x+17\right\}=2x-12$$
$$4x+13+2x-17=2x-12$$
$$6x-4=2x-12$$
$$4x-4=-12$$
$$4x=-8$$
$$x=-2$$
The solution set is $\{-2\}$.

66. $$-2\left\{7-\left[4-2\left(1-x\right)+3\right]\right\}=10-\left[4x-2(x-3)\right]$$
$$-2\left\{7-\left[4-2+2x+3\right]\right\}=10-\left[4x-2x+6\right]$$
$$-2\left\{7-\left[2x+5\right]\right\}=10-\left[2x+6\right]$$
$$-2\left\{7-2x-5\right\}=10-2x-6$$
$$-2\left\{-2x+2\right\}=-2x+4$$
$$4x-4=-2x+4$$
$$6x-4=4$$
$$6x=8$$
$$x=\frac{8}{6}=\frac{4}{3}$$
The solution set is $\left\{\frac{4}{3}\right\}$.

67. a. Model 1: $T=1157x+14{,}961$
$$=1157\left(14\right)+14{,}961$$
$$=31{,}159$$
Model 2: $T=21x^2+862x+15{,}552$
$$T=21(14)^2+862(14)+15{,}552$$
$$=31{,}736$$
Model 1 estimates the cost in 2014 to be \$31,159 which means Model 1 underestimates by \$542.
Model 2 estimates the cost in 2014 to be \$31,736 which means Model 2 overestimates by \$35.

b. $$T=1157x+14{,}961$$
$$36{,}944=1157x+14{,}961$$
$$21{,}983=1157x$$
$$\frac{21{,}983}{1157}=\frac{1157x}{1157}$$
$$19=x$$
Tuition and fees will average \$36,944 at private four-year colleges in the school year ending 19 years after 2000, or 2019.

68. a. Model 1: $T=1157x+14{,}961$
$$=1157\left(12\right)+14{,}961$$
$$=28{,}845$$
Model 2: $T=21x^2+862x+15{,}552$
$$T=21(12)^2+862(12)+15{,}552$$
$$=28{,}920$$
Model 1 estimates the cost in 2012 to be \$28,845 which means Model 1 underestimates by \$211.
Model 2 estimates the cost in 2012 to be \$28,920 which means Model 2 underestimates by \$136.

b. $$T=1157x+14{,}961$$
$$39{,}258=1157x+14{,}961$$
$$24{,}297=1157x$$
$$\frac{24{,}297}{1157}=\frac{1157x}{1157}$$
$$21=x$$
Tuition and fees will average \$39,258 at private four-year colleges in the school year ending 21 years after 2000, or 2021.

69. a. \$22,000

b. $$C=442x+12{,}969$$
$$=442\left(20\right)+12{,}969$$
$$=\$21{,}809$$
It describes the estimate from part (a) reasonably well.

c. $$C=2x^2+390x+13{,}126$$
$$=2(20)^2+390(20)+13{,}126$$
$$=\$21{,}726$$
It describes the estimate from part (a) reasonably well.

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70. **a.** \$17,000

b. $C = 442x + 12,969$
$= 442(10) + 12,969$
$= \$17,389$
It describes the estimate from part (a) reasonably well.

c. $C = 2x^2 + 390x + 13,126$
$= 2(10)^2 + 390(10) + 13,126$
$= \$17,226$
It describes the estimate from part (a) reasonably well.

71. Model 1:
$C = 442x + 12,969$
$= 442(0) + 12,969$
$= \$12,969$

Model 2:
$C = 2x^2 + 390x + 13,126$
$= 2(0)^2 + 390(0) + 13,126$
$= \$13,126$

According to the graph, the cost in 1990 was \$13,100. Thus, Model 2 is the better model. Model 2 overestimates the cost shown in the graph by \$26.

72. Model 1:
$C = 442x + 12,969$
$= 442(23) + 12,969$
$= \$23,135$

Model 2:
$C = 2x^2 + 390x + 13,126$
$= 2(23)^2 + 390(23) + 13,126$
$= \$23,154$

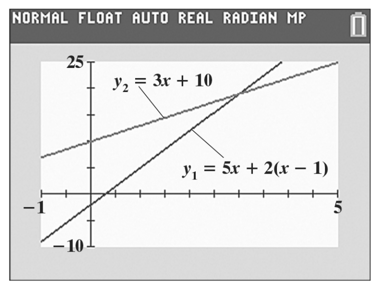
According to the graph, the cost in 2013 was \$23,300. Thus, Model 2 is the better model. Model 2 underestimates the cost shown in the graph by \$146.

73.
$$C = 442x + 12,969$$
$$26,229 = 442x + 12,969$$
$$13,260 = 442x$$
$$\frac{13,260}{442} = \frac{442x}{442}$$
$$30 = x$$
Model 1 predicts the cost will be \$26,229 30 years after 1990, or 2020.

74.
$$C = 442x + 12,969$$
$$25,345 = 442x + 12,969$$
$$12,376 = 442x$$
$$\frac{12,376}{442} = \frac{442x}{442}$$
$$28 = x$$
Model 1 predicts the cost will be \$25,345 28 years after 1990, or 2018.

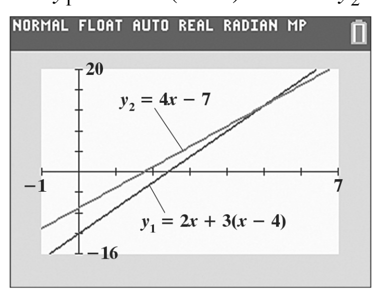
75. – 85. Answers will vary.

86. $5x + 2(x-1) = 3x + 10$
Let $y_1 = 5x + 2(x-1)$ and let $y_2 = 3x + 10$.



The solution set is $\{3\}$.

87. $2x + 3(x-4) = 4x - 7$
Let $y_1 = 2x + 3(x-4)$ and let $y_2 = 4x - 7$.



The solution set is $\{5\}$.

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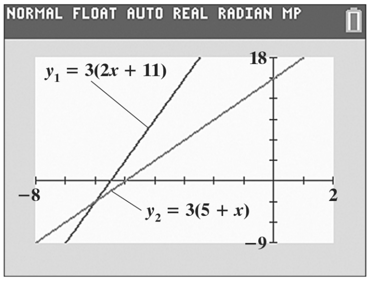
88. $3(2x+11)=3(5+x)$

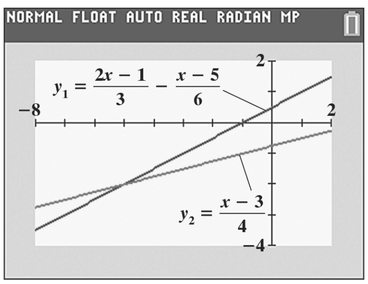
Let $y_1=3(2x+11)$ and let $y_2=3(5+x)$.



The solution set is {–6}.

89. $\dfrac{2x-1}{3}-\dfrac{x-5}{6}=\dfrac{x-3}{4}$

Let $y_1=\dfrac{2x-1}{3}-\dfrac{x-5}{6}$ and let $y_2=\dfrac{x-3}{4}$.



The solution set is {−5}.

90. makes sense

91. makes sense

92. does not make sense; Explanations will vary. Sample explanation: The solution set is all real numbers.

93. does not make sense; Explanations will vary. Sample explanation: The equation is solved by using the multiplication property.

94. false; Changes to make the statement true will vary. A sample change is: The equation has a solution set of {0}.

$$\begin{aligned}-7x&=x\\-7x-x&=x-x\\-8x&=0\\x&=0\end{aligned}$$

95. false; Changes to make the statement true will vary. A sample change is: The equations are not equivalent. If the equations were equivalent, they would have the same solution set. 4 cannot be the solution to the first equation, because 4 would make the denominator 0.

96. true

97. false; Changes to make the statement true will vary. A sample change is: If *a* and *b* are both zero, there are an infinite number of values of *x* for which the equation is true.

98.

$$\begin{aligned}ax+b&=c\\ax+b-b&=c-b\\ax&=c-b\\x&=\frac{c-b}{a}\end{aligned}$$

99. Answers will vary.

100. Answers will vary.

101.

$$\begin{aligned}\frac{7(-6)+4}{b}+13&=-6\\\frac{-42+4}{b}+13-13&=-6-13\\\frac{-38}{b}&=-19\\-38&=-19b\\2&=b\end{aligned}$$

When $b = 2$, the solution set is $\{-6\}$.

102. $-\dfrac{1}{5}-\left(-\dfrac{1}{2}\right)=-\dfrac{1}{5}+\dfrac{1}{2}=-\dfrac{1}{5}\cdot\dfrac{2}{2}+\dfrac{1}{2}\cdot\dfrac{5}{5}$

$=-\dfrac{2}{10}+\dfrac{5}{10}=\dfrac{3}{10}$

103. $4(-3)(-1)(-5)=(-12)(5)=-60$

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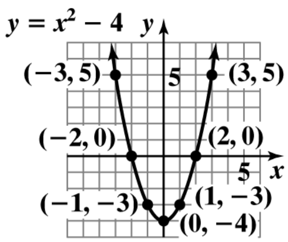
104.

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



105. a. $3x-4=32$

b. $3x-4=32$
$$3x=36$$
$$x=12$$
The number is 12.

106. $x+44$

107. $20,000-2500x$

Mid-Chapter Check Point – Chapter 1

1. $-5+3(x+5)=-5+3x+15$
$$=3x+10$$

2. $-5+3(x+5)=2(3x-4)$
$$-5+3x+15=6x-8$$
$$3x+10=6x-8$$
$$-3x+10=-8$$
$$-3x=-18$$
$$x=6$$
The solution set is $\{6\}$.

3. $3[7-4(5-2)]=3[7-4(3)]$
$$=3[7-12]$$
$$=3(-5)$$
$$=-15$$
The solution set is $\{-15\}$.

4. $\frac{x-3}{5}-1=\frac{x-5}{4}$
$$20\left(\frac{x-3}{5}-1\right)=20\left(\frac{x-5}{4}\right)$$
$$4(x-3)-20=5(x-5)$$
$$4x-12-20=5x-25$$
$$4x-32=5x-25$$
$$-x-32=-25$$
$$-x=7$$
$$x=-7$$
The solution set is $\{-7\}$.

5. $\frac{-2^4+(-2)^2}{-4-(2-2)}=\frac{-16+4}{-4-0}=\frac{-12}{-4}=3$

6. $7x-[8-3(2x-5)]$
$$=7x-[8-6x+15]$$
$$=7x-[-6x+23]$$
$$=7x+6x-23$$
$$=13x-23$$

7. $3(2x-5)-2(4x+1)=-5(x+3)-2$
$$6x-15-8x-2=-5x-15-2$$
$$-2x-17=-5x-17$$
$$3x-17=-17$$
$$3x=0$$
$$x=0$$
The solution set is $\{0\}$.

8. $3(2x-5)-2(4x+1)-5(x+3)-2$
$$=6x-15-8x-2-5x-15-2$$
$$=(6x-8x-5x)+(-15-2-15-2)$$
$$=-7x-34$$

9. $-4^2\div 2+(-3)(-5)=-16\div 2+(-3)(-5)$
$$=-8+15$$
$$=7$$

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10. $3x+1-(x-5)=2x-4$

$$3x+1-x+5=2x-4$$
$$2x+6=2x-4$$
$$6=-4$$

This is a contradiction, so the equation has no solution. The solution set is $\varnothing$.

11. $\frac{3x}{4}-\frac{x}{3}+1=\frac{4x}{5}-\frac{3}{20}$

$$60\left(\frac{3x}{4}-\frac{x}{3}+1\right)=60\left(\frac{4x}{5}-\frac{3}{20}\right)$$
$$45x-20x+60=48x-9$$
$$25x+60=48x-9$$
$$-23x+60=-9$$
$$-23x=-69$$
$$x=3$$

The solution set is $\{3\}$.

12. $(6-9)(8-12)\div\frac{5^2+4\div 2}{8^2-9^2+8}$

$$=(-3)(-4)\div\frac{25+2}{64-81+8}$$
$$=(-3)(-4)\div\frac{27}{-9}$$
$$=(-3)(-4)\div(-3)$$
$$=12\div(-3)$$
$$=-4$$

13. $4x-2(1-x)=3(2x+1)-5$

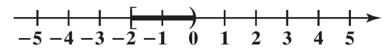
$$4x-2+2x=6x+3-5$$
$$6x-2=6x-2$$

The equation is an identity. The solution set is $\{x|x$ is a real number$\}$ or $\mathbb{R}$.

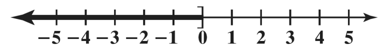
14. $\frac{3\left[4-3(-2)^2\right]}{2^2-2^4}=\frac{3(4-3\cdot 4)}{4-16}$

$$=\frac{3(4-12)}{-12}$$
$$=\frac{3(-8)}{-12}$$
$$=\frac{-24}{-12}$$
$$=2$$

15. $\{x|-2\le x<0\}$

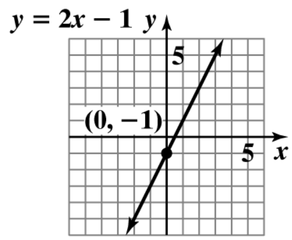


16. $\{x|x\le 0\}$



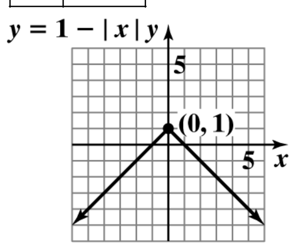
17.

x	(x, y)
−2	−5
−1	−3
0	−1
1	1
2	3



18.

x	(x, y)
−3	−2
−2	−1
−1	0
0	1
1	0
2	−1
3	−2



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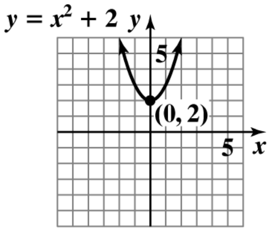
19.

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



20. true

21. false; $\{x|x$ is a negative greater than $-4\}$ $= \{-3, -2, -1\}$, not $\{-4, -3, -2, -1\}$.

22. false; -17 does belong to the set of rational numbers.

23. true; $-128 \div (2 \cdot 4) > (-128 \div 2) \cdot 4$

$$-128 \div 8 > -64 \cdot 4$$
$$-16 > -256$$

which is true because -16 is to the right of -256 on the number line.

1.5 Check Points

1. Let x = the average yearly salary, in thousands, of women with an associate's degree
Let $x + 14$ = the average yearly salary, in thousands, of women with an bachelor's degree
Let $x + 26$ = the average yearly salary, in thousands, of women with a master's degree

$$x + (x+14) + (x+26) = 139$$
$$x + x + 14 + x + 26 = 139$$
$$3x + 40 = 139$$
$$3x = 99$$
$$x = 33$$

$x = 33$, associate's degree: \$33,000
$x + 14 = 47$, bachelor's degree: \$47,000
$x + 26 = 59$, master's degree: \$59,000

2. Let x = the number of years since 1969.

$$85 - 0.9x = 25$$
$$-0.9x = 25 - 85$$
$$-0.9x = -60$$
$$x = \frac{-60}{-0.9}$$
$$x \approx 67$$

25% of freshmen will respond this way 67 years after 1969, or 2036.

3. Let x = the number of bridge crossings.

$$5x = 40 + 3x$$
$$5x - 3x = 40$$
$$2x = 40$$
$$x = 20$$

The two plans cost the same for 20 bridge crossings.

4. Let x = the original price of the new computer.

$$x - 0.30x = 840$$
$$0.70x = 840$$
$$\frac{0.70x}{0.70} = \frac{840}{0.70}$$
$$x = 1200$$

The original price of the new computer was \$1200.

5. Let x = the width of the basketball court.
Let $x + 44 =$ length of the basketball court.

$$P = 2l + 2w$$
$$288 = 2(x + 44) + 2x$$
$$288 = 2x + 88 + 2x$$
$$288 = 4x + 88$$
$$-4x = -200$$
$$x = 50$$
$$x + 44 = 94$$

The dimensions of the basketball court are 50 feet by 94 feet.

6.
$$2l + 2w = P$$
$$2w = P - 2l$$
$$\frac{2w}{2} = \frac{P - 2l}{2}$$
$$w = \frac{P - 2l}{2}$$

7.
$$V = lwh$$
$$\frac{V}{lw} = \frac{lwh}{lw}$$
$$\frac{V}{lw} = h$$
$$h = \frac{V}{lw}$$

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8. $\frac{W}{2} - 3H = 53$

$\frac{W}{2} = 53 + 3H$

$2\left(\frac{W}{2}\right) = 2(53 + 3H)$

$W = 106 + 6H$

9. $P = C + MC$

$P = C(1 + M)$

$\frac{P}{1+M} = \frac{C(1+M)}{1+M}$

$\frac{P}{1+M} = C$

$C = \frac{P}{1+M}$

1.5 Concept and Vocabulary Check

1. $x + 658.6$

2. $31 + 2.4x$

3. $4 + 0.15x$

4. $x - 0.15x$ or $0.85x$

5. isolated on one side

6. distributive

1.5 Exercise Set

1. Let x = a number.
$5x - 4 = 26$
$5x = 30$
$x = 6$
The number is 6.

2. Let x = a number.
$2x - 3 = 11$
$2x = 14$
$x = 7$
The number is 7.

3. Let x = a number.
$x - 0.20x = 20$
$0.80x = 20$
$x = 25$
The number is 25.

4. Let x = a number.
$x - 0.30x = 28$
$0.70x = 28$
$x = 40$
The number is 40.

5. Let x = a number.
$0.60x + x = 192$
$1.6x = 192$
$x = 120$
The number is 120.

6. Let x = a number.
$0.80x + x = 252$
$1.8x = 252$
$x = 140$
The number is 140.

7. Let x = a number.
$0.70x = 224$
$x = 320$
The number is 320.

8. Let x = a number.
$0.70x = 252$
$x = 360$
The number is 360.

9. Let x = a number.
Let $x + 26$ = the other number.
$x + (x + 26) = 64$
$x + x + 26 = 64$
$2x + 26 = 64$
$2x = 38$
$x = 19$
If x = 19, then $x + 26 = 45$.
The numbers are 19 and 45.

10. Let x = a number.
Let x +24 = the other number.
$x + (x + 24) = 58$
$x + x + 24 = 58$
$2x + 24 = 58$
$2x = 34$
$x = 17$
If x = 17, then x +24 = 41.
The numbers are 17 and 41.

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11.
$$\begin{aligned} y_1 - y_2 &= 2 \\ (13x-4)-(5x+10) &= 2 \\ 13x-4-5x-10 &= 2 \\ 8x-14 &= 2 \\ 8x &= 16 \\ x &= 2 \end{aligned}$$

12.
$$\begin{aligned} y_1 - y_2 &= 3 \\ (10x+6)-(12x-7) &= 3 \\ 10x+6-12x+7 &= 3 \\ -2x+13 &= 3 \\ -2x &= -10 \\ x &= 5 \end{aligned}$$

13.
$$\begin{aligned} y_1 &= 8y_2+14 \\ 10(2x-1) &= 8(2x+1)+14 \\ 20x-10 &= 16x+8+14 \\ 20x-10 &= 16x+22 \\ 4x &= 32 \\ x &= 8 \end{aligned}$$

14.
$$\begin{aligned} y_1 &= 12y_2-51 \\ 9(3x-5) &= 12(3x-1)-51 \\ 27x-45 &= 36x-12-51 \\ 27x-45 &= 36x-63 \\ 27x-36x &= 45-63 \\ -9x &= -18 \\ x &= 2 \end{aligned}$$

15.
$$\begin{aligned} 3y_1-5y_2 &= y_3-22 \\ 3(2x+6)-5(x+8) &= (x)-22 \\ 6x+18-5x-40 &= x-22 \\ x-22 &= x-22 \\ -22 &= -22 \end{aligned}$$
x is satisfied by all real numbers.

16.
$$\begin{aligned} 2y_1-3y_2 &= 4y_3-8 \\ 2(2.5)-3(2x+1) &= 4(x)-8 \\ 5-6x-3 &= 4x-8 \\ -6x+2 &= 4x-8 \\ -6x-4x &= -8-2 \\ -10x &= -10 \\ x &= 1 \end{aligned}$$

17. Let x = the longest lifespan of a goldfish.
Let $x+21 =$ the longest lifespan of a horse.
Let $x+79 =$ the longest lifespan of a human.
$$\begin{aligned} x+(x+21)+(x+79) &= 229 \\ x+x+21+x+79 &= 229 \\ 3x+100 &= 229 \\ 3x &= 129 \\ x &= 43 \\ x+21 &= 64 \\ x+79 &= 122 \end{aligned}$$
The longest lifespan of a goldfish was 43 years.
The longest lifespan of a horse was 64 years.
The longest lifespan of a human was 122 years.

18. Let x = the number of words, in thousands, in Japanese.
Let $x+767 =$ the number of words, in thousands, in English.
Let $x+268 =$ the number of words, in thousands, in Chinese.
$$\begin{aligned} x+(x+767)+(x+268) &= 1731 \\ x+x+767+x+268 &= 1731 \\ 3x+1035 &= 1731 \\ 3x &= 696 \\ x &= 232 \\ x+767 &= 999 \\ x+268 &= 500 \end{aligned}$$
The number of words, in thousands, in Japanese, English, and Chinese are 232, 999, and 500, respectively.

19. Let x = the measure of the 2nd angle.
Let $2x$ = the measure of the 1st angle.
$x-8$ = the measure of the 3rd angle.
$$\begin{aligned} x+2x+(x-8) &= 180 \\ 4x-8 &= 180 \\ 4x &= 188 \\ x &= 47 \end{aligned}$$
If $x=47$, then $2x=94$ and $x-8=39$. Thus, the measure of the 1st angle is $94°$, the 2nd angle is $47°$, and the 3rd angle is $39°$.

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20. Let x = the measure of the second angle.
Let $3x$ = the measure of the first angle.
Let $x-35=$ the measure of the third angle.

$$\begin{aligned} x+3x+(x-35)&=180\\ x+3x+x-35&=180\\ 5x-35&=180\\ 5x&=215\\ x&=43 \end{aligned}$$

If $x=43$, $3x=3(43)=129$ and
$x-35=43-35=8$.
The measure of the first angle is 129°.
The measure of the second angle is 43°.
The measure of the third angle is 8°.

21. Let x = the measure of the first angle.
Let $x+1$ = the measure of the second angle.
Let $x+2$ = the measure of the third angle.

$$\begin{aligned} x+(x+1)+(x+2)&=180\\ 3x+3&=180\\ 3x&=177\\ x&=59 \end{aligned}$$

If $x=59$, then $x+1=60$ and $x+2=61$. Thus, the measures of the three angles are $59°$, $60°$, and $61°$.

22. Let x = the measure of the first angle.
Let $x+2$ = the measure of the second angle.
Let $x+4$ = the measure of the third angle.

$$\begin{aligned} x+(x+2)+(x+4)&=180\\ 3x+6&=180\\ 3x&=174\\ x&=58 \end{aligned}$$

If $x=58$, $x+2=58+2=60$, and
$x+4=58+4=62$.
The measure of the first angle is 58°.
The measure of the second angle is 60°.
The measure of the third angle is 62°.

23. Let x = the number of years since 2000.

$$\begin{aligned} 31+2.4x&=67\\ 2.4x&=67-31\\ 2.4x&=36\\ x&=\frac{36}{2.4}\\ x&=15 \end{aligned}$$

67% of American adults will view college education as essential 15 years after 2000, or 2015.

24. Let x = the number of years since 2000.

$$\begin{aligned} 45-1.7x&=11\\ -1.7x&=11-45\\ -1.7x&=-34\\ x&=\frac{-34}{-1.7}\\ x&=20 \end{aligned}$$

11% of American adults will believe that most qualified students get to attend college 20 years after 2000, or 2020.

25. Let x = the number of years since 1960.

$$\begin{aligned} 23-0.28x&=0\\ -0.28x&=-23\\ \frac{-0.28x}{-0.28}&=\frac{-23}{-0.28}\\ x&\approx 82 \end{aligned}$$

If this trend continues, corporations will pay zero taxes 82 years after 1960, or 2042.

26. Let x = the number of years since 1960.

$$\begin{aligned} 23-0.28x&=5\\ -0.28x&=-18\\ \frac{-0.28x}{-0.28}&=\frac{-18}{-0.28}\\ x&\approx 64 \end{aligned}$$

If this trend continues, 5% of federal tax receipts will come from corporations 64 years after 1960, or 2024.

27. **a.** Let x = the number of deaths, in thousands, per day.
Let $3x-84$ = the number of births, in thousands, per day.

$$\begin{aligned} (3x-84)-x&=228\\ 3x-84-x&=228\\ 2x-84&=228\\ 2x&=312\\ x&=156\\ 3x-84&=384 \end{aligned}$$

births: 384,000
deaths: 156,000

b. $$\begin{aligned} 228{,}000\cdot 365&=83{,}220{,}000\\ &\approx 83 \text{ million} \end{aligned}$$

c. $\dfrac{320 \text{ million}}{83 \text{ million}}\approx 4$

It will take about 4 years.

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28. **a.** Let x = the number of deaths, in thousands, per day.
Let $2x+72$ = the number of births, in thousands, per day.

$$(2x+72)-x=228$$
$$2x+72-x=228$$
$$x+72=228$$
$$x=156$$
$$2x+72=384$$

births: 384,000
deaths: 156,000

b. $228{,}000\cdot 365=83{,}220{,}000$
≈ 83 million

c. $\dfrac{320 \text{ million}}{83 \text{ million}}\approx 4$

It will take about 4 years.

29. Let x = the number of bus uses.
Cost without discount pass: $1.25x$
Cost with discount pass: $15+0.75x$

$$1.25x=15+0.75x$$
$$0.50x=15$$
$$x=30$$

The bus must be used 30 times in a month for the costs to be equal.

30. Let x = the number of months.
The cost for Club A: $25x+40$
The cost for Club B: $30x+15$

$$25x+40=30x+15$$
$$-5x+40=15$$
$$-5x=-25$$
$$x=5$$

The total cost for the clubs will be the same at 5 months. The cost will be
$25(5)+40=30(5)+15=\$165$

31. Let x = the number of crossings.
Cost without discount pass: $\$5x$
Cost with discount pass: $\$30$ + $\$3.50x$

$$5x=30+3.50x$$
$$1.50x=30$$
$$x=20$$

The bridge must be used 20 times in a month for the costs to be equal.

32. Let x = the number of gigabytes used.

$$40+15x=30+20x$$
$$10=5x$$
$$2=x$$

The two data plans will be the same cost fot 2 GB.

33. **a.** Let x = the number of years (after 2008).
College A's enrollment: $13{,}300+1000x$
College B's enrollment: $26{,}800-500x$

$$13{,}300+1000x=26{,}800-500x$$
$$13{,}300+1500x=26{,}800$$
$$1500x=13{,}500$$
$$x=9$$

The two colleges will have the same enrollment 9 years after 2008, or 2017.
That year the enrollments will be

$$13{,}300+1000(9)=26{,}800-500(9)$$
$$=22{,}300 \text{ students}$$

b. Check points to determine that $y_1=13300+1000x$ and $y_2=26800-500x$.

34. Let x = the number of years after 2000.

$$10{,}600{,}000-28{,}000x=10{,}200{,}000-12{,}000x$$
$$-16{,}000x=-400{,}000$$
$$x=25$$

The countries will have the same population 25 years after the year 2000, or the year 2025.

$$10{,}200{,}000-12{,}000x=10{,}200{,}000-12{,}000(25)$$
$$=10{,}200{,}000-300{,}000$$
$$=9{,}900{,}000$$

The population in the year 2025 will be 9,900,000.

35. Let x = the cost of the television set.

$$x-0.20x=336$$
$$0.80x=336$$
$$x=420$$

The television set's price is \$420.

36. Let x = the cost of the dictionary.

$$x-0.30x=30.80$$
$$0.70x=30.80$$
$$x=44$$

The dictionary's price before the reduction was \$44.

37. Let x = the nightly cost.

$$x+0.08x=162$$
$$1.08x=162$$
$$x=150$$

The nightly cost is \$150.

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38. Let x = the nightly cost.
$x + 0.05x = 252$
$1.05x = 252$
$x = 240$
The nightly cost is \$240.

39. Let c = the dealer's cost.
$584 = c + 0.25c$
$584 = 1.25c$
$467.20 = c$
The dealer's cost is \$467.20.

40. Let c = the dealer's cost.
$15 = c + 0.25c$
$15 = 1.25c$
$12 = c$
The dealer's cost is \$12.

41. Let w = the width of the field.
Let $2w$ = the length of the field.
$P = 2(\text{length}) + 2(\text{width})$
$300 = 2(2w) + 2(w)$
$300 = 4w + 2w$
$300 = 6w$
$50 = w$
If $w = 50$, then $2w = 100$. Thus, the dimensions are 50 yards by 100 yards.

42. Let w = the width of the swimming pool.
Let $3w$ = the length of the swimming pool.
$P = 2(\text{length}) + 2(\text{width})$
$320 = 2(3w) + 2(w)$
$320 = 6w + 2w$
$320 = 8w$
$40 = w$
If $w = 40$, $3w = 3(40) = 120$.
The dimensions are 40 feet by 120 feet.

43. Let w = the width of the field.
Let $2w + 6$ = the length of the field.
$P = 2(\text{length}) + 2(\text{width})$
$228 = 2(2w + 6) + 2w$
$228 = 4w + 12 + 2w$
$228 = 6w + 12$
$216 = 6w$
$36 = w$
If $w = 36$, then $2w + 6 = 2(36) + 6 = 78$. Thus, the dimensions are 36 feet by 78 feet.

44. Let w = the width of the pool.
Let $2w - 6$ = the length of the pool.
$P = 2(\text{length}) + 2(\text{width})$
$126 = 2(2w - 6) + 2(w)$
$126 = 4w - 12 + 2w$
$126 = 6w - 12$
$138 = 6w$
$23 = w$
Find the length.
$2w - 6 = 2(23) - 6 = 46 - 6 = 40$
The dimensions are 23 meters by 40 meters.

45. Let x = the width of the frame.
Total length: $16 + 2x$.
Total width: $12 + 2x$.
$P = 2(\text{length}) + 2(\text{width})$
$72 = 2(16 + 2x) + 2(12 + 2x)$
$72 = 32 + 4x + 24 + 4x$
$72 = 8x + 56$
$16 = 8x$
$2 = x$
The width of the frame is 2 inches.

46. Let w = the width of the path.
Let $40 + 2w$ = the width of the pool and path.
Let $60 + 2w$ = the length of the pool and path.
$2(40 + 2w) + 2(60 + 2w) = 248$
$80 + 4w + 120 + 4w = 248$
$200 + 8w = 248$
$8w = 48$
$w = 6$
The width of the path is 6 feet.

47. Let x = the length of the call.
$0.43 + 0.32(x - 1) + 2.10 = 5.73$
$0.43 + 0.32x - 0.32 + 2.10 = 5.73$
$0.32x + 2.21 = 5.73$
$0.32x = 3.52$
$x = 11$
The person talked for 11 minutes.

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48. Let g = the gross amount of the paycheck.

$$\text{Yearly Salary} = 2(12)g + 750$$
$$33150 = 24g + 750$$
$$32400 = 24g$$
$$1350 = g$$

The gross amount of each paycheck is \$1350.

49. (from geometry)
$$A = lw$$
$$l = \frac{A}{w}$$

50. (from geometry)
$$A = lw$$
$$w = \frac{A}{l}$$

51. (from geometry)
$$A = \frac{1}{2}bh$$
$$2A = bh$$
$$b = \frac{2A}{h}$$

52. (from geometry)
$$A = \frac{1}{2}bh$$
$$2A = bh$$
$$h = \frac{2A}{b}$$

53. (from finance)
$$I = Prt$$
$$P = \frac{I}{rt}$$

54. (from finance)
$$I = Prt$$
$$t = \frac{I}{Pr}$$

55. (from finance)
$$T = D + pm$$
$$T - D = pm$$
$$p = \frac{T - D}{m}$$

56. (from finance)
$$P = C + MC$$
$$P - C = MC$$
$$M = \frac{P - C}{C}$$

57. (from geometry)
$$A = \frac{1}{2}h(a+b)$$
$$2A = h(a+b)$$
$$\frac{2A}{h} = a + b$$
$$a = \frac{2A}{h} - b \text{ or } a = \frac{2A - hb}{h}$$

58. (from geometry)
$$A = \frac{1}{2}h(a+b)$$
$$2A = h(a+b)$$
$$\frac{2A}{h} = a + b$$
$$b = \frac{2A}{h} - a \text{ or } b = \frac{2A - ha}{h}$$

59. (from geometry)
$$V = \frac{1}{3}\pi r^2 h$$
$$3V = \pi r^2 h$$
$$h = \frac{3V}{\pi r^2}$$

60. (from geometry)
$$V = \frac{1}{3}\pi r^2 h$$
$$3V = \pi r^2 h$$
$$r^2 = \frac{3V}{\pi h}$$

61. (from algebra)
$$y - y_1 = m(x - x_1)$$
$$m = \frac{y - y_1}{x - x_1}$$

62. (from algebra)
$$y_2 - y_1 = m(x_2 - x_1)$$
$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

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63. (from physics)

$$V = \frac{d_1 - d_2}{t}$$
$$Vt = d_1 - d_2$$
$$d_1 = Vt + d_2$$

64. (from statistics)

$$z = \frac{x-u}{s}$$
$$zs = x - u$$
$$x = zs + u$$

65. (from algebra)

$$Ax + By = C$$
$$Ax = C - By$$
$$x = \frac{C - By}{A}$$

66. (from algebra)

$$Ax + By = C$$
$$By = C - Ax$$
$$y = \frac{C - Ax}{B}$$

67. (from physics)

$$s = \frac{1}{2}at^2 + vt$$
$$2s = \cancel{2}\left(\frac{1}{\cancel{2}}at^2\right) + 2vt$$
$$2s = at^2 + 2vt$$
$$2s - at^2 = 2vt$$
$$\frac{2s - at^2}{2t} = \frac{2vt}{2t}$$
$$v = \frac{2s - at^2}{2t}$$

68. (from physics)

$$s = \frac{1}{2}at^2 + vt$$
$$s - vt = \frac{1}{2}at^2$$
$$2s - 2vt = at^2$$
$$a = \frac{2s - 2vt}{t^2}$$

69. (from algebra)

$$L = a + (n-1)d$$
$$L - a = (n-1)d$$
$$\frac{L-a}{d} = n - 1$$
$$n = \frac{L-a}{d} + 1$$

or

$$n = \frac{L - a + d}{d}$$

70. (from algebra)

$$L = a + (n-1)d$$
$$L - a = (n-1)d$$
$$d = \frac{L-a}{n-1}$$

71. (from geometry)

$$A = 2lw + 2lh + 2wh$$
$$A - 2wh = 2lw + 2lh$$
$$A - 2wh = l(2w + 2h)$$
$$l = \frac{A - 2wh}{2w + 2h}$$

72. (from geometry)

$$A = 2lw + 2lh + 2wh$$
$$A - 2lw = 2lh + 2wh$$
$$A - 2lw = h(2l + 2w)$$
$$h = \frac{A - 2lw}{2l + 2w}$$

73. (from physics)

$$IR + Ir = E$$
$$I(R + r) = E$$
$$I = \frac{E}{R + r}$$

74. (from statistics)

$$A = \frac{x_1 + x_2 + x_3}{n}$$
$$nA = x_1 + x_2 + x_3$$
$$n = \frac{x_1 + x_2 + x_3}{A}$$

75. – 80. Answers will vary.

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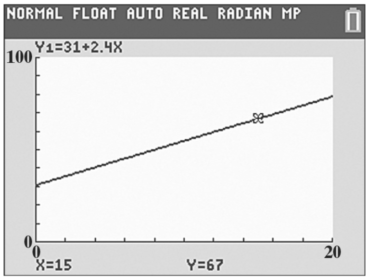
81.



82. **a.** Let x = the number of years after 1960.
$y = 23 - 0.28x$

b. The table and graph of y_1 verify the results.

83. does not make sense; Explanations will vary. Sample explanation: The variable may be solved in terms of other variables.

84. makes sense

85. makes sense

86. does not make sense; Explanations will vary. Sample explanation: When traveling in Europe, the temperature is typically reported in Celsius. Thus, the most useful temperature conversion formula will be from Celsius to Fahrenheit.

87. false; Changes to make the statement true will vary. A sample change is: If $I = prt$, then $t = \frac{I}{pr}$.

88. true

89. false; Changes to make the statement true will vary. A sample change is: The solution uses the distributive property.

$$P = C + MC$$
$$P = C(1+M)$$
$$C = \frac{P}{1+M}$$

90. false; Changes to make the statement true will vary. A sample change is: It is modeled by $x - \frac{1}{3}x$.

91. Let x = the original price of the dress.
If the reduction in price is 40%, the price paid is 60%.

$$\text{price paid} = 0.60(0.60x)$$
$$72 = 0.60(0.60x)$$
$$72 = 0.36x$$
$$200 = x$$

The original price is \$200.

92. Let x = the number of problems solved correctly.
Let $26 - x$ = the number of problems solved incorrectly.

$$0.08x = 0.05(26 - x)$$
$$0.08x = 1.3 - 0.05x$$
$$0.13x = 1.3$$
$$x = 10$$

10 problems were solved correctly.

93. Let x = the amount a girl would receive.
$2x$ = the amount Mrs. Ricardo would receive.
$4x$ = the amount a boy would receive.

$$\text{Total Savings} = x + 2x + 4x$$
$$14,000 = 7x$$
$$2,000 = x$$

Mrs. Ricardo received \$4000, the boy received \$8000, and the girl received \$2000.

94. Let x = the number of plants originally stolen.

After passing the first security guard, the thief has:

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

After passing the second security guard, the thief has:

$$\frac{1}{2}x - 2 - \left(\frac{1}{2}\left(\frac{1}{2}x - 2\right) + 2\right)$$
$$= \frac{1}{2}x - 2 - \left(\frac{1}{4}x - 1 + 2\right) = \frac{1}{2}x - 2 - \left(\frac{1}{4}x + 1\right)$$
$$= \frac{1}{2}x - 2 - \frac{1}{4}x - 1 = \frac{1}{4}x - 3.$$

After passing the third security guard, the thief has:

$$\frac{1}{4}x - 3 - \left(\frac{1}{2}\left(\frac{1}{4}x - 3\right) + 2\right)$$
$$= \frac{1}{4}x - 3 - \left(\frac{1}{8}x - \frac{3}{2} + 2\right) = \frac{1}{4}x - 3 - \left(\frac{1}{8}x + \frac{1}{2}\right)$$
$$= \frac{1}{4}x - 3 - \frac{1}{8}x - \frac{1}{2} = \frac{1}{8}x - \frac{7}{2}.$$

Since the thief has 1 plant after passing the third security guard, we can set the expression equal to 1 and solve for x.

$$\frac{1}{8}x - \frac{7}{2} = 1$$
$$8\left(\frac{1}{8}x - \frac{7}{2}\right) = 8(1)$$
$$x - 4(7) = 8$$
$$x - 28 = 8$$
$$x = 36$$

The thief stole 36 plants.

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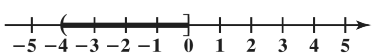
95.
$$\begin{aligned} V &= C - \frac{C-S}{L}N \\ V &= C - \left(\frac{C-S}{L}\right)\frac{N}{1} \\ V &= C - \frac{CN-SN}{L} \\ V &= \frac{CL}{L} - \frac{CN-SN}{L} \\ V &= \frac{CL-CN+SN}{L} \\ LV &= CL-CN+SN \\ LV-SN &= CL-CN \\ LV-SN &= C(L-N) \\ C &= \frac{LV-SN}{L-N} \end{aligned}$$

96. $\{x \mid -4 < x \le 0\}$



97. $\dfrac{(2+4)^2+(-1)^5}{12 \div 2 \cdot 3 - 3} = \dfrac{(6)^2+(-1)}{6 \cdot 3 - 3} = \dfrac{36+(-1)}{18-3}$
$= \dfrac{35}{15} = \dfrac{7}{3}$

98.
$$\begin{aligned} \frac{2x}{3} - \frac{8}{3} &= x \\ 3\left(\frac{2x}{3} - \frac{8}{3}\right) &= 3(x) \\ 2x - 8 &= 3x \\ -8 &= x \end{aligned}$$
The solution set is $\{-8\}$.

99. **a.** $b^4 \cdot b^3 = (b \cdot b \cdot b \cdot b)(b \cdot b \cdot b) = b^7$

b. $b^5 \cdot b^5 = (b \cdot b \cdot b \cdot b \cdot b)(b \cdot b \cdot b \cdot b \cdot b) = b^{10}$

c. When multiplying exponential expressions with the same base, add the exponents.

100. **a.** $\dfrac{b^7}{b^3} = \dfrac{\cancel{b} \cdot \cancel{b} \cdot \cancel{b} \cdot b \cdot b \cdot b \cdot b}{\cancel{b} \cdot \cancel{b} \cdot \cancel{b}} = b^4$

b. $\dfrac{b^8}{b^2} = \dfrac{\cancel{b} \cdot \cancel{b} \cdot b \cdot b \cdot b \cdot b \cdot b \cdot b}{\cancel{b} \cdot \cancel{b}} = b^6$

c. When dividing exponential expressions with the same base, subtract the exponents.

101.
$$\begin{aligned} \frac{1}{\left(-\frac{1}{2}\right)^3} &= \frac{1}{\left(-\frac{2}{1}\right)^{-3}} \\ &= \frac{1}{(-2)^{-3}} \\ &= (-2)^3 \\ &= -8 \end{aligned}$$

1.6 Check Points

1. **a.** $b^6 \cdot b^5 = b^{6+5} = b^{11}$

b. $\begin{aligned}[t] (4x^3y^4)(10x^2y^6) &= 4 \cdot 10 \cdot x^3 \cdot x^2 \cdot y^4 \cdot y^6 \\ &= 40x^{3+2}y^{4+6} \\ &= 40x^5y^{10} \end{aligned}$

2. **a.** $\dfrac{(-3)^6}{(-3)^3} = (-3)^{6-3} = (-3)^3 = -27$

b. $\dfrac{27x^{14}y^8}{3x^3y^5} = \dfrac{27}{3}x^{14-3}y^{8-5} = 9x^{11}y^3$

3. **a.** $7^0 = 1$

b. $(-5)^0 = 1$

c. $-5^0 = -(5^0) = -1$

d. $10x^0 = 10 \cdot 1 = 10$

e. $(10x)^0 = 1$

4. **a.** $5^{-2} = \dfrac{1}{5^2} = \dfrac{1}{25}$

b. $(-3)^{-3} = \dfrac{1}{(-3)^3} = \dfrac{1}{-27} = -\dfrac{1}{27}$

c. $\dfrac{1}{4^{-2}} = 4^2 = 16$

d. $3x^{-6}y^4 = 3 \cdot \dfrac{1}{x^6} \cdot y^4 = \dfrac{3y^4}{x^6}$

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5. a. $\dfrac{7^{-2}}{4^{-3}} = \dfrac{4^3}{7^2} = \dfrac{64}{49}$

b. $\dfrac{1}{5x^{-2}} = \dfrac{x^2}{5}$

6. a. $\left(x^5\right)^3 = x^{5\cdot 3} = x^{15}$

b. $\left(y^7\right)^{-2} = y^{(7)(-2)} = y^{-14} = \dfrac{1}{y^{14}}$

c. $\left(b^{-3}\right)^{-4} = b^{(-3)(-4)} = b^{12}$

7. a. $(2x)^4 = (2)^4(x)^4 = 16x^4$

b. $\left(-3y^2\right)^3 = (-3)^3\left(y^2\right)^3 = -27y^6$

c. $\left(-4x^5y^{-1}\right)^{-2} = (-4)^{-2}\left(x^5\right)^{-2}\left(y^{-1}\right)^{-2}$

$= \dfrac{1}{(-4)^2} \cdot \dfrac{1}{\left(x^5\right)^2} \cdot y^2$

$= \dfrac{y^2}{16x^{10}}$

8. a. $\left(\dfrac{x^5}{4}\right)^3 = \dfrac{x^{5\cdot 3}}{4^3} = \dfrac{x^{15}}{64}$

b. $\left(\dfrac{2x^{-3}}{y^2}\right)^4 = \dfrac{2^4x^{(-3)(4)}}{y^{(2)(4)}} = \dfrac{16x^{-12}}{y^8} = \dfrac{16}{x^{12}y^8}$

c. $\left(\dfrac{x^{-3}}{y^4}\right)^{-5} = \dfrac{x^{(-3)(-5)}}{y^{(4)(-5)}} = \dfrac{x^{15}}{y^{-20}} = x^{15}y^{20}$

9. a. $\left(-3x^{-6}y\right)\left(-2x^3y^4\right)^2$

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

$= -3 \cdot x^{-6} \cdot y \cdot 4 \cdot x^6 \cdot y^8$

$= -12 \cdot x^{-6+6} \cdot y^{1+8}$

$= -12x^0y^9$

$= -12y^9$

b. $\left(\dfrac{10x^3y^5}{5x^6y^{-2}}\right)^2 = \left(2x^{3-6}y^{5+2}\right)^2$

$= \left(2x^{-3}y^7\right)^2 = 4x^{-6}y^{14} = \dfrac{4y^{14}}{x^6}$

c. $\left(\dfrac{x^3y^5}{4}\right)^{-3} = \dfrac{x^{(3)(-3)}y^{(5)(-3)}}{4^{-3}}$

$= \dfrac{x^{-9}y^{-15}}{4^{-3}} = \dfrac{4^3}{x^9y^{15}} = \dfrac{64}{x^9y^{15}}$

1.6 Concept and Vocabulary Check

1. b^{m+n}; add
2. b^{m-n}; subtract
3. 1
4. $\dfrac{1}{b^n}$
5. false
6. b^n
7. true

1.6 Exercise Set

1. $b^4 \cdot b^7 = b^{4+7} = b^{11}$

2. $b^5 \cdot b^9 = b^{5+9} = b^{14}$

3. $x \cdot x^3 = x^{1+3} = x^4$

4. $x \cdot x^4 = x^{1+4} = x^5$

5. $2^3 \cdot 2^2 = 2^{3+2} = 2^5 = 32$

4. $x \cdot x^4 = x^{1+4} = x^5$

7. $3x^4 \cdot 2x^2 = 6x^{4+2} = 6x^6$

8. $5x^3 \cdot 3x^2 = 15x^{3+2} = 15x^5$

9. $\left(-2y^{10}\right)\left(-10y^2\right) = 20y^{10+2} = 20y^{12}$

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10. $\left(-4y^8\right)\left(-8y^4\right) = 32y^{8+4} = 32y^{12}$

11. $\left(5x^3y^4\right)\left(20x^7y^8\right) = 100x^{3+7}y^{4+8}$
$= 100x^{10}y^{12}$

12. $\left(4x^5y^6\right)\left(20x^7y^4\right) = 80x^{5+7}y^{6+4} = 80x^{12}y^{10}$

13. $\left(-3x^4y^0z\right)\left(-7xyz^3\right)$
$= 21x^{(4+1)}y^{0+1}z^{1+3}$
$= 21x^5y^1z^4 = 21x^5yz^4$

14. $(-9x^3yz^4)(-5xy^0z^2) = -9(-5)x^{3+1}y^{1+0}z^{4+2}$
$= 45x^4yz^6$

15. $\dfrac{b^{12}}{b^3} = b^{12-3} = b^9$

16. $\dfrac{b^{25}}{b^5} = b^{25-5} = b^{20}$

17. $\dfrac{15x^9}{3x^4} = 5x^{9-4} = 5x^5$

18. $\dfrac{18x^{11}}{3x^4} = 6x^{11-4} = 6x^7$

19. $\dfrac{x^9y^7}{x^4y^2} = x^{9-4}y^{7-2} = x^5y^5$

20. $\dfrac{x^9y^{12}}{x^2y^6} = x^{9-2}y^{12-6} = x^7y^6$

21. $\dfrac{50x^2y^7}{5xy^4} = 10x^{2-1}y^{7-4} = 10xy^3$

22. $\dfrac{36x^{12}y^4}{4xy^2} = 9x^{12-1}y^{4-2} = 9x^{11}y^2$

23. $\dfrac{-56a^{12}b^{10}c^8}{7ab^2c^4} = -8a^{12-1}b^{10-2}c^{8-4}$
$= -8a^{11}b^8c^4$

24. $\dfrac{-66a^9b^7c^6}{6a^3bc^2} = -11a^6b^6c^4$

25. $6^0 = 1$

26. $9^0 = 1$

27. $(-4)^0 = 1$

28. $(-2)^0 = 1$

29. $-4^0 = -1$

30. $-2^0 = -1$

31. $13y^0 = 13(1) = 13$

32. $17y^0 = 17(1) = 17$

33. $(13y)^0 = 1$

34. $(17y)^0 = 1$

35. $3^{-2} = \dfrac{1}{3^2} = \dfrac{1}{9}$

36. $4^{-2} = \dfrac{1}{4^2} = \dfrac{1}{16}$

37. $(-5)^{-2} = \dfrac{1}{(-5)^2} = \dfrac{1}{25}$

38. $(-7)^{-2} = \dfrac{1}{(-7)^2} = \dfrac{1}{49}$

39. $-5^{-2} = -\left(5^{-2}\right) = -\dfrac{1}{5^2} = -\dfrac{1}{25}$

40. $-7^{-2} = -\left(7^{-2}\right) = -\dfrac{1}{7^2} = -\dfrac{1}{49}$

41. $x^2y^{-3} = \dfrac{x^2}{y^3}$

42. $x^3y^{-4} = \dfrac{x^3}{y^4}$

43. $8x^{-7}y^3 = \dfrac{8y^3}{x^7}$

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44. $9x^{-8}y^4 = \dfrac{9y^4}{x^8}$

45. $\dfrac{1}{5^{-3}} = 5^3 = 125$

46. $\dfrac{1}{2^{-5}} = 2^5 = 32$

47. $\dfrac{1}{(-3)^{-4}} = (-3)^4 = 81$

48. $\dfrac{1}{(-2)^{-4}} = (-2)^4 = 16$

49. $\dfrac{x^{-2}}{y^{-5}} = \dfrac{y^5}{x^2}$

50. $\dfrac{x^{-3}}{y^{-7}} = \dfrac{y^7}{x^3}$

51. $\dfrac{a^{-4}b^7}{c^{-3}} = \dfrac{b^7c^3}{a^4}$

52. $\dfrac{a^{-3}b^8}{c^{-2}} = \dfrac{b^8c^2}{a^3}$

53. $\left(x^6\right)^{10} = x^{(6\cdot10)} = x^{60}$

54. $\left(x^3\right)^2 = x^{(3\cdot2)} = x^6$

55. $\left(b^4\right)^{-3} = \dfrac{1}{\left(b^4\right)^3} = \dfrac{1}{b^{(4\cdot3)}} = \dfrac{1}{b^{12}}$

56. $\left(b^8\right)^{-3} = \dfrac{1}{\left(b^8\right)^3} = \dfrac{1}{b^{(8\cdot3)}} = \dfrac{1}{b^{24}}$

57. $\left(7^{-4}\right)^{-5} = 7^{-4\cdot(-5)} = 7^{20}$

58. $\left(9^{-4}\right)^{-5} = 9^{-4\cdot(-5)} = 9^{20}$

59. $(4x)^3 = 4^3x^3 = 64x^3$

60. $(2x)^5 = 2^5x^5 = 32x^5$

61. $\left(-3x^7\right)^2 = (-3)^2x^{7\cdot2} = 9x^{14}$

62. $\left(-4x^9\right)^2 = (-4)^2x^{9\cdot2} = 16x^{18}$

63. $\left(2xy^2\right)^3 = 8x^{(1\cdot3)}y^{(2\cdot3)} = 8x^3y^6$

64. $\left(3x^2y\right)^4 = 3^4x^{(2\cdot4)}y^4 = 81x^8y^4$

65. $\left(-3x^2y^5\right)^2 = (-3)^2x^{(2\cdot2)}y^{(5\cdot2)} = 9x^4y^{10}$

66. $\left(-3x^4y^6\right)^2 = (-3)^2x^{(4\cdot2)}y^{(6\cdot2)} = 9x^8y^{12}$

67. $\left(-3x^{-2}\right)^{-3} = (-3)^{-3}\left(x^{-2}\right)^{-3}$

$= \dfrac{x^6}{(-3)^3} = \dfrac{x^6}{-27} = -\dfrac{x^6}{27}$

68. $\left(-2x^{-4}\right)^{-3} = (-2)^{-3}\left(x^{-4}\right)^{-3} = \dfrac{x^{12}}{(-2)^3} = -\dfrac{x^{12}}{8}$

69. $\left(5x^3y^{-4}\right)^{-2} = 5^{-2}\left(x^3\right)^{-2}\left(y^{-4}\right)^{-2}$

$= 5^{-2}x^{-6}y^8 = \dfrac{y^8}{25x^6}$

70. $\left(7x^2y^{-5}\right)^{-2} = 7^{-2}x^{-4}y^{10} = \dfrac{y^{10}}{7^2x^4} = \dfrac{y^{10}}{49x^4}$

71. $\left(-2x^{-5}y^4z^2\right)^{-4} = (-2)^{-4}x^{20}y^{-16}z^{-8}$

$= \dfrac{x^{20}}{(-2)^4y^{16}z^8}$

$= \dfrac{x^{20}}{16y^{16}z^8}$

72. $\left(-2x^{-4}y^5z^3\right)^{-4} = (-2)^{-4}x^{16}y^{-20}z^{-12}$

$= \dfrac{x^{16}}{(-2)^4y^{20}z^{12}} = \dfrac{x^{16}}{16y^{20}z^{12}}$

73. $\left(\dfrac{2}{x}\right)^4 = \dfrac{2^4}{x^4} = \dfrac{16}{x^4}$

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74. $\left(\frac{y}{2}\right)^5 = \frac{y^5}{2^5} = \frac{y^5}{32}$

75. $\left(\frac{x^3}{5}\right)^2 = \frac{x^{(3\cdot 2)}}{5^2} = \frac{x^6}{25}$

76. $\left(\frac{x^4}{6}\right)^2 = \frac{x^{(4\cdot 2)}}{6^2} = \frac{x^8}{36}$

77. $\left(-\frac{3x}{y}\right)^4 = \frac{(-3)^4 x^4}{y^4} = \frac{81x^4}{y^4}$

78. $\left(-\frac{2x}{y}\right)^5 = -\frac{2^5 x^5}{y^5} = -\frac{32x^5}{y^5}$

79. $\left(\frac{x^4}{y^2}\right)^6 = \frac{x^{(4\cdot 6)}}{y^{(2\cdot 6)}} = \frac{x^{24}}{y^{12}}$

80. $\left(\frac{x^5}{y^3}\right)^6 = \frac{x^{(5\cdot 6)}}{y^{(3\cdot 6)}} = \frac{x^{30}}{y^{18}}$

81. $\left(\frac{x^3}{y^{-4}}\right)^3 = \frac{x^{(3\cdot 3)}}{y^{(-4\cdot 3)}} = \frac{x^9}{y^{-12}} = x^9 y^{12}$

82. $\left(\frac{x^4}{y^{-2}}\right)^3 = \frac{x^{(4\cdot 3)}}{y^{(-2\cdot 3)}} = \frac{x^{12}}{y^{-6}} = x^{12} y^6$

83. $\left(\frac{a^{-2}}{b^3}\right)^{-4} = \frac{a^{(-2\cdot(-4))}}{b^{(3\cdot(-4))}} = \frac{a^8}{b^{-12}} = a^8 b^{12}$

84. $\left(\frac{a^{-3}}{b^5}\right)^{-4} = \frac{a^{-3(-4)}}{b^{5(-4)}} = \frac{a^{12}}{b^{-20}} = a^{12} b^{20}$

85. $\frac{x^3}{x^9} = x^{3-9} = x^{-6} = \frac{1}{x^6}$

86. $\frac{x^6}{x^{10}} = x^{6-10} = x^{-4} = \frac{1}{x^4}$

87. $\frac{20x^3}{-5x^4} = -4x^{3-4} = -4x^{-1} = -\frac{4}{x}$

88. $\frac{10x^5}{-2x^6} = -5x^{5-6} = -5x^{-1} = -\frac{5}{x}$

89. $\frac{16x^3}{8x^{10}} = 2x^{3-10} = 2x^{-7} = \frac{2}{x^7}$

90. $\frac{15x^2}{3x^{11}} = 5x^{2-11} = 5x^{-9} = \frac{5}{x^9}$

91. $\frac{20a^3b^8}{2ab^{13}} = 10a^{3-1}b^{8-13}$

$= 10a^2b^{-5} = \frac{10a^2}{b^5}$

92. $\frac{72a^5b^{11}}{9ab^{17}} = 8a^{5-1}b^{11-17} = 8a^4b^{-6} = \frac{8a^4}{b^6}$

93. $x^3 \cdot x^{-12} = x^{3+(-12)} = x^{-9} = \frac{1}{x^9}$

94. $x^4 \cdot x^{-12} = x^{4+(-12)} = x^{-8} = \frac{1}{x^8}$

95. $\left(2a^5\right)\left(-3a^{-7}\right) = -6a^{5+(-7)}$

$= -6a^{-2} = -\frac{6}{a^2}$

96. $\left(4a^2\right)\left(-2a^{-5}\right) = -8a^{-3} = -\frac{8}{a^3}$

97. $\left(-\frac{1}{4}x^{-4}y^5z^{-1}\right)\left(-12x^{-3}y^{-1}z^4\right)$

$= 3x^{-4+(-3)}y^{5+(-1)}z^{-1+4}$

$= 3x^{-7}y^4z^3 = \frac{3y^4z^3}{x^7}$

98. $\left(-\frac{1}{3}x^{-5}y^4z^6\right)\left(-18x^{-2}y^{-1}z^{-7}\right)$

$= 6x^{-5+(-2)}y^{4+(-1)}z^{6+(-7)}$

$= 6x^{-7}y^3z^{-1} = \frac{6y^3}{x^7z}$

99. $\frac{6x^2}{2x^{-8}} = 3x^{2-(-8)} = 3x^{2+8} = 3x^{10}$

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100. $\frac{12x^5}{3x^{-10}} = 4x^{5-(-10)} = 4x^{15}$

101. $\frac{x^{-7}}{x^3} = x^{-7-3} = x^{-10} = \frac{1}{x^{10}}$

102. $\frac{x^{-10}}{x^4} = x^{-10-4} = x^{-14} = \frac{1}{x^{14}}$

103. $\frac{30x^2y^5}{-6x^8y^{-3}} = -5x^{2-8}y^{5-(-3)}$

$= -5x^{-6}y^8 = -\frac{5y^8}{x^6}$

104. $\frac{24x^2y^{13}}{-2x^5y^{-2}} = -12x^{2-5}y^{13-(-2)}$

$= -12x^{-3}y^{15} = -\frac{12y^{15}}{x^3}$

105. $\frac{-24a^3b^{-5}c^5}{-3a^{-6}b^{-4}c^{-7}} = 8a^{3-(-6)}b^{-5-(-4)}c^{5-(-7)}$

$= 8a^9b^{-1}c^{12} = \frac{8a^9c^{12}}{b}$

106. $\frac{-24a^2b^{-2}c^8}{-8a^{-5}b^{-1}c^{-3}} = 3a^{2-(-5)}b^{-2-(-1)}c^{8-(-3)}$

$= 3a^7b^{-1}c^{11}$

$= \frac{3a^7c^{11}}{b}$

107. $\left(\frac{x^3}{x^{-5}}\right)^2 = \left(x^{3-(-5)}\right)^2 = \left(x^8\right)^2 = x^{16}$

108. $\left(\frac{x^4}{x^{-11}}\right)^3 = \left(x^{4-(-11)}\right)^3 = \left(x^{15}\right)^3 = x^{45}$

109. $\left(\frac{-15a^4b^2}{5a^{10}b^{-3}}\right)^3 = \left(-3a^{4-10}b^{2-(-3)}\right)^3$

$= \left(-3a^{-6}b^{2+3}\right)^3$

$= \left(-3a^{-6}b^5\right)^3$

$= (-3)^3\left(a^{-6}\right)^3\left(b^5\right)^3$

$= -27a^{-18}b^{15}$

$= -\frac{27b^{15}}{a^{18}}$

110. $\left(\frac{-30a^{14}b^8}{10a^{17}b^{-2}}\right)^3 = \left(-3a^{14-17}b^{8-(-2)}\right)^3$

$= \left(-3a^{-3}b^{10}\right)^3$

$= -27a^{-9}b^{30} = -\frac{27b^{30}}{a^9}$

111. $\left(\frac{3a^{-5}b^2}{12a^3b^{-4}}\right)^0 = 1$

Recall the Zero Exponent Rule.

112. $\left(\frac{4a^{-5}b^3}{12a^3b^{-5}}\right)^0 = 1$

113. $\left(\frac{x^{-5}y^8}{3}\right)^{-4} = \frac{x^{(-5)(-4)}y^{8(-4)}}{3^{-4}}$

$= \frac{x^{20}y^{-32}}{3^{-4}} = \frac{3^4x^{20}}{y^{32}} = \frac{81x^{20}}{y^{32}}$

114. $\left(\frac{x^6y^{-7}}{2}\right)^{-3} = \frac{x^{-18}y^{21}}{2^{-3}} = \frac{8y^{21}}{x^{18}}$

115. $\left(\frac{20a^{-3}b^4c^5}{-2a^{-5}b^{-2}c}\right)^{-2} = \left(10a^{-3-(-5)}b^{4-(-2)}c^{5-1}\right)^{-2}$

$= \frac{1}{\left(10a^2b^6c^4\right)^2}$

$= \frac{1}{10^2a^{2(2)}b^{6(2)}c^{4(2)}}$

$= \frac{1}{100a^4b^{12}c^8}$

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116. $\left(\dfrac{-2a^{-4}b^{3}c^{-1}}{3a^{-2}b^{-5}c^{-2}}\right)^{-4} = \left(\dfrac{-2a^{-4-(-2)}b^{3-(-5)}c^{-1-(-2)}}{3}\right)^{-4}$

$$= \left(\frac{-2a^{-2}b^{8}c}{3}\right)^{-4}$$
$$= \frac{(-2)^{-4}a^{8}b^{-32}c^{-4}}{3^{-4}}$$
$$= \frac{3^{4}a^{8}}{(-2)^{4}b^{32}c^{4}}$$
$$= \frac{81a^{8}}{16b^{32}c^{4}}$$

117. $\dfrac{9y^4}{x^{-2}} + \left(\dfrac{x^{-1}}{y^2}\right)^{-2} = 9x^2y^4 + \dfrac{x^{(-1)(-2)}}{y^{2(-2)}}$

$$= 9x^2y^4 + \frac{x^2}{y^{-4}}$$
$$= 9x^2y^4 + x^2y^4$$
$$= 10x^2y^4$$

118. $\dfrac{7x^3}{y^{-9}} + \left(\dfrac{x^{-1}}{y^3}\right)^{-3} = 7x^3y^9 + \dfrac{x^{(-1)(-3)}}{y^{3(-3)}}$

$$= 7x^3y^9 + \frac{x^3}{y^{-9}}$$
$$= 7x^3y^9 + x^3y^9$$
$$= 8x^3y^9$$

119. $\left(\dfrac{3x^4}{y^{-4}}\right)^{-1}\left(\dfrac{2x}{y^2}\right)^{3} = \dfrac{3^{-1}x^{4(-1)}}{y^{(-4)(-1)}}\cdot\dfrac{2^3x^{1\cdot3}}{y^{2\cdot3}}$

$$= \frac{x^{-4}}{3y^4}\cdot\frac{8x^3}{y^6}$$
$$= \frac{8x^{-4+3}}{3y^{4+6}}$$
$$= \frac{8x^{-1}}{3y^{10}}$$
$$= \frac{8}{3xy^{10}}$$

120. $\left(\dfrac{2^{-1}x^{-2}y}{x^4y^{-1}}\right)^{-2}\left(\dfrac{xy^{-3}}{x^{-3}y}\right)^{3}$

$$= \frac{2^{(-1)(-2)}x^{(-2)(-2)}y^{1(-2)}}{x^{4(-2)}y^{(-1)(-2)}}\cdot\frac{x^{1\cdot3}y^{-3\cdot3}}{x^{-3\cdot3}y^{1\cdot3}}$$
$$= \frac{2^2x^4y^{-2}}{x^{-8}y^2}\cdot\frac{x^3y^{-9}}{x^{-9}y^3}$$
$$= 4x^{4-(-8)}y^{-2-2}\cdot x^{3-(-9)}y^{-9-3}$$
$$= 4x^{12}y^{-4}\cdot x^{12}y^{-12}$$
$$= 4x^{12+12}y^{-4+(-12)}$$
$$= 4x^{24}y^{-16}$$
$$= \frac{4x^{24}}{y^{16}}$$

121. $\left(-4x^3y^{-5}\right)^{-2}\left(2x^{-8}y^{-5}\right) = \dfrac{2x^{-8}y^{-5}}{\left(-4x^3y^{-5}\right)^2}$

$$= \frac{2x^{-8}y^{-5}}{(-4)^2x^{3\cdot2}y^{-5\cdot2}}$$
$$= \frac{2x^{-8}y^{-5}}{16x^6y^{-10}}$$
$$= \frac{y^{-5-(-10)}}{8x^{6-(-8)}}$$
$$= \frac{y^5}{8x^{14}}$$

122. $\left(-4x^{-4}y^5\right)^{-2}\left(-2x^5y^{-6}\right) = \dfrac{-2x^5y^{-6}}{\left(-4x^{-4}y^5\right)^2}$

$$= \frac{-2x^5y^{-6}}{(-4)^2x^{-4\cdot2}y^{5\cdot2}}$$
$$= -\frac{2x^5y^{-6}}{16x^{-8}y^{10}}$$
$$= -\frac{x^{5-(-8)}}{8y^{10-(-6)}}$$
$$= -\frac{x^{13}}{8y^{16}}$$

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123. $\dfrac{\left(2x^2y^4\right)^{-1}\left(4xy^3\right)^{-3}}{\left(x^2y\right)^{-5}\left(x^3y^2\right)^4}$

$= \dfrac{\left(x^2y\right)^5}{\left(2x^2y^4\right)^1\left(4xy^3\right)^3\left(x^3y^2\right)^4}$

$= \dfrac{x^{2\cdot5}y^{1\cdot5}}{\left(2x^2y^4\right)\left(4^3x^{1\cdot3}y^{3\cdot3}\right)\left(x^{3\cdot4}y^{2\cdot4}\right)}$

$= \dfrac{x^{10}y^5}{\left(2x^2y^4\right)\left(64x^3y^9\right)\left(x^{12}y^8\right)}$

$= \dfrac{x^{10}y^5}{128x^{2+3+12}y^{4+9+8}}$

$= \dfrac{x^{10}y^5}{128x^{17}y^{21}}$

$= \dfrac{1}{128x^{17-10}y^{21-5}} = \dfrac{1}{128x^7y^{16}}$

124. $\dfrac{\left(3x^3y^2\right)^{-1}\left(2x^2y\right)^{-2}}{\left(xy^2\right)^{-5}\left(x^2y^3\right)^3}$

$= \dfrac{\left(xy^2\right)^5}{\left(3x^3y^2\right)^1\left(2x^2y\right)^2\left(x^2y^3\right)^3}$

$= \dfrac{x^{1\cdot5}y^{2\cdot5}}{\left(3x^3y^2\right)\left(2^2x^{2\cdot2}y^2\right)\left(x^{2\cdot3}y^{3\cdot3}\right)}$

$= \dfrac{x^5y^{10}}{\left(3x^3y^2\right)\left(4x^4y^2\right)\left(x^6y^9\right)}$

$= \dfrac{x^5y^{10}}{12x^{3+4+6}y^{2+2+9}}$

$= \dfrac{x^5y^{10}}{12x^{13}y^{13}} = \dfrac{1}{12x^{13-5}y^{13-10}} = \dfrac{1}{12x^8y^3}$

125. **a.** $A = 1000\cdot2^t = 1000\cdot2^0 = 1000\cdot1 = 1000$
The present aphid population is 1000.

b. $A = 1000\cdot2^t = 1000\cdot2^4 = 1000\cdot16 = 16{,}000$
In four weeks the aphid population will be 16,000.

c. $A = 1000\cdot2^t = 1000\cdot2^{-3}$

$= 1000\cdot\dfrac{1}{2^3} = 1000\cdot\dfrac{1}{8} = 125$

Three weeks ago the aphid population was 125.

126. **a.** $A = 1000\cdot2^t = 1000\cdot2^0 = 1000\cdot1 = 1000$
The present aphid population is 1000.

b. $A = 1000\cdot2^t = 1000\cdot2^3 = 1000\cdot8 = 8{,}000$
In three weeks the aphid population will be 8000.

c. $A = 1000\cdot2^t = 1000\cdot2^{-2}$

$= 1000\cdot\dfrac{1}{2^2} = 1000\cdot\dfrac{1}{4} = 250$

Two weeks ago the aphid population was 250.

127. **a.** $N = \dfrac{25}{1+24\cdot2^{-t}} = \dfrac{25}{1+24\cdot2^{-0}}$

$= \dfrac{25}{1+24\cdot1} = \dfrac{25}{25} = 1$

One person started the rumor.

b. $N = \dfrac{25}{1+24\cdot2^{-t}} = \dfrac{25}{1+24\cdot2^{-4}}$

$= \dfrac{25}{1+\dfrac{24}{2^4}} = \dfrac{25}{1+\dfrac{24}{16}} = \dfrac{25}{1+1.5} = \dfrac{25}{2.5} = 10$

After 4 minutes, 10 people in the class had heard the rumor.

128. **a.** $N = \dfrac{25}{1+24\cdot2^{-t}} = \dfrac{25}{1+24\cdot2^{-0}}$

$= \dfrac{25}{1+24\cdot1} = \dfrac{25}{25} = 1$

One person started the rumor.

b. $N = \dfrac{25}{1+24\cdot2^{-t}} = \dfrac{25}{1+24\cdot2^{-4}}$

$= \dfrac{25}{1+\dfrac{24}{2^6}} = \dfrac{25}{1+\dfrac{24}{64}} = \dfrac{25}{1+0.375} = \dfrac{25}{1.375} \approx 18$

After 6 minutes, about 18 people in the class had heard the rumor.

129. **a.** At time zero, one person started the rumor. This is represented by the point $(0,1)$.

b. After 4 minutes, 10 people in the class had heard the rumor. This is represented by the point $(4,10)$.

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130. **a.** At time zero, one person started the rumor. This is represented by the point $(0,1)$.

b. After 6 minutes, about 18 people in the class had heard the rumor. This is represented by the point $(6,18)$.

131. Statement d best describes the graph.

132. 25 people in the class eventually heard the rumor.

133 . If $n = 1$,

$$d = \frac{3\left(2^{n-2}\right)+4}{10} = \frac{3\left(2^{1-2}\right)+4}{10} = \frac{3\left(2^{-1}\right)+4}{10} = \frac{3\left(\frac{1}{2}\right)+4}{10} = \frac{1.5+4}{10} = \frac{5.5}{10} = 0.55$$

Mercury is 0.55 astronomical units from the sun.

134. If $n = 2$,

$$d = \frac{3\left(2^{n-2}\right)+4}{10} = \frac{3\left(2^{2-2}\right)+4}{10} = \frac{3\left(2^{0}\right)+4}{10} = \frac{3(1)+4}{10} = \frac{3+4}{10} = \frac{7}{10} = 0.7$$

Venus is 0.7 astronomical units from the Sun.

135. If $n = 5$,

$$d = \frac{3\left(2^{n-2}\right)+4}{10} = \frac{3\left(2^{5-2}\right)+4}{10} = \frac{3\left(2^{3}\right)+4}{10} = \frac{3(8)+4}{10} = \frac{24+4}{10} = \frac{28}{10} = 2.8$$

Jupiter is 2.8 astronomical units from the Sun. Thus, Jupiter is 1.8 astronomical units farther from the Sun than Earth.

136. If $n = 7$,

$$d = \frac{3\left(2^{n-2}\right)+4}{10} = \frac{3\left(2^{7-2}\right)+4}{10} = \frac{3\left(2^{5}\right)+4}{10} = \frac{3(32)+4}{10} = \frac{96+4}{10} = \frac{100}{10} = 10$$

Uranus is 10 astronomical units from the Sun. Thus, Uranus is 9 astronomical units farther from the Sun than Earth.

137. – 145. Answers will vary.

146. makes sense

147. makes sense

148. does not make sense; Explanations will vary. Sample explanation: $25(x^3)^9 = 25x^{27}$, not $25x^{12}$.

149. does not make sense; Explanations will vary. Sample explanation: $b^0 = 1$, so $\frac{a^n}{b^0} = \frac{a^n}{1} = a^n$.

150. false; Changes to make the statement true will vary. A sample change is: $2^2 \cdot 2^4 = 2^{2+4} = 2^6$

151. false; Changes to make the statement true will vary. A sample change is: $5^6 \cdot 5^2 = 5^{6+2} = 5^8$

152. false; Changes to make the statement true will vary. A sample change is: $6^5 = (2 \cdot 3)^5 = 2^5 \cdot 3^5$

153. false; Changes to make the statement true will vary. A sample change is: $\frac{1}{(-2)^3} = \frac{1}{-8} = -\frac{1}{8}$, but $2^{-3} = \frac{1}{2^3} = \frac{1}{8}$.

154. false; Changes to make the statement true will vary. A sample change is: $\frac{2^8}{2^{-3}} = 2^{8-(-3)} = 2^{11}$, not 2^5.

155. false; Changes to make the statement true will vary. A sample change is: $2^4 + 2^5 = 16 + 32 = 48$, but $2^9 = 512$.

156. true

157. true

158. $x^{n-1} \cdot x^{3n+4} = x^{n-1+3n+4} = x^{4n+3}$

159.
$$\left(x^{-4n} \cdot x^{n}\right)^{-3} = \left(x^{-4n+n}\right)^{-3} = \left(x^{-3n}\right)^{-3} = x^{(-3n)(-3)} = x^{9n}$$

160.
$$\left(\frac{x^{3-n}}{x^{6-n}}\right)^{-2} = (x^{3-n-(6-n)})^{-2} = (x^{3-n-6+n})^{-2} = (x^{-3})^{-2} = x^6$$

161. $\left(\dfrac{x^n y^{3n+1}}{y^n}\right)^{-2} = \left(x^n y^{(3n+1)-n}\right)^3$

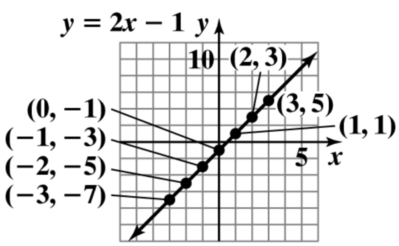
$= \left(x^n y^{2n+1}\right)^3$

$= x^{n\cdot 3} y^{(2n+1)\cdot 3}$

$= x^{3n} y^{6n+3}$

162.

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



163. $Ax + By = C$

$By = C - Ax$

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

164. Let w = the width of the playing field.

Let $2w – 5$ = the length of the playing field.

$$\begin{aligned} P &= 2(\text{length}) + 2(\text{width}) \\ 230 &= 2(2w-5)+2w \\ 230 &= 4w-10+2w \\ 230 &= 6w-10 \\ 240 &= 6w \\ 40 &= w \end{aligned}$$

Find the length. $2w-5 = 2(40)-5 = 80-5 = 75$

The playing field is 40 meters by 75 meters.

165. It moves the decimal point 3 places to the right.

166. It moves the decimal point 2 places to the left.

167. **a.** $10^9 \times 10^{-4} = 10^{9-4} = 10^5 = 100{,}000$

b. $\dfrac{10^4}{10^{-2}} = 10^4 \times 10^2 = 10^{4+2} = 10^6 = 1{,}000{,}000$

1.7 Check Points

1. **a.** Move the decimal point 7 places to the right.
$-2.6 \times 10^9 = -2{,}600{,}000{,}000$

b. Move the decimal point 6 places to the left.
$3.017 \times 10^{-6} = 0.000003017$

2. **a.** The decimal point must be moved 9 places to the left to get a number whose absolute value is between 1 and 10. Thus the exponent on 10 is 9.
$5{,}210{,}000{,}000 = 5.21 \times 10^9$

b. The decimal point must be moved 8 places to the right to get a number whose absolute value is between 1 and 10. Thus the exponent on 10 is –8.
$-0.00000006893 = -6.893 \times 10^{-8}$

3. 18 million $= 18{,}000{,}000 = 1.8 \times 10^7$

4. **a.** $(7.1\times10^5)(5\times10^{-7}) = (7.1\times5)\times(10^5\times10^{-7})$

$= 35.5\times10^{-2} = 3.55\times10^{-1}$

b. $\dfrac{1.2\times10^6}{3\times10^{-3}} = \left(\dfrac{1.2}{3}\right)\times\left(\dfrac{10^6}{10^{-3}}\right)$

$= 0.4\times10^{6-(-3)} = 0.4\times10^9 = 4\times10^8$

5. $\dfrac{2.42\times10^{12}}{3.12\times10^8} = \left(\dfrac{2.42}{3.12}\right)\times\left(\dfrac{10^{12}}{10^8}\right)$

$\approx 0.7756\times10^{12-8}$

$= 0.7756\times10^4 = 7756$

The per capita tax was about \$7756 in 2011.

6. $d = rt$

$d = (1.55\times10^3)(20{,}000)$

$d = (1.55\times10^3)(2\times10^4)$

$d = (1.55\times2)\times(10^3\times10^4)$

$d = 3.1\times10^7$

The distance from Venus to Mercury is 3.1×10^7, or 31 million miles.

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1.7 Concept and Vocabulary Check

1. a number greater than or equal to 1 and less than 10; integer
2. true
3. false

1.7 Exercise Set

1. $3.8\times10^2 = 380$
2. $9.2\times10^2 = 920$
3. $6\times10^{-4} = 0.0006$
4. $7\times10^{-5} = 0.00007$
5. $-7.16\times10^6 = -7{,}160{,}000$
6. $-8.17\times10^6 = -8{,}170{,}000$
7. $1.4\times10^0 = 1.4\times1 = 1.4$
8. $2.4\times10^0 = 2.4\times1 = 2.4$
9. $7.9\times10^{-1} = 0.79$
10. $6.8\times10^{-1} = 0.68$
11. $-4.15\times10^{-3} = -0.00415$
12. $-3.14\times10^{-3} = -0.00314$
13. $-6.00001\times10^{10} = -60{,}000{,}100{,}000$
14. $-7.00001\times10^{10} = -70{,}000{,}100{,}000$
15. $32{,}000 = 3.2\times10^4$
16. $64{,}000 = 6.4\times10^4$
17. $638{,}000{,}000{,}000{,}000{,}000 = 6.38\times10^{17}$
18. $579{,}000{,}000{,}000{,}000{,}000 = 5.79\times10^{17}$
19. $-317 = -3.17\times10^2$
20. $-326 = -3.26\times10^2$
21. $-5716 = -5.716\times10^3$
22. $-3829 = -3.829\times10^3$
23. $0.0027 = 2.7\times10^{-3}$
24. $0.0083 = 8.3\times10^{-3}$
25. $-0.00000000504 = -5.04\times10^{-9}$
26. $-0.00000000405 = -4.05\times10^{-9}$
27. $0.007 = 7\times10^{-3}$
28. $0.005 = 5\times10^{-3}$
29. $3.14159 = 3.14159\times10^0$
30. $2.71828 = 2.71828\times10^0$
31. $$\begin{aligned}\left(3\times10^4\right)\left(2.1\times10^3\right) &= (3\times2.1)\left(10^4\times10^3\right)\\ &= 6.3\times10^{4+3}\\ &= 6.3\times10^7\end{aligned}$$
32. $\left(2\times10^4\right)\left(4.1\times10^3\right) = 8.2\times10^7$
33. $$\begin{aligned}\left(1.6\times10^{15}\right)\left(4\times10^{-11}\right) &= (1.6\times4)\left(10^{15}\times10^{-11}\right)\\ &= 6.4\times10^{15+(-11)}\\ &= 6.4\times10^4\end{aligned}$$
34. $\left(1.4\times10^{15}\right)\left(3\times10^{-11}\right) = 4.2\times10^4$
35. $$\begin{aligned}\left(6.1\times10^{-8}\right)\left(2\times10^{-4}\right) &= (6.1\times2)\left(10^{-8}\times10^{-4}\right)\\ &= 12.2\times10^{-8+(-4)}\\ &= 12.2\times10^{-12}\\ &= 1.22\times10^{-11}\end{aligned}$$
36. $$\begin{aligned}\left(5.1\times10^{-8}\right)\left(3\times10^{-4}\right) &= 15.3\times10^{-12}\\ &= 1.53\times10^{-11}\end{aligned}$$

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37. $(4.3\times10^8)(6.2\times10^4)$
$= (4.3\times6.2)(10^8\times10^4)$
$= 26.66\times10^{8+4}$
$= 26.66\times10^{12}$
$= 2.666\times10^{13} \approx 2.67\times10^{13}$

38. $(8.2\times10^8)(4.6\times10^4)$
$= 37.72\times10^{8+4} = 37.72\times10^{12}$
$= 3.772\times10^{13} \approx 3.77\times10^{13}$

39. $\dfrac{8.4\times10^8}{4\times10^5} = \dfrac{8.4}{4}\times\dfrac{10^8}{10^5}$
$= 2.1\times10^{8-5} = 2.1\times10^3$

40. $\dfrac{6.9\times10^8}{3\times10^5} = 2.3\times10^{8-5} = 2.3\times10^3$

41. $\dfrac{3.6\times10^4}{9\times10^{-2}} = \dfrac{3.6}{9}\times\dfrac{10^4}{10^{-2}}$
$= 0.4\times10^{4-(-2)}$
$= 0.4\times10^6 = 4\times10^5$

42. $\dfrac{1.2\times10^4}{2\times10^{-2}} = 0.6\times10^{4-(-2)} = 0.6\times10^6$
$= (6\times10^{-1})\times10^6 = 6\times10^5$

43. $\dfrac{4.8\times10^{-2}}{2.4\times10^6} = \dfrac{4.8}{2.4}\times\dfrac{10^{-2}}{10^6}$
$= 2\times10^{-2-6} = 2\times10^{-8}$

44. $\dfrac{7.5\times10^{-2}}{2.5\times10^6} = 3\times10^{-2-6} = 3\times10^{-8}$

45. $\dfrac{2.4\times10^{-2}}{4.8\times10^{-6}} = \dfrac{2.4}{4.8}\times\dfrac{10^{-2}}{10^{-6}}$
$= 0.5\times10^{-2-(-6)}$
$= 0.5\times10^4 = 5\times10^3$

46. $\dfrac{1.5\times10^{-2}}{5\times10^{-6}} = 0.5\times10^{-2-(-6)}$
$= 0.5\times10^4 = 5\times10^3$

47. $\dfrac{480{,}000{,}000{,}000}{0.00012} = \dfrac{4.8\times10^{11}}{1.2\times10^{-4}}$
$= \dfrac{4.8}{1.2}\times\dfrac{10^{11}}{10^{-4}}$
$= 4\times10^{11-(-4)}$
$= 4\times10^{15}$

48. $\dfrac{282{,}000{,}000{,}000}{0.00141} = \dfrac{2.82\times10^{11}}{1.41\times10^{-3}}$
$= 2\times10^{11-(-3)}$
$= 2\times10^{14}$

49. $\dfrac{0.00072\times0.003}{0.00024} = \dfrac{(7.2\times10^{-4})(3\times10^{-3})}{2.4\times10^{-4}}$
$= \dfrac{7.2\times3}{2.4}\times\dfrac{10^{-4}\cdot10^{-3}}{10^{-4}}$
$= 9\times10^{-3}$

50. $\dfrac{66000\times0.001}{0.003\times0.002} = \dfrac{(6.6\times10^4)(1\times10^{-3})}{(3\times10^{-3})(2\times10^{-3})}$
$= \dfrac{6.6\times10^1}{6\times10^{-6}}$
$= 1.1\times10^{1-(-6)}$
$= 1.1\times10^7$

51. $(2\times10^{-5})x = 1.2\times10^9$
$x = \dfrac{1.2\times10^9}{2\times10^{-5}}$
$= \dfrac{1.2}{2}\times\dfrac{10^9}{10^{-5}}$
$= 0.6\times10^{9-(-5)}$
$= 0.6\times10^{14}$
$= 6\times10^{13}$

52. $(3\times10^{-2})x = 1.2\times10^4$
$x = \dfrac{1.2\times10^4}{3\times10^{-2}}$
$= \dfrac{1.2}{3}\times\dfrac{10^4}{10^{-2}}$
$= 0.4\times10^{4-(-2)}$
$= 0.4\times10^6 = 4\times10^5$

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53. $\dfrac{x}{2\times10^8} = -3.1\times10^{-5}$

$$\begin{aligned} x &= \left(2\times10^8\right)\left(-3.1\times10^{-5}\right) \\ &= \left[2\cdot(-3.1)\right]\times\left(10^8\cdot10^{-5}\right) \\ &= -6.2\times10^{8+(-5)} = -6.2\times10^3 \end{aligned}$$

54. $\dfrac{x}{5\times10^{11}} = -2.9\times10^{-3}$

$$\begin{aligned} x &= \left(5\times10^{11}\right)\left(-2.9\times10^{-3}\right) \\ &= \left[5(-2.9)\right]\times\left(10^{11}\cdot10^{-3}\right) \\ &= -14.5\times10^{11+(-3)} \\ &= -14.5\times10^8 = -1.45\times10^9 \end{aligned}$$

55. $x-\left(7.2\times10^{18}\right) = 9.1\times10^{18}$

$$\begin{aligned} x &= \left(9.1\times10^{18}\right)+\left(7.2\times10^{18}\right) \\ &= (9.1+7.2)\times10^{18} \\ &= 16.3\times10^{18} \\ &= 1.63\times10^{19} \end{aligned}$$

56. $x-\left(5.3\times10^{-16}\right) = 8.4\times10^{-16}$

$$\begin{aligned} x &= \left(8.4\times10^{-16}\right)+\left(5.3\times10^{-16}\right) \\ &= (8.4+5.3)\times10^{-16} \\ &= 13.7\times10^{-16} \\ &= 1.37\times10^{-15} \end{aligned}$$

57. $\left(-1.2\times10^{-3}\right)x = \left(1.8\times10^{-4}\right)\left(2.4\times10^6\right)$

$$\begin{aligned} x &= \frac{\left(1.8\times10^{-4}\right)\left(2.4\times10^6\right)}{-1.2\times10^{-3}} \\ &= \frac{1.8\cdot2.4}{-1.2}\times\frac{10^{-4}\cdot10^6}{10^{-3}} \\ &= 1.8(-2)\times10^{-4+6-(-3)} \\ &= -3.6\times10^5 \end{aligned}$$

58. $\left(-7.8\times10^{-4}\right)x = \left(3.9\times10^{-7}\right)\left(6.8\times10^5\right)$

$$\begin{aligned} x &= \frac{\left(3.9\times10^{-7}\right)\left(6.8\times10^5\right)}{-7.8\times10^{-4}} \\ &= \frac{3.9\cdot6.8}{-7.8}\times\frac{10^{-7}\cdot10^5}{10^{-4}} \\ &= \frac{6.8}{-2}\times10^{-7+5-(-4)} \\ &= -3.4\times10^2 \end{aligned}$$

59. 78.1 billion $= 78{,}100{,}000{,}000 = 7.8\times10^{10}$
Bill Gates is worth $\$7.81\times10^{10}$.

60. 70.7 billion $= 70{,}700{,}000{,}000 = 70.7\times10^{10}$
Warren Buffett is worth $\$70.7\times10^{10}$.

61.
$$\begin{aligned} 52.6\times10^9-41.9\times10^9 &= (52.6-41.9)\times10^9 \\ &= 10.7\times10^9 \\ &= 1.07\times10^{10} \end{aligned}$$
Larry Ellison's worth exceeds Charles Koch's worth by $\$1.07\times10^{10}$.

62.
$$\begin{aligned} 41.9\times10^9+41.9\times10^9 &= (41.9+41.9)\times10^9 \\ &= 83.8\times10^9 \\ &= 8.38\times10^{10} \end{aligned}$$
The Koch brothers combined worth is $\$8.38\times10^{10}$.

63. 20 billion $= 20\times10^9 = 2\times10^{10}$

$$\begin{aligned} \frac{2\times10^{10}}{3\times10^8} &= \frac{2}{3}\times\frac{10^{10}}{10^8} \\ &\approx 0.67\times10^{10-8} \\ &= 0.67\times10^2 \\ &= 67 \end{aligned}$$
The average American consumes about 67 hotdogs each year.

64. $\dfrac{6\times10^8}{3\times10^8} = 2\times10^{8-8} = 2\times10^0 = 2\times1 = 2$
Approximately 2 Big Macs per person would be consumed by each American in a year.

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65. 8 billion = 8×10^9

$$\frac{8\times10^9}{3.2\times10^7}=\frac{8}{3.2}\times\frac{10^9}{10^7}$$
$$=2.5\times10^{9-7}$$
$$=2.5\times10^2=250$$

$2.5\times10^2=250$ chickens are raised for food each second in the U.S.

66. $127\times3.2\times10^7=406.4\times10^7=4.064\times10^9$

4.064×10^9 chickens are eaten per year in the U.S.

67. a. $$\frac{519\times10^9}{48\times10^6}\approx10.813\times10^3$$
$$=\$1.0813\times10^4$$
$$=\$10,813$$

b. $$\frac{\$10,813}{12}\approx\$901$$

68. a. $$\frac{33\times10^9}{25.7\times10^6}\approx1.284\times10^3$$
$$=\$1284$$

b. $$\frac{\$1284}{12}\approx\$107$$

69. Medicaid: $$\frac{198\times10^9}{53.4\times10^6}\approx3.708\times10^3$$
$$=\$3708$$

Medicare: $$\frac{294\times10^9}{42.3\times10^6}\approx6.950\times10^3$$
$$=\$6950$$

Medicare provides a greater per person benefit by \$3242.

70. $$\frac{7.2\times10^6}{3.66\times10^8}\approx1.97\times10^{-2}=0.0197\approx0.02$$

The U.S. paid Russia approximately \$0.02 per acre.

71. $$20,000\left(5.3\times10^{-23}\right)$$
$$=\left(2\times10^4\right)\left(5.3\times10^{-23}\right)$$
$$=\left(2\cdot5.3\right)\times\left(10^4\cdot10^{-23}\right)$$
$$=10.6\times10^{4+(-23)}$$
$$=10.6\times10^{-19}$$
$$=1.06\times10^{-18}$$

The mass of 20,000 oxygen molecules is 1.06×10^{-18} grams.

72. $$80,000\left(1.67\times10^{-24}\right)$$
$$=\left(8\times10^4\right)\left(1.67\times10^{-24}\right)=13.36\times10^{4-24}$$
$$=\left(1.336\times10\right)\times10^{-20}=1.336\times10^{-19}$$

The mass of 80,000 hydrogen atoms is 1.336×10^{-19} grams.

73. $$\frac{365\text{ days}}{1\text{ year}}\cdot\frac{24\text{ hours}}{1\text{ day}}$$
$$=8760\text{ hours/year}$$
$$=8.76\times10^3\text{ hours/year}$$

$$\frac{8.76\times10^3\text{ hours}}{1\text{ year}}\cdot\frac{60\text{ minutes}}{1\text{ hour}}$$
$$=525.6\times10^3\text{ minutes/year}$$
$$=5.256\times10^5\text{ minutes/year}$$

$$\frac{5.256\times10^5\text{ minutes}}{1\text{ year}}\cdot\frac{60\text{ seconds}}{1\text{ minute}}$$
$$=315.36\times10^5\text{ seconds/year}$$
$$=3.1536\times10^7\text{ seconds/year}$$

There are 3.1536×10^7 seconds in a year.

74. – 80. Answers will vary.

81. does not make sense; Explanations will vary. Sample explanation: That would be less than \$1 per person.

82. makes sense

83. makes sense

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84. does not make sense; Explanations will vary. Sample explanation: 58 million $= 58,000,000 = 5.8\times10^7$. 58 millionths $= 0.000058 = 5.8\times10^{-5}$. 7 and –5 do not have the same absolute value.

85. false; Changes to make the statement true will vary. A sample change is: $534.7 = 5.347\times10^2$, not 5.347×10^3.

86. false; Changes to make the statement true will vary. A sample change is:
$$\frac{8\times10^{30}}{4\times10^{-5}} = 2\times10^{30-(-5)} = 2\times10^{35}, \text{ not } 2\times10^{25}.$$

87. false; Changes to make the statement true will vary. A sample change is:
$$\left(7\times10^5\right)+\left(2\times10^{-3}\right) = 700,000+0.002$$
$$= 700,000.002, \text{ not } 9\times10^2 = 900.$$

88. true

89. true

90. $$5.6\times10^{13}+3.1\times10^{13} = (5.6+3.1)\times10^{13}$$
$$= 8.7\times10^{13}$$

91. $$8.2\times10^{-16}+4.3\times10^{-16}$$
$$= (8.2+4.3)\times10^{-16}$$
$$= 12.5\times10^{-16} = 1.25\times10^{-15}$$

92. $$\frac{70 \text{ bts}}{\cancel{\text{min}}}\cdot\frac{60\cancel{\text{ min}}}{\cancel{\text{hr}}}\cdot\frac{24\cancel{\text{ hrs}}}{\cancel{\text{day}}}\cdot\frac{365\cancel{\text{ days}}}{\cancel{\text{yr}}}\cdot 80\cancel{\text{ yrs}}$$
$$= 70\cdot60\cdot24\cdot365\cdot80 \text{ beats}$$
$$= 2943360000 \text{ beats}$$
$$= 2.94336\times10^9 \text{ beats}$$
$$\approx 2.94\times10^9 \text{ beats}$$
The heart beats approximately 2.94×10^9 times over a lifetime of 80 years.

93. Answers will vary.

94. $$9(10x-4)-(5x-10) = 90x-36-5x+10$$
$$= 90x-5x-36+10$$
$$= 85x-26$$

95. $$\frac{4x-1}{10} = \frac{5x+2}{4}-4$$
$$20\left(\frac{4x-1}{10}\right) = 20\left(\frac{5x+2}{4}-4\right)$$
$$2(4x-1) = 5(5x+2)-80$$
$$8x-2 = 25x+10-80$$
$$8x-2 = 25x-70$$
$$-2 = 17x-70$$
$$68 = 17x$$
$$4 = x$$

96. $$\left(8x^4y^{-3}\right)^{-2} = 8^{-2}\left(x^4\right)^{-2}\left(y^{-3}\right)^{-2}$$
$$= 8^{-2}x^{-8}y^6 = \frac{y^6}{64x^8}$$

97. In set 1, each x-coordinate is paired with one and only one y-coordinate.

98. $$r^3-2r^2+5$$
$$= (-5)^3-2(-5)^2+5$$
$$= -125-2(25)+5$$
$$= -125-50+5$$
$$= -170$$

99. $$5x+7 = 5(a+h)+7$$
$$= 5a+5h+7$$

Chapter 1 Review

1. $2x-10$

2. $4+6x = 6x+4$

3. $\frac{9}{x}+\frac{1}{2}x$

4. $$x^2-7x+4 = (10)^2-7(10)+4$$
$$= 100-70+4$$
$$= 34$$

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5. $6+2(x-8)^3=6+2(11-8)^3$
$=6+2(3)^3$
$=60$

6. $x^4-(x-y)=(2)^4-(2-1)=15$

7. $\{1, 2\}$

8. $\{-3, -2, -1, 0, 1\}$

9. false; Zero is not a natural number.

10. true; –2 is a rational number.

11. true; $\frac{1}{3}$ is not an irrational number.

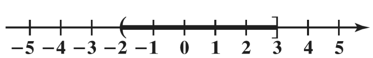
12. Negative five is less than two. True.

13. Negative seven is greater than or equal to negative three. False.

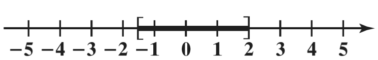
14. Negative seven is less than or equal to negative seven. True.

15. $S=4x^2+0.7x+5$
$S=4(6)^2+0.7(6)+5$
$=153.2$
The model overestimates the actual value by 3.2 million.

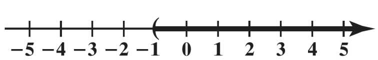
16. $\{x|-2<x\leq 3\}$



17. $\{x|-1.5\leq x\leq 2\}$



18. $\{x|x>-1\}$



19. $|-9.7|=9.7$

20. $|5.003|=5.003$

21. $|0|=0$

22. $-2.4+(-5.2)=-7.6$

23. $-6.8+2.4=-4.4$

24. $-7-(-20)=-7+20=13$

25. $(-3)(-20)=60$

26. $-\frac{3}{5}-\left(-\frac{1}{2}\right)=-\frac{3}{5}+\frac{1}{2}$
$=-\frac{3}{5}\cdot\frac{2}{2}+\frac{1}{2}\cdot\frac{5}{5}$
$=-\frac{6}{10}+\frac{5}{10}$
$=-\frac{1}{10}$

27. $\left(\frac{2}{7}\right)\left(-\frac{3}{10}\right)=-\frac{6}{70}=-\frac{3}{35}$

28. $4(-3)(-2)(-10)=-12(-2)(-10)$
$=-240$

29. $(-2)^4=16$

30. $-2^5=-32$

31. $-\frac{2}{3}\div\frac{8}{5}=-\frac{2}{3}\cdot\frac{5}{8}=-\frac{5}{12}$

32. $\frac{-35}{-5}=7$

33. $\frac{54.6}{-6}=-9.1$

34. $x=-7$
$-1(x)=-1(-7)$
$-x=7$

35. $-11-[-17+(-3)]=-11-[-20]=9$

36. $\left(-\frac{1}{2}\right)^3\cdot 2^4=-\frac{1}{8}\cdot 16=-2$

37. $-3[4-(6-8)]=-3[4-(-2)]$
$=-3[6]=-18$

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38. $8^2 - 36 \div 3^2 \cdot 4 - (-7)$
$= 64 - 36 \div 9 \cdot 4 + 7$
$= 64 - 4 \cdot 4 + 7 = 64 - 16 + 7$
$= 48 + 7 = 55$

39. $\dfrac{(-2)^4 + (-3)^2}{2^2 - (-21)} = \dfrac{16+9}{4-(-21)} = \dfrac{25}{25} = 1$

40. $\dfrac{(7-9)^3 - (-4)^2}{2 + 2(8) \div 4} = \dfrac{(-2)^3 - 16}{2 + 16 \div 4} = \dfrac{-8-16}{2+4}$
$= \dfrac{-24}{6} = -4$

41. $4 - (3-8)^2 + 3 \div 6 \cdot 4^2 = 4 - (-5)^2 + 3 \div 6 \cdot 16$
$= 4 - 25 + 3 \div 6 \cdot 16$
$= 4 - 25 + \dfrac{1}{2} \cdot 16$
$= 4 - 25 + 8 = -13$

42. $5(2x-3) + 7x = 10x - 15 + 7x$
$= 17x - 15$

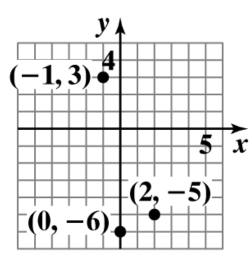
43. $5x + 7x^2 - 4x + 2x^2 = x + 9x^2 = 9x^2 + x$

44. $3(4y-5) - (7y+2) = 12y - 15 - 7y - 2$
$= 5y - 17$

45. $8 - 2[3 - (5x-1)] = 8 - 2[3 - 5x + 1]$
$= 8 - 6 + 10x - 2 = 10x$

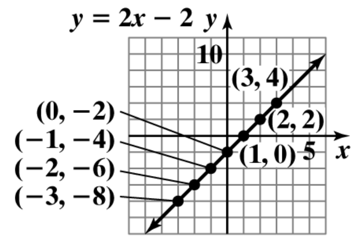
46. $6(2x-3) - 5(3x-2) = 12x - 18 - 15x + 10$
$= -3x - 8$

47. – 49.



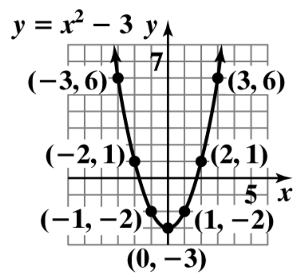
50.

x	(x, y)
-3	$(-3, -8)$
-2	$(-2, -6)$
-1	$(-1, -4)$
0	$(0, -2)$
1	$(1, 0)$
2	$(2, 2)$
3	$(3, 4)$



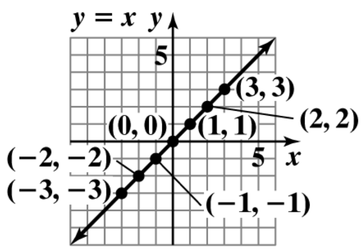
51.

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



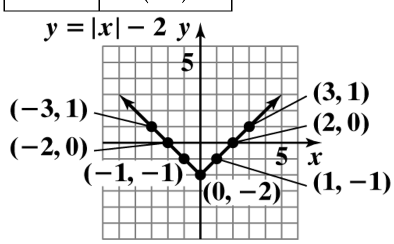
52.

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

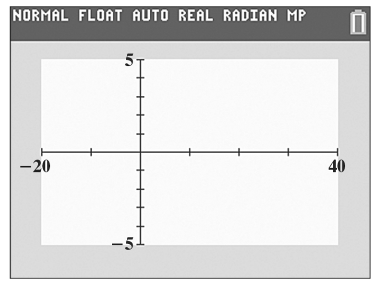


53.

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



54. The minimum x-value is –20 and the maximum x-value is 40. The distance between tick marks is 10. The minimum y-value is –5 and the maximum y-value is 5. The distance between tick marks is 1.



55. 20% of 75-year-old Americans have Alzheimer's.

56. Age 85 represents a 50% prevalence.

57. Answers will vary.

58. Graph c illustrates the description.

59.
$$\begin{aligned} 2x-5&=7\\ 2x&=12\\ x&=6 \end{aligned}$$
The solution set is $\{6\}$.

60.
$$\begin{aligned} 5x+20&=3x\\ 2x+20&=0\\ 2x&=-20\\ x&=-10 \end{aligned}$$
The solution set is $\{-10\}$.

61.
$$\begin{aligned} 7(x-4)&=x+2\\ 7x-28&=x+2\\ 6x-28&=2\\ 6x&=30\\ x&=5 \end{aligned}$$
The solution set is $\{5\}$.

62.
$$\begin{aligned} 1-2(6-x)&=3x+2\\ 1-12+2x&=3x+2\\ -11+2x&=3x+2\\ -11&=x+2\\ -13&=x \end{aligned}$$
The solution set is $\{-13\}$.

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63. $2(x-4)+3(x+5)=2x-2$
$$2x-8+3x+15=2x-2$$
$$5x+7=2x-2$$
$$3x+7=-2$$
$$3x=-9$$
$$x=-3$$
The solution set is $\{-3\}$.

64. $2x-4(5x+1)=3x+17$
$$2x-20x-4=3x+17$$
$$-18x-4=3x+17$$
$$-4=21x+17$$
$$-21=21x$$
$$-1=x$$
The solution set is $\{-1\}$.

65. $\frac{2x}{3}=\frac{x}{6}+1$
$$6\left(\frac{2x}{3}\right)=6\left(\frac{x}{6}+1\right)$$
$$4x=x+6$$
$$3x=6$$
$$x=2$$
The solution set is $\{2\}$.

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

67. $\frac{2x}{3}=6-\frac{x}{4}$
$$12\left(\frac{2x}{3}\right)=12\left(6-\frac{x}{4}\right)$$
$$8x=72-3x$$
$$11x=72$$
$$x=\frac{72}{11}$$
The solution set is $\left\{\frac{72}{11}\right\}$.

68. $\frac{x}{4}=2+\frac{x-3}{3}$
$$12\left(\frac{x}{4}\right)=12\left(2+\frac{x-3}{3}\right)$$
$$3x=24+4(x-3)$$
$$3x=24+4x-12$$
$$3x=12+4x$$
$$-x=12$$
$$x=-12$$
The solution set is $\{-12\}$.

69. $\frac{3x+1}{3}-\frac{13}{2}=\frac{1-x}{4}$
$$12\left(\frac{3x+1}{3}-\frac{13}{2}\right)=12\left(\frac{1-x}{4}\right)$$
$$4(3x+1)-6(13)=3(1-x)$$
$$12x+4-78=3-3x$$
$$12x-74=3-3x$$
$$15x-74=3$$
$$15x=77$$
$$x=\frac{77}{15}$$
The solution set is $\left\{\frac{77}{15}\right\}$.

70. $7x+5=5(x+3)+2x$
$$7x+5=5x+15+2x$$
$$7x+5=7x+15$$
$$5=15$$
There is no solution. The solution set is $\varnothing$. The equation is inconsistent.

71. $7x+13=4x-10+3x+23$
$$7x+13=7x+13$$
The solution set is $(-\infty,\infty)$. The equation is an identity.

72. $7x+13=3x-10+2x+23$
$$7x+13=5x-10+23$$
$$7x+13=5x+13$$
$$2x+13=13$$
$$2x=0$$
$$x=0$$
The solution set is $\{0\}$. The equation is conditional.

73. $4(x-3)+5=x+5(x-2)$

$$4x-12+5=x+5x-10$$
$$4x-7=6x-10$$
$$-2x-7=-10$$
$$-2x=-3$$
$$x=\frac{-3}{-2}=\frac{3}{2}$$

The solution set is $\left\{\frac{3}{2}\right\}$. The equation is conditional.

74. $(2x-3)2-3(x+1)=(x-2)4-3(x+5)$

$$4x-6-3x-3=4x-8-3x-15$$
$$x-9=x-23$$
$$-9=-23$$

There is no solution. The solution set is $\varnothing$. The equation is inconsistent.

75. **a.** $M=-0.4x+48$

$$M=-0.4(20)+48$$
$$=40$$

According to the model, there were 40% of married filers in 2005. This underestimates the actual value shown in the graph by 1%.

b. $M=-0.4x+48$

$$34=-0.4x+48$$
$$-14=-0.4x$$
$$35=x$$

According to the model, 34% of federal tax returns will be submitted by married filers 35 years after 1985, or in 2020.

76. Let $x=$ the average yearly earnings, in thousands, of marketing majors.
Let $x+19=$ the average yearly earnings, in thousands, of engineering majors.
Let $x+6=$ the average yearly earnings, in thousands, of accounting majors.

$$x+(x+19)+(x+6)=196$$
$$x+x+19+x+6=196$$
$$3x+25=196$$
$$3x=171$$
$$x=57$$
$$x+19=76$$
$$x+6=63$$

The average yearly earnings for marketing majors, engineering majors, and accounting majors were \$57 thousand, \$76 thousand, and \$63 thousand, respectively.

77. Let x = the measure of the second angle.
$x+10$ = the measure of the first angle.
$2\left[x+(x+10)\right]$ = the measure of the 3rd angle.

$$x+(x+10)+2\left[x+(x+10)\right]=180$$
$$x+x+10+2x+2x+20=180$$
$$6x+30=180$$
$$6x=150$$
$$x=25$$
$$x+10=25+10=35$$
$$2\left[x+(x+10)\right]=2[25+35]$$
$$=2(60)=120$$

The angles measure $25°$, $35°$, and $120°$

78. **a.** Let $x=$ the number of years after 2004.

$$575+43x=1177$$
$$43x=602$$
$$x=14$$

The system's income will be \$1177 billion 14 years after 2004, or 2018.

b. 2018 is 14 years after 2004.

$$B=0.07x^2+47.4x+500$$
$$=0.07(14)^2+47.4(14)+500$$
$$\approx 1177$$

The amount paid in benefits for 2018 will be \$1177 billion.

c. In 2018 the \$1177 billion paid in benefits is represented by the point $(2018, 1177)$.

79. Let x = the number of GB used.
Plan A: $C=52+18x$
Plan B: $C=32+22x$
Set the costs equal to each other.

$$52+18x=32+22x$$
$$52=32+4x$$
$$20=4x$$
$$5=x$$

The cost will be the same for 5 GB.

80. Let x = the original price of the phone.

$$48=x-0.20x$$
$$48=0.80x$$
$$60=x$$

The original price is \$60.

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81. Let x = the amount sold to earn \$800 in one week.

$800 = 300 + 0.05x$

$500 = 0.05x$

$10{,}000 = x$

Sales must be \$10,000 in one week to earn \$800.

82. Let w = the width of the playing field.
Let $3w - 6$ = the length of the playing field.

$P = 2(\text{length}) + 2(\text{width})$

$340 = 2(3w - 6) + 2w$

$340 = 6w - 12 + 2w$

$340 = 8w - 12$

$352 = 8w$

$44 = w$

The dimensions are 44 yards by 126 yards.

83. a. Let x = the number of years (after 2015).
College A's enrollment: $14{,}100 + 1500x$
College B's enrollment: $41{,}700 - 800x$

$14{,}100 + 1500x = 41{,}700 - 800x$

b. Check points to determine that $y_1 = 14{,}100 + 1500x$ and $y_2 = 41{,}700 - 800x$. Since $y_1 = y_2 = 32{,}100$ when $x = 12$, the two colleges will have the same enrollment in the year $2015 + 12 = 2027$. That year the enrollments will be 32,100 students.

84.

$$V = \frac{1}{3}Bh$$
$$3V = Bh$$
$$h = \frac{3V}{B}$$

85.

$$y - y_1 = m(x - x_1)$$
$$\frac{y - y_1}{m} = x - x_1$$
$$x = \frac{y - y_1}{m} + x_1$$

or

$$x = \frac{y - y_1 + mx_1}{m}$$

86.

$$E = I(R + r)$$
$$\frac{E}{I} = R + r$$
$$R = \frac{E}{I} - r \quad \text{or} \quad R = \frac{E - Ir}{I}$$

87.

$$C = \frac{5F - 160}{9}$$
$$9C = 5F - 160$$
$$9C + 160 = 5F$$
$$F = \frac{9C + 160}{5} \quad \text{or} \quad F = \frac{9}{5}C + 32$$

88.

$$s = vt + gt^2$$
$$s - vt = gt^2$$
$$g = \frac{s - vt}{t^2}$$

89.

$$T = gr + gvt$$
$$T = g(r + vt)$$
$$g = \frac{T}{r + vt}$$

90. $\left(-3x^7\right)\left(-5x^6\right) = 15x^{7+6} = 15x^{13}$

91. $x^2y^{-5} = \dfrac{x^2}{y^5}$

92. $\dfrac{3^{-2}x^4}{y^{-7}} = \dfrac{x^4y^7}{3^2} = \dfrac{x^4y^7}{9}$

93. $\left(x^3\right)^{-6} = x^{3\cdot(-6)} = x^{-18} = \dfrac{1}{x^{18}}$

94. $\left(7x^3y\right)^2 = 7^2x^{3\cdot 2}y^{1\cdot 2} = 49x^6y^2$

95. $\dfrac{16y^3}{-2y^{10}} = -8y^{3-10} = -8y^{-7} = -\dfrac{8}{y^7}$

96. $\left(-3x^4\right)\left(4x^{-11}\right) = -12x^{-7} = -\dfrac{12}{x^7}$

97. $\dfrac{12x^7}{4x^{-3}} = 3x^{7-(-3)} = 3x^{10}$

98.

$$\frac{-10a^5b^6}{20a^{-3}b^{11}} = \frac{-1}{2}a^{5-(-3)}b^{6-11}$$
$$= \frac{-1}{2}a^8b^{-5} = -\frac{a^8}{2b^5}$$

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99. $\left(-3xy^4\right)\left(2x^2\right)^3 = \left(-3xy^4\right)\left(8x^6\right)$
$= -24x^{1+6}y^4 = -24x^7y^4$

100. $2^{-2} + \frac{1}{2}x^0 = \frac{1}{2^2} + \frac{1}{2}\cdot 1 = \frac{1}{4} + \frac{1}{2} = \frac{3}{4}$

101. $\left(5x^2y^{-4}\right)^{-3} = \left(\frac{5x^2}{y^4}\right)^{-3} = \left(\frac{y^4}{5x^2}\right)^3 = \frac{y^{12}}{125x^6}$

102. $\left(3x^4y^{-2}\right)\left(-2x^5y^{-3}\right) = \left(\frac{3x^4}{y^2}\right)\left(\frac{-2x^5}{y^3}\right) = -\frac{6x^9}{y^5}$

103. $\left(\frac{3xy^3}{5x^{-3}y^{-4}}\right)^2 = \left(\frac{3x^{1-(-3)}y^{3-(-4)}}{5}\right)^2$
$= \left(\frac{3x^4y^7}{5}\right)^2$
$= \frac{3^2x^{4\cdot 2}y^{7\cdot 2}}{5^2} = \frac{9x^8y^{14}}{25}$

104. $\left(\frac{-20x^{-2}y^3}{10x^5y^{-6}}\right)^{-3} = \left(-2x^{-2-5}y^{3-(-6)}\right)^{-3}$
$= \left(-2x^{-7}y^9\right)^{-3}$
$= (-2)^{-3}x^{(-7)(-3)}y^{9(-3)}$
$= \frac{x^{21}y^{-27}}{(-2)^3}$
$= \frac{x^{21}}{-8y^{27}} = -\frac{x^{21}}{8y^{27}}$

105. $7.16\times 10^6 = 7{,}160{,}000$

106. $1.07\times 10^{-4} = 0.000107$

107. $-41{,}000{,}000{,}000{,}000 = -4.1\times 10^{13}$

108. $0.00809 = 8.09\times 10^{-3}$

109. $\left(4.2\times 10^{13}\right)\left(3\times 10^{-6}\right) = 12.6\times 10^{13+(-6)}$
$= 12.6\times 10^7$
$= 1.26\times 10^8$

110. $\frac{5\times 10^{-6}}{20\times 10^{-8}} = 0.25\times 10^{-6-(-8)}$
$= 0.25\times 10^2 = 2.5\times 10^1$

111. $180\left(3.2\times 10^4\right)\left(5\times 10^6\right)$
$= (180\times 3.2\times 5)\times\left(10^4\times 10^6\right)$
$= 2880\times 10^{10}$
$= 2.880\times 10^3\times 10^{10}$
$= 2.88\times 10^{13}$
The approximate number of red blood cells in the human body of a 180-pound person is 2.88×10^{13}.

Chapter 1 Test

1. $4x-5$

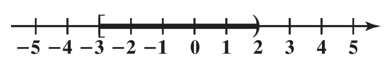
2. $8+2(x-7)^4 = 8+2(10-7)^4$
$= 8+2(3)^4$
$= 8+2(81)$
$= 8+162$
$= 170$

3. $\{-4, -3, -2, -1\}$

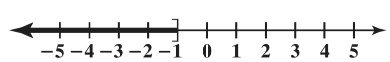
4. true; $\frac{1}{4}$ is not a natural number.

5. Negative three is greater than negative one: false

6. $\{x \mid -3 \le x < 2\}$



7. $\{x \mid x \le -1\}$



8. $G = -82x^2 + 410x + 7079$
$P = -82(6)^2 + 410(6) + 7079$
$= 6587$
The model estimates the aid per student in 2011 was \$6587. This underestimates the actual number shown in the bar graph by \$13.

9. $|-17.9| = 17.9$

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10. $-10.8+3.2=-7.6$

11. $-\frac{1}{4}-\left(-\frac{1}{2}\right)=-\frac{1}{4}+\frac{1}{2}=-\frac{1}{4}+\frac{2}{4}=\frac{1}{4}$

12. $2(-3)(-1)(-10)=-60$

13. $-\frac{1}{4}\left(-\frac{1}{2}\right)=\frac{1}{8}$

14. $\frac{-27.9}{-9}=3.1$

15. $24-36\div 4\cdot 3=24-9\cdot 3=24-27=-3$

16. $\left(5^2-2^4\right)+\left[9\div(-3)\right]=(25-16)+[-3]$
$=(9)+[-3]=6$

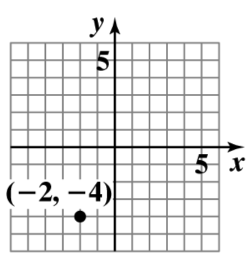
17. $\frac{(8-10)^3-(-4)^2}{2+8(2)\div 4}=\frac{(-2)^3-16}{2+16\div 4}$
$=\frac{-8-16}{2+4}=\frac{-24}{6}=-4$

18. $7x-4(3x+2)-10=7x-12x-8-10$
$=-5x-18$

19. $5(2y-6)-(4y-3)=10y-30-4y+3$
$=6y-27$

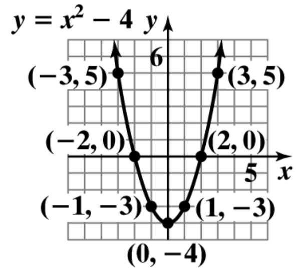
20. $9x-\left[10-4(2x-3)\right]$
$=9x-\left[10-8x+12\right]$
$=9x-10+8x-12=17x-22$

21.



22.

x	(x, y)
−3	$(-3,5)$
−2	$(-2,0)$
−1	$(-1,-3)$
0	$(0,-4)$
1	$(1,-3)$
2	$(2,0)$
3	$(3,5)$



23. $3(2x-4)=9-3(x+1)$
$6x-12=9-3x-3$
$6x-12=6-3x$
$9x-12=6$
$9x=18$
$x=2$
The solution set is $\{2\}$.

24. $\frac{2x-3}{4}=\frac{x-4}{2}-\frac{x+1}{4}$
$4\left(\frac{2x-3}{4}\right)=4\left(\frac{x-4}{2}-\frac{x+1}{4}\right)$
$2x-3=2(x-4)-(x+1)$
$2x-3=2x-8-x-1$
$2x-3=x-9$
$x-3=-9$
$x=-6$
The solution set is $\{-6\}$.

25. $3(x-4)+x=2(6+2x)$
$3x-12+x=12+4x$
$4x-12=12+4x$
$-12=12$
There is no solution. The solution set is $\{\ \}$ or $\varnothing$.
The equation is inconsistent.

26. Let x = the first number.
Let $2x + 3$ = the second number.

$$x+2x+3=72$$
$$3x+3=72$$
$$3x=69$$
$$x=23$$

Find the second number.

$$2x+3=2(23)+3=46+3=49$$

The first number is 23 and the second number is 49.

27. Let x = the number of years since the car was purchased.

$$\text{Value}=\$13{,}805-\$1820x$$
$$4705=13{,}805-1820x$$
$$-9100=-1820x$$
$$5=x$$

The car will have a value of \$4705 in 5 years.

28. Let x = the number of bridge crossings.
Without discount pass: $8x$
With discount pass: $45+5x$

$$8x=45+5x$$
$$3x=45$$
$$x=15$$

The cost will be the same for 15 bridge crossings.

29. Let x = the original selling price.

$$20=x-0.60x$$
$$20=0.40x$$
$$50=x$$

The original price is \$50.

30. Let x = the width of the playing field.
Let $x + 260$ = the length of the playing field.

$$P=2(\text{length})+2(\text{width})$$
$$1000=2(x+260)+2x$$
$$1000=2x+520+2x$$
$$1000=4x+520$$
$$480=4x$$
$$x=120$$

The dimensions of the playing field are 120 yards by 380 yards.

31.
$$V=\frac{1}{3}lwh$$
$$3V=lwh$$
$$h=\frac{3V}{lw}$$

32.
$$Ax+By=C$$
$$By=C-Ax$$
$$y=\frac{C-Ax}{B}$$

33. $\left(-2x^5\right)\left(7x^{-10}\right)=-14x^{5+(-10)}=-14x^{-5}=-\dfrac{14}{x^5}$

34.
$$\left(-8x^{-5}y^{-3}\right)\left(-5x^2y^{-5}\right)=40x^{-5+2}y^{-3+(-5)}$$
$$=40x^{-3}y^{-8}$$
$$=\frac{40}{x^3y^8}$$

35. $\dfrac{-10x^4y^3}{-40x^{-2}y^6}=\dfrac{1}{4}x^{4-(-2)}y^{3-6}=\dfrac{1}{4}x^6y^{-3}=\dfrac{x^6}{4y^3}$

36. $\left(4x^{-5}y^2\right)^{-3}=\left(\dfrac{4y^2}{x^5}\right)^{-3}=\left(\dfrac{x^5}{4y^2}\right)^3=\dfrac{x^{15}}{64y^6}$

37.
$$\left(\frac{-6x^{-5}y}{2x^3y^{-4}}\right)^{-2}=\left(-3x^{-5-3}y^{1-(-4)}\right)^{-2}$$
$$=\left(-3x^{-8}y^5\right)^{-2}$$
$$=(-3)^{-2}x^{(-8)(-2)}y^{5(-2)}$$
$$=\frac{x^{16}y^{-10}}{(-3)^2}$$
$$=\frac{x^{16}}{9y^{10}}$$

38. $3.8\times10^{-6}=0.0000038$

39. $407{,}000{,}000{,}000=4.07\times10^{11}$

40. $\dfrac{4\times10^{-3}}{8\times10^{-7}}=0.5\times10^{-3-(-7)}=0.5\times10^4=5\times10^3$

41. $2\left(6.9\times10^9\right)=13.8\times10^9=1.38\times10^{10}$

The population will be 1.38×10^{10}.

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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. $h(4b) = 3(4b)^2 + 5 = 3\left(16b^2\right) + 5$
$= 48b^2 + 5$

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. $h(5b) = 2(5b)^2 - 4 = 2\left(25b^2\right) - 4$
$= 50b^2 - 4$

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

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

a. $$\begin{aligned} f(0) &= 3(0)^2 + 4(0) - 2 \\ &= 3(0) + 0 - 2 \\ &= 0 + 0 - 2 = -2 \end{aligned}$$

b. $$\begin{aligned} f(3) &= 3(3)^2 + 4(3) - 2 \\ &= 3(9) + 12 - 2 \\ &= 27 + 12 - 2 = 37 \end{aligned}$$

c. $$\begin{aligned} f(-5) &= 3(-5)^2 + 4(-5) - 2 \\ &= 3(25) - 20 - 2 \\ &= 75 - 20 - 2 = 53 \end{aligned}$$

d. $$\begin{aligned} f(b) &= 3(b)^2 + 4(b) - 2 \\ &= 3b^2 + 4b - 2 \end{aligned}$$

e. $$\begin{aligned} f(5a) &= 3(5a)^2 + 4(5a) - 2 \\ &= 3\left(25a^2\right) + 20a - 2 \\ &= 75a^2 + 20a - 2 \end{aligned}$$

17. a. $$\begin{aligned} f(0) &= (-0)^3 - (0)^2 - (0) + 7 \\ &= 7 \end{aligned}$$

b. $$\begin{aligned} f(2) &= (-2)^3 - (2)^2 - (2) + 7 \\ &= -7 \end{aligned}$$

c. $$\begin{aligned} f(-2) &= \left(-(-2)\right)^3 - (-2)^2 - (-2) + 7 \\ &= 13 \end{aligned}$$

d. $$\begin{aligned} f(1) + f(-1) &= \left[(-1)^3 - (1)^2 - (1) + 7\right] + \left[\left(-(-1)\right)^3 - (-1)^2 - (-1) + 7\right] \\ &= 4 + 8 \\ &= 12 \end{aligned}$$

18. a. $$\begin{aligned} f(0) &= (-0)^3 - (0)^2 - (0) + 10 \\ &= 10 \end{aligned}$$

b. $$\begin{aligned} f(2) &= (-2)^3 - (2)^2 - (2) + 10 \\ &= -4 \end{aligned}$$

c. $$\begin{aligned} f(-2) &= \left(-(-2)\right)^3 - (-2)^2 - (-2) + 10 \\ &= 16 \end{aligned}$$

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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.** $f(0)=\dfrac{2(0)-3}{(0)-4}=\dfrac{0-3}{0-4}$
$$=\frac{-3}{-4}=\frac{3}{4}$$

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

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

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

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

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

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

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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. $\sqrt{3-(-1)}-(-6)^2+6\div-6\cdot4$
$=\sqrt{3+1}-36+-1\cdot4$
$=\sqrt{4}-36+-4=2-36-4=-38$

28. $|-4-(-1)|-(-3)^2+-3\div3\cdot-6$
$=|-4+1|-9+-3\div3\cdot-6$
$=|-3|-9+-1\cdot-6$
$=3-9+6=-6+6=0$

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 $\{-15\}$.

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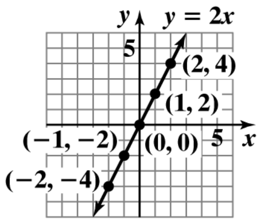
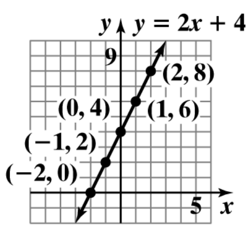
55.

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. $[1,\infty)$

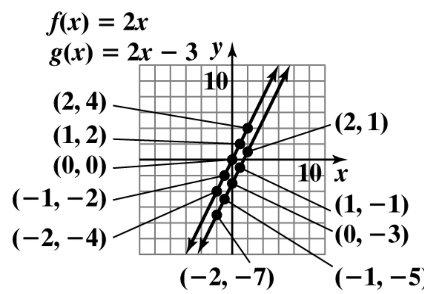
2.2 Check Points

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.

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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

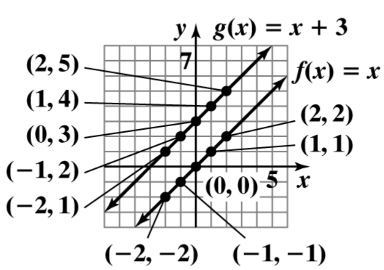
1. ordered pairs
2. more than once; function
3. $[1,3)$; domain
4. $[1,\infty)$; range

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	$g(2)=2+3=5$	$(2,5)$

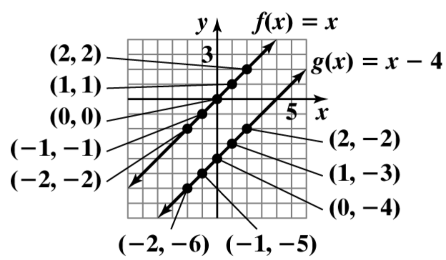


The graph of g is the graph of f shifted up 3 units.

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	$g(2)=-2(2)-1=-5$	$(2,-5)$

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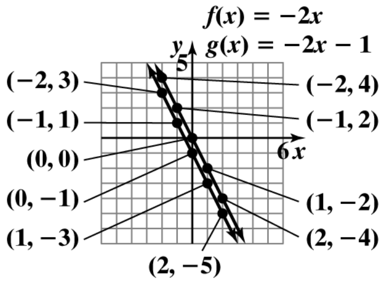
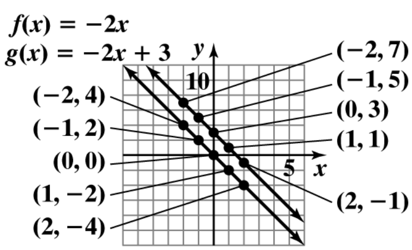


The graph of g is the graph of f shifted down 1 unit.

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	$g(2) = -2(2) + 3 = -1$	$(2, -1)$

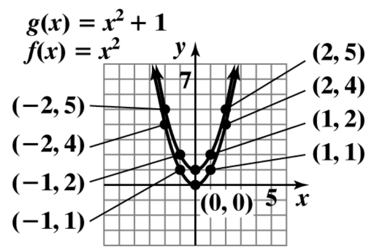


The graph of g is the graph of f shifted up 3 units.

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	$g(2) = (2)^2 - 2 = 2$	$(2, 2)$

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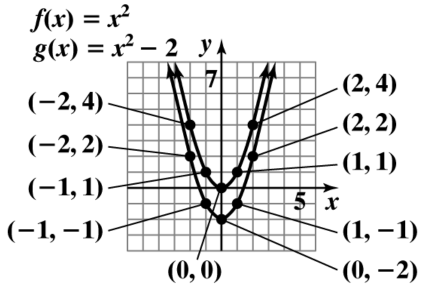
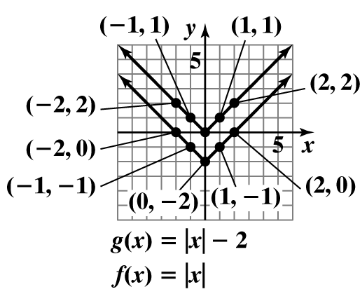


The graph of g is the graph of f shifted down 2 units.

7.

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

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

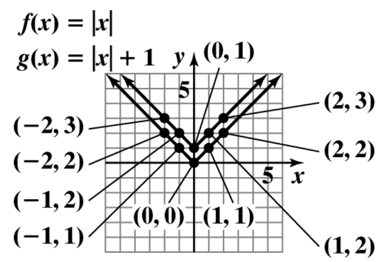


The graph of g is the graph of f shifted down 2 units.

8.

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

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



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	$g(2) = (2)^3 + 2 = 10$	$(2, 10)$

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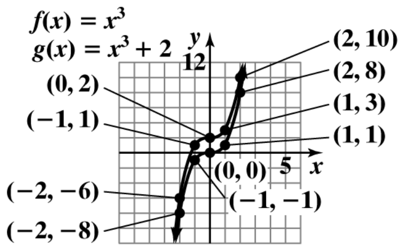
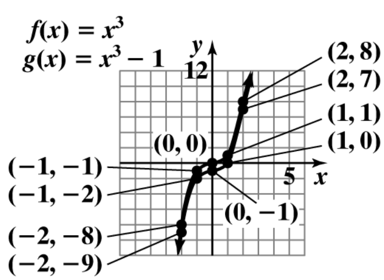


The graph of g is the graph of f shifted up 2 units.

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 $[0,\infty)$.

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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.

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

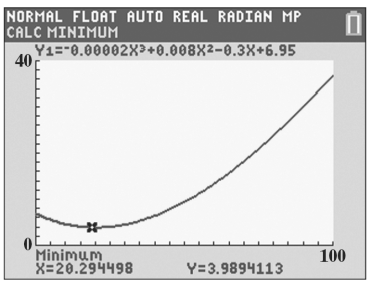
50. $f(3.5) = 1.12$
The cost of mailing a first-class letter weighing 3.5 ounces is \$1.12.

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: $f(0) = 0.6$

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

72. Let x = the width of the rectangle.
Let $3x+8=$ length of the rectangle.
$$\begin{aligned} P&=2l+2w\\ 624&=2(3x+8)+2x\\ 624&=6x+16+2x\\ 624&=8x+16\\ -8x&=-608\\ x&=76\\ 3x+8&=236 \end{aligned}$$
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.
$$\begin{aligned} f(4)+g(4)&=\overbrace{(4^2+4)}^{f(4)}+\overbrace{(4-5)}^{g(4)}\\ &=20+(-1)\\ &=19 \end{aligned}$$

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

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

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.
$$\begin{aligned}(f-g)(x) &= f(x)-g(x)=[x^2-2x]-[x+3]=x^2-3x-3\\ (f-g)(-1) &= (-1)^2-3(-1)-3=1\end{aligned}$$

c.
$$\begin{aligned}\left(\frac{f}{g}\right)(x) &= \frac{f(x)}{g(x)}=\frac{x^2-2x}{x+3}\\ \left(\frac{f}{g}\right)(7) &= \frac{(7)^2-2(7)}{(7)+3}=\frac{35}{10}=\frac{7}{2}\end{aligned}$$

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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 $(-4, \infty)$.

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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. $(f+g)(x)$

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

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

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 $(6, \infty)$.

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

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

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

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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 $(2,\infty)$.

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

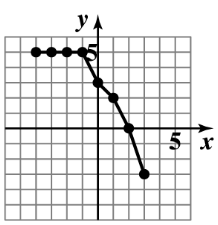
53. $(fg)(2) = f(2)g(2) = (-1)(1) = -1$

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

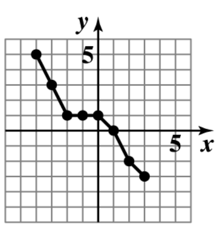
55. The domain of $f + g$ is $[-4, 3]$.

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.

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

$$\begin{aligned}(R-C)(x) &= 65x-(600,000+45x)\\ &= 65x-600,000-45x\\ &= 20x-600,000\end{aligned}$$

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

$= 20\left(20,000\right)-600,000$

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

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

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

$= 20\left(30,000\right)-600,000$

$= 600,000-600,000 = 0$

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

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

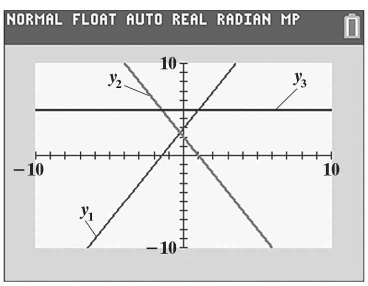
$= 20\left(40,000\right)-600,000$

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

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

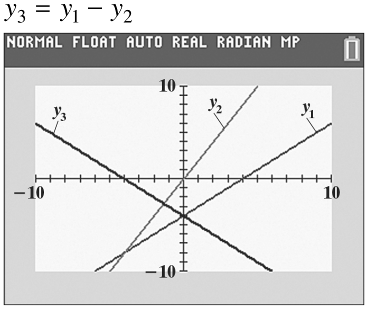
67. – 70. Answers will vary.

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

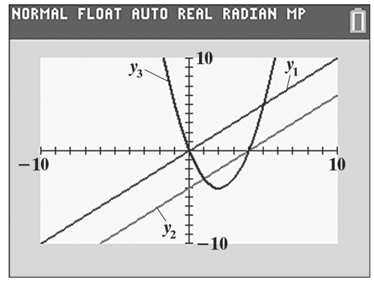


72. $y_1 = x-4 \qquad y_2 = 2x$

$y_3 = y_1 - y_2$



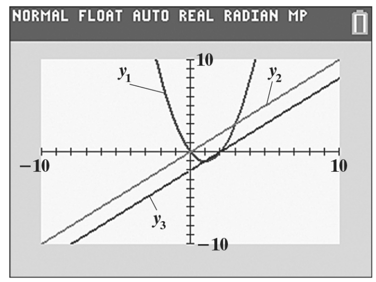
73. $y_1 = x \qquad y_2 = x-4 \qquad y_3 = y_1 \cdot y_2$



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

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

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.

$$\begin{aligned}R &= 3\left(a+b\right)\\ R &= 3a+3b\\ R-3a &= 3b\\ b &= \frac{R-3a}{3} \text{ or } b = \frac{R}{3}-a\end{aligned}$$

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

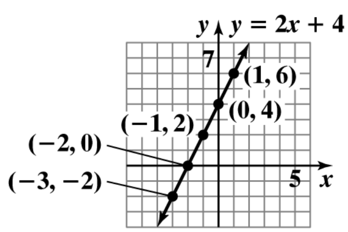
$$4x-3(0)=6$$
$$4x=6$$
$$x=\frac{3}{2}$$

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. $f(0)=0^2-3(0)+8=8$
$g(-10)=-2(-10)-5=20-5=15$
$f(0)+g(-10)=8+15=23$

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

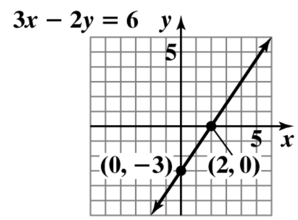
20. $f(-1) = (-1)^2 - 3(-1) + 8$
$= 1 + 3 + 8 = 12$
$g(-1) = -2(-1) - 5 = 2 - 5 = -3$
$(fg)(-1) = 12(-3) = -36$

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 $x = 0$.
$3x - 2y = 6$
$3(0) - 2y = 6$
$-2y = 6$
$y = -3$

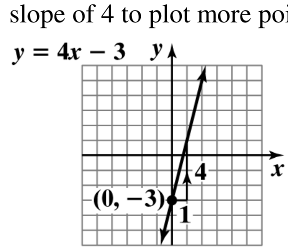


2. a. $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-2 - 4}{-4 - (-3)} = \frac{-6}{-1} = 6$

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

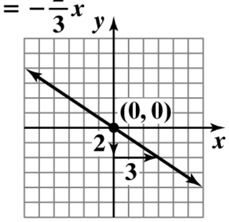
3. First, convert the equation to slope-intercept form by solving the equation for y.
$8x - 4y = 20$
$-4y = -8x + 20$
$\frac{-4y}{-4} = \frac{-8x + 20}{-4}$
$y = 2x - 5$
In this form, the coefficient of x is the line's slope and the constant term is the y-intercept.
The slope is 2 and the y-intercept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

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

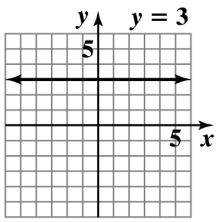


5. Begin by plotting the y-intercept of 0. Then use the slope of $\frac{-2}{3}$ to plot more points.

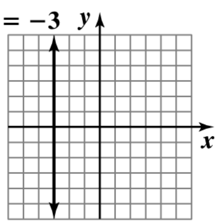
$f(x) = -\frac{2}{3}x$



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

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2.4 Exercise Set

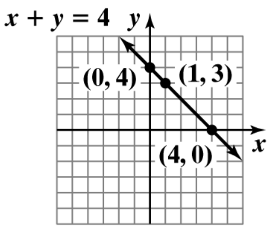
1. $x + y = 4$

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

$$\begin{aligned} x + y &= 4 \\ x + 0 &= 4 \\ x &= 4 \end{aligned}$$

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

$$\begin{aligned} x + y &= 4 \\ 0 + y &= 4 \\ y &= 4 \end{aligned}$$



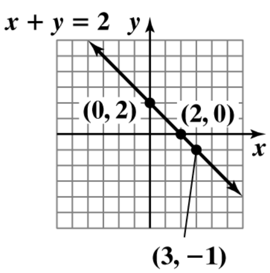
2. $x + y = 2$

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

$$\begin{aligned} x + 0 &= 2 \\ x &= 2 \end{aligned}$$

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

$$\begin{aligned} 0 + y &= 2 \\ y &= 2 \end{aligned}$$



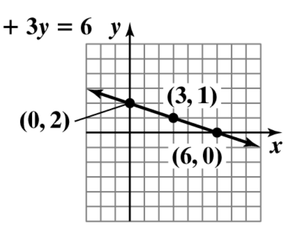
3. $x + 3y = 6$

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

$$\begin{aligned} x + 3(0) &= 6 \\ x &= 6 \end{aligned}$$

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

$$\begin{aligned} (0) + 3y &= 6 \\ y &= 2 \end{aligned}$$



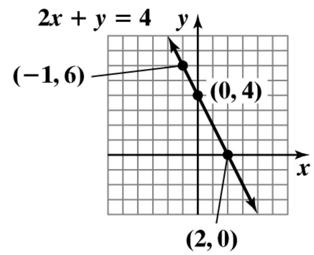
4. $2x + y = 4$

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

$$\begin{aligned} 2x + 0 &= 4 \\ 2x &= 4 \\ x &= 2 \end{aligned}$$

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

$$\begin{aligned} 2(0) + y &= 4 \\ y &= 4 \end{aligned}$$



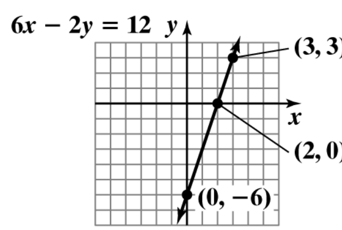
5. $6x - 2y = 12$

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

$$\begin{aligned} 6x - 2(0) &= 12 \\ 6x &= 12 \\ x &= 2 \end{aligned}$$

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

$$\begin{aligned} 6(0) - 2y &= 12 \\ -2y &= 12 \\ y &= -6 \end{aligned}$$



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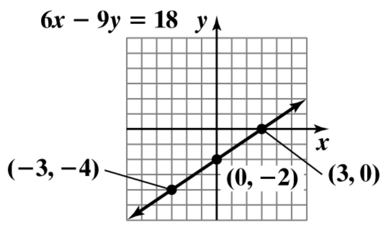
6. $6x - 9y = 18$

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

$$\begin{aligned} 6x - 9(0) &= 18 \\ 6x &= 18 \\ x &= 3 \end{aligned}$$

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

$$\begin{aligned} 6(0) - 9y &= 18 \\ 0 - 9y &= 18 \\ -9y &= 18 \\ y &= -2 \end{aligned}$$



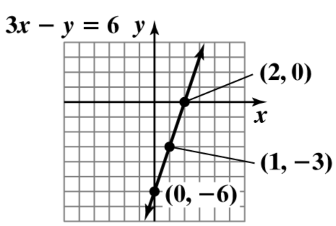
7. $3x - y = 6$

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

$$\begin{aligned} 3x - 0 &= 6 \\ 3x &= 6 \\ x &= 2 \end{aligned}$$

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

$$\begin{aligned} 3(0) - y &= 6 \\ -y &= 6 \\ y &= -6 \end{aligned}$$



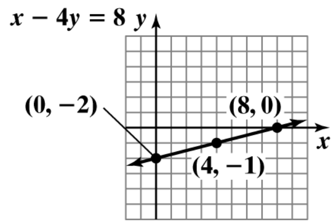
8. $x - 4y = 8$

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

$$\begin{aligned} x + 4(0) &= 8 \\ x + 0 &= 8 \\ x &= 8 \end{aligned}$$

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

$$\begin{aligned} 0 - 4y &= 8 \\ -4y &= 8 \\ y &= -2 \end{aligned}$$



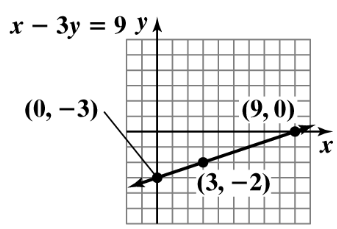
9. $x - 3y = 9$

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

$$\begin{aligned} x - 3(0) &= 9 \\ x &= 9 \end{aligned}$$

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

$$\begin{aligned} (0) - 3y &= 9 \\ -3y &= 9 \\ y &= -3 \end{aligned}$$



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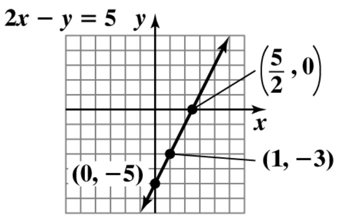
10. $2x - y = 5$

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

$$\begin{aligned} 2x - 0 &= 5 \\ 2x &= 5 \\ x &= \frac{5}{2} \end{aligned}$$

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

$$\begin{aligned} 2(0) - y &= 5 \\ -y &= 5 \\ y &= -5 \end{aligned}$$



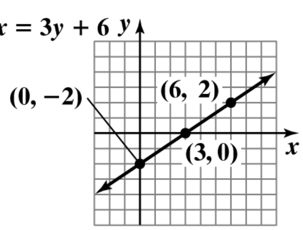
11. $2x = 3y + 6$

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

$$\begin{aligned} 2x &= 3(0) + 6 \\ 2x &= 6 \\ x &= 3 \end{aligned}$$

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

$$\begin{aligned} 2(0) &= 3y + 6 \\ 0 &= 3y + 6 \\ -6 &= 3y \\ -2 &= y \end{aligned}$$



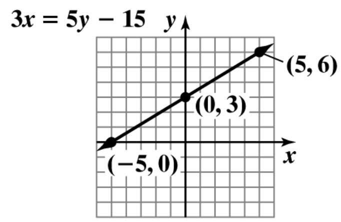
12. $3x = 5y - 15$

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

$$\begin{aligned} 3x &= 5(0) - 15 \\ 3x &= 0 - 15 \\ 3x &= -15 \\ x &= -5 \end{aligned}$$

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

$$\begin{aligned} 3(0) &= 5y - 15 \\ 0 &= 5y - 15 \\ 15 &= 5y \\ 3 &= y \end{aligned}$$



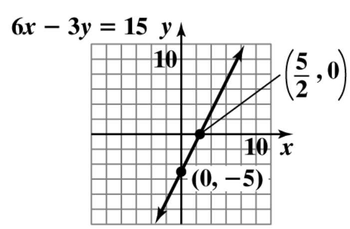
13. $6x - 3y = 15$

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

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

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

$$\begin{aligned} 6(0) - 3y &= 15 \\ -3y &= 15 \\ y &= -5 \end{aligned}$$



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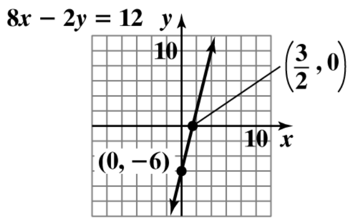
14. $8x-2y=12$

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 $(-3,0)$.

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

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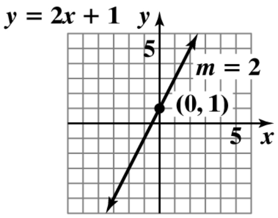
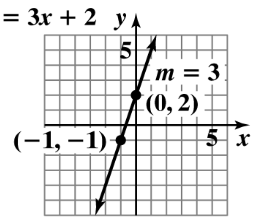
29. $y = 2x + 1$

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



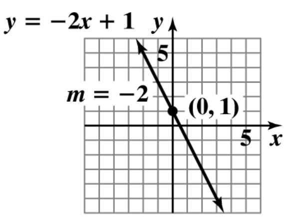
30. $y = 3x + 2$

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



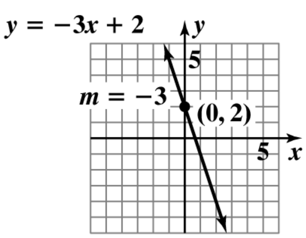
31. $y = -2x + 1$

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



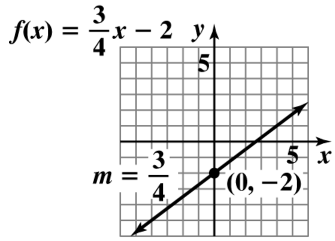
32. $f(x) = -3x + 2$

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



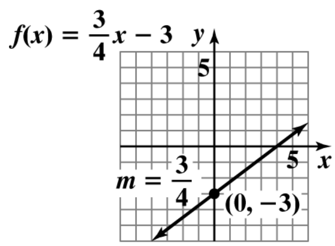
33. $f(x) = \frac{3}{4}x - 2$

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



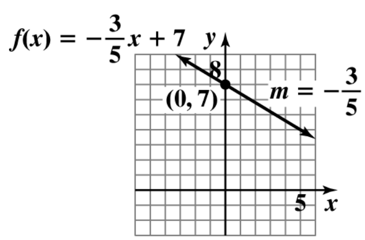
34. $f(x) = \frac{3}{4}x - 3$

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



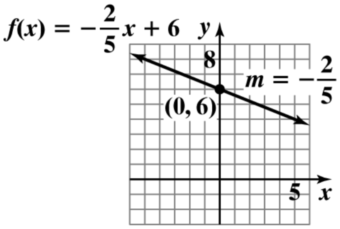
35. $f(x) = -\frac{3}{5}x + 7$

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



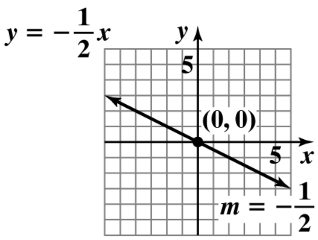
36. $f\left(x\right)=-\dfrac{2}{5}x+6$

$m=-\dfrac{2}{5}\qquad y-\text{intercept}=6$



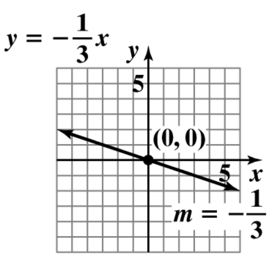
37. $y=-\dfrac{1}{2}x$

$m=-\dfrac{1}{2}\qquad y-\text{intercept}=0$



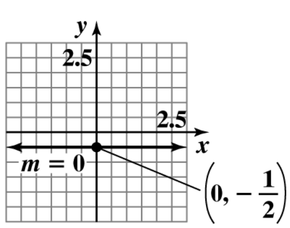
38. $y=-\dfrac{1}{3}x$

$m=-\dfrac{1}{3}\qquad y-\text{intercept}=0$



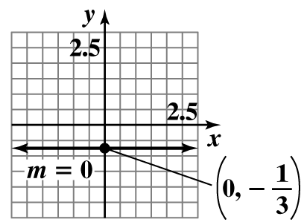
39. $y=-\dfrac{1}{2}$

$m=0\qquad y-\text{intercept}=-\dfrac{1}{2}$



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

$m=0\qquad y-\text{intercept}=-\dfrac{1}{3}$

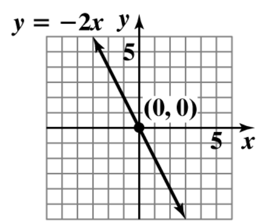


41. **a.** $2x+y=0$

$y=-2x$

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

c.

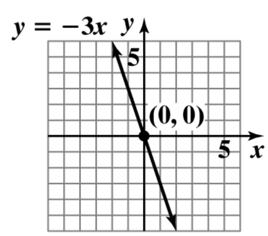


42. **a.** $3x+y=0$

$y=-3x$

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

c.

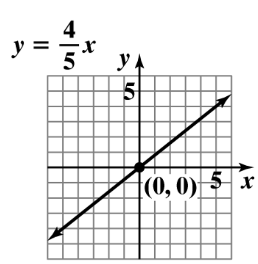


43. **a.** $5y=4x$

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

b. $m=\dfrac{4}{5}\qquad y-\text{intercept}=0$

c.



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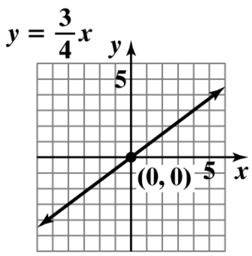
44. a. $4y = 3x$

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

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

c.

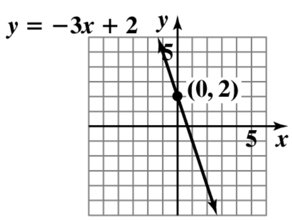


45. a. $3x + y = 2$

$y = -3x + 2$

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

c.

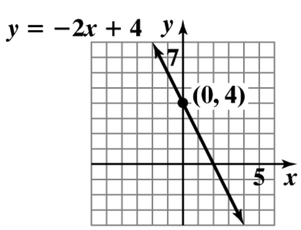


46. a. $2x + y = 4$

$y = -2x + 4$

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

c.



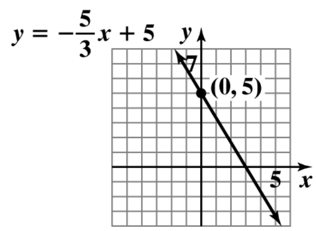
47. a. $5x + 3y = 15$

$3y = -5x + 15$

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

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

c.



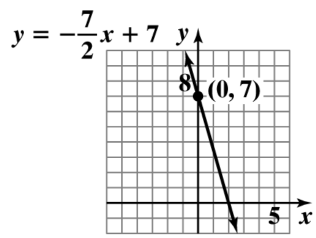
48. a. $7x + 2y = 14$

$2y = -7x + 14$

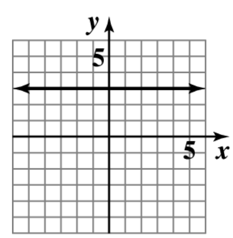
$y = -\frac{7}{2}x + 7$

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

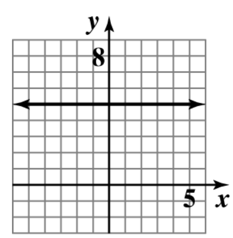
c.



49. $y = 3$

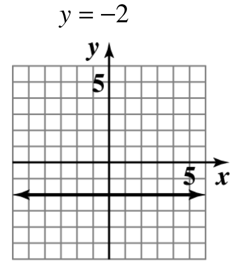


50. $y = 5$

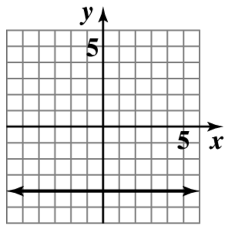


51. $f(x) = -2$

$y = -2$

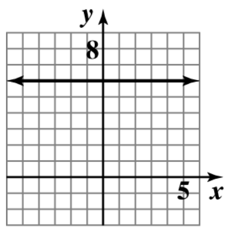


52. $f(x) = -4$ which is the same as $y = -4$



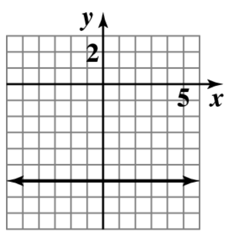
53. $3y = 18$

$y = 6$



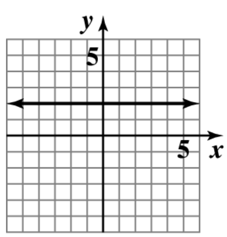
54. $5y = -30$

$y = -6$

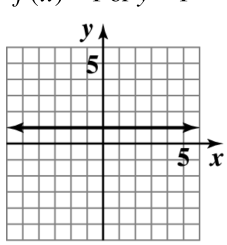


55. $f(x) = 2$

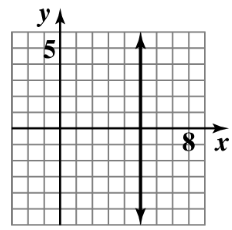
$y = 2$



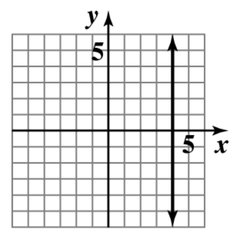
56. $f(x) = 1$ or $y = 1$



57. $x = 5$

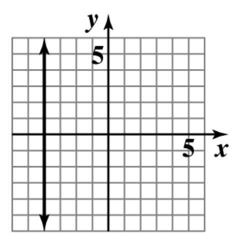


58. $x = 4$



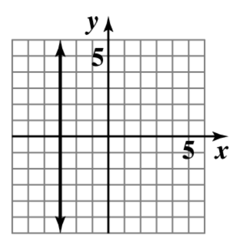
59. $3x = -12$

$x = -4$



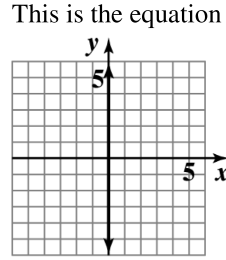
60. $4x = -12$

$x = -3$



61. $x = 0$

This is the equation of the y–axis.



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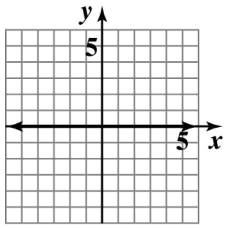
62. $y = 0$

This is the equation of the x–axis.



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

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

Therefore, the line falls.

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

The line falls.

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

The slope is undefined.
The line is vertical.

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

The line rises.

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

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

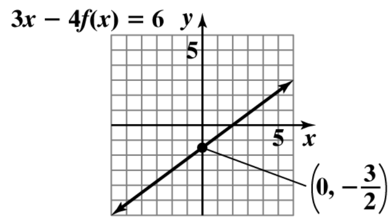
68.
$$Ax = By - C$$
$$Ax + C = By$$
$$\frac{A}{B}x + \frac{C}{B} = y$$

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

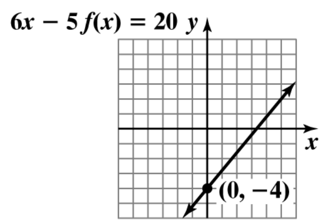
69.
$$-3 = \frac{4-y}{1-3}$$
$$-3 = \frac{4-y}{-2}$$
$$6 = 4 - y$$
$$2 = -y$$
$$-2 = y$$

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

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

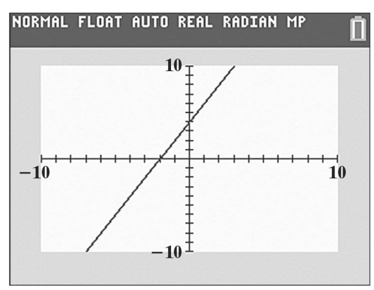
c. $C(x) = 0.18x + 3.1$
$C(80) = 0.18(80) + 3.1$
$= 17.5$
The percentage of America’s black population that will be foreign-born in 2060 is 17.5%..

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.

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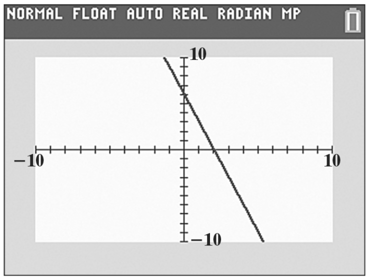
106. $y = -3x + 6$

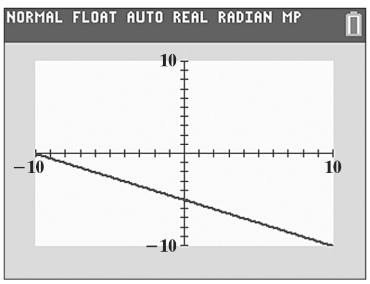


Two points found using [TRACE] are (0, 6) and (2, 0). Based on these points, the slope is:

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

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

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

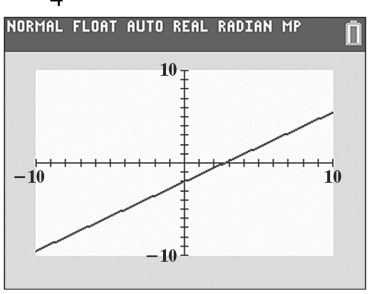


Two points found using [TRACE] are $(0,-5)$ and $(1,-5.5)$. Based on these points, the slope is:

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

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.

$$\begin{aligned} y - y_1 &= m(x - x_1) \\ y - 0 &= 2(x - (-2)) \\ y &= 2(x+2) \\ y &= 2x + 4 \\ -2x + y &= 4 \end{aligned}$$

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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.

$$\begin{aligned}-2x+y&=4\\3(-2x+y)&=3(4)\\-6x+3y&=12\end{aligned}$$

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.

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

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

119. **a.** $f\left(x_1+x_2\right)=m\left(x_1+x_2\right)+b$
$=mx_1+mx_2+b$

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

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.
$$\begin{aligned}y-5&=7(x+4)\\y-5&=7x+28\\y&=7x+33\end{aligned}$$

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

125. **a.**
$$\begin{aligned}x+4y-8&=0\\4y&=-x+8\\\frac{4y}{4}&=\frac{-x+8}{4}\\y&=-\frac{1}{4}x+2\end{aligned}$$

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

b.
$$\begin{aligned}-\frac{1}{4}\cdot m_2&=-1\\\frac{1}{4}\cdot m_2&=1\\m_2&=4\end{aligned}$$

The slope of the second line is 4.

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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

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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

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

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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

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

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

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

Slope-Intercept Form

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

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

$y = -x - \dfrac{5}{2}$

$f(x) = -x - \dfrac{5}{2}$

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

Point-Slope Form

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

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

Slope-Intercept Form

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

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

$y = -x - \frac{17}{4}$

$f(x) = -x - \frac{17}{4}$

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

Point-Slope Form

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

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

Slope-Intercept Form

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

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

$f(x) = \frac{1}{4}x$

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

Point-Slope Form

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

Slope-Intercept Form

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

$f(x) = \frac{1}{5}x$

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

Point-Slope Form

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

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

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

Slope-Intercept Form

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

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

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

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

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

Point-Slope Form

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

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

Slope-Intercept Form

$y + 4 = -\frac{2}{5}x + 6$

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

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

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

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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

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

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25. Passing through $(7,8)$ with $x-\text{intercept}=3$
If the line has an $x-\text{intercept}=3$, 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 $m=-\frac{1}{5}$.

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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: $m = \frac{2}{3}$

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

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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 $f(x) = \frac{2}{3}x + \frac{10}{3}$.

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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.

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

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.

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

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 $\frac{B}{A}$.

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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.

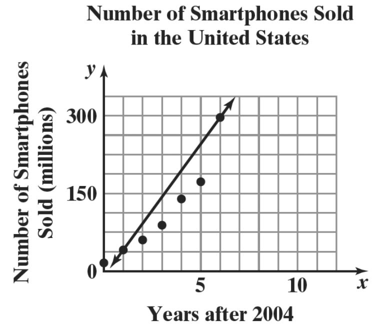
$$y - y_1 = m(x - x_1)$$
$$y - 62.6 = 1.09(x - 30)$$
or
$$y - 51.7 = 1.09(x - 20)$$

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
$$y - 296.6 = 51.16(x - 6)$$

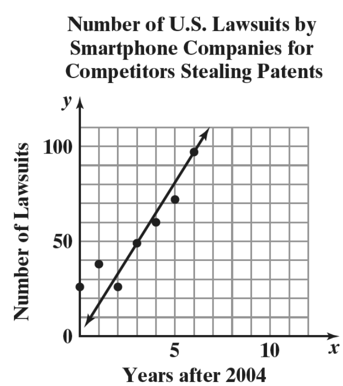
Solve for y to obtain slope-intercept form.

$$y - 40.8 = 51.16(x - 1)$$
$$y - 40.8 = 51.16x - 51.16$$
$$y = 51.16x - 10.36$$
$$f(x) = 51.16x - 10.36$$

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.

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$$m = \frac{97-49}{6-3} = \frac{48}{3} = 16$$

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.

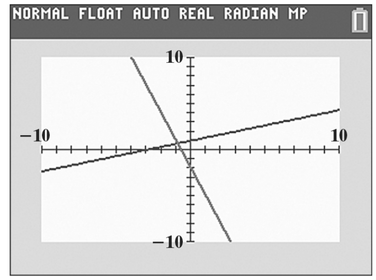
b. $m = \dfrac{392-195}{2016-2007} = \dfrac{197}{9} \approx 21.9$

The cost of Medicaid is projected to increase at a rate of approximately \$21.9 billion per year.

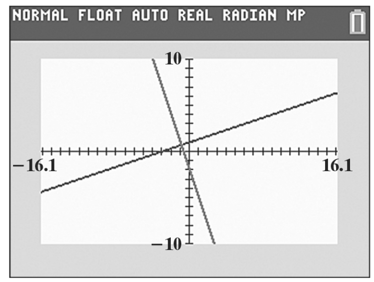
c. No, the slopes are not the same. This means that the cost of Social Security is projected to increase at a faster rate than the cost of Medicaid.

73. – 79. Answers will vary.

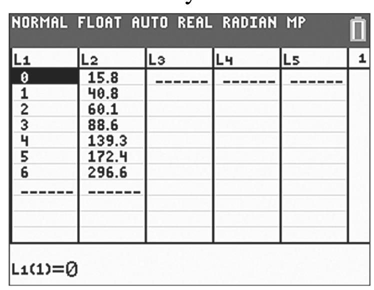
80. a. Answers will vary.



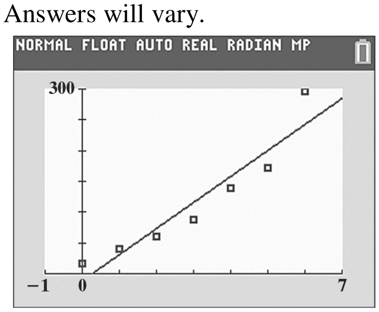
b. Answers will vary.



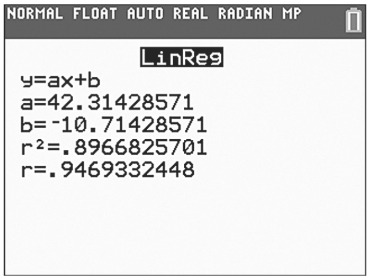
81. a. Answers will vary.



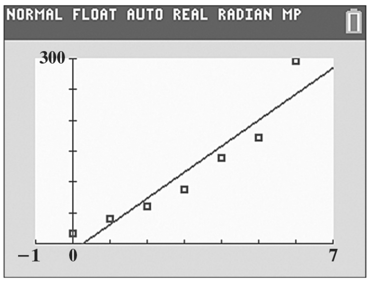
b. Answers will vary.



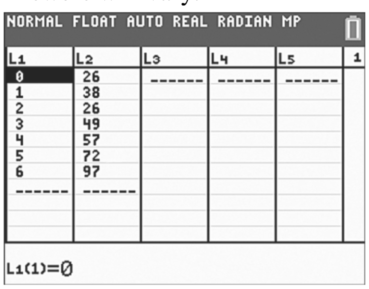
c. Answers will vary.



d. Answers will vary.



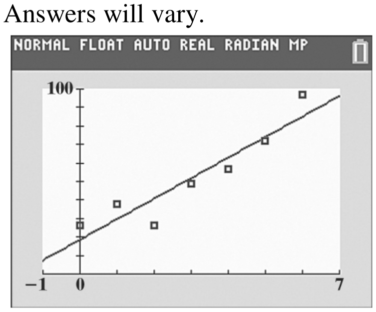
82. **a.** Answers will vary.


NORMAL FLOAT AUTO REAL RADIAN MP

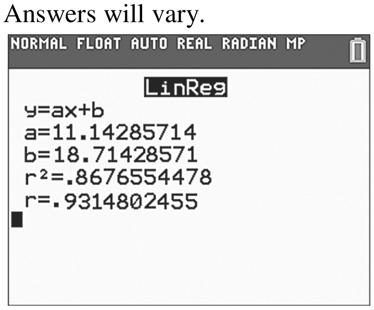
L1	L2	L3	L4	L5	1
0	26	------	------	------	
1	38				
2	26				
3	49				
4	57				
5	72				
6	97				
------	------				

L1(1)=0

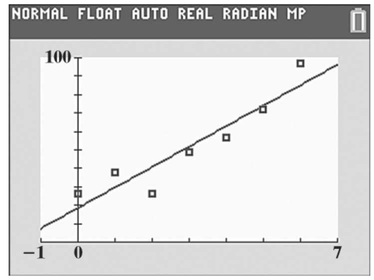
b. Answers will vary.



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 $A = -\frac{3}{7}$.

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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. $3x-5y=15$

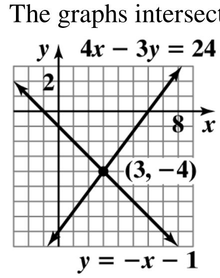
$3(-5)-5(-6)=15$

$-15+30=15$

$15=15$, 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 $\{1\}$.

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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.** $g(0)=3(0)^2-5(0)+2=2$

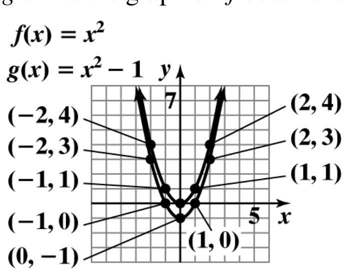
b. $g(5)=3(5)^2-5(5)+2$
$=3(25)-25+2$
$=75-25+2=52$

c. $g(-4)=3(-4)^2-5(-4)+2=70$

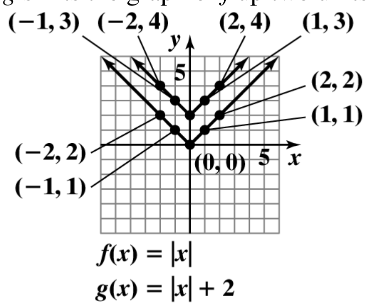
d. $g(b)=3(b)^2-5(b)+2$
$=3b^2-5b+2$

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.

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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. $$\begin{aligned}(f+g)(x) &= (4x-5)+(2x+1)\\ &= 4x-5+2x+1\\ &= 6x-4\end{aligned}$$

b. $$\begin{aligned}(f+g)(3) &= 6(3)-4\\ &= 18-4=14\end{aligned}$$

24. a. $$\begin{aligned}&(f+g)(x)\\ &= (5x^2-x+4)+(x-3)\\ &= 5x^2-x+4+x-3=5x^2+1\end{aligned}$$

b. $$\begin{aligned}(f+g)(3) &= 5(3)^2+1=5(9)+1\\ &= 45+1=46\end{aligned}$$

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. $f(x)=x^2-2x,\quad g(x)=x-5$
$$\begin{aligned}(f+g)(x) &= (x^2-2x)+(x-5)\\ &= x^2-2x+x-5\\ &= x^2-x-5\end{aligned}$$
$$\begin{aligned}(f+g)(-2) &= (-2)^2-(-2)-5\\ &= 4+2-5=1\end{aligned}$$

28. From Exercise 27 we know $(f+g)(x)=x^2-x-5.$ We can use this to find $f(3)+g(3)$.
$$\begin{aligned}f(3)+g(3) &= (f+g)(3)\\ &= (3)^2-(3)-5\\ &= 9-3-5=1\end{aligned}$$

29. $f(x)=x^2-2x,\quad g(x)=x-5$
$$\begin{aligned}(f-g)(x) &= (x^2-2x)-(x-5)\\ &= x^2-2x-x+5\\ &= x^2-3x+5\end{aligned}$$
$$(f-g)(x)=x^2-3x+5$$
$$\begin{aligned}(f-g)(1) &= (1)^2-3(1)+5\\ &= 1-3+5=3\end{aligned}$$

30. From Exercise 29 we know $(f-g)(x)=x^2-3x+5.$ We can use this to find $f(4)-g(4)$.
$$\begin{aligned}f(4)-g(4) &= (f-g)(4)\\ &= (4)^2-3(4)+5\\ &= 16-12+5=9\end{aligned}$$

31. Since $(fg)(-3)=f(-3)\cdot g(-3)$, find $f(-3)$ and $g(-3)$ first.
$$\begin{aligned}f(-3) &= (-3)^2-2(-3)\\ &= 9+6=15\end{aligned}$$
$$g(-3)=-3-5=-8$$
$$\begin{aligned}(fg)(-3) &= f(-3)\cdot g(-3)\\ &= 15(-8)=-120\end{aligned}$$

32. $f(x)=x^2-2x,\quad g(x)=x-5$
$$\left(\frac{f}{g}\right)(x)=\frac{x^2-2x}{x-5}$$
$$\begin{aligned}\left(\frac{f}{g}\right)(4) &= \frac{(4)^2-2(4)}{4-5}=\frac{16-8}{-1}\\ &= \frac{8}{-1}=-8\end{aligned}$$

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 $(5,\infty)$.

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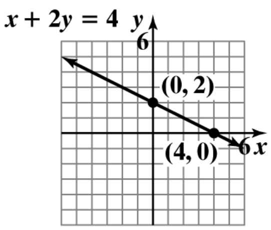
35. $x + 2y = 4$

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

$$\begin{aligned} x + 2(0) &= 4 & 0 + 2y &= 4 \\ x + 0 &= 4 & 2y &= 4 \\ x &= 4 & y &= 2 \end{aligned}$$

Choose another point to use as a check.
Let $x = 1$.

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



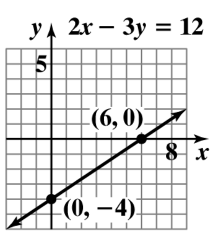
36. $2x - 3y = 12$

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

$$\begin{aligned} 2x - 3(0) &= 12 & 2(0) - 3y &= 12 \\ 2x + 0 &= 12 & 0 - 3y &= 12 \\ 2x &= 12 & -3y &= 12 \\ x &= 6 & y &= -4 \end{aligned}$$

Choose another point to use as a check.
Let $x = 1$.

$$\begin{aligned} 2(1) - 3y &= 12 \\ 2 - 3y &= 12 \\ -3y &= 10 \\ y &= -\frac{10}{3} \end{aligned}$$



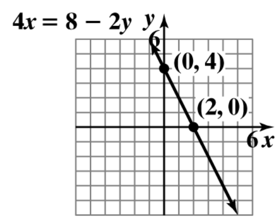
37. $4x = 8 - 2y$

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

$$\begin{aligned} 4x &= 8 - 2(0) & 4(0) &= 8 - 2y \\ 4x &= 8 - 0 & 0 &= 8 - 2y \\ 4x &= 8 & 2y &= 8 \\ x &= 2 & y &= 4 \end{aligned}$$

Choose another point to use as a check. Let $x = 1$.

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



38. $m = \dfrac{2-(-4)}{5-2} = \dfrac{6}{3} = 2$

The line through the points rises.

39. $m = \dfrac{3-(-3)}{-2-7} = \dfrac{6}{-9} = -\dfrac{2}{3}$

The line through the points falls.

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

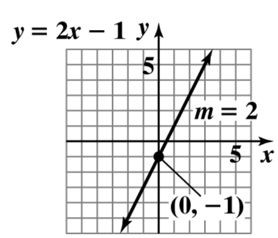
m is undefined. The line through the points is vertical.

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

The line through the points is horizontal.

42. $y = 2x - 1$

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



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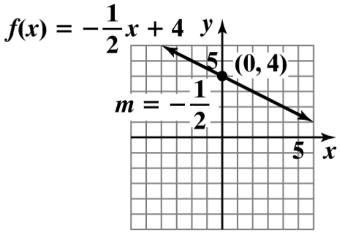
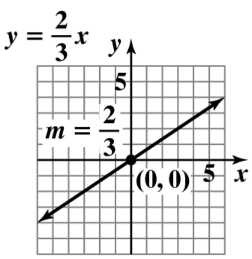
43. $f(x) = -\frac{1}{2}x + 4$

$m = -\frac{1}{2} \qquad y - \text{intercept} = 4$



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

$m = \frac{2}{3} \qquad y - \text{intercept} = 0$



45. To rewrite the equation in slope-intercept form, solve for y.

$2x + y = 4$

$y = -2x + 4$

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

46. $-3y = 5x$

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

$m = -\frac{5}{3} \qquad y - \text{intercept} = 0$

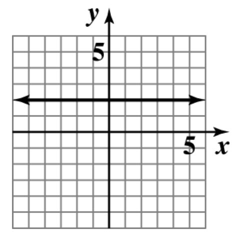
47. $5x + 3y = 6$

$3y = -5x + 6$

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

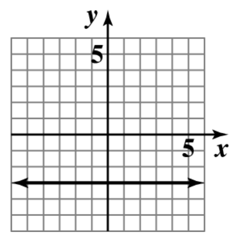
$m = -\frac{5}{3} \qquad y - \text{intercept} = 2$

48. $y = 2$



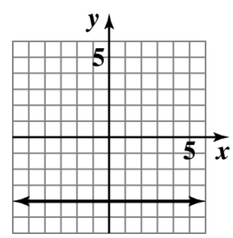
49. $7y = -21$

$y = -3$

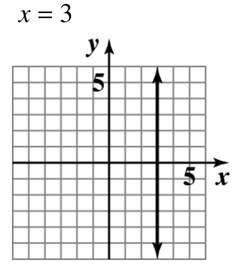


50. $f(x) = -4$

$y = -4$

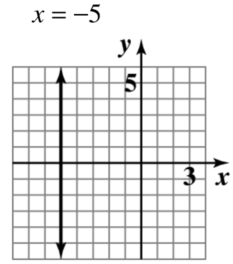


51. $x = 3$



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).

$$m=\frac{212-32}{100-0}=\frac{180}{100}=\frac{9}{5}$$

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

$$\begin{aligned} y-y_1&=m(x-x_1)\\ y-32&=\frac{9}{5}(x-0)\\ y-32&=\frac{9}{5}x\\ y&=\frac{9}{5}x+32\\ F&=\frac{9}{5}C+32 \end{aligned}$$

b. Let $C=30$.

$$F=\frac{9}{5}(30)+32=54+32=86$$

The Fahrenheit temperature is $86°$ when the Celsius temperature is $30°$.

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

Point-Slope Form

$$\begin{aligned} y-y_1&=m(x-x_1)\\ y-2&=-6(x-(-3))\\ y-2&=-6(x+3) \end{aligned}$$

Slope-Intercept Form

$$\begin{aligned} y-2&=-6(x+3)\\ y-2&=-6x-18\\ y&=-6x-16\\ f(x)&=-6x-16 \end{aligned}$$

57. Passing through $(1,6)$ and $(-1,2)$

First, find the slope.

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

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

$$\begin{aligned} y-y_1&=m(x-x_1)\\ y-6&=2(x-1) \end{aligned}$$

or

$$\begin{aligned} y-y_1&=m(x-x_1)\\ y-2&=2(x-(-1))\\ y-2&=2(x+1) \end{aligned}$$

Slope-Intercept Form

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

58. Rewrite $3x+y=9$ in slope-intercept form.

$$\begin{aligned} 3x+y&=9\\ y&=-3x+9 \end{aligned}$$

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.

$$\begin{aligned} y-y_1&=m(x-x_1)\\ y-(-7)&=-3(x-4)\\ y+7&=-3(x-4) \end{aligned}$$

Solve for y to obtain slope-intercept form.

$$\begin{aligned} y+7&=-3(x-4)\\ y+7&=-3x+12\\ y&=-3x+5 \end{aligned}$$

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.

$$\begin{aligned} y-y_1&=m(x-x_1)\\ y-6&=-3(x-(-2))\\ y-6&=-3(x+2) \end{aligned}$$

Solve for y to obtain slope-intercept form.

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

In function notation, the equation of the line is $f(x)=-3x$.

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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.

$$\begin{aligned} y - 28.2 &= 0.2(x - 2) \\ y - 28.2 &= 0.2x - 0.4 \\ y &= 0.2x + 27.8 \\ f(x) &= 0.2x + 27.8 \end{aligned}$$

c.
$$\begin{aligned} f(x) &= 0.2x + 27.8 \\ f(7) &= 0.2(12) + 27.8 \\ &= 30.2 \end{aligned}$$

The linear function predicts men's average age of first marriage will be 30.2 years in 2020.

Chapter 2 Test

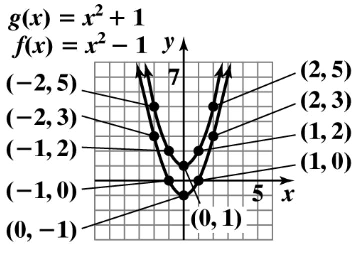
1. The relation is a function.
Domain {1, 3, 5, 6}
Range {2, 4, 6}

2. The relation is not a function.
Domain {2, 4, 6}
Range {1, 3, 5, 6}

3.
$$\begin{aligned} f(a+4) &= 3(a+4) - 2 \\ &= 3a + 12 - 2 = 3a + 10 \end{aligned}$$

4.
$$\begin{aligned} f(-2) &= 4(-2)^2 - 3(-2) + 6 \\ &= 4(4) + 6 + 6 = 16 + 6 + 6 = 28 \end{aligned}$$

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 $g(x) = x + 2$

$$\begin{aligned} (f+g)(x) &= f(x) + g(x) \\ &= (x^2 + 4x) + (x + 2) \\ &= x^2 + 4x + x + 2 \\ &= x^2 + 5x + 2 \end{aligned}$$
$$\begin{aligned} (f+g)(3) &= (3)^2 + 5(3) + 2 \\ &= 9 + 15 + 2 = 26 \end{aligned}$$

14. $f(x) = x^2 + 4x$ and $g(x) = x + 2$

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

15. We know that $(fg)(x) = f(x) \cdot g(x)$. So, to find $(fg)(-5)$, we use $f(-5)$ and $g(-5)$.

$$f(-5) = (-5)^2 + 4(-5) = 25 - 20 = 5$$
$$g(-5) = -5 + 2 = -3$$
$$\begin{aligned} (fg)(-5) &= f(-5) \cdot g(-5) \\ &= 5(-3) = -15 \end{aligned}$$

16. $f(x) = x^2 + 4x$ and $g(x) = x + 2$

$$\left(\frac{f}{g}\right)(x) = \frac{x^2 + 4x}{x + 2}$$
$$\left(\frac{f}{g}\right)(2) = \frac{(2)^2 + 4(2)}{2 + 2} = \frac{4 + 8}{4} = \frac{12}{4} = 3$$

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

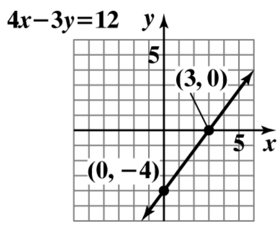
18. $4x-3y=12$

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

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

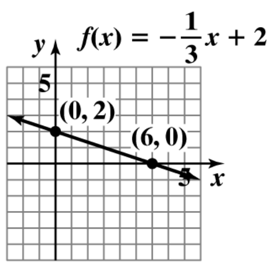
Find the y–intercept by setting $x=0$.

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



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

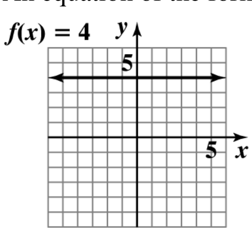
$m=-\frac{1}{3}$ $\quad$ $y-\text{intercept}=2$



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 $f(x)=2x+7$.

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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 a 200-pound person who consumes 8 one-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. $\dfrac{x-2}{4}=\dfrac{2x+6}{3}$

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

$8x+24=3x-6$

$5x+24=-6$

$5x=-30$

$x=-6$

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. $A=p+prt$

$A-p=prt$

$\dfrac{A-p}{pr}=t$

11. $\left(3x^4y^{-5}\right)^{-2}=\left(\dfrac{3x^4}{y^5}\right)^{-2}=\left(\dfrac{y^5}{3x^4}\right)^2=\dfrac{y^{10}}{9x^8}$

12. $\left(\dfrac{3x^2y^{-4}}{x^{-3}y^2}\right)^2=\left(\dfrac{3x^2x^3}{y^2y^4}\right)^2$

$=\left(\dfrac{3x^5}{y^6}\right)^2=\dfrac{9x^{10}}{y^{12}}$

13. $\left(7\times10^{-8}\right)\left(3\times10^2\right)$

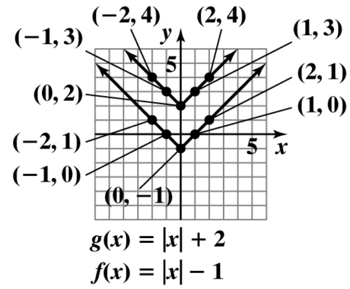
$=(7\times3)\left(10^{-8}\times10^2\right)=21\times10^{-6}$

$=(2.1\times10)\times10^{-6}=2.1\left(10\times10^{-6}\right)$

$=2.1\times10^{-5}$

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. $(f-g)(x)$

$=\left(3x^2-4x+2\right)-\left(x^2-5x-3\right)$

$=3x^2-4x+2-x^2+5x+3$

$=2x^2+x+5$

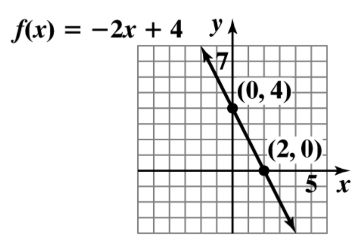
$(f-g)(-1)=2(-1)^2+(-1)+5$

$=2(1)-1+5=2-1+5=6$

18. $f(x)=-2x+4$

$y=-2x+4$

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



19. $x-2y=6$

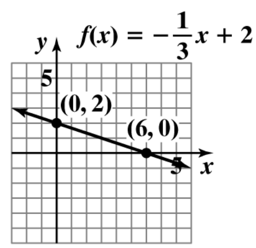
Rewrite the equation of the line in slope-intercept form.

$x-2y=6$

$-2y=-x+6$

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

$m=\dfrac{1}{2} \qquad y-\text{intercept}=-3$



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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 $f(x) = 4x - 17$.

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Chapter 3
Systems of Linear Functions

3.1 Check Points

1. a.

$$\begin{aligned} 2x+5y &= -24 \\ 2(-7)+5(-2) &= -24 \\ -24 &= -24, \text{ true} \end{aligned} \qquad \begin{aligned} 3x-5y &= 14 \\ 3(-7)-5(-2) &= 14 \\ -11 &= 14, \text{ false} \end{aligned}$$

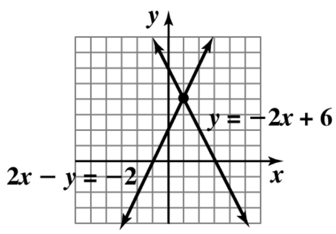
The pair is not a solution of the system.

b.

$$\begin{aligned} 2x+5y &= -24 \\ 2(-2)+5(-4) &= -24 \\ -24 &= -24, \text{ true} \end{aligned} \qquad \begin{aligned} 3x-5y &= 14 \\ 3(-2)-5(-4) &= 14 \\ 14 &= 14, \text{ true} \end{aligned}$$

The pair is a solution of the system.

2. Graph both equations.



The intersection is $(1,4)$.

The solution set is $\{(1,4)\}$.

3. $y = 3x - 7$

$5x - 2y = 8$

Use substitution.

$$\begin{aligned} 5x-2y &= 8 \\ 5x-2(\overbrace{3x-7}^{y}) &= 8 \\ 5x-6x+14 &= 8 \\ -x+14 &= 8 \\ -x &= -6 \\ x &= 6 \end{aligned}$$

Find y.

$$\begin{aligned} y &= 3x-7 \\ y &= 3(6)-7 \\ y &= 11 \end{aligned}$$

The solution is $(6,11)$.

The solution set is $\{(6,11)\}$.

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4. $3x+2y=4$

$2x+y=1$

Solve $2x+y=1$ for y.

$2x+y=1$

$y=-2x+1$

Use substitution.

$3x+2y=4$

$3x+2(\overbrace{-2x+1}^{y})=4$

$3x-4x+2=4$

$-x+2=4$

$-x=2$

$x=-2$

Find y.

$y=-2x+1$

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

$y=5$

The solution is $(-2,5)$.

The solution set is $\{(-2,5)\}$.

5. $4x-7y=-16$

$2x+5y=\ \ 9$

Multiply the second equation by –2.

$$\begin{array}{r} 4x-7y=-16 \\ -4x-10y=-18 \\ \hline -17y=-34 \end{array}$$

$y=2$

Back-substitute to find x.

$2x+5y=9$

$2x+5(2)=9$

$2x+10=9$

$2x=-1$

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

The solution is $\left(-\frac{1}{2},2\right)$.

The solution set is $\left\{\left(-\frac{1}{2},2\right)\right\}$.

6. $3x=2-4y$

$5y=-1-2x$

Rewrite in the form $Ax+By=C$.

$3x+4y=2$

$2x+5y=-1$

Multiply the first equation by –2. Multiply the second equation by 3.

$$\begin{array}{r} -6x-8y=-4 \\ 6x+15y=-3 \\ \hline 7y=-7 \end{array}$$

$y=-1$

Back-substitute to find x.

$3x=2-4(-1)$

$3x=6$

$x=2$

The solution is $(2,-1)$.

The solution set is $\{(2,-1)\}$.

7. $\dfrac{3x}{2}-2y=\dfrac{5}{2}$

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

Rewrite in the form $Ax+By=C$.

$3x-4y=5$

$2x-5y=-3$

Multiply the first equation by –2. Multiply the second equation by 3.

$$\begin{array}{r} -6x+8y=-10 \\ 6x-15y=-9 \\ \hline -7y=-19 \end{array}$$

$y=\dfrac{19}{7}$

Back-substitute to find x.

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

$x-\dfrac{5\left(\frac{19}{7}\right)}{2}=-\dfrac{3}{2}$

$x-\dfrac{95}{14}=-\dfrac{3}{2}$

$x=\dfrac{37}{7}$

The solution is $\left(\dfrac{37}{7},\dfrac{19}{7}\right)$.

The solution set is $\left\{\left(\dfrac{37}{7},\dfrac{19}{7}\right)\right\}$.

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8. $$5x-2y=4$$
$$-10x+4y=7$$
Multiply the first equation by 2.
$$\begin{aligned}10x-4y&=8\\ -10x+4y&=7\\ \hline 0&=15\end{aligned}$$
Since there are no pairs (x, y) for which 0 will equal 15, the system is inconsistent and has no solution. The solution set is $\varnothing$ or $\{\ \}$.

9. $$x=4y-8$$
$$5x-20y=-40$$
Substitute $4y-8$ for x in the second equation.
$$5x-20y=-40$$
$$5(\overbrace{4y-8}^{x})-20y=-40$$
$$20y-40-20y=-40$$
$$-40=-40$$
Since –40 = –40 for all values of x and y, the system is dependent. The solution set is
$\{(x, y)|x=4y-8\}$ or $\{(x, y)|5x-20y=-40\}$.

3.1 Concept and Vocabulary Check

1. satisfies both equations in the system
2. the intersection point
3. $\left\{\left(\frac{1}{3},-2\right)\right\}$
4. -2
5. -3
6. $\varnothing$; inconsistent; parallel
7. $\{(x, y)|x=3y+2\}$ or $\{(x, y)|5x-15y=10\}$; dependent; are identical or coincide

3.1 Exercise Set

1. $x-y=12$ $x+y=2$
$7-(-5)=12$ $7+(-5)=2$
$12=12$, true $2=2$, true
The pair is a solution of the system.

2. $-3-1=-4$ $2(-3)+10(1)=4$
$-4=-4$ $-6+10=4$
$4=4$
The pair is a solution of the system.

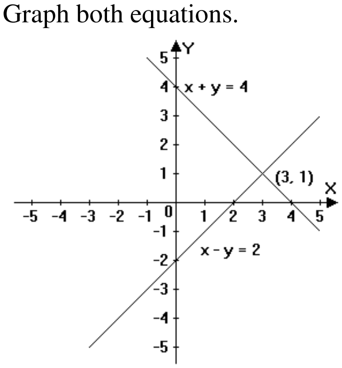
3. $3x+4y=2$ $2x+5y=1$
$3(2)+4(-1)=2$ $2(2)+5(-1)=1$
$2=2$, true $-1=1$, false
The pair is not a solution of the system.

4. $2(4)-5(2)=-2$ $3(4)+4(2)=18$
$8-10=-2$ $12+8=18$
$-2=-2$ $20\neq 18$
The pair is not a solution of the system.

5. $y=2x-13$ $4x+9y=-7$
$-3=2(5)-13$ $4(5)+9(-3)=-7$
$-3=10-13$ $20-27=-7$
$-3=-3$ $-7=-7$
The pair is a solution of the system.

6. $-4=3(-3)+5$ $5(-3)-2(-4)=-7$
$-4=-9+5$ $-15+8=-7$
$-4=-4$ $-7=-7$
The pair is a solution of the system.

7. Graph both equations.



The solution is $(3,1)$.
The solution set is $\{(3,1)\}$.

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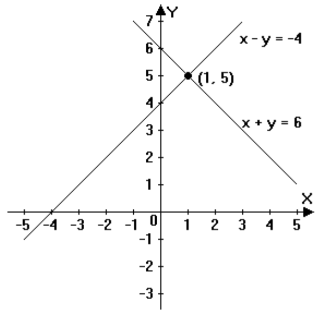
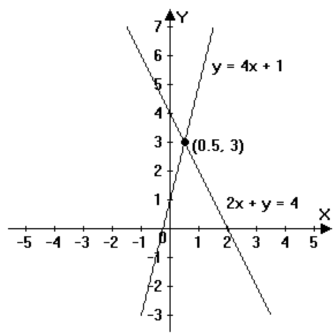
8. Graph both equations.



The solution is $(1,5)$.

The solution set is $\{(1,5)\}$.

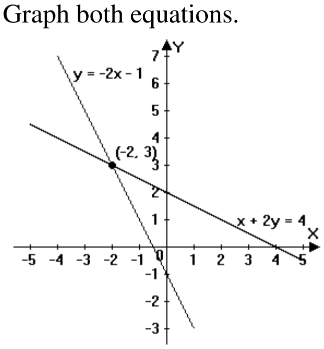
9. Graph both equations.



The solution is $\left(\frac{1}{2},3\right)$.

The solution set is $\left\{\left(\frac{1}{2},3\right)\right\}$.

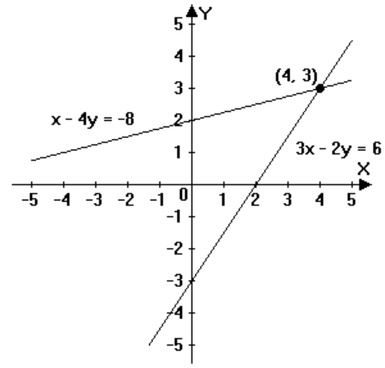
10. Graph both equations.



The solution is $(-2,3)$.

The solution set is $\{(-2,3)\}$.

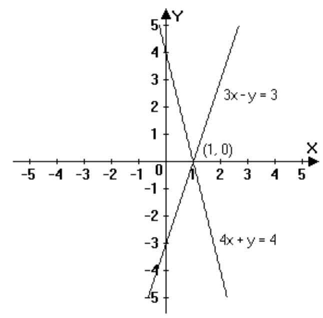
11. Graph both equations.



The solution is $(4,3)$.

The solution set is $\{(4,3)\}$.

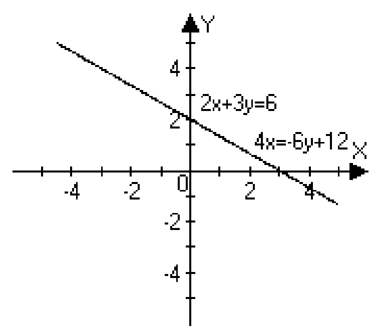
12. Graph both equations.



The solution is $(1,0)$.

The solution set is $\{(1,0)\}$.

13. Graph both equations.



The lines coincide. The solution set is $\{(x, y)|2x+3y=6\}$ or $\{(x, y)|4x=-6y+12\}$.

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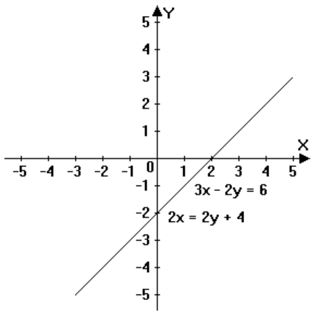
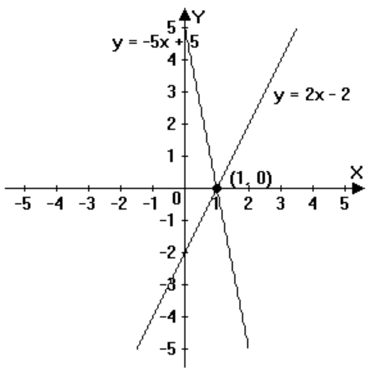
14. Graph both equations.



The lines coincide. The solution set is
$\{(x,y)|3x-3y=6\}$ or $\{(x,y)|2x=2y+4\}$.

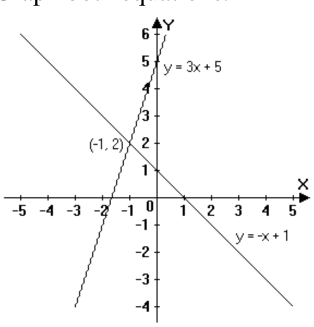
15. Graph both equations.



The solution is $(1,0)$.

The solution set is $\{(1,0)\}$.

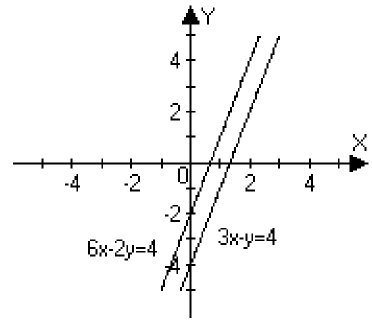
16. Graph both equations.



The solution is $(-1,2)$.

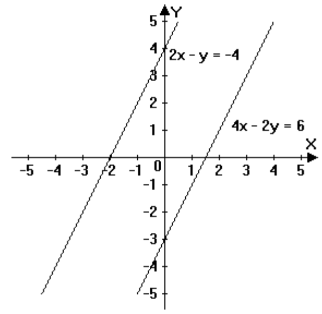
The solution set is $\{(-1,2)\}$.

17. Graph both equations.



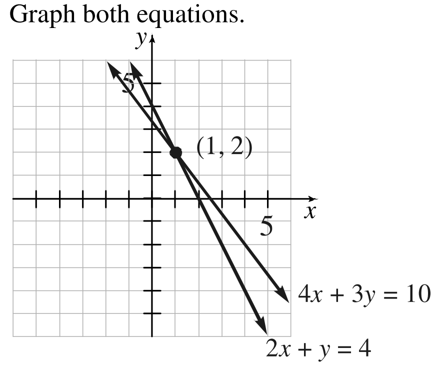
Since the lines do not intersect, there is no solution. The solution set is $\varnothing$ or $\{\ \}$.

18. Graph both equations.



Since the lines do not intersect, there is no solution. The solution set is $\varnothing$ or $\{\ \}$.

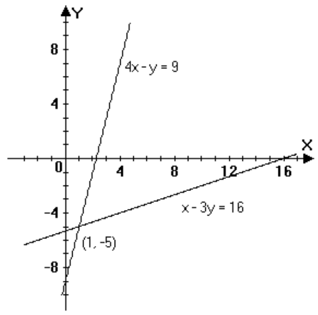
19. Graph both equations.



The solution is $(1,2)$.

The solution set is $\{(1,2)\}$.

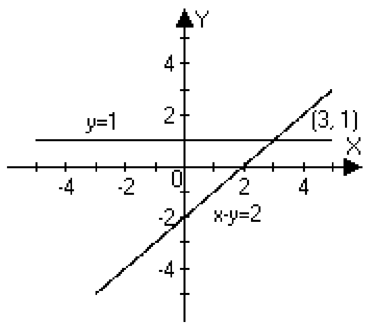
20. Graph both equations.



The solution is $(1,-5)$.

The solution set is $\{(1,-5)\}$.

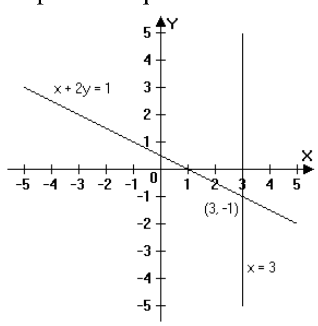
21. Graph both equations.



The solution is $(3,1)$.

The solution set is $\{(3,1)\}$.

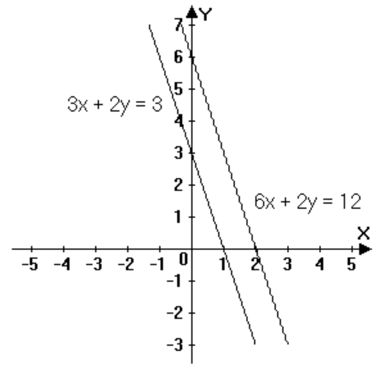
22. Graph both equations.



The solution is $(3,-1)$.

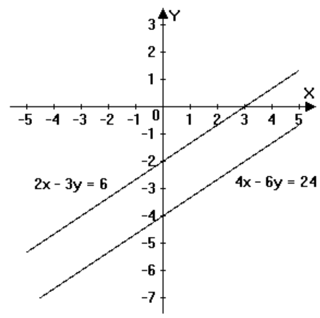
The solution set is $\{(3,-1)\}$.

23. Graph both equations.



Since the lines do not intersect, there is no solution.
The solution set is $\varnothing$ or $\{\ \}$.

24. Graph both equations.



Since the lines do not intersect, there is no solution.
The solution set is $\varnothing$ or $\{\ \}$.

25. $x + y = 6$

$y = 2x$

Substitute $2x$ for y in the first equation.

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

Back-substitute to find y.

$$2 + y = 6$$
$$y = 4$$

The solution is $(2,4)$.

The solution set is $\{(2,4)\}$.

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26. Substitute $4x$ for y in the first equation.

$$\begin{aligned} x+y&=10 \\ x+4x&=10 \\ 5x&=10 \\ x&=2 \end{aligned}$$

Back-substitute to find *y*.

$$\begin{aligned} x+y&=10 \\ 2+y&=10 \\ y&=8 \end{aligned}$$

The solution is $(2,8)$.

The solution set is $\{(2,8)\}$.

27. $2x+3y=9$

$x=y+2$

Substitute $y+2$ for x in the first equation.

$$\begin{aligned} 2x+3y&=9 \\ 2(y+2)+3y&=9 \\ 2y+4+3y&=9 \\ 5y+4&=9 \\ 5y&=5 \\ y&=1 \end{aligned}$$

Back-substitute to find *x*.

$$\begin{aligned} x&=y+2 \\ x&=1+2 \\ x&=3 \end{aligned}$$

The solution is $(3,1)$.

The solution set is $\{(3,1)\}$.

28. Substitute $1-2x$ for y in the first equation.

$$\begin{aligned} 3x-4y&=18 \\ 3x-4(1-2x)&=18 \\ 3x-4+8x&=18 \\ 11x-4&=18 \\ 11x&=22 \\ x&=2 \end{aligned}$$

Back-substitute to find *y*.

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

The solution is $(2,-3)$.

The solution set is $\{(2,-3)\}$.

29. $y=-3x+7$

$5x-2y=8$

Substitute $-3x+7$ for *y* in the second equation.

$$\begin{aligned} 5x-2y&=8 \\ 5x-2(-3x+7)&=8 \\ 5x+6x-14&=8 \\ 11x-14&=8 \\ 11x&=22 \\ x&=2 \end{aligned}$$

Back-substitute to find *y*.

$$\begin{aligned} y&=-3(2)+7 \\ y&=-6+7 \\ y&=1 \end{aligned}$$

The solution is $(2,1)$.

The solution set is $\{(2,1)\}$.

30. Substitute $3y+8$ for x in the second equation.

$$\begin{aligned} 2x-y&=6 \\ 2(3y+8)-y&=6 \\ 6y+16-y&=6 \\ 5y+16&=6 \\ 5y&=-10 \\ y&=-2 \end{aligned}$$

Back-substitute to find *y*.

$x=3y+8=3(-2)+8=-6+8=2$

The solution is $(2,-2)$.

The solution set is $\{(2,-2)\}$.

31. $4x+y=5$

$2x-3y=13$

Solve for *y* in the first equation.

$$\begin{aligned} 4x+y&=5 \\ y&=-4x+5 \end{aligned}$$

Substitute $-4x+5$ for y in the second equation.

$$\begin{aligned} 2x-3(-4x+5)&=13 \\ 2x+12x-15&=13 \\ 14x-15&=13 \\ 14x&=28 \\ x&=2 \end{aligned}$$

Back-substitute to find *y*.

$$\begin{aligned} 4x+y&=5 \\ 4(2)+y&=5 \\ 8+y&=5 \\ y&=-3 \end{aligned}$$

The solution is $(2,-3)$.

The solution set is $\{(2,-3)\}$.

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32. Solve for x in the first equation.

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

Substitute $3y+3$ for x in the second equation.

$$\begin{aligned}3x+5y&=-19\\3(3y+3)+5y&=-19\\9y+9+5y&=-19\\14y+9&=-19\\14y&=-28\\y&=-2\end{aligned}$$

Back-substitute to find *y*.

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

The solution is $(-3,-2)$.

The solution set is $\{(-3,-2)\}$.

33.

$$\begin{aligned}x-2y&=4\\2x-4y&=5\end{aligned}$$

Solve for x in the first equation.

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

Substitute $2y+4$ for x in the second equation.

$$\begin{aligned}2x-4y&=5\\2(2y+4)-4y&=5\\4y+8-4y&=5\\4y+8-4y&=5\\8&\neq 5\end{aligned}$$

The system is inconsistent. There are no values of x and y for which 8 will equal 5. The solution set is $\varnothing$ or $\{\ \}$.

34. Solve for x in the first equation.

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

Substitute $3y+6$ for x in the second equation.

$$\begin{aligned}2x-6y&=5\\2(3y+6)-6y&=5\\6y+12-6y&=5\\12&=5\end{aligned}$$

The system is inconsistent. There are no pairs (x,y) which will make 12 equal to 5. The solution set is $\varnothing$ or $\{\ \}$.

35.

$$\begin{aligned}2x+5y&=-4\\3x-y&=11\end{aligned}$$

Solve for y in the second equation.

$$\begin{aligned}3x-y&=11\\-y&=-3x+11\\y&=3x-11\end{aligned}$$

Substitute $3x-11$ for y in the first equation.

$$\begin{aligned}2x+5y&=-4\\2x+5(3x-11)&=-4\\2x+15x-55&=-4\\17x-55&=-4\\17x&=51\\x&=3\end{aligned}$$

Back-substitute to find *y*.

$$\begin{aligned}3x-y&=11\\3(3)-y&=11\\9-y&=11\\-y&=2\\y&=-2\end{aligned}$$

The solution is $(3,-2)$.

The solution set is $\{(3,-2)\}$.

36. Solve for x in the second equation.

$$\begin{aligned}-x+6y&=8\\6y&=8+x\\6y-8&=x\end{aligned}$$

Substitute $6y-8$ for x in the first equation.

$$\begin{aligned}2(6y-8)+5y&=1\\12y-16+5y&=1\\17y&=17\\y&=1\end{aligned}$$

Back-substitute to find *x*.

$$\begin{aligned}x&=6y-8\\x&=6(1)-8\\x&=6-8\\x&=-2\end{aligned}$$

The solution is $(-2,1)$.

The solution set is $\{(-2,1)\}$.

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37. $2(x-1)-y=-3$

$y=2x+3$

Substitute $2x+3$ for y in the first equation.

$$2(x-1)-y=-3$$
$$2(x-1)-(2x+3)=-3$$
$$2x-2-2x-3=-3$$
$$-5\neq-3$$

Since there are no values of x and y for which –5 will equal –3, the system is inconsistent. The solution set is $\varnothing$ or $\{\ \}$.

38. Substitute $3x-1$ for y in the first equation.

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

The system is dependent. The solution set is $\{(x,y)|\,x+y-1=2(y-x)\}$ or $\{(x,y)|\,y=3x-1\}$.

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

$x+4y=-9$

Solve for x in the second equation.

$$x+4y=-9$$
$$x=-4y-9$$

Substitute $-4y-9$ for x in the first equation.

$$\frac{x}{4}-\frac{y}{4}=-1$$
$$\frac{-4y-9}{4}-\frac{y}{4}=-1$$
$$4\left(\frac{-4y-9}{4}-\frac{y}{4}\right)=4(-1)$$
$$-4y-9-y=-4$$
$$-5y-9=-4$$
$$-5y=5$$
$$y=-1$$

Back-substitute to find x.

$$x+4y=-9$$
$$x+4(-1)=-9$$
$$x-4=-9$$
$$x=-5$$

The solution is $(-5,-1)$.

The solution set is $\{(-5,-1)\}$.

40. Solve for x in the second equation.

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

Substitute $-2y-3$ for x in the first equation.

$$\frac{x}{6}-\frac{y}{2}=\frac{1}{3}$$
$$\frac{-2y-3}{6}-\frac{y}{2}=\frac{1}{3}$$
$$6\left(\frac{-2y-3}{6}\right)-6\left(\frac{y}{2}\right)=6\left(\frac{1}{3}\right)$$
$$-2y-3-3y=2$$
$$-3-5y=2$$
$$-5y=5$$
$$y=-1$$

Back-substitute to find x.

$$x+2y=-3$$
$$x+2(-1)=-3$$
$$x-2=-3$$
$$x=-1$$

The solution is $(-1,-1)$.

The solution set is $\{(-1,-1)\}$.

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

$2x-5y=10$

Substitute $\frac{2}{5}x-2$ for y in the second equation.

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

Since 10 = 10 for all values of x and y, the system is dependent. The solution set is $\left\{(x,y)\middle|\,y=\frac{2}{5}x-2\right\}$ or $\{(x,y)|\,2x-5y=10\}$.

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42. Substitute $\frac{1}{3}x+4$ for y in the second equation.

$$3\left(\frac{1}{3}x+4\right)=x+12$$
$$x+12=x+12$$

Since $x+12$ equals $x+12$ for an infinite number of pairs (x, y), the system is dependent. The solution set is $\left\{(x, y) \middle| y=\frac{1}{3}x+4\right\}$ or $\{(x, y) | 3y=x+12\}$.

43. Solve by addition.

$$\begin{aligned} x+y&=7 \\ \underline{x-y}&\underline{=3} \\ 2x&=10 \\ x&=5 \end{aligned}$$

Back-substitute to find *y*.

$$\begin{aligned} x+y&=7 \\ 5+y&=7 \\ y&=2 \end{aligned}$$

The solution is $(5,2)$.

The solution set is $\{(5,2)\}$.

44. Solve by addition.

$$\begin{aligned} 2x+y&=3 \\ \underline{x-y}&\underline{=3} \\ 3x&=6 \\ x&=2 \end{aligned}$$

Back-substitute to find *y*.

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

The solution is $(2,-1)$.

The solution set is $\{(2,-1)\}$.

45. Solve by addition.

$$\begin{aligned} 12x+3y&=15 \\ \underline{2x-3y}&\underline{=13} \\ 14x&=28 \\ x&=2 \end{aligned}$$

Back-substitute to find *y*.

$$\begin{aligned} 12(2)+3y&=15 \\ 24+3y&=15 \\ 3y&=-9 \\ y&=-3 \end{aligned}$$

The solution is $(2,-3)$.

The solution set is $\{(2,-3)\}$.

46. Solve by addition.

$$\begin{aligned} 4x+2y&=12 \\ \underline{3x-2y}&\underline{=16} \\ 7x&=28 \\ x&=4 \end{aligned}$$

Back-substitute to find *y*.

$$\begin{aligned} 4x+2y&=12 \\ 4(4)+2y&=12 \\ 16+2y&=12 \\ 2y&=-4 \\ y&=-2 \end{aligned}$$

The solution is $(4,-2)$.

The solution set is $\{(4,-2)\}$.

47.
$$\begin{aligned} x+3y&=2 \\ 4x+5y&=1 \end{aligned}$$

Multiply the first equation by –4.

$$\begin{aligned} -4x-12y&=-8 \\ \underline{4x+5y}&\underline{=1} \\ -7y&=-7 \\ y&=1 \end{aligned}$$

Back-substitute to find *x*.

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

The solution is $(-1,1)$.

The solution set is $\{(-1,1)\}$.

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48. Multiply the second equation by 2.

$$\begin{aligned} x+2y&=-1\\ \underline{4x-2y}&\underline{=\;\;6}\\ 5x&=5\\ x&=1 \end{aligned}$$

Back-substitute to find *x*.

$$\begin{aligned} x+2y&=-1\\ 1+2y&=-1\\ 2y&=-2\\ y&=-1 \end{aligned}$$

The solution is $(1,-1)$.

The solution set is $\{(1,-1)\}$.

49.

$$\begin{aligned} 6x-y&=-5\\ 4x-2y&=6 \end{aligned}$$

Multiply the first equation by –2.

$$\begin{aligned} -12x+2y&=10\\ \underline{4x-2y}&\underline{=6}\\ -8x&=16\\ x&=-2 \end{aligned}$$

Back-substitute to find *y*.

$$\begin{aligned} 6(-2)-y&=-5\\ -12-y&=-5\\ -y&=7\\ y&=-7 \end{aligned}$$

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

The solution set is $\{(-2,-7)\}$.

50. Multiply the second equation by –2.

$$\begin{aligned} x-2y&=5\\ \underline{-10x+2y}&\underline{=4}\\ -9x&=9\\ x&=-1 \end{aligned}$$

Back-substitute to find *y*.

$$\begin{aligned} x-2y&=5\\ -1-2y&=5\\ -2y&=6\\ y&=-3 \end{aligned}$$

The solution is $(-1,-3)$.

The solution set is $\{(-1,-3)\}$.

51.

$$\begin{aligned} 3x-5y&=11\\ 2x-6y&=2 \end{aligned}$$

Multiply the first equation by –2 and the second equation by 3.

$$\begin{aligned} -6x+10y&=-22\\ \underline{6x-18y}&\underline{=\;\;6}\\ -8y&=-16\\ y&=2 \end{aligned}$$

Back-substitute to find *x*.

$$\begin{aligned} 2x-6(2)&=2\\ 2x-12&=2\\ 2x&=14\\ x&=7 \end{aligned}$$

The solution is $(7,2)$.

The solution set is $\{(7,2)\}$.

52. Multiply the first equation by –3 and the second equation by 4 and solve by addition.

$$\begin{aligned} -12x+9y&=-36\\ \underline{12x-16y}&\underline{=\;\;8}\\ -7y&=-28\\ y&=4 \end{aligned}$$

Back-substitute 4 for *y* to find *x*.

$$\begin{aligned} 4x-3(4)&=12\\ 4x-12&=12\\ 4x&=24\\ x&=6 \end{aligned}$$

The solution is $(6,4)$.

The solution set is $\{(6,4)\}$.

53.

$$\begin{aligned} 2x-5y&=13\\ 5x+3y&=17 \end{aligned}$$

Multiply the first equation by 3 and the second equation by 5.

$$\begin{aligned} 6x-15y&=39\\ \underline{25x+15y}&\underline{=85}\\ 31x&=124\\ x&=4 \end{aligned}$$

Back-substitute to find *y*.

$$\begin{aligned} 5(4)+3y&=17\\ 20+3y&=17\\ 3y&=-3\\ y&=-1 \end{aligned}$$

The solution is $(4,-1)$.

The solution set is $\{(4,-1)\}$.

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54. Multiply the first equation by 3 and the second equation by 5.

$$\begin{aligned} 12x+15y&=-27 \\ \underline{30x-15y}&\underline{=-15} \\ 42x&=-42 \\ x&=-1 \end{aligned}$$

Back-substitute to find *y*.

$$\begin{aligned} 4(-1)+5y&=-9 \\ -4+5y&=-9 \\ 5y&=-5 \\ y&=-1 \end{aligned}$$

The solution is $(-1,-1)$.

The solution set is $\{(-1,-1)\}$.

55. $2x+6y=8$

$3x+9y=12$

Multiply the first equation by –3 and the second equation by 2.

$$\begin{aligned} -6x-18y&=-24 \\ \underline{6x+18y}&\underline{=\ \ 24} \\ 0&=0 \end{aligned}$$

Since 0 = 0 for all values of *x* and *y*, the system is dependent. The solution set is $\{(x, y)|\ 2x+6y=8\}$ or $\{(x, y)|\ 3x+9y=12\}$.

56. Multiply the first equation by –3.

$$\begin{aligned} -3x+9y&=18 \\ \underline{3x-9y}&\underline{=\ \ 9} \\ 0&=27 \end{aligned}$$

Since there are no pairs (x, y) for which 0 will equal 27, the system is inconsistent. The solution set is $\varnothing$ or $\{\ \ \}$.

57. $2x-3y=4$

$4x+5y=3$

Multiply the first equation by –2.

$$\begin{aligned} -4x+6y&=-8 \\ \underline{4x+5y}&\underline{=3} \\ 11y&=-5 \\ y&=-\frac{5}{11} \end{aligned}$$

Back-substitute to find *x*.

$$\begin{aligned} 2x-3y&=4 \\ 2x-3\left(-\frac{5}{11}\right)&=4 \\ 2x+\frac{15}{11}&=4 \\ 2x&=\frac{29}{11} \\ x&=\frac{29}{22} \end{aligned}$$

The solution is $\left(\frac{29}{22},-\frac{5}{11}\right)$.

The solution set is $\left\{\left(\frac{29}{22},-\frac{5}{11}\right)\right\}$.

58. Multiply the second equation by –2.

$$\begin{aligned} 4x-\ \ 3y&=\ \ 8 \\ \underline{-4x+10y}&\underline{=28} \\ 7y&=36 \\ y&=\frac{36}{7} \end{aligned}$$

Back-substitute to find *x*.

$$\begin{aligned} (fg)(x)&=f(x)\cdot g(x) \\ &=3x(2x-3) \\ &=6x^2-9x \end{aligned}$$

The solution is $\left(\frac{41}{7},\frac{36}{7}\right)$.

The solution set is $\left\{\left(\frac{41}{7},\frac{36}{7}\right)\right\}$.

59. $3x-7y=1$

$2x-3y=-1$

Multiply the first equation by –2 and the second equation by 3.

$$\begin{aligned} -6x+14y&=-2 \\ \underline{6x-\ \ 9y}&\underline{=-3} \\ 5y&=-5 \\ y&=-1 \end{aligned}$$

Back-substitute to find *x*.

$$\begin{aligned} 3x-7(-1)&=1 \\ 3x+7&=1 \\ 3x&=-6 \\ x&=-2 \end{aligned}$$

The solution is $(-2,-1)$.

The solution set is $\{(-2,-1)\}$.

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60. Multiply the first equation by 4 and the second equation by 3.

$$\begin{aligned} 8x-12y &= \quad 8 \\ 15x+12y &= 153 \\ \hline 23x &= 161 \\ x &= 7 \end{aligned}$$

Back-substitute to find *y*.

$$\begin{aligned} 2x-3y &= 2 \\ 2(7)-3y &= 2 \\ 14-3y &= 2 \\ -3y &= -12 \\ y &= 4 \end{aligned}$$

The solution is $(7,4)$.

The solution set is $\{(7,4)\}$.

61. $$\begin{aligned} x &= y+4 \\ 3x+7y &= -18 \end{aligned}$$

Substitute $y+4$ for x in the second equation.

$$\begin{aligned} 3x+7y &= -18 \\ 3(y+4)+7y &= -18 \\ 3y+12+7y &= -18 \\ 10y+12 &= -18 \\ 10y &= -30 \\ y &= -3 \end{aligned}$$

Back-substitute to find *x*.

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

The solution is $(1,-3)$.

The solution set is $\{(1,-3)\}$.

62. Substitute $3x+5$ for y in the second equation.

$$\begin{aligned} 5x-2(3x+5) &= -7 \\ 5x-6x-10 &= -7 \\ -x-10 &= -7 \\ -3 &= x \end{aligned}$$

Back-substitute to find *x*.

$$y = 3(-3)+5 = -9+5 = -4$$

The solution is $(-3,-4)$.

The solution set is $\{(-3,-4)\}$.

63. $$\begin{aligned} 9x+\frac{4y}{3} &= 5 \\ 4x-\frac{y}{3} &= 5 \end{aligned}$$

Multiply the second equation by 4.

$$\begin{aligned} 9x+\frac{4y}{3} &= \ 5 \\ 16x-\frac{4y}{3} &= 20 \\ \hline 25x &= 25 \\ x &= 1 \end{aligned}$$

Back-substitute to find *y*.

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

The solution is $(1,-3)$.

The solution set is $\{(1,-3)\}$.

64. First, clear fractions from both equations.

$$\begin{aligned} \frac{x}{6}-\frac{y}{5} &= -4 \\ 30\left(\frac{x}{6}\right)-30\left(\frac{y}{5}\right) &= 30(-4) \\ 5x-6y &= -120 \\ \frac{x}{4}-\frac{y}{6} &= -2 \\ 24\left(\frac{x}{4}\right)-24\left(\frac{y}{6}\right) &= 24(-2) \\ 6x-4y &= -48 \end{aligned}$$

The system becomes

$$\begin{aligned} 5x-6y &= -120 \\ 6x-4y &= -48. \end{aligned}$$

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Multiply the first equation by –6 and the second equation by 5.

$$\begin{array}{r} -30x+36y = 720 \\ \underline{30x-20y = -240} \\ 16y = 480 \\ y = 30 \end{array}$$

Back-substitute to find *x*.

$$x=\frac{D_x}{D}=\frac{-6}{-3}=2$$

The solution is $(12,30)$.

The solution set is $\{(12,30)\}$.

65. $\frac{1}{4}x-\frac{1}{9}y=\frac{2}{3}$

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

Multiply the first equation by –2.

$$-2\left(\frac{1}{4}x\right)-(-2)\left(\frac{1}{9}y\right)=-2\left(\frac{2}{3}\right)$$

$$-\frac{1}{2}x+\frac{2}{9}y=-\frac{4}{3}$$

We now have a system of two equations in two variables.

$$-\frac{1}{2}x+\frac{2}{9}y=-\frac{4}{3}$$

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

Solve the addition.

$$\begin{array}{r} -\frac{1}{2}x+\frac{2}{9}y=-\frac{4}{3} \\ \underline{\frac{1}{2}x-\frac{1}{3}y=1} \\ -\frac{1}{9}y=-\frac{1}{3} \\ y=-\frac{1}{3}(-9) \\ y=3 \end{array}$$

Back-substitute to find *x*.

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

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

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

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

$$x=4$$

The solution is $(4,3)$.

The solution set is $\{(4,3)\}$.

66. First, clear fractions from both equations.

$$\frac{1}{16}x-\frac{3}{4}y=-1$$

$$16\left(\frac{1}{16}x\right)-16\left(\frac{3}{4}y\right)=16(-1)$$

$$x-4(3y)=-16$$

$$x-12y=-16$$

$$\frac{3}{4}x+\frac{5}{2}y=11$$

$$4\left(\frac{3}{4}x\right)+4\left(\frac{5}{2}y\right)=4(11)$$

$$3x+2(5y)=44$$

$$3x+10y=44$$

The system becomes

$x-12y=-16$

$3x+10y=44.$

Multiply the first equation by –3.

$$\begin{array}{r} -3x+36y=48 \\ \underline{3x+10y=44} \\ 46y=92 \\ y=2 \end{array}$$

Back-substitute to find *x*.

$$3x+10y=44$$

$$3x+10(2)=44$$

$$3x+20=44$$

$$3x=24$$

$$x=8$$

The solution is $(8,2)$.

The solution set is $\{(8,2)\}$.

67. $x=3y-1$

$2x-6y=-2$

Substitute $3y-1$ for x in the second equation.

$$2x-6y=-2$$

$$2(3y-1)-6y=-2$$

$$6y-2-6y=-2$$

$$-2=-2$$

Since –2 = –2 for all values of *x* and *y*, the system is dependent. The solution set is $\{(x,y)|\ x=3y-1\}$ or $\{(x,y)|\ 2x-6y=-2\}$.

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68. Substitute $4y-1$ for x in the second equation.

$$2(4y-1)-8y=-2$$
$$\cancel{8y}-2-\cancel{8y}=-2$$
$$-2=-2$$

Since $-2=-2$ for an infinite number of pairs, (x, y), the system is dependent. The solution set is $\{(x, y) | x=4y-1\}$ or $\{(x, y) | 2x-8y=-2\}$.

69. $y=2x+1$

$y=2x-3$

Multiply the first equation by –1.

$$\begin{array}{l} -y=-2x-1 \\ \underline{\ \ y=\ \ 2x-3} \\ 0\neq -4 \end{array}$$

Since there are no values of x and y for which 0 = –4, the system is inconsistent. The solution set is $\varnothing$ or $\{\ \ \}$.

70. Multiply the first equation by –1.

$$\begin{array}{l} -y=-2x-4 \\ \underline{\ \ y=\ \ 2x-1} \\ 0=-5 \end{array}$$

Since there are no values of x and y for which $0=-5$, the system is inconsistent. The solution set is $\varnothing$ or $\{\ \ \}$.

71. $0.4x+0.3y=2.3$

$0.2x-0.5y=0.5$

Multiply the second equation by –2.

$$\begin{array}{r} 0.4x+0.3y=\ \ 2.3 \\ \underline{-0.4x+1.0y=-1.0} \\ 1.3y=1.3 \\ y=1 \end{array}$$

Back-substitute to find x.

$$0.2x-0.5y=0.5$$
$$0.2x-0.5(1)=0.5$$
$$0.2x-0.5=0.5$$
$$0.2x=1.0$$
$$x=5$$

The solution is $(5,1)$.

The solution set is $\{(5,1)\}$.

72. Multiply both equations by 10 to clear the decimals.

$2x-10y=-14$

$7x-\ 2y=-16$

Multiply the second equation by –5.

$$\begin{array}{r} 2x-10y=-14 \\ \underline{-35x+10y=80} \\ -33x=66 \\ x=-2 \end{array}$$

Back-substitute to find y.

$$x=\frac{D_x}{D}=\frac{-10}{5}=-2$$

The solution is $(-2,1)$.

The solution set is $\{(-2,1)\}$.

73. $5x-40=6y$

$2y=8-3x$

Rewrite the equations in general form.

$5x-6y=40$

$3x+2y=8$

Multiply the second equation by 3.

$$\begin{array}{r} 5x-6y=40 \\ \underline{9x+6y=24} \\ 14x=64 \\ x=\frac{32}{7} \end{array}$$

Back-substitute to find y.

$$2y=8-3x$$
$$2y=8-3\left(\frac{32}{7}\right)$$
$$2y=8-\frac{96}{7}$$
$$2y=-\frac{40}{7}$$
$$y=-\frac{40}{14}=-\frac{20}{7}$$

The solution is $\left(\frac{32}{7},-\frac{20}{7}\right)$.

The solution set is $\left\{\left(\frac{32}{7},-\frac{20}{7}\right)\right\}$.

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74. Rewrite the equations in $Ax+By=C$ form.

$$4x-3y=24$$
$$-3x+9y=-1$$

Multiply the first equation by 3.

$$\begin{array}{r} 12x-9y=72 \\ \underline{-3x+9y=-1} \\ 9x=71 \\ x=\dfrac{71}{9} \end{array}$$

Back-substitute to find *y*.

$$4\left(\frac{71}{9}\right)-3y=24$$
$$\frac{284}{9}-3y=24$$
$$284-27y=216$$
$$-27y=-68$$
$$y=\frac{68}{27}$$

The solution is $\left(\frac{71}{9},\frac{68}{27}\right)$.

The solution set is $\left\{\left(\frac{71}{9},\frac{68}{27}\right)\right\}$.

75. $3(x+y)=6$

$3(x-y)=-36$

Divide both equations by 3.

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

Solve the system by addition.

$$\begin{array}{r} x+y=2 \\ \underline{x-y=-12} \\ 2x=-10 \\ x=-5 \end{array}$$

Back-substitute to find *y*.

$$x+y=2$$
$$-5+y=2$$
$$y=7$$

The solution is $(-5,7)$.

The solution set is $\{(-5,7)\}$.

76. Distribute the 4 in both equations to eliminate the parentheses.

$$4x-4y=-12$$
$$4x+4y=-20$$

Solve the system by addition.

$$\begin{array}{r} 4x-4y=-12 \\ \underline{4x+4y=-20} \\ 8x=-32 \\ x=-4 \end{array}$$

Back-substitute to find *y*.

$$4x-4y=-12$$
$$4(-4)-4y=-12$$
$$-16-4y=-12$$
$$-4y=4$$
$$y=-1$$

The solution is $(-4,-1)$.

The solution set is $\{(-4,-1)\}$.

77. $3(x-3)-2y=0$

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

Rewrite the equations in general form.

$$3(x-3)-2y=0 \quad 2(x-y)=-x-3$$
$$3x-9-2y=0 \quad 2x-2y=-x-3$$
$$3x-2y=9 \quad 3x-2y=-3$$

We now have a system of two equations in two variables.

$$3x-2y=9$$
$$3x-2y=-3$$

Multiply the second equation by -1.

$$\begin{array}{r} 3x-2y=9 \\ \underline{-3x+2y=3} \\ 0\neq 12 \end{array}$$

Since there are no values of *x* and *y* for which 0 = 12, the system is inconsistent. The solution set is $\varnothing$ or $\{\ \}$.

78. Rewrite the second equation in $Ax+By=C$ form.

$$4(x+y)=6(2-x)$$
$$4x+4y=12-6x$$
$$10x+4y=12$$

The system becomes

$$5x+2y=-5$$
$$10x+4y=12.$$

Multiply the second equation by –2.

$$\begin{array}{r} -10x-4y=10 \\ \underline{10x+4y=12} \\ 0=22 \end{array}$$

Since there are no pairs (x,y) for which $0=22$, the system is inconsistent. The solution set is $\varnothing$ or $\{\ \}$.

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

$12=8y+4x$

Rewrite the equations in general form.

$$\begin{array}{ll} x+2y-3=0 & 12=8y+4x \\ x+2y=3 & 8y+4x=12 \\ & 4x+8y=12 \end{array}$$

We now have a system of two equations in two variables.

$$x+2y=3$$
$$4x+8y=12$$

Multiply the first equation by -4.

$$\begin{array}{r} -4x-8y=-12 \\ \underline{4x+8y=\ \ 12} \\ 0=0 \end{array}$$

Since 0 = 0 for all values of *x* and *y*, the system is dependent. The solution set is

$\{(x,y)|\ x+2y-3=0\}$ or $\{(x,y)|\ 12=8y+4x\}$.

80. Rewrite the equations in $Ax+By=C$ form.

$$\begin{array}{ll} 2x-y-5=0 & 10=4x-2y \\ 2x-y=5 & 4x-2y=10 \end{array}$$

The system becomes

$$2x-\ \ y=\ \ 5$$
$$4x-2y=10.$$

Multiply the first equation by –2.

$$\begin{array}{r} -4x+2y=-10 \\ \underline{4x-2y=\ \ 10} \\ 0=0 \end{array}$$

Since 0 = 0 for an infinite number of pairs (x,y), the system is dependent. The solution set is

$\{(x,y)|2x-y-5=0\}$ or $\{(x,y)|10=4x-2y\}$.

81. $3x+4y=0$

$7x=3y$

After rewriting the second equation in general form, the system becomes

$$3x+4y=0$$
$$7x-3y=0$$

Multiply the first equation by 3 and the second equation by 4.

$$\begin{array}{r} 9x+12y=0 \\ \underline{28x-12y=0} \\ 37x=0 \\ x=0 \end{array}$$

Back-substitute to find *y*.

$$7(0)=3y$$
$$0=3y$$
$$0=y$$

The solution is $(0,0)$.

The solution set is $\{(0,0)\}$.

82. Solve the second equation for *x*.

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

Substitute $-\frac{4}{5}y$ for x and solve for *y*.

$$5\left(-\frac{4}{5}y\right)+8y=20$$
$$-4y+8y=20$$
$$4y=20$$
$$y=5$$

Back-substitute to find *x*.

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

The solution is $(-4,5)$.

The solution set is $\{(-4,5)\}$.

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

$\dfrac{x+y}{5}=\dfrac{x-y}{2}-\dfrac{5}{2}$

Start by multiplying each equation by its LCD and simplifying to clear the fractions.

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

$\dfrac{x+y}{5}=\dfrac{x-y}{2}-\dfrac{5}{2}$

Start by multiplying each equation by its LCD and simplifying to clear the fractions.

$$6\left(\frac{x+2}{2}-\frac{y+4}{3}\right)=6(3)$$
$$3(x+2)-2(y+4)=18$$
$$3x+6-2y-8=18$$
$$3x-2y=20$$

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$$10\left(\frac{x+y}{5}\right)=10\left(\frac{x-y}{2}-\frac{5}{2}\right)$$
$$2(x+y)=5(x-y)-5(5)$$
$$2x+2y=5x-5y-25$$
$$3x-7y=25$$

We now need to solve the equivalent system of equations:

$$3x-2y=20$$
$$3x-7y=25$$

Subtract the two equations:

$$\begin{array}{r} 3x-2y=20 \\ \underline{-(3x-7y=25)} \\ 5y=-5 \\ y=-1 \end{array}$$

Back-substitute this value for y and solve for x.

$$3x-2y=20$$
$$3x-2(-1)=20$$
$$3x+2=20$$
$$3x=18$$
$$x=6$$

The solution is $(6,-1)$.

The solution set is $\{(6,-1)\}$.

84. $\dfrac{x-y}{3}=\dfrac{x+y}{2}-\dfrac{1}{2}$

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

Start by multiplying each equation by its LCD and simplifying to clear the fractions.

$$6\left(\frac{x-y}{3}\right)=6\left(\frac{x+y}{2}-\frac{1}{2}\right)$$
$$2(x-y)=3(x+y)-3(1)$$
$$2x-2y=3x+3y-3$$
$$x+5y=3$$

$$6\left(\frac{x+2}{2}-4\right)=6\left(\frac{y+4}{3}\right)$$
$$3(x+2)-6(4)=2(y+4)$$
$$3x+6-24=2y+8$$
$$3x-2y=26$$

We now need to solve the equivalent system of equations:

$$x+5y=3$$
$$3x-2y=26$$

Multiply the first equation by -3 and then add the equations.

$$\begin{array}{r} -3x-15y=-9 \\ \underline{3x-\ \ 2y=26} \\ -17y=17 \\ y=-1 \end{array}$$

Back-substitute this value for y into one of the above equations and solve for x.

$$x+5(-1)=3$$
$$x-5=3$$
$$x=8$$

The solution is $(8,-1)$.

The solution set is $\{(8,-1)\}$.

85. $5ax+4y=17$

$ax+7y=22$

Multiply the second equation by -5 and add the equations.

$$\begin{array}{r} 5ax+4y=17 \\ \underline{-5ax-35y=-110} \\ -31y=-93 \\ y=3 \end{array}$$

Back-substitute into one of the original equations to solve for x.

$$ax+7y=22$$
$$ax+7(3)=22$$
$$ax+21=22$$
$$ax=1$$
$$x=\frac{1}{a}$$

The solution is $\left(\frac{1}{a},3\right)$.

The solution set is $\left\{\left(\frac{1}{a},3\right)\right\}$.

86. $4ax+by=3$

$6ax+5by=8$

Multiply the first equation by -5 and add the equations.

$$\begin{array}{r} -20ax-5by=-15 \\ \underline{6ax+5by=8} \\ -14ax=-7 \\ x=\dfrac{1}{2a} \end{array}$$

Back-substitute into one of the original equations to solve for y.

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$$4a\left(\frac{1}{2a}\right)+by=3$$
$$2+by=3$$
$$by=1$$
$$y=\frac{1}{b}$$

The solution is $\left(\frac{1}{2a},\frac{1}{b}\right)$.

The solution set is $\left\{\left(\frac{1}{2a},\frac{1}{b}\right)\right\}$.

87. $f(-2)=11 \quad \rightarrow \quad -2m+b=11$

$f(3)=-9 \quad \rightarrow \quad 3m+b=-9$

We need to solve the resulting system of equations:

$$-2m+b=11$$
$$3m+b=-9$$

Subtract the two equations:

$$\begin{array}{r} -2m+b=11 \\ \underline{3m+b=-9} \\ -5m=20 \\ m=-4 \end{array}$$

Back-substitute into one of the original equations to solve for *b*.

$$-2m+b=11$$
$$-2(-4)+b=11$$
$$8+b=11$$
$$b=3$$

Therefore, $m=-4$ and $b=3$.

88. $f(-3)=23 \quad \rightarrow \quad -3m+b=23$

$f(2)=-7 \quad \rightarrow \quad 2m+b=-7$

We need to solve the resulting system of equations:

$$-3m+b=23$$
$$2m+b=-7$$

Subtract the two equations:

$$\begin{array}{r} -3m+b=23 \\ \underline{2m+b=-7} \\ -5m=30 \\ m=-6 \end{array}$$

Back-substitute into one of the original equations to solve for *b*.

$$-3m+b=23$$
$$-3(-6)+b=23$$
$$18+b=23$$
$$b=5$$

Therefore, $m=-6$ and $b=5$.

89. The solution to a system of linear equations is the point of intersection of the graphs of the equations in the system. If $(6,2)$ is a solution, then we need to find the lines that intersect at that point.

Looking at the graph, we see that the graphs of $x+3y=12$ and $x-y=4$ intersect at the point $(6,2)$. Therefore, the desired system of equations is

$$\begin{array}{lcl} x+3y=12 & \text{or} & y=-\frac{1}{3}x+4 \\ x-y=4 & & y=x-4 \end{array}$$

90. A system whose solution set is the empty set consists of parallel lines (assuming there are only two equations in the system). Therefore, we check the graph for two parallel lines.

From the graph, the desired system is
$$x-3y=-6$$
$$x-3y=6$$

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

91. a. $-3x+10y=160$

$x+2y=142$

Multiply the second equation by -5 and add the equations.

$$\begin{array}{r} -3x+10y=160 \\ \underline{-5x-10y=-710} \\ -8x=-550 \end{array}$$

Use the resulting equation to find *x*.

$$\frac{-8x}{-8}=\frac{-550}{-8}$$
$$x=68.75$$
$$x\approx 69$$

Back-substitute to find *y*.

$$x+2y=142$$
$$68.75+2y=142$$
$$2y=73.25$$
$$y=36.625$$
$$y\approx 37$$

The percentage of married and never-married adults will be the same about 69 years after 1970, or 2039.
In 2039, about 37% of Americans will belong to each group.

b. The approximate solution in part (a) is described by the point of intersection of the graphs $(69,37)$.

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92. **a.** Answers will vary. Approximate point is $(2004, 180)$. This means that in 2004 the number of cellphones and land-lines were both 180 million.

b. Using substitution,

$$4.3x + y = 198$$
$$4.3x + \overbrace{(19.8x + 98)}^{y} = 198$$
$$4.3x + 19.8x + 98 = 198$$
$$24.1x + 98 = 198$$
$$24.1x = 100$$
$$x \approx 4$$

The number of cellphone and land-line customers will be they same 4 years after 2000, or 2004.

$$y = 19.8x + 98$$
$$y = 19.8(4) + 98$$
$$y = 177.2$$
$$y \approx 180$$

The number of customers that each will have in 2004 is about 180 million.

c. The models describe the point of intersection quite well.

93. **a.** $y = 0.04x + 5.48$

b. $y = 0.17x + 1.84$

c. Using substitution,

$$0.17x + 1.84 = 0.04x + 5.48$$
$$0.13x = 3.64$$
$$x = 28$$

The costs for Medicare and Medicaid will be the same 28 years after 2000, or 2028.
Back-substitute to find *y*.

$$y = 0.17x + 1.84$$
$$y = 0.17(28) + 1.84$$
$$y = 6.6$$

In 2028, Medicare and Medicaid will each cost 6.6% of the GDP. After 2028, Medicare will have the greater cost.

94. **a.** $y = 2.8x + 60$

b. $y = 3.8x + 44$

c. Using substitution,

$$2.8x + 60 = 3.8x + 44$$
$$16 = x$$
$$y = 2.8x + 60$$
$$y = 2.8(16) + 60$$
$$= 104.8$$

16 years after 1998, or in 2014, the number of federal inmates for drug offenses will be the same as the number of federal inmates for all other crimes. Both will be 104.8 thousand inmates.

95. **a.** $m = \dfrac{27.3 - 38}{20 - 0} = \dfrac{-10.7}{20} \approx -0.54$

From the point $(0, 38)$ we have that the *y*-intercept is $b = 38$. Therefore, the equation of the line is $y = -0.54x + 38$.

b. $m = \dfrac{24.2 - 40}{20 - 0} = \dfrac{-15.8}{20} = -0.79$

From the point $(0, 40)$ we have that the *y*-intercept is $b = 40$. Therefore, the equation of the line is $y = -0.79x + 40$.

c. To find the year when cigarette use is the same, we set the two equations equal to each other and solve for *x*.

$$-0.54x + 38 = -0.79x + 40$$
$$0.25x = 2$$
$$x = 8$$

Cigarette use was the same for African Americans and Hispanics 8 years after 1985, or 1993.

$$y = -0.54x + 38$$
$$y = -0.54(8) + 38$$
$$y = 33.68$$

At that time about 33.68% of each group used cigarettes.

96. **a.** $m = \dfrac{27.3 - 38.9}{20 - 0} = \dfrac{-11.6}{20} = -0.58$

From the point $(0, 38.9)$ we have that the *y*-intercept is $b = 38.9$. Therefore, the equation of the line is $y = -0.58x + 38.9$.

b. $m = \dfrac{24.2 - 40}{20 - 0} = \dfrac{-15.8}{20} = -0.79$

From the point $(0, 40)$ we have that the *y*-intercept is $b = 40$. Therefore, the equation of the line is $y = -0.79x + 40$.

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c. To find the year when cigarette use is the same, we set the two equations equal to each other and solve for x.

$$-0.58x + 38.9 = -0.79x + 40$$
$$0.21x = 1.1$$
$$x \approx 5$$

Cigarette use was the same for whites and Hispanics 5 years after 1985, or 1990.

$$y = -0.58x + 38.9$$
$$y = -0.58(5) + 38.9$$
$$y = 36$$

At that time about 36% of each group used cigarettes.

97. a. $N_d = -5p + 750$
$= -5(120) + 750$
$= -600 + 750$
$= 150$

$N_s = 2.5(120) = 300$

If the price of the televisions is \$120, 150 sets can be sold and 300 sets can be supplied.

b. To find the price at which supply and demand are equal, we set the two equations equal to each other and solve for p.

$$-5p + 750 = 2.5p$$
$$750 = 7.5p$$
$$\frac{750}{7.5} = p$$
$$100 = p$$

$N = 2.5(100) = 250$.

Supply and demand will be equal if the price of the televisions is \$100. At that price, 250 sets can be supplied and sold.

98. a. Demand;

$N = -25p + 7800$
$N = -25(50) + 7800$
$= -1250 + 7800 = 6550$

6550 tickets will be sold at \$50 per ticket.

Supply ;

$N = 5p + 6000$
$N = 5(50) + 6000$
$= 250 + 6000 = 6250$

6250 tickets will be supplied at \$50 per ticket.

b. Multiply the second equation by –1.

$$\begin{aligned} N &= -25p + 7800 \\ -N &= -5p - 6000 \\ \hline 0 &= -30p + 1800 \end{aligned}$$

$$30p = 1800$$
$$p = 60$$

Back-substitute to find N.

$N = 5p + 6000$
$N = 5(60) + 6000 = 300 + 6000 = 6300$

At \$60, the supply and demand will be equal. At this price, 6300 tickets will be supplied and sold.

99. – 108. Answers will vary.

109. makes sense

110. does not make sense; Explanations will vary. Sample explanation: When the left side of the second equation was multiplied by 6, the –8 on the right side of the equation should also have been multiplied by 6.

111. makes sense

112. makes sense

113. false; Changes to make the statement true will vary. A sample change is: The addition method *can* be used to eliminate either variable.

114. false; Changes to make the statement true will vary. A sample change is: The solution set for the system contains all points on the line $5x - y = 1$.

115. false; Changes to make the statement true will vary. A sample change is: A system of linear equations can never have exactly two ordered pair solutions. There can be 0, 1, or an infinite number of solutions.

116. true

117. Substitute $(2, 1)$ into both equations.

$$ax - by = 4$$
$$a(2) - b(1) = 4$$
$$2a - b = 4$$

$$bx + ay = 7$$
$$b(2) + a(1) = 7$$
$$2b + a = 7$$

The two equations we need to solve now are

$$2a - b = 4$$
$$2b + a = 7$$

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Solve the second equation for a.

$$2b + a = 7$$
$$a = 7 - 2b$$

Substitute $a = 7 - 2b$ into the first equation.

$$\begin{aligned} 2a - b &= 4 \\ 2(7 - 2b) - b &= 4 \\ 14 - 4b - b &= 4 \\ -5b &= -10 \\ b &= 2 \end{aligned}$$

Back substitute to solve for a.

$$\begin{aligned} 2a - b &= 4 \\ 2a - 2 &= 4 \\ 2a &= 6 \\ a &= 3 \end{aligned}$$

The solution of the system is $a = 3, b = 2$.

118. Answers will vary. One system of equations with solution set $\{(-2,7)\}$ is: $3x + 4y = 22$
$-x - y = -5.$

119. Multiply the first equation by $-a_2$ and the second equation by a_1.

$$\begin{aligned} -a_1a_2x - a_2b_1y &= -a_2c_1 \\ a_1a_2x + a_1b_2y &= a_1c_2 \\ \hline (a_1b_2 - a_2b_1)y &= a_1c_2 - a_2c_1 \\ y &= \frac{a_1c_2 - a_2c_1}{a_1b_2 - a_2b_1} \end{aligned}$$

Back-substitute $\frac{a_1c_2 - a_2c_1}{a_1b_2 - a_2b_1}$ for y to find x.

$$\begin{aligned} -a - b - c &= -4 \\ 9a + 3b + c &= 20 \\ \hline 8a + 2b &= 16 \end{aligned}$$

$$\begin{aligned} -3x + 3y + 6z &= -6 \\ 2x - 3y + 6z &= 5 \\ \hline -x + 12z &= -1 \end{aligned}$$

$$a_1x = \frac{-a_1b_1c_2 + a_2b_1c_1}{a_1b_2 - a_2b_1} + \frac{a_1b_2c_1 - a_2b_1c_1}{a_1b_2 - a_2b_1}$$

$$a_1x = \frac{-a_1b_1c_2 + \cancel{a_2b_1c_1} + a_1b_2c_1 - \cancel{a_2b_1c_1}}{a_1b_2 - a_2b_1}$$

$$a_1x = \frac{-a_1b_1c_2 + a_1b_2c_1}{a_1b_2 - a_2b_1}$$

$$\frac{\cancel{a_1}x}{\cancel{a_1}} = \frac{\frac{-a_1b_1c_2 + a_1b_2c_1}{a_1b_2 - a_2b_1}}{a_1}$$

$$x = \frac{-a_1b_1c_2 + a_1b_2c_1}{a_1b_2 - a_2b_1} \cdot \frac{1}{a_1}$$

$$x = \frac{(-b_1c_2 + b_2c_1)\cancel{a_1}}{a_1b_2 - a_2b_1} \cdot \frac{1}{\cancel{a_1}}$$

$$x = \frac{-b_1c_2 + b_2c_1}{a_1b_2 - a_2b_1} = \frac{b_2c_1 - b_1c_2}{a_1b_2 - a_2b_1}$$

The solution is $\left(\frac{b_2c_1 - b_1c_2}{a_1b_2 - a_2b_1}, \frac{a_1c_2 - a_2c_1}{a_1b_2 - a_2b_1}\right)$.

The solution set is $\left\{\left(\frac{b_2c_1 - b_1c_2}{a_1b_2 - a_2b_1}, \frac{a_1c_2 - a_2c_1}{a_1b_2 - a_2b_1}\right)\right\}$.

120.
$$\begin{aligned} 6x &= 10 + 5(3x - 4) \\ 6x &= 10 + 15x - 20 \\ 6x &= 15x - 10 \\ -9x &= -10 \\ x &= \frac{10}{9} \end{aligned}$$

The solution is $\frac{10}{9}$.

The solution set is $\left\{\frac{10}{9}\right\}$.

121.
$$\begin{aligned} (4x^2y^4)^2(-2x^5y^0)^3 &= 4^2x^{2\cdot2}y^{4\cdot2}(-2)^3x^{5\cdot3}y^{0\cdot3} \\ &= 4^2x^4y^8(-2)^3x^{15}y^0 \\ &= 16(-8)x^4x^{15}y^8y^0 \\ &= -128x^{19}y^8 \end{aligned}$$

122.
$$f(x) = x^2 - 3x + 7$$
$$f(-1) = (-1)^2 - 3(-1) + 7 = 1 + 3 + 7 = 11$$

123.
$$\begin{aligned} P_1r_1 + P_2r_2 &= x \cdot 0.15 + y \cdot 0.07 \\ &= 0.15x + 0.07y \end{aligned}$$

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124. $x = (0.30)(50) = 15$ milliliters

125. $\underbrace{80}_{\substack{\text{Price}\\\text{per pair}}} \cdot \underbrace{x}_{\substack{\text{Number}\\\text{of pairs}}} = 80x$

3.2 Check Points

1. Let x = the number of calories in hamburger and fries.
Let y = the number of calories in fettuccine Alfredo.
$x + 2y = 4240$
$2x + y = 3980$
This system can be solved by substitution.
Solve for x in terms of y.
$x + 2y = 4240$
$x = -2y + 4240$
Substitute this value into the other equation.

$$2x + y = 3980$$
$$2(\overbrace{-2y + 4240}^{x}) + y = 3980$$
$$-4y + 8480 + y = 3980$$
$$-3y + 8480 = 3980$$
$$-3y = -4500$$
$$y = 1500$$

Back-substitute to find x.
$x = -2y + 4240$
$x = -2(1500) + 4240$
$x = 1240$
There are 1240 calories in hamburger and fries and 1500 calories in fettuccine Alfredo.

2. Let x = the amount invested at 9%.
Let y = the amount invested at 11%.
$x + y = 5000$
$0.09x + 0.11y = 487$
This system can be solved by substitution.
Solve for y in terms of x.
$x + y = 5000$
$y = -x + 5000$
Substitute this value into the other equation.

$$0.09x + 0.11y = 487$$
$$0.09x + 0.11(\overbrace{-x + 5000}^{y}) = 487$$
$$0.09x - 0.11x + 550 = 487$$
$$-0.02x + 550 = 487$$
$$-0.02x = -63$$
$$x = 3150$$

Back-substitute to find y.

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$y = -x + 5000$

$y = -(3150) + 5000$

$y = 1850$

There was \$3150 invested at 9% and \$1850 invested at 11%.

3. Let x = the number of ounces of 12% acid solution.
Let y = the number of ounces of 20% acid solution.

$$x + y = 160$$
$$0.12x + 0.20y = 0.15(160)$$

This system can be solved by substitution.
Solve for y in terms of x.

$x + y = 160$

$y = -x + 160$

Substitute this value into the other equation.

$$0.12x + 0.20y = 0.15(160)$$
$$0.12x + 0.20y = 24$$
$$0.12x + 0.20(\overbrace{-x + 160}^{y}) = 24$$
$$-0.08x + 32 = 24$$
$$-0.08x = -8$$
$$x = 100$$

Back-substitute to find y.

$y = -x + 160$

$y = -(100) + 160$

$y = 60$

The chemist should mix 100 ounces of the 12% acid solution and 60 ounces of the 20% acid solution.

4. Let x = the rate of the motorboat in still water.
Let y = the rate of the current.

	Rate	×	Time	=	Distance
Trip with the Current	$x + y$		2		$2(x + y)$
Trip against the Current	$x - y$		3		$3(x - y)$

This gives,

$2(x + y) = 84$

$3(x - y) = 84$

This system simplifies to:

$x + y = 42$

$x - y = 28$

This system can be solved by addition.

$$\begin{array}{r} x + y = 42 \\ \underline{x - y = 28} \\ 2x \qquad = 70 \\ x = 35 \end{array}$$

Back-substitute to find y.

$x + y = 42$

$35 + y = 42$

$y = 7$

The rate of the motorboat in still water is 35 miles per hour and the rate of the current is 7 miles per hour.

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5. a. $C(x) = 300{,}000 + 30x$

b. $R(x) = 80x$

c. $y = 300{,}000 + 30x$

$y = 80x$

This system can be solved by substitution.

$80x = 300{,}000 + 30x$

$50x = 300{,}000$

$x = 6000$

Back-substitute to find y.

$y = 80x$

$y = 80(6000)$

$y = 480{,}000$

The break-even point is (6000, 480,000). This means the company will break even when it produces and sells 6000 pairs of shoes. At this level, both revenue and costs are $480,000.

6. Profit equals revenue minus cost.

$$\begin{aligned} P(x) &= R(x) - C(x) \\ &= (80x) - (300{,}000 + 30x) \\ &= 50x - 300{,}000 \end{aligned}$$

3.2 Concept and Vocabulary Check

1. $1180x + 125y$

2. $0.12x + 0.09y$

3. $0.09x + 0.6y$

4. $x + y$; $x - y$

5. $4(x + y)$

6. revenue; profit

7. break-even point

3.2 Exercise Set

1. Let x = the first number.
Let y = the second number.

$x + y = 7$

$x - y = -1$

Solve by addition:

$$\begin{array}{r} x + y = 7 \\ \underline{x - y = -1} \\ 2x = 6 \\ x = 3 \end{array}$$

Back-substitute to find y.

$3 + y = 7$

$y = 4$

The numbers are 3 and 4.

2. Let x = the first number.
Let y = the second number.

$x + y = 2$

$x - y = 8$

Solve by addition.

$$\begin{array}{r} x + y = 2 \\ \underline{x - y = 8} \\ 2x = 10 \\ x = 5 \end{array}$$

Back-substitute to find y.

$x + y = 2$

$5 + y = 2$

$y = -3$

The numbers are 5 and –3.

3. Let x = the first number.
Let y = the second number.

$3x - y = 1$

$x + 2y = 12$

Multiply the first equation by 2.

$$\begin{array}{r} 6x - 2y = 2 \\ \underline{x + 2y = 12} \\ 7x = 14 \\ x = 2 \end{array}$$

Back-substitute to find y.

$x + 2y = 12$

$2 + 2y = 12$

$2y = 10$

$y = 5$

The numbers are 2 and 5.

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4. Let x = the first number.
Let y = the second number.

$$\begin{aligned} 3x+2y&=8 \\ 2x-\ \ y&=3 \end{aligned}$$

Multiply the second equation by 2 and add to the first equation.

$$\begin{aligned} 3x+2y&=8 \\ \underline{4x-2y}&\underline{=6} \\ 7x&=14 \\ x&=2 \end{aligned}$$

Back-substitute to find y.

$$\begin{aligned} 3x+2y&=8 \\ 3(2)+2y&=8 \\ 6+2y&=8 \\ 2y&=2 \\ y&=1 \end{aligned}$$

The numbers are 2 and 1.

5. a. At the break-even point, $R(x)=C(x)$.

$$\begin{aligned} 25500+15x&=32x \\ 25500&=17x \\ 1500&=x \end{aligned}$$

$$\begin{aligned} C(x)&=32x \\ C(1500)&=32(1500) \\ &=48000 \end{aligned}$$

Fifteen hundred units must be produced and sold to break even. At this point, there will $48,000 in costs and revenue.

b.
$$\begin{aligned} P(x)&=R(x)-C(x) \\ &=(32x)-(25,500+15x) \\ &=32x-25,500-15x \\ &=17x-25,500 \end{aligned}$$

6. a. At the break-even point, $C(x)=R(x)$.

$$\begin{aligned} 15,000+12x&=32x \\ 15,000&=20x \\ 750&=x \end{aligned}$$

$$\begin{aligned} R(x)&=32x \\ R(750)&=32(750) \\ &=24,000 \end{aligned}$$

750 units must be produced and sold to break even. At this point, there will $24,000 in cost and revenue.

b.
$$\begin{aligned} P(x)&=R(x)-C(x) \\ &=(32x)-(15,000+12x) \\ &=32x-15,000-12x \\ &=20x-15,000 \end{aligned}$$

7. a. At the break-even point, $R(x)=C(x)$.

$$\begin{aligned} 105x+70,000&=245x \\ 70,000&=140x \\ 500&=x \end{aligned}$$

$$\begin{aligned} C(x)&=245x \\ C(500)&=245(500) \\ &=122,500 \end{aligned}$$

Five hundred units must be produced and sold to break even. At this point, there will $122,500 in costs and revenue.

b.
$$\begin{aligned} P(x)&=R(x)-C(x) \\ &=(245x)-(105x+70,000) \\ &=245x-105x-70,000 \\ &=140x-70,000 \end{aligned}$$

8. a. At the break-even point, $C(x)=R(x)$.

$$\begin{aligned} 1.2x+1500&=1.7x \\ 1500&=0.5x \\ 3000&=x \end{aligned}$$

$$\begin{aligned} R(x)&=1.7x \\ R(3000)&=1.7(3000) \\ &=5100 \end{aligned}$$

3000 units must be produced and sold to break even. At this point, there will be $5100 in cost and revenue.

b.
$$\begin{aligned} P(x)&=R(x)-C(x) \\ &=(1.7x)-(1.2x+1500) \\ &=1.7x-1.2x-1500 \\ &=0.5x-1500 \end{aligned}$$

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9. Let x = the percent of college men who play online games multiple times per day.
Let y = the percent of college men who play online games once per day.
Use the given information to set up a system of equations.

$$x + y = 41$$
$$x - y = 7$$

Solve by addition.

$$\begin{aligned} x + y &= 41 \\ \underline{x - y} &\underline{= 7} \\ 2x &= 48 \\ x &= 24 \end{aligned}$$

Back-substitute to find y.

$$\begin{aligned} x + y &= 41 \\ 24 + y &= 41 \\ y &= 17 \end{aligned}$$

24% of college men play online games multiple times per day. While 17% of college men play online games once per day.

10. Let x = the percent of college students who sleep between 5 and 7 hours.
Let y = the percent of college students who sleep between 9 and 11 hours
Use the given information to set up a system of equations.

$$x + y = 45$$
$$y - x = 41$$

Solve by addition.

$$\begin{aligned} x + y &= 45 \\ \underline{x - y} &\underline{= 41} \\ 2x &= 86 \\ x &= 43 \end{aligned}$$

Back-substitute to find x.

$$\begin{aligned} x + y &= 45 \\ 43 + y &= 45 \\ y &= 2 \end{aligned}$$

43% of college students sleep betweeb 5 and 7 hours. While 2% of college students sleep between 9 and 11 hours.

11. Let x = the number of computers sold.
Let y = the number of hard drives sold.

$$\begin{aligned} x + y &= 36 \\ 1180x + 125y &= 27{,}710 \end{aligned}$$

Multiply the first equation by -125 and add the two equations.

$$\begin{aligned} -125x - 125y &= -4500 \\ \underline{1180x + 125y} &\underline{= 27{,}710} \\ 1055x &= 23{,}210 \\ x &= 22 \end{aligned}$$

Back-substitute to solve for y.

$$\begin{aligned} x + y &= 36 \\ 22 + y &= 36 \\ y &= 14 \end{aligned}$$

The store sold 22 computers and 14 hard drives.

12. Let x = the number of nonmembers.
Let y = the number of members.

$$\begin{aligned} x + y &= 180 \\ 4.50x + 8.25y &= 1222.50 \end{aligned}$$

Multiply the first equation by -4.50 and add the two equations.

$$\begin{aligned} -4.50x - 4.50y &= -810 \\ \underline{4.50x + 8.25y} &\underline{= 1222.50} \\ 3.75x &= 412.50 \\ x &= 110 \end{aligned}$$

Back-substitute to solve for y.

$$\begin{aligned} x + y &= 180 \\ 110 + y &= 180 \\ y &= 70 \end{aligned}$$

70 members and 110 nonmembers attended the fundraiser.

13. Let x = the amount invested at 6%.
Let y = the amount invested at 8%.

$$\begin{aligned} x + y &= 7000 \\ 0.06x + 0.08y &= 520 \end{aligned}$$

Solve the first equation for x.

$$x = 7000 - y$$

Substitute this result for x in the second equation.

$$\begin{aligned} 0.06(7000 - y) + 0.08y &= 520 \\ 420 - 0.06y + 0.08y &= 520 \\ 0.02y &= 100 \\ y &= \frac{100}{0.02} = 5000 \end{aligned}$$

Back-substitute to solve for x.

$$\begin{aligned} x + y &= 7000 \\ x + 5000 &= 7000 \\ x &= 2000 \end{aligned}$$

\$2000 was invested at 6% and \$5000 was invested at 8%.

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14. Let x = the amount invested in stocks.
Let y = the amount invested in bonds.

$$x + y = 11000$$
$$0.05x + 0.08y = 730$$

Solve the first equation for x.

$$x = 11000 - y$$

Substitute this result for x in the second equation.

$$0.05(11000 - y) + 0.08y = 730$$
$$550 - 0.05y + 0.08y = 730$$
$$0.03y = 180$$
$$y = \frac{180}{0.03} = 6000$$

Back-substitute to solve for x.

$$x + y = 11000$$
$$x + 6000 = 11000$$
$$x = 5000$$

\$5000 was invested in stocks and \$6000 was invested in bonds.

15. Let x = the amount in the first fund.
Let y = the amount in the second fund.

$$0.09x + 0.03y = 900$$
$$0.10x + 0.01y = 860$$

Multiply the second equation by -3 and add the two equations.

$$0.09x + 0.03y = 900$$
$$\underline{-0.30x - 0.03y = -2580}$$
$$-0.21x = -1680$$
$$x = 8000$$

Back-substitute to solve for y.

$$0.10x + 0.01y = 860$$
$$0.10(8000) + 0.01y = 860$$
$$800 + 0.01y = 860$$
$$0.01y = 60$$
$$y = \frac{60}{0.01} = 6000$$

\$8000 was invested in the first fund and \$6000 was invested in the second fund.

16. Let x = the amount in the first fund.
Let y = the amount in the second fund.

$$0.08x + 0.05y = 1330$$
$$0.12x + 0.02y = 1500$$

Multiply the first equation by -1.5 and add the two equations.

$$-0.12x - 0.075y = -1995$$
$$\underline{0.12x + 0.02y = 1500}$$
$$-0.055y = -495$$
$$y = 9000$$

Back-substitute to solve for y.

$$0.12x + 0.02y = 1500$$
$$0.12x + 0.02y = 1500$$
$$0.12x + 0.02(9000) = 1500$$
$$0.12x + 180 = 1500$$
$$0.12x = 1320$$
$$x = \frac{1320}{0.12} = 11000$$

\$11,000 was invested in the first fund and \$9,000 was invested in the second fund.

17. Let x = amount invested with 12% return.
Let y = amount invested with the 5% loss.

$$x + y = 20{,}000$$
$$0.12x - 0.05y = 1890$$

Multiply the first equation by 0.05 and add the two equations.

$$0.05x + 0.05y = 1000$$
$$\underline{0.12x - 0.05y = 1890}$$
$$0.17x = 2890$$
$$x = 17{,}000$$

Back-substitute to solve for y.

$$x + y = 20{,}000$$
$$17{,}000 + y = 20{,}000$$
$$y = 3{,}000$$

\$17,000 was invested at 12% return and \$3000 was invested at a 5% loss.

18. Let x = amount invested with 14% return.
Let y = amount invested with the 6% loss.

$$x + y = 30{,}000$$
$$0.14x - 0.06y = 200$$

Multiply the first equation by 0.06 and add the two equations.

$$0.06x + 0.06y = 1800$$
$$\underline{0.14x - 0.06y = 200}$$
$$0.20x = 2000$$
$$x = 10{,}000$$

Back-substitute to solve for y.

$$x + y = 30{,}000$$
$$10{,}000 + y = 30{,}000$$
$$y = 20{,}000$$

\$10,000 was invested at 14% return and \$20,000 was invested at a 6% loss.

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19. Let x = gallons of 5% wine.
Let y = gallons of 9% wine.

$$x + y = 200$$
$$0.05x + 0.09y = 0.07(200)$$

or

$$x + y = 200$$
$$0.05x + 0.09y = 14$$

Solve the first equation for x.

$$x + y = 200$$
$$x = 200 - y$$

Substitute this expression for x in the second equation.

$$0.05(200 - y) + 0.09y = 14$$
$$10 - 0.05y + 0.09y = 14$$
$$0.04y = 4$$
$$y = 100$$

Back-substitute and solve for x.

$$x = 200 - y$$
$$= 200 - 100$$
$$= 100$$

The wine company should mix 100 gallons of the 5% California wine with 100 gallons of the 9% French wine.

20. Let x = ounces of 16% gold content.
Let y = ounces of 28% gold content.

$$x + y = 32$$
$$0.16x + 0.28y = 0.25(32)$$

or

$$x + y = 32$$
$$0.16x + 0.28y = 8$$

Solve the first equation for x.

$$x = 32 - y$$

Substitute this result for x into the second equation and solve for y.

$$0.16(32 - y) + 0.28y = 8$$
$$5.12 - 0.16y + 0.28y = 8$$
$$0.12y = 2.88$$
$$y = 24$$

Back-substitute to solve for x.

$$x = 32 - y = 32 - 24 = 8$$

You would need to use 8 ounces of 16% gold content and 24 ounces of 28% gold content.

21. Let x = grams of 18-karat gold.
Let y = grams of 12-karat gold.

$$x + y = 300$$
$$0.75x + 0.5y = 0.58(300)$$

or

$$x + y = 300$$
$$0.75x + 0.5y = 174$$

Solve the first equation for x.

$$x = 300 - y$$

Substitute this result for x into the second equation and solve for y.

$$0.75(300 - y) + 0.5y = 174$$
$$225 - 0.75 + 0.5y = 174$$
$$-0.25y = -51$$
$$y = 204$$

Back-substitute to solve for x.

$$x = 300 - y = 300 - 204 = 96$$

You would need 96 grams of 18-karat gold and 204 grams of 12-karat gold.

22. Let x = gallons of cream.
Let y = gallons of milk.

$$x + y = 50$$
$$0.25x + 0.35y = 0.125(50)$$

or

$$x + y = 50$$
$$0.25x + 0.035y = 6.25$$

Multiply the first equation by -0.25 and add the two equations.

$$\begin{array}{r} -0.25x - 0.25y = -12.5 \\ \underline{0.25x + 0.035y = 6.25} \\ -0.215y = -6.25 \end{array}$$
$$y \approx 29.07$$

Back-substitute to solve for x.

$$x + y = 50$$
$$x + 29.07 = 50$$
$$x = 20.93$$

20.93 gallons of cream and 29.07 gallons of milk should be mixed.

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23. Let x = pounds of cheaper candy.
Let y = pounds of more expensive candy.

$$x + y = 75$$
$$1.6x + 2.1y = 1.9(75)$$

or

$$x + y = 75$$
$$1.6x + 2.1y = 142.5$$

Multiply the first equation by -1.6 and add the two equations.

$$\begin{array}{r} -1.6x - 1.6y = -120 \\ \underline{1.6x + 2.1y = 142.5} \\ 0.5y = 22.5 \\ y = 45 \end{array}$$

Back-substitute to solve for x.

$$x + 45 = 75$$
$$x = 30$$

The manager should mix 30 pounds of the cheaper candy and 45 pounds of the more expensive candy.

24. Let x = pounds of raisins.
Let y = pounds of granola.

$$x + y = 10$$
$$2x + 3.25y = 2.50(10)$$

or

$$x + y = 10$$
$$2x + 3.25y = 25$$

Solve the first equation for x.

$$x = 10 - y$$

Substitute this result for x into the second equation and solve for y.

$$2(10 - y) + 3.25y = 25$$
$$20 - 2y + 3.25y = 25$$
$$1.25y = 5$$
$$y = 4$$

Back substitute to solve for x.

$$x + y = 10$$
$$x + 4 = 10$$
$$x = 6$$

The grocer needs to use 6 pounds of raisins and 4 pounds of granola.

25. Let n = the number of nickels.
Let d = the number of dimes.

$$n + d = 15$$
$$0.05n + 0.1d = 1.10$$

Solve the first equation for n.

$$n = 15 - d$$
$$0.05(15 - d) + 0.1d = 1.10$$
$$0.75 - 0.05d + 0.1d = 1.10$$
$$0.05d = 0.35$$
$$d = 7$$

Back-substitute to solve for n.

$$n + 7 = 15$$
$$n = 8$$

The purse has 8 nickels and 7 dimes.

26. Let d = the number of dimes.
Let q = the number of quarters.

$$d + q = 15$$
$$0.10d + 0.25q = 3.30$$

Solve the first equation for d.

$$d = 15 - q$$
$$0.10(15 - q) + 0.25q = 3.30$$
$$1.5 - 0.1q + 0.25q = 3.30$$
$$0.15q = 1.8$$
$$q = 12$$

Back-substitute to solve for d.

$$d + 12 = 15$$
$$d = 3$$

The purse has 3 dimes and 12 quarters.

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27. Let x = the speed of the plane in still air.
Let y = the speed of the wind.

	Rate	×	Time	=	Distance
Trip with the Wind	$x+y$		5		$5(x+y)$
Trip against the Wind	$x-y$		8		$8(x-y)$

$$5(x+y)=800$$
$$8(x-y)=800$$

$$5x+5y=800$$
$$8x-8y=800$$

Multiply the first equation by 8 and the second equation by 5.

$$40x+40y=6400$$
$$40x-40y=4000$$
$$80x=10400$$
$$x=130$$

Back-substitute to find y.

$$5x+5y=800$$
$$5(130)+5y=800$$
$$650+5y=800$$
$$5y=150$$
$$y=30$$

The speed of the plane in still air is 130 miles per hour and the speed of the wind is 30 miles per hour.

28. Let x = the speed of the plane in still air.
Let y = the speed of the wind.

	Rate	×	Time	=	Distance
Trip with the Wind	$x+y$		6		$6(x+y)$
Trip against the Wind	$x-y$		7		$7(x-y)$

$$6(x+y)=4200$$
$$7(x-y)=4200$$

Divide the first equation by 6 and the second equation by 7 and solve by addition.

$$x+y=700$$
$$x-y=600$$
$$2x=1300$$
$$x=650$$

Back-substitute to find y.

$$650+y=700$$
$$y=50$$

The speed of the plane is 650 mph and the speed of the wind is 50 mph.

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29. Let x = the crew's rowing rate.
Let y = the rate of the current.

	Rate	×	Time	=	Distance
Trip with the Current	$x+y$		2		$2(x+y)$
Trip against the Current	$x-y$		4		$4(x-y)$

$2(x+y)=16$

$4(x-y)=16$

Rewrite the system in $Ax+By=C$ form.

$2x+2y=16$

$4x-4y=16$

Multiply the first equation by –2.

$$\begin{array}{r} -4x-4y=-32 \\ \underline{4x-4y=\ \ 16} \\ -8y=-16 \\ y=2 \end{array}$$

Back-substitute to find x.

$$\begin{aligned} 2x+2(2)&=16 \\ 2x+4&=16 \\ 2x&=12 \\ x&=6 \end{aligned}$$

The crew's rowing rate is 6 kilometers per hour and the rate of the current is 2 kilometers per hour.

30. Let x = the boat's rate in still water.
Let y = the rate of the current.

	Rate	×	Time	=	Distance
Trip with the Current	$x+y$		1.5		$1.5(x+y)$
Trip against the Current	$x-y$		2		$2(x-y)$

$1.5(x+y)=36$

$2(x-y)=36$

Divide the first equation by 1.5 and the second equation by 2 and solve by addition.

$$\begin{array}{r} x+y=24 \\ \underline{x-y=18} \\ 2x=42 \\ x=21 \end{array}$$

Back-substitute to find y.

$$\begin{aligned} x+y&=24 \\ 21+y&=24 \\ y&=3 \end{aligned}$$

The speed of the boat in still water is 21 miles per hour, and the rate of the current is 3 miles per hour.

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31. Let x = the speed in still water.
Let y = the speed of the current.

	Rate	×	Time	=	Distance
Trip with the Current	$x+y$		4		$4(x+y)$
Trip against the Current	$x-y$		6		$6(x-y)$

$$4(x+y)=24$$
$$6(x-y)=\frac{3}{4}(24)$$

Rewrite the system in $Ax+By=C$ form.

$$4x+4y=24$$
$$6x-6y=18$$

Multiply the first equation by –3 and the second equation by 2.

$$\begin{aligned} -12x-12y&=-72\\ \underline{12x-12y}&\underline{=36}\\ -24y&=-36\\ y&=1.5 \end{aligned}$$

Back-substitute to find x.

$$\begin{aligned} 4x+4y&=24\\ 4x+4(1.5)&=24\\ 4x+6&=24\\ 4x&=18\\ x&=4.5 \end{aligned}$$

The speed in still water is 4.5 miles per hour and the speed of the current is 1.5 miles per hour.

32. Let x = the speed in still water.
Let y = the speed of the current.

	Rate	×	Time	=	Distance
Trip with the Current	$x+y$		3		$3(x+y)$
Trip against the Current	$x-y$		4		$4(x-y)$

$$3(x+y)=24$$
$$4(x-y)=\frac{2}{3}(24)$$

Divide the first equation by 3 and the second equation by 4 and solve by addition.

$$\begin{aligned} x+y&=8\\ \underline{x-y}&\underline{=4}\\ 2x&=12\\ x&=6 \end{aligned}$$

Back-substitute to find y

$$\begin{aligned} x+y&=8\\ 6+y&=8\\ y&=2 \end{aligned}$$

The rowing speed in still water is 6 mph and the speed of the current is 2 mph.

33. Let x = the larger score.
Let y = the smaller score.

$$x - y = 12$$
$$\frac{x+y}{2} = 80$$

Rewrite the second equation in standard form.

$$x - y = 12$$
$$x + y = 160$$

Add the two equations.

$$\begin{array}{l} x - y = 12 \\ \underline{x + y = 160} \\ 2x \quad = 172 \\ x \quad = 86 \end{array}$$

Back-substitute to solve for y.

$$\begin{aligned} x - y &= 12 \\ 86 - y &= 12 \\ -y &= -74 \\ y &= 74 \end{aligned}$$

The two test scores are 74 and 86.

34. Let x = the larger score.
Let y = the smaller score.

$$x - y = 8$$
$$\frac{x+y}{2} = 88$$

Rewrite the second equation in standard form.

$$x - y = 8$$
$$x + y = 176$$

Add the two equations.

$$\begin{array}{l} x - y = 8 \\ \underline{x + y = 176} \\ 2x \quad = 184 \\ x = 92 \end{array}$$

Back-substitute to solve for y.

$$\begin{aligned} x - y &= 8 \\ 92 - y &= 8 \\ -y &= -84 \\ y &= 84 \end{aligned}$$

The two test scores are 92 and 84.

35.

$$\begin{aligned} x + 2y &= 180 \\ (2x - 30) + y &= 180 \end{aligned}$$

Rewrite the second equation in standard form.

$$x + 2y = 180$$
$$2x + y = 210$$

Multiply the first equation by -2 and add the equations.

$$\begin{array}{l} -2x - 4y = -360 \\ \underline{2x + y = 210} \\ -3y = -150 \\ y = 50 \end{array}$$

Back-substitute to solve for x.

$$\begin{aligned} x + 2y &= 180 \\ x + 2(50) &= 180 \\ x + 100 &= 180 \\ x &= 80 \end{aligned}$$

The three interior angles measure $80°$, $50°$, and $50°$.

36.

$$\begin{aligned} x + 2y &= 180 \\ (3x + 15) + y &= 180 \end{aligned}$$

Rewrite the second equation in standard form.

$$x + 2y = 180$$
$$3x + y = 165$$

Multiply the first equation by -3 and add the equations.

$$\begin{array}{l} -3x - 6y = -540 \\ \underline{3x + y = 165} \\ -5y = -375 \\ y = 75 \end{array}$$

Back-substitute to solve for x.

$$\begin{aligned} x + 2y &= 180 \\ x + 2(75) &= 180 \\ x + 150 &= 180 \\ x &= 30 \end{aligned}$$

The three interior angles measure $30°$, $75°$, and $75°$.

37. Let x = the lot length.
Let y = the lot width.

$$\begin{aligned} 2x + 2y &= 220 \\ 20x + 8(2y) &= 2040 \end{aligned}$$

Rewriting the second equation gives the following equivalent system:

$$\begin{aligned} 2x + 2y &= 220 \\ 20x + 16y &= 2040 \end{aligned}$$

Multiply the first equation by -8 and add the two equations.

$$\begin{array}{l} -16x - 16y = -1760 \\ \underline{20x + 16y = 2040} \\ 4x = 280 \\ x = 70 \end{array}$$

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Back-substitute to find y.

$$\begin{aligned} 2x+2y&=220 \\ 2(70)+2y&=220 \\ 140+2y&=220 \\ 2y&=80 \\ y&=40 \end{aligned}$$

The lot is 70 feet long and 40 feet wide.

38. Let x = the length of the rectangular lot,
Let y = the width of the rectangular lot

$$\begin{aligned} 2x+\ \ 2y&=\ 260 \\ 16x+5(2y)&=1780 \end{aligned}$$

$$\begin{aligned} 2x+\ \ 2y&=\ 260 \\ 16x+\ 10y&=1780 \end{aligned}$$

Multiply the first equation by –8.

$$\begin{aligned} -16x-16y&=-2080 \\ 16x+10y&=\ \ 1780 \\ \hline -6y&=-300 \\ y&=50 \end{aligned}$$

Back-substitute to find x.

$$\begin{aligned} 2x+2y&=260 \\ 2x+2(50)&=260 \\ 2x+100&=260 \\ 2x&=160 \\ x&=80 \end{aligned}$$

The length is 80 feet and the width is 50 feet.

39. Let x = the number of two-seat tables.
Let y = the number of four-seat tables.

$$\begin{aligned} 2x+4y&=56 \\ x+y&=17 \end{aligned}$$

Multiply the second equation by -2 and add the two equations.

$$\begin{aligned} 2x+4y&=56 \\ -2x-2y&=-34 \\ \hline 2y&=22 \\ y&=11 \end{aligned}$$

Back-substitute to find x.

$$\begin{aligned} x+y&=17 \\ x+11&=17 \\ x&=6 \end{aligned}$$

The owners should buy 6 two-seat tables and 11 four-seat tables.

40. Let x = the number of rooms with kitchen facilities.
Let y = the number of rooms without kitchen facilities.

$$\begin{aligned} x+y&=200 \\ 100x+80y&=17{,}000 \end{aligned}$$

Solve the first equation for y.

$$y=200-x$$

$$\begin{aligned} 100x+80(200-x)&=17{,}000 \\ 100x+16{,}000-80x&=17{,}000 \\ 20x&=1{,}000 \\ x&=50 \end{aligned}$$

Back substitute to solve for y.

$$\begin{aligned} x+y&=200 \\ 50+y&=200 \\ y&=150 \end{aligned}$$

The hotel has 50 rooms with kitchen facilities and 150 rooms without kitchen facilities.

41. At the break-even point, $R(x)=C(x)$.

$$\begin{aligned} 50x&=10{,}000+30x \\ 20x&=10{,}000 \\ 20x&=10{,}000 \\ x&=500 \end{aligned}$$

500 radios must be produced and sold to break even.

42. To have a profit, the revenue must surpass the costs.

$$R(x)>C(x).$$

$$\begin{aligned} 50x&>10{,}000+30x \\ 20x&>10{,}000 \\ 20x&>10{,}000 \\ x&>500 \end{aligned}$$

More than 500 radios must be produced and sold to have a profit.

43.

$$\begin{aligned} R(x)&=50x \\ R(200)&=50(200)=10{,}000 \\ C(x)&=10{,}000+30x \\ C(200)&=10{,}000+30(200) \\ &=10{,}000+6000=16{,}000 \end{aligned}$$

$$\begin{aligned} R(200)-C(200)&=10{,}000-16{,}000 \\ &=-6000 \end{aligned}$$

This means that if 200 radios are produced and sold the company will lose $6000.

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44. $R(300) = 50(300) = 15{,}000$

$C(300) = 10{,}000 + 30(300)$
$= 10{,}000 + 9000 = 19{,}000$

$R(300) - C(300) = 15{,}000 - 19{,}000$
$= -4000$

This means that if 300 radios are produced and sold the company will lose $4000.

45. a. $P(x) = R(x) - C(x)$
$= 50x - (10{,}000 + 30x)$
$= 50x - 10{,}000 - 30x$
$= 20x - 10{,}000$

$P(x) = 20x - 10{,}000$

b. $P(10{,}000) = 20(10{,}000) - 10{,}000$
$= 200{,}000 - 10{,}000 = 190{,}000$

If 10,000 radios are produced and sold the profit will be $190,000.

46. a. $P(x) = R(x) - C(x)$
$= 50x - (10{,}000 + 30x)$
$= 50x - 10{,}000 - 30x$
$= 20x - 10{,}000$

b. $P(20{,}000) = 20(20{,}000) - 10{,}000$
$= 400{,}000 - 10{,}000$
$= 390{,}000$

If 20,000 radios are produced and sold the profit will be $390,000.

47. a. The cost function is:
$C(x) = 18{,}000 + 20x$

b. The revenue function is:
$R(x) = 80x$

c. At the break-even point, $R(x) = C(x)$.
$80x = 18{,}000 + 20x$
$60x = 18{,}000$
$x = 300$

$R(x) = 80x$
$R(300) = 80(300)$
$= 24{,}000$

When approximately 300 canoes are produced the company will break even with cost and revenue at $24,000.

48. a. The cost function is
$C(x) = 100{,}000 + 100x$.

b. The revenue function is $R(x) = 300x$.

c. At the break-even point, $R(x) = C(x)$.
$300x = 100{,}000 + 100x$
$200x = 100{,}000$
$x = 500$

$R(x) = 300x$
$R(500) = 300(500)$
$= 150{,}000$

When 500 bicycles are produced and sold, both cost and revenue are $150,000.

49. a. The cost function is:
$C(x) = 30{,}000 + 2500x$

b. The revenue function is:
$R(x) = 3125x$

c. At the break-even point, $R(x) = C(x)$.
$3125x = 30000 + 2500x$
$625x = 30000$
$x = 48$

After 48 sold out performances, the investor will break-even. ($150,000)

50. a. The cost function is $C(x) = 30{,}000 + 0.02x$

b. The revenue function is $R(x) = 0.5x$

c. At the break-even point,
$R(x) = C(x)$
$0.5x = 30{,}000 + 0.02x$
$0.48x = 30{,}000$
$x = 62{,}500$

$R(x) = 0.5x$
$R(62{,}500) = 0.5(62{,}500) = 31{,}250$

For 62,500 cards, both cost and revenue are $31,250.

51. – 58. Answers will vary.

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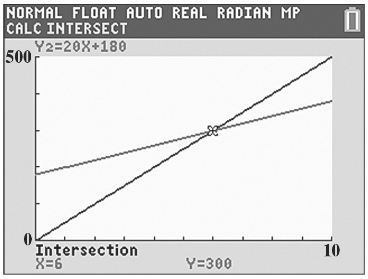
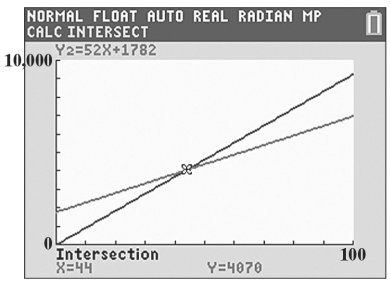
59. $R(x) = 50x$

$C(x) = 20x + 180$



The break-even point is 6 units. When 6 units are produced and sold, cost and revenue are the same at \$300.

60. $R(x) = 92.5x;\quad C(x) = 52x + 1782$



The break-even point is 44 units. When 44 units are produced and sold, cost and revenue are the same at \$4070.

61. Answers will vary

62. makes sense

63. does not make sense; Explanations will vary. Sample explanation: Mixing a 50% acid solution with a 25% acid solution will produce an acid solution that is between 25% and 50%.

64. makes sense

65. makes sense

66. Let x=number of gallons of 45% antifreeze solution.
Let y=number of gallons of pure antifreeze.

$$x + y = 4$$
$$0.45x + y = 0.60(4)$$

or

$$x + y = 4$$
$$0.45x + y = 2.4$$

Solve the first equation for y.

$y = 4 - x$

Substitute into the second equation and solve for x.

$$0.45x + (4 - x) = 2.4$$
$$-0.55x = -1.6$$
$$x = 2.9$$

Back-substitution to find y.

$y = 4 - x = 4 - 2.9 = 1.1$

1.1 gallons should be drained and replaced with pure antifreeze to have a 60% antifreeze solution.

67. Let h = the number of hexagons.
Let s = the number of squares.
We need to solve the following system of equations:

$6h + s = 52$ (band)

$h + 4s = 24$ (pom-pom)

Multiply the first equation by -4 and add the equations.

$$\begin{array}{rl} -24h - 4s &= -208 \\ h + 4s &= 24 \\ \hline -23h \qquad &= -184 \\ h \qquad &= 8 \end{array}$$

Back-substitute to solve for s.

$$6h + s = 52$$
$$6(8) + s = 52$$
$$48 + s = 52$$
$$s = 4$$

The students can form 8 hexagons and 4 squares.

68. Let b = the number of boys.
Let g = the number of girls.

$g = b - 1$

$b = 2(g - 1)$

Substitute $b - 1$ for g to find b.

$$b = 2((b-1) - 1)$$
$$b = 2(b - 2)$$
$$b = 2b - 4$$
$$-b = -4$$
$$b = 4$$

Back-substitute 4 for b to find g.

$g = b - 1 = 4 - 1 = 3$

There are 4 boys and 3 girls in the family.

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69. Let t = the original tens-place digit.
Let u = the original ones-place digit.

$$x + u = 14 \quad \text{(digits sum)}$$
$$(10x + u) - (10u + x) = 36 \quad \text{(score diff.)}$$

Simplify the second equation so it is in standard form.

$$10x + u - 10u - x = 36$$
$$9x - 9u = 36$$

Solve the following system:

$$x + u = 14$$
$$9x - 9u = 36$$

Multiply the first equation by 9 and add the two equations.

$$\begin{aligned} 9x + 9u &= 126 \\ \underline{9x - 9u} &\underline{= 36} \\ 18x \quad &= 162 \\ x \quad &= 9 \end{aligned}$$

Back-substitute to solve for u.

$$x + u = 14$$
$$9 + u = 14$$
$$u = 5$$

Therefore, your original score was 95.

70. Let x = the cost of the mangos.
Let y = the cost of the avocados.

$$x + y = 67$$
$$0.20x - 0.02y = 8.56$$

Multiply the first equation by 0.02.

$$\begin{aligned} 0.02x + 0.02y &= 1.34 \\ \underline{0.20x - 0.02y} &\underline{= 8.56} \\ 0.22x &= 9.90 \\ x &= 45 \end{aligned}$$

Back-substitute to find y.

$$x + y = 67$$
$$45 + y = 67$$
$$y = 22$$

The dealer paid \$45 for the mangos and \$22 for the avocados.

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

First, find the slope.

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{13 - 5}{-6 - (-2)} = \frac{8}{-4} = -2$$

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

$$y - y_1 = m(x - x_1)$$
$$y - 13 = -2(x - (-6))$$
$$y - 13 = -2(x + 6)$$

Rewrite the equation in slope-intercept form by solving for y.

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

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

72. Since the line is parallel to $-x + y = 7$, we can use it to obtain the slope. Rewriting the equation in slope-intercept form, we obtain $y = x + 7$. The slope is $m = 1$. We are given that it passes through $(-3, 0)$. We use the slope and point to write the equation in point-slope form.

$$y - y_1 = m(x - x_1)$$
$$y - 0 = 1(x - (-3))$$
$$y - 0 = 1(x + 3)$$

Rewrite the equation in slope-intercept form by solving for y.

$$y - 0 = 1(x + 3)$$
$$y = x + 3$$

In function notation, the equation of the line is $f(x) = x + 3$.

73. Since the denominator of a fraction cannot be zero, the domain of g is $(-\infty, 3)$ or $(3, \infty)$.

74.

$$2x - y + 4z = -8$$
$$2(3) - (2) + 4(-3) = -8$$
$$-8 = -8, \text{ true}$$

Yes, the ordered triple satisfies the equation.

75.

$$5x - 2y - 4z = 3$$
$$3x + 3y + 2z = -3$$

Multiply Equation 2 by 2.

$$5x - 2y - 4z = 3$$
$$6x + 6y + 4z = -6$$

Then add to eliminate z.

$$\begin{aligned} 5x - 2y - 4z &= 3 \\ \underline{6x + 6y + 4z} &\underline{= -6} \\ 11x + 4y \qquad &= -3 \end{aligned}$$

76.

$$ax^2 + bx + c = y$$
$$a(4)^2 + b(4) + c = 1682$$
$$16a + 4b + c = 1682$$

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3.3 Check Points

1. Test the ordered triple in each equation.

$$x - 2y + 3z = 22$$
$$(-1) - 2(-4) + 3(5) = 22$$
$$22 = 22, \text{ true}$$

$$2x - 3y - z = 5$$
$$2(-1) - 3(-4) - (5) = 5$$
$$5 = 5, \text{ true}$$

$$3x + y - 5z = -32$$
$$3(-1) + (-4) - 5(5) = -32$$
$$-32 = -32, \text{ true}$$

The ordered triple (–1, –4, 5) makes all three equations true, so it is a solution to the system.

2.
$$x + 4y - z = 20$$
$$3x + 2y + z = 8$$
$$2x - 3y + 2z = -16$$

Add the first two equations to eliminate z.

$$\begin{array}{r} x + 4y - z = 20 \\ \underline{3x + 2y + z = 8} \\ 4x + 6y = 28 \end{array}$$

Multiply the first equation by 2 and add to the third equation to eliminate z again.

$$\begin{array}{r} 2x + 8y - 2z = 40 \\ \underline{2x - 3y + 2z = -16} \\ 4x + 5y = 24 \end{array}$$

Solve the system of two equations in two variables.

$$4x + 6y = 28$$
$$4x + 5y = 24$$

Multiply the second equation by –1 and add the equations.

$$\begin{array}{r} 4x + 6y = 28 \\ \underline{-4x - 5y = -24} \\ y = 4 \end{array}$$

Back-substitute 4 for y to find x.

$$4x + 6y = 28$$
$$4x + 6(4) = 28$$
$$4x + 24 = 28$$
$$4x = 4$$
$$x = 1$$

Back-substitute into an original equation.

$$3x + 2y + z = 8$$
$$3(1) + 2(4) + z = 8$$
$$11 + z = 8$$
$$z = -3$$

The solution is $(1, 4, -3)$ and the solution set is $\{(1, 4, -3)\}$.

3.
$$2y - z = 7$$
$$x + 2y + z = 17$$
$$2x - 3y + 2z = -1$$

Since the first equation already has only two variables, use the second and third equations to eliminate x.
Multiply the second equation by –2 and add to the third equation.

$$\begin{array}{r} -2x - 4y - 2z = -34 \\ \underline{2x - 3y + 2z = -1} \\ -7y = -35 \end{array}$$

$$\frac{-7y}{-7} = \frac{-35}{-7}$$
$$y = 5$$

Back-substitute 5 for y to find z.

$$2y - z = 7$$
$$2(5) - z = 7$$
$$10 - z = 7$$
$$-z = -3$$
$$z = 3$$

Back-substitute into an original equation to find x.

$$x + 2y + z = 17$$
$$x + 2(5) + (3) = 17$$
$$x + 13 = 17$$
$$x = 4$$

The solution is $(4, 5, 3)$ and the solution set is $\{(4, 5, 3)\}$.

4. Use each ordered pair to write an equation.

$$(x, y) = (1, 4)$$
$$y = ax^2 + bx + c$$
$$4 = a(1)^2 + b(1) + c$$
$$4 = a + b + c$$

$$(x, y) = (2, 1)$$
$$y = ax^2 + bx + c$$
$$1 = a(2)^2 + b(2) + c$$
$$1 = 4a + 2b + c$$

$$(x, y) = (3, 4)$$
$$y = ax^2 + bx + c$$
$$4 = a(3)^2 + b(3) + c$$
$$4 = 9a + 3b + c$$

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The system of three equations in three variables is:

$$a+b+c=4$$
$$4a+2b+c=1$$
$$9a+3b+c=4$$

Multiplying the first equation by –1 and adding it to the second gives $3a+b=-3$.
Multiplying the first equation by –1 and adding it to the third gives $8a+2b=0$.
Solve this system of two equations in two variables.

$$3a+b=-3$$
$$8a+2b=0$$

Multiply the first equation by –2 and add to the second equation.

$$\begin{aligned}-6a-2b&=6\\ 8a+2b&=0\\ \hline 2a&=6\\ a&=3\end{aligned}$$

Back-substitute to find b.

$$\begin{aligned}3a+b&=-3\\ 3(3)+b&=-3\\ 9+b&=-3\\ b&=-12\end{aligned}$$

Back-substitute into an original equation to find c.

$$\begin{aligned}a+b+c&=4\\ (3)+(-12)+c&=4\\ -9+c&=4\\ c&=13\end{aligned}$$

The quadratic function is $y=3x^2-12x+13$ or $f(x)=3x^2-12x+13$.

3.3 Concept and Vocabulary Check

1. triple; all
2. -2; –4
3. z; add Equations 1 and 3
4. quadratic
5. curve fitting

3.3 Exercise Set

1. Test the ordered triple in each equation.

$$\begin{aligned}x+y+z&=4\\ 2-1+3&=4\\ 4&=4,\ \text{true}\end{aligned}$$

$$\begin{aligned}x-2y-z&=1\\ 2-2(-1)-3&=1\\ 2+2-3&=1\\ 1&=1,\ \text{true}\end{aligned}$$

$$\begin{aligned}2x-y-z&=-1\\ 2(2)-(-1)-3&=-1\\ 4+1-3&=-1\\ 2&=-1,\ \text{false}\end{aligned}$$

The ordered triple (2, –1, 3) does not make all three equations true, so it is not a solution.

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2. Test the ordered triple in each equation.

$$\begin{aligned} x+y+z&=0 \\ 5-3-2&=0 \\ 0&=0,\ \text{true} \end{aligned} \qquad \begin{aligned} x+2y-3z&=5 \\ 5+2(-3)-3(-2)&=5 \\ 5-6+6&=5 \\ 5&=5,\ \text{true} \end{aligned} \qquad \begin{aligned} 3x+4y+2z&=-1 \\ 3(5)+4(-3)+2(-2)&=-1 \\ 15-12-4&=-1 \\ -1&=-1,\ \text{true} \end{aligned}$$

The ordered triple makes all three equations true, so it is a solution.

3. Test the ordered triple in each equation.

$$\begin{aligned} x-2y&=2 \\ 4-2(1)&=2 \\ 4-2&=2 \\ 2&=2,\ \text{true} \end{aligned} \qquad \begin{aligned} 2x+3y&=11 \\ 2(4)+3(1)&=11 \\ 8+3&=11 \\ 11&=11,\ \text{true} \end{aligned} \qquad \begin{aligned} y-4z&=-7 \\ 1-4(2)&=-7 \\ 1-8&=-7 \\ -7&=-7,\ \text{true} \end{aligned}$$

The ordered triple makes all three equations true, so it is a solution.

4. Test the ordered triple in each equation.

$$\begin{aligned} x-2z&=-5 \\ -1-2(2)&=-5 \\ -1-4&=-5 \\ -5&=-5,\ \text{true} \end{aligned} \qquad \begin{aligned} y-3z&=-3 \\ 3-3(2)&=-3 \\ 3-6&=-3 \\ -3&=-3,\ \text{true} \end{aligned} \qquad \begin{aligned} 2x-z&=-4 \\ 2(-1)-2&=-4 \\ -2-2&=-4 \\ -4&=-4,\ \text{true} \end{aligned}$$

The ordered triple makes all three equations true, so it is a solution.

5.

$$\begin{aligned} x+y+2z&=11 \\ x+y+3z&=14 \\ x+2y-z&=5 \end{aligned}$$

Multiply the second equation by –1 and add to the first equation.

$$\begin{array}{r} x+y+2z=\ \ 11 \\ \underline{-x-y-3z=-14} \\ -z=-\ 3 \\ z=\ \ \ 3 \end{array}$$

Back-substitute 3 for z in the first and third equations.

$$\begin{aligned} x+y+2z&=11 \\ x+y+2(3)&=11 \\ x+y+6&=11 \\ x+y&=5 \end{aligned} \qquad \begin{aligned} x+2y-z&=5 \\ x+2y-3&=5 \\ x+2y&=8 \end{aligned}$$

We now have two equations in two variables.

$$\begin{aligned} x+y&=5 \\ x+2y&=8 \end{aligned}$$

Multiply the first equation by –1 and solve by addition.

$$\begin{array}{r} -x-y=-5 \\ \underline{x+2y=\ \ 8} \\ y=\ \ 3 \end{array}$$

Back-substitute 3 for y into one of the equations in two variables.

$$\begin{aligned} x+y&=5 \\ x+3&=5 \\ x&=2 \end{aligned}$$

The solution is $(2,3,3)$ and the solution set is $\{(2,3,3)\}$.

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6. Multiply the first equation by 3 and add to the second equation.

$$\begin{array}{r} 6x+3y-6z=-3 \\ \underline{3x-3y-\ \ z=\ \ 5} \\ 9x-7z=2 \end{array}$$

Multiply the first equation by 2 and add to the third equation.

$$\begin{array}{r} 4x+2y-4z=-2 \\ \underline{x-2y+3z=\ \ 6} \\ 5x-z=4 \end{array}$$

We now have two equations in two variables.

$$\begin{array}{l} 9x-7z=2 \\ 5x-\ \ z=4 \end{array}$$

Multiply the second equation by –7 and eliminate y.

$$\begin{array}{r} 9x-7z=\ \ \ 2 \\ \underline{-35x+7z=-28} \\ -26x=-26 \\ x=1 \end{array}$$

Back-substitute 1 for x into one of the equations in two variables.

$$\begin{array}{r} 5(1)-z=4 \\ 5-z=4 \\ -z=-1 \\ z=1 \end{array}$$

Back-substitute 1 for x and 1 for z into one of the original equations in three variables.

$$\begin{array}{r} 2x+y-2z=-1 \\ 2(1)+y-2(1)=-1 \\ 2+y-2=-1 \\ y=-1 \end{array}$$

The solution is $(1,-1,1)$ and the solution set is $\{(1,-1,1)\}$.

7.
$$\begin{array}{r} 4x-\ \ y+2z=11 \\ x+\ 2y-\ \ z=-1 \\ 2x+\ 2y-3z=-1 \end{array}$$

Multiply the second equation by –4 and add to the first equation.

$$\begin{array}{r} 4x-\ \ y+2z=11 \\ \underline{-4x-8y+4z=\ \ 4} \\ -9y+6z=15 \end{array}$$

Multiply the second equation by –2 and add it to the third equation.

$$\begin{array}{r} -2x-4y+2z=\ \ 2 \\ \underline{2x+2y-3z=-1} \\ -2y-\ \ z=\ \ 1 \end{array}$$

We now have two equations in two variables.

$$\begin{array}{r} -9y+6z=15 \\ -2y-\ \ z=\ \ 1 \end{array}$$

Multiply the second equation by 6 and solve by addition.

$$\begin{array}{r} -9y+6z=15 \\ \underline{-12y-6z=\ \ 6} \\ -21y\qquad=21 \\ y\qquad=-1 \end{array}$$

Back-substitute –1 for y in one of the equations in two variables.

$$\begin{array}{r} -2y-z=1 \\ -2(-1)-z=1 \\ 2-z=1 \\ -z=-1 \\ z=1 \end{array}$$

Back-substitute –1 for y and 1 for z in one of the original equations in three variables.

$$\begin{array}{r} x+2y-z=-1 \\ x+2(-1)-1=-1 \\ x-2-1=-1 \\ x-3=-1 \\ x=2 \end{array}$$

The solution is $(2,-1,1)$ and the solution set is $\{(2,-1,1)\}$.

8. Add the first and second equations to obtain an equation in two variables.

$$\begin{array}{r} x-\ \ y+3z=\ \ 8 \\ \underline{3x+\ \ y-2z=-2} \\ 4x+z=6 \end{array}$$

Multiply the second equation by –4 and add it to the third equation.

$$\begin{array}{r} -12x-4y+8z=8 \\ \underline{2x+4y+\ z=\ 0} \\ -10x+9z=8 \end{array}$$

We now have two equations in two variables.

$$\begin{array}{r} 4x+\ \ z=6 \\ -10x+9z=8 \end{array}$$

Multiply the first equation by –9 and add to the second equation.

$$\begin{array}{r} -36x-9z=-54 \\ \underline{-10x+9z=\ \ \ 8} \\ -46x=-46 \\ x=1 \end{array}$$

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Back-substitute 1 for x in one of the equations in two variables.

$$\begin{aligned} 4x+z&=6\\ 4(1)+z&=6\\ 4+z&=6\\ z&=2 \end{aligned}$$

Back-substitute 1 for x and 2 for z in one of the original equations in three variables.

$$\begin{aligned} x-y+3z&=8\\ 1-y+3(2)&=8\\ 1-y+6&=8\\ -y+7&=8\\ -y&=1\\ y&=-1 \end{aligned}$$

The solution is $(1,-1,2)$ and the solution set is $\{(1,-1,2)\}$.

9. $$\begin{aligned} 3x+2y-3z&=-2\\ 2x-5y+2z&=-2\\ 4x-3y+4z&=10 \end{aligned}$$

Multiply the second equation by –2 and add to the third equation.

$$\begin{array}{r} -4x+10y-4z=4\\ \underline{4x-\ \ 3y+4z=10}\\ 7y\qquad=14\\ y\qquad=\ \ 2 \end{array}$$

Back-substitute 2 for y in the first and third equations to obtain two equations in two unknowns.

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

$$\begin{aligned} 4x-3y+4z&=10\\ 4x-3(2)+4z&=10\\ 4x-6+4z&=10\\ 4x+4z&=16 \end{aligned}$$

The system of two equations in two variables becomes:

$$\begin{aligned} 3x-3z&=-6\\ 4x+4z&=16 \end{aligned}$$

Multiply the first equation by –4 and the second equation by 3.

$$\begin{array}{r} -12x+12z=24\\ \underline{12x+12z=48}\\ 24z=72\\ z=\ \ 3 \end{array}$$

Back-substitute 3 for z to find x.

$$\begin{aligned} 3x-3z&=-6\\ 3x-3(3)&=-6\\ 3x-9&=-6\\ 3x&=3\\ x&=1 \end{aligned}$$

The solution is $(1,2,3)$ and the solution set is $\{(1,2,3)\}$.

10. Multiply the first equation by –3 and the second equation by 2 and add.

$$\begin{array}{r} -6x-9y-21z=-39\\ \underline{6x+4y-10z=-44}\\ -5y-31z=-83 \end{array}$$

Multiply the second equation by –5 and the third equation by 3 and add.

$$\begin{array}{r} -15x-10y+25z=110\\ \underline{15x+21y-\ \ 9z=-86}\\ 11y+16z=26 \end{array}$$

The system of two equations in two variables becomes:

$$\begin{aligned} -5y-31z&=-83\\ 11y+16z&=\ \ 26 \end{aligned}$$

Multiply the first equation by 11 and the second equation by 5.

$$\begin{array}{r} -55y-341z=-913\\ \underline{55y+\ \ 80z=\ \ 130}\\ -261z=-783\\ z=3 \end{array}$$

Back-substitute 3 for z in one of the equations in two variables.

$$\begin{aligned} -5y-31z&=-83\\ -5y-31(3)&=-83\\ -5y-93&=-83\\ -5y&=10\\ y&=-2 \end{aligned}$$

Back-substitute –2 for y and 3 for z in one of the original equations in three variables.

$$\begin{aligned} 2x+3y+7z&=13\\ 2x+3(-2)+7(3)&=13\\ 2x-6+21&=13\\ 2x+15&=13\\ 2x&=-2\\ x&=-1 \end{aligned}$$

The solution is $(-1,-2,3)$ and the solution set is $\{(-1,-2,3)\}$.

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11. $2x - 4y + 3z = 17$

$x + 2y - z = 0$

$4x - y - z = 6$

Multiply the second equation by –1 and add it to the third equation.

$$\begin{array}{l} -x - 2y + z = 0 \\ \underline{4x - y - z = 6} \\ 3x - 3y \quad = 6 \end{array}$$

Multiply the second equation by 3 and add it to the first equation.

$$\begin{array}{l} 2x - 4y + 3z = 17 \\ \underline{3x + 6y - 3z = 0} \\ 5x + 2y \quad = 17 \end{array}$$

The system in two variables becomes:

$3x - 3y = 6$

$5x + 2y = 17$

Multiply the first equation by 2 and the second equation by 3 and solve by addition.

$$\begin{array}{l} 6x - 6y = 12 \\ \underline{15x + 6y = 51} \\ 21x \quad = 63 \\ x \quad = 3 \end{array}$$

Back-substitute 3 for x in one of the equations in two variables.

$$\begin{aligned} 3x - 3y &= 6 \\ 3(3) - 3y &= 6 \\ 9 - 3y &= 6 \\ -3y &= -3 \\ y &= 1 \end{aligned}$$

Back-substitute 3 for x and 1 for y in one of the original equations in three variables.

$$\begin{aligned} x + 2y - z &= 0 \\ 3 + 2(1) - z &= 0 \\ 3 + 2 - z &= 0 \\ 5 - z &= 0 \\ 5 &= z \end{aligned}$$

The solution is $(3,1,5)$ and the solution set is $\{(3,1,5)\}$.

12. Multiply the third equation by 2 and add it to the second equation.

$$\begin{array}{l} x + 2y - z = 1 \\ \underline{4x - 2y + 2z = 6} \\ 5x + z = 7 \end{array}$$

The system in two variables becomes:

$x + z = 3$

$5x + z = 7$

Multiply the first equation by –1 and to the second equation.

$$\begin{array}{l} -x - z = -3 \\ \underline{5x + z = 7} \\ 4x = 4 \\ x = 1 \end{array}$$

Back-substitute 1 for x in one of the equations in two variables.

$$\begin{aligned} x + z &= 3 \\ 1 + z &= 3 \\ z &= 2 \end{aligned}$$

Back-substitute 1 for x and 2 for z in one of the original equations in three variables.

$$\begin{aligned} x + 2y - z &= 1 \\ 1 + 2y - 2 &= 1 \\ 2y - 1 &= 1 \\ 2y &= 2 \\ y &= 1 \end{aligned}$$

The solution is $(1,1,2)$ and the solution set is $\{(1,1,2)\}$.

13. $2x + y \quad = 2$

$x + y - z = 4$

$3x + 2y + z = 0$

Add the second and third equations together to obtain an equation in two variables.

$$\begin{array}{l} x + y - z = 4 \\ \underline{3x + 2y + z = 0} \\ 4x + 3y \quad = 4 \end{array}$$

Use this equation and the first equation in the original system to write two equations in two variables.

$2x + y = 2$

$4x + 3y = 4$

Multiply the first equation by –2 and solve by addition.

$$\begin{array}{l} -4x - 2y = -4 \\ \underline{4x + 3y = 4} \\ y = 0 \end{array}$$

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Back-substitute 0 for y in one of the equations in two unknowns.

$$\begin{aligned} 2x + y &= 2 \\ 2x + 0 &= 2 \\ 2x &= 2 \\ x &= 1 \end{aligned}$$

Back-substitute 1 for x and 0 for y in one of the equations in three unknowns.

$$\begin{aligned} x + y - z &= 4 \\ 1 + 0 - z &= 4 \\ 1 - z &= 4 \\ -z &= 3 \\ z &= -3 \end{aligned}$$

The solution is $(1, 0, -3)$ and the solution set is $\{(1, 0, -3)\}$.

14. Multiply the first equation by –3 and add to the third equation.

$$\begin{array}{r} -3x - 9y - 15z = -60 \\ \underline{3x - 2y + 9z = 36} \\ -11y - 6z = -24 \end{array}$$

The system of two equations in two variables becomes:

$$\begin{aligned} y - 4z &= -16 \\ -11y - 6z &= -24 \end{aligned}$$

Multiply the first equation by 11 and add to the second equation.

$$\begin{array}{r} 11y - 44z = -176 \\ \underline{-11y - 6z = -24} \\ -50z = -200 \\ z = 4 \end{array}$$

Back-substitute 4 for z in one of the equations in two unknowns.

$$\begin{aligned} y - 4z &= -16 \\ y - 4(4) &= -16 \\ y - 16 &= -16 \\ y &= 0 \end{aligned}$$

Back-substitute 0 for y and 4 for z in one of the equations in three unknowns.

$$\begin{aligned} x + 3y + 5z &= 20 \\ x + 3(0) + 5(4) &= 20 \\ x + 0 + 20 &= 20 \\ x + 20 &= 20 \\ x &= 0 \end{aligned}$$

The solution is $(0, 0, 4)$ and the solution set is $\{(0, 0, 4)\}$.

15.

$$\begin{aligned} x + y &= -4 \\ y - z &= 1 \\ 2x + y + 3z &= -21 \end{aligned}$$

Multiply the first equation by –1 and add to the second equation.

$$\begin{array}{r} -x - y = 4 \\ \underline{y - z = 1} \\ -x - z = 5 \end{array}$$

Multiply the second equation by –1 and add to the third equation.

$$\begin{array}{r} -y + z = -1 \\ \underline{2x + y + 3z = -21} \\ 2x + 4z = -22 \end{array}$$

The system of two equations in two variables becomes:

$$\begin{aligned} -x - z &= 5 \\ 2x + 4z &= -22 \end{aligned}$$

Multiply the first equation by 2 and add to the second equation.

$$\begin{array}{r} -2x - 2z = 10 \\ \underline{2x + 4z = -22} \\ 2z = -12 \\ z = -6 \end{array}$$

Back-substitute –6 for z in one of the equations in two variables.

$$\begin{aligned} -x - z &= 5 \\ -x - (-6) &= 5 \\ -x + 6 &= 5 \\ -x &= -1 \\ x &= 1 \end{aligned}$$

Back-substitute 1 for x in the first equation of the original system.

$$\begin{aligned} x + y &= -4 \\ 1 + y &= -4 \\ y &= -5 \end{aligned}$$

The solution is $(1, -5, -6)$ and the solution set is $\{(1, -5, -6)\}$.

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16. Multiply the first equation by –1 and add to the second equation.

$$\begin{array}{r} -x-y \quad\;\; =-4 \\ \underline{x \quad\;\; +z=\;\;4} \\ -y+z=0 \end{array}$$

The system of two equations in two variables is as follows.

$$\begin{array}{r} -y+z=0 \\ \underline{y+z=4} \\ 2z=4 \\ z=2 \end{array}$$

Back-substitute 2 for z in one of the equations in two variables.

$$\begin{aligned} y+z&=4 \\ y+2&=4 \\ y&=2 \end{aligned}$$

Back-substitute 2 for y to find x.

$$\begin{aligned} x+y&=4 \\ x+2&=4 \\ x&=2 \end{aligned}$$

The solution is $(2,2,2)$ and the solution set is $\{(2,2,2)\}$.

17.
$$\begin{aligned} 2x+\;\;y+2z&=1 \\ 3x-\;\;y+\;\;z&=2 \\ x-2y-\;\;z&=0 \end{aligned}$$

Add the first and second equations to eliminate y.

$$\begin{array}{r} 2x+y+2z=1 \\ \underline{3x-y+\;\;z=2} \\ 5x \quad\;\; +3z=3 \end{array}$$

Multiply the second equation by –2 and add to the third equation.

$$\begin{array}{r} -6x+2y-2z=-4 \\ \underline{x-2y-\;\;z=\;\;0} \\ -5x \quad\;\; -3z=-4 \end{array}$$

We obtain two equations in two variables.

$$\begin{aligned} 5x+3z&=\;\;3 \\ -5x-3z&=-4 \end{aligned}$$

Adding the two equations, we obtain:

$$\begin{array}{r} 5x+3z=\;\;3 \\ \underline{-5x-3z=-4} \\ 0=-1 \end{array}$$

The system is inconsistent. There are no values of *x, y,* and *z* for which $0=-1$. The solution set is $\varnothing$ or $\{\;\}$.

18. Multiply the second equation by 2 and add to the first equation.

$$\begin{array}{r} 3x+4y+5z=\quad 8 \\ \underline{2x-4y+6z=-12} \\ 5x+11z=-4 \end{array}$$

Multiply the second equation by –2 and add to the third equation.

$$\begin{array}{r} -2x+4y-6z=12 \\ \underline{2x-4y+6z=\;\;8} \\ 0=20 \end{array}$$

The system is inconsistent and there is no solution. There are no values of *x, y* and *z* for which $0=20$. The solution set is $\varnothing$ or $\{\;\}$.

19.
$$\begin{aligned} 5x-2y-\;\;5z&=1 \\ 10x-4y-10z&=2 \\ 15x-6y-15z&=3 \end{aligned}$$

Multiply the first equation by –2 and add to the second equation.

$$\begin{array}{r} -10x+4y+10z=-2 \\ \underline{10x-4y-10z=\;\;2} \\ 0=\;\;0 \end{array}$$

The system is dependent and has infinitely many solutions.

20. Multiply the first equation by 2 and add to the second equation.

$$\begin{array}{r} 2x+4y+2z=8 \\ \underline{3x-4y+\;\;z=4} \\ 5x+3z=12 \end{array}$$

Multiply the first equation by 2 and add to the second equation.

$$\begin{array}{r} 4x+8y+4z=16 \\ \underline{6x-8y+2z=\;\;8} \\ 10x+6z=24 \end{array}$$

The system of two equations in two variables becomes:

$$\begin{aligned} 5x+3z&=12 \\ 10x+6z&=24 \end{aligned}$$

Multiply the first equation by –2 and add to the second equation.

$$\begin{array}{r} -10x-6z=-24 \\ \underline{10x+6z=\;\;24} \\ 0=0 \end{array}$$

The system is dependent and there are infinitely many solutions.

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21. $3(2x+y)+5z=-1$
$2(x-3y+4z)=-9$
$4(1+x)=-3(z-3y)$

Rewrite each equation and obtain the system of three equations in three variables.

$$\begin{aligned}6x+3y+5z&=-1\\2x-6y+8z&=-9\\4x-9y+3z&=-4\end{aligned}$$

Multiply the second equation by –3 and add to the first equation.

$$\begin{array}{r}6x+\ \ 3y+\ 5z=-1\\ \underline{-6x+18y-24z=27}\\ 21y-19z=26\end{array}$$

Multiply the second equation by –2 and add to the third equation.

$$\begin{array}{r}-4x+12y-16z=\ 18\\ \underline{4x-\ 9y+\ \ 3z=-4}\\ 3y-13z=\ 14\end{array}$$

The system of two variables in two equations is:

$$\begin{aligned}21y-19z&=26\\3y-13z&=14\end{aligned}$$

Multiply the second equation by –7 and add to the third equation.

$$\begin{array}{r}21y-19z=\ \ 26\\ \underline{-21y+91z=-98}\\ 72z=-72\\ z=-1\end{array}$$

Back-substitute –1 for z in one of the equations in two variables to find y.

$$\begin{aligned}3y-13z&=14\\3y-13(-1)&=14\\3y+13&=14\\3y&=1\\y&=\frac{1}{3}\end{aligned}$$

Back-substitute –1 for z and $\frac{1}{3}$ for y in one of the original equations in three variables.

$$\begin{aligned}6x+3y+5z&=-1\\6x+1-5&=-1\\6x-4&=-1\\6x&=3\\x&=\frac{1}{2}\end{aligned}$$

The solution is $\left(\frac{1}{2},\frac{1}{3},-1\right)$ and the solution set is $\left\{\left(\frac{1}{2},\frac{1}{3},-1\right)\right\}$.

22. After rewriting the equations, the system becomes

$$\begin{aligned}-2x+6y+7z&=\ 3\\-4x+5y+3z&=\ 7\\-6x+3y+5z&=-4\end{aligned}$$

Multiply the first equation by –2 and add to the second equation.

$$\begin{array}{r}4x-12y-14z=-6\\ \underline{-4x+\ \ 5y+\ \ 3z=\ 7}\\ -7y-11z=1\end{array}$$

Multiply the first equation by –3 and add to the third equation.

$$\begin{array}{r}6x-18y-21z=-9\\ \underline{-6x+\ 3y+\ \ 5z=-4}\\ -15y-16z=-13\end{array}$$

The system of two variables in two equations is as follows.

$$\begin{aligned}-7y-11z&=\ \ \ 1\\-15y-16z&=-13\end{aligned}$$

Multiply the first equation by –15 and the second equation by 7 to eliminate y.

$$\begin{array}{r}105y+165z=-15\\ \underline{-105y-112z=-91}\\ 53z=-106\\ z=-2\end{array}$$

Back-substitute –2 for z in one of the equations in two variables to find y.

$$\begin{aligned}-7y-11z&=1\\-7y-11(-2)&=1\\-7y+22&=1\\-7y&=-21\\y&=3\end{aligned}$$

Back-substitute –2 for z and 3 for y in one of the original equations in three variables.

$$\begin{aligned}-2x+6y+7z&=3\\-2x+6(3)+7(-2)&=3\\-2x+18-14&=3\\-2x+4&=3\\-2x&=-1\\x&=\frac{1}{2}\end{aligned}$$

The solution is $\left(\frac{1}{2},3,-2\right)$ and the solution set is $\left\{\left(\frac{1}{2},3,-2\right)\right\}$.

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23. Use each ordered pair to write an equation.

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

$y = ax^2 + bx + c$

$6 = a(-1)^2 + b(-1) + c$

$6 = a - b + c$

$(x, y) = (1, 4)$

$y = ax^2 + bx + c$

$4 = a(1)^2 + b(1) + c$

$4 = a + b + c$

$(x, y) = (2, 9)$

$y = ax^2 + bx + c$

$9 = a(2)^2 + b(2) + c$

$9 = a(4) + 2b + c$

$9 = 4a + 2b + c$

The system of three equations in three variables is:

$$\begin{aligned} a - b + c &= 6 \\ a + b + c &= 4 \\ 4a + 2b + c &= 9 \end{aligned}$$

Add the first and second equations.

$$\begin{array}{r} a - b + c = 6 \\ \underline{a + b + c = 4} \\ 2a + 2c = 10 \end{array}$$

Multiply the first equation by 2 and add to the third equation.

$$\begin{array}{r} 2a - 2b + 2c = 12 \\ \underline{4a + 2b + c = 9} \\ 6a + 3c = 21 \end{array}$$

The system of two equations in two variables becomes:

$$\begin{aligned} 2a + 2c &= 10 \\ 6a + 3c &= 21 \end{aligned}$$

Multiply the first equation by –3 and add to the second equation.

$$\begin{array}{r} -6a - 6c = -30 \\ \underline{6a + 3c = 21} \\ -3c = -9 \\ c = 3 \end{array}$$

Back-substitute 3 for c in one of the equations in two variables.

$$\begin{aligned} 2a + 2c &= 10 \\ 2a + 2(3) &= 10 \\ 2a + 6 &= 10 \\ 2a &= 4 \\ a &= 2 \end{aligned}$$

Back-substitute 3 for c and 2 for a in one of the equations in three variables.

$$\begin{aligned} a + b + c &= 4 \\ 2 + b + 3 &= 4 \\ b + 5 &= 4 \\ b &= -1 \end{aligned}$$

The quadratic function is $y = 2x^2 - x + 3$.

24. Use each ordered pair to write an equation.

$$\begin{aligned} 4a - 2b + c &= 7 \\ a + b + c &= -2 \\ 4a + 2b + c &= 3 \end{aligned}$$

Multiply the first equation by –1 and add to the third equation.

$$\begin{array}{r} -4a + 2b - c = -7 \\ \underline{4a + 2b + c = 3} \\ 4b = -4 \\ b = -1 \end{array}$$

Back-substitute –1 for b to obtain a system of two equations in two variables.

$$\begin{aligned} 4a + 2b + c &= 3 \\ 4a + 2(-1) + c &= 3 \\ 4a - 2 + c &= 3 \\ 4a + c &= 5 \end{aligned} \qquad \begin{aligned} a + b + c &= -2 \\ a - 1 + c &= -2 \\ a + c &= -1 \end{aligned}$$

The system of two equations in two variables is as follows.

$$\begin{aligned} 4a + c &= 5 \\ a + c &= -1 \end{aligned}$$

Multiply the first equation by –1 and add to the second equation.

$$\begin{array}{r} -4a - c = -5 \\ \underline{a + c = -1} \\ -3a = -6 \\ a = 2 \end{array}$$

Back-substitute –1 for b and 2 for a in one of the equations in three variables.

$$\begin{aligned} a + b + c &= -2 \\ 2 - 1 + c &= -2 \\ 1 + c &= -2 \\ c &= -3 \end{aligned}$$

The quadratic function is $y = 2x^2 - x - 3$.

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25. Use each ordered pair to write an equation.

$$(x, y) = (-1, -4)$$
$$y = ax^2 + bx + c$$
$$-4 = a(-1)^2 + b(-1) + c$$
$$-4 = a - b + c$$

$$(x, y) = (1, -2)$$
$$y = ax^2 + bx + c$$
$$-2 = a(1)^2 + b(1) + c$$
$$-2 = a + b + c$$

$$(x, y) = (2, 5)$$
$$y = ax^2 + bx + c$$
$$5 = a(2)^2 + b(2) + c$$
$$5 = a(4) + 2b + c$$
$$5 = 4a + 2b + c$$

The system of three equations in three variables is:

$$\begin{aligned} a - \ \ b + c &= -4 \\ a + \ \ b + c &= -2 \\ 4a + 2b + c &= \ \ 5 \end{aligned}$$

Multiply the second equation by –1 and add to the first equation.

$$\begin{aligned} a - b + c &= -4 \\ \underline{-a - b - c} &\underline{= \ \ 2} \\ -2b &= -2 \\ b &= 1 \end{aligned}$$

Back-substitute 4 for b in first and third equations to obtain two equations in two variables.

$$\begin{aligned} a - b + c &= -4 \\ a - 1 + c &= -4 \\ a + c &= -3 \end{aligned} \qquad \begin{aligned} 4a + 2b + c &= 5 \\ 4a + 2(1) + c &= 5 \\ 4a + 2 + c &= 5 \\ 4a + c &= 3 \end{aligned}$$

The system of two equations in two variables becomes:

$$\begin{aligned} a + c &= -3 \\ 4a + c &= \ \ 3 \end{aligned}$$

Multiply the first equation by –1 and add to the second equation.

$$\begin{aligned} -a - c &= 3 \\ \underline{4a + c} &\underline{= 3} \\ 3a &= 6 \\ a &= 2 \end{aligned}$$

Back-substitute 2 for a and 1for b in one of the equations in three variables.

$$\begin{aligned} a - b + c &= -4 \\ 2 - 1 + c &= -4 \\ 1 + c &= -4 \\ c &= -5 \end{aligned}$$

The quadratic function is $y = 2x^2 + x - 5$.

26. Use each ordered pair to write an equation. The system is as follows.

$$\begin{aligned} a + \ \ b + c &= \ \ 3 \\ 9a + 3b + c &= -1 \\ 16a + 4b + c &= \ \ 0 \end{aligned}$$

Multiply the first equation by –1 and add to the second equation.

$$\begin{aligned} -a - \ \ b - c &= -3 \\ \underline{9a + 3b + c} &\underline{= -1} \\ 8a + 2b &= -4 \end{aligned}$$

Multiply the first equation by –1 and add to the third equation.

$$\begin{aligned} -a - \ \ b - c &= -3 \\ \underline{16a + 4b + c} &\underline{= \ \ 0} \\ 15a + 3b &= -3 \end{aligned}$$

The system of two equations in two variables becomes:

$$\begin{aligned} 8a + 2b &= -4 \\ 15a + 3b &= -3 \end{aligned}$$

Multiply the first equation by –3 and the second equation by 2 to eliminate b.

$$\begin{aligned} -24a - 6b &= 12 \\ \underline{30a + 6b} &\underline{= -6} \\ 6a &= 6 \\ a &= 1 \end{aligned}$$

Back-substitute 1 for a to find b.

$$\begin{aligned} 8a + 2b &= -4 \\ 8(1) + 2b &= -4 \\ 8 + 2b &= -4 \\ 2b &= -12 \\ b &= -6 \end{aligned}$$

Back-substitute 1 for a and –6 for b in one of the equations in three variables.

$$\begin{aligned} a + b + c &= 3 \\ 1 - 6 + c &= 3 \\ -5 + c &= 3 \\ c &= 8 \end{aligned}$$

The quadratic function is $y = x^2 - 6x + 8$.

27. Let x = the first number.
Let y = the second number.
Let z = the third number.

$$x + y + z = 16$$
$$2x + 3y + 4z = 46$$
$$5x - y = 31$$

Multiply the first equation by –4 and add to the second equation.

$$\begin{array}{r} -4x - 4y - 4z = -64 \\ \underline{2x + 3y + 4z = 46} \\ -2x - y = -18 \end{array}$$

The system of two equations in two variables becomes:

$$5x - y = 31$$
$$-2x - y = -18$$

Multiply the first equation by –1 and add to the second equation.

$$\begin{array}{r} -5x + y = -31 \\ \underline{-2x - y = -18} \\ -7x = -49 \\ x = 7 \end{array}$$

Back-substitute 7 for x in one of the equations in two variables.

$$\begin{aligned} 5x - y &= 31 \\ 5(7) - y &= 31 \\ 35 - y &= 31 \\ -y &= -4 \\ y &= 4 \end{aligned}$$

Back-substitute 7 for x and 4 for y in one of the equations in two variables.

$$\begin{aligned} x + y + z &= 16 \\ 7 + 4 + z &= 16 \\ 11 + z &= 16 \\ z &= 5 \end{aligned}$$

The numbers are 7, 4 and 5.

28. Let x = the first number.
Let y = the second number.
Let z = the third number.

$$3x + y + 2z = 5$$
$$(x + 3z) - 3y = 2$$
$$(2x + 3y) - z = 1$$

Rewrite the system in $Ax + By + Cz = D$ form.

$$3x + y + 2z = 5$$
$$x - 3y + 3z = 2$$
$$2x + 3y - z = 1$$

Multiply the first equation by 3 and add to the second equation.

$$\begin{array}{r} 9x + 3y + 6z = 15 \\ \underline{x - 3y + 3z = 2} \\ 10x + 9z = 17 \end{array}$$

Add the second and third equations to eliminate y.

$$\begin{array}{r} x - 3y + 3z = 2 \\ \underline{2x + 3y - z = 1} \\ 3x + 2z = 3 \end{array}$$

Multiply the first equation by 3 and add to the second equation.

$$10x + 9z = 17$$
$$3x + 2z = 3$$

Multiply the first equation by –3 and the second equation by 10 to eliminate x.

$$\begin{array}{r} -30x - 27z = -51 \\ \underline{30x + 20z = 30} \\ -7z = -21 \\ z = 3 \end{array}$$

Back-substitute 3 for z in one of the equations in two variables.

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

Back-substitute –1 for x and 3 for z in one of the equations in three variables.

$$\begin{aligned} x - 3y + 3z &= 2 \\ -1 - 3y + 3(3) &= 2 \\ -1 - 3y + 9 &= 2 \\ -3y + 8 &= 2 \\ -3y &= -6 \\ y &= 2 \end{aligned}$$

The numbers are –1, 2, and 3.

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29. Simplify each equation.

$$\frac{x+2}{6}-\frac{y+4}{3}+\frac{z}{2}=0$$
$$6\left(\frac{x+2}{6}-\frac{y+4}{3}+\frac{z}{2}\right)=6(0)$$
$$(x+2)-2(y+4)+3z=0$$
$$x+2-2y-8+3z=0$$
$$x-2y+3z=6$$

$$\frac{x+1}{2}+\frac{y-1}{2}-\frac{z}{4}=\frac{9}{2}$$
$$4\left(\frac{x+1}{2}+\frac{y-1}{2}-\frac{z}{4}\right)=4\left(\frac{9}{2}\right)$$
$$2(x+1)+2(y-1)-z=18$$
$$2x+2+2y-2-z=18$$
$$2x+2y-z=18$$

$$\frac{x-5}{4}+\frac{y+1}{3}+\frac{z-2}{2}=\frac{19}{4}$$
$$12\left(\frac{x-5}{4}+\frac{y+1}{3}+\frac{z-2}{2}\right)=12\left(\frac{19}{4}\right)$$
$$3(x-5)+4(y+1)+6(z-2)=57$$
$$3x-15+4y+4+6z-12=57$$
$$3x+4y+6z=80$$

Now solve the equivalent system.

$$x-2y+3z=6$$
$$2x+2y-z=18$$
$$3x+4y+6z=80$$

Add the first two equations together.

$$x-2y+3z=6$$
$$\underline{2x+2y-z=18}$$
$$3x+2z=24$$

Multiply the second equation by -2 and add it to the third equation.

$$-4x-4y+2z=-36$$
$$\underline{3x+4y+6z=80}$$
$$-x+8z=44$$

Using the two reduced equations, we solve the system.

$$3x+2z=24$$
$$-x+8z=44$$

Multiply the second equation by 3 and add the equations.

$$3x+2z=24$$
$$\underline{-3x+24z=132}$$
$$26z=156$$
$$z=6$$

Back-substitute to find *x*.

$$-x+8(6)=44$$
$$-x+48=44$$
$$-x=-4$$
$$x=4$$

Back substitute to find *y*.

$$x-2y+3z=6$$
$$4-2y+3(6)=6$$
$$-2y=-16$$
$$y=8$$

The solution is $(4,8,6)$ and the solution set is $\{(4,8,6)\}$.

30. Simplify each equation.

$$\frac{x+3}{2}-\frac{y-1}{2}+\frac{z+2}{4}=\frac{3}{2}$$
$$4\left(\frac{x+3}{2}-\frac{y-1}{2}+\frac{z+2}{4}\right)=4\left(\frac{3}{2}\right)$$
$$2(x+3)-2(y-1)+(z+2)=6$$
$$2x+6-2y+2+z+2=6$$
$$2x-2y+z=-4$$

$$\frac{x-5}{2}+\frac{y+1}{3}-\frac{z}{4}=-\frac{25}{6}$$
$$12\left(\frac{x-5}{2}+\frac{y+1}{3}-\frac{z}{4}\right)=12\left(-\frac{25}{6}\right)$$
$$6(x-5)+4(y+1)-3z=-50$$
$$6x-30+4y+4-3z=-50$$
$$6x+4y-3z=-24$$

$$\frac{x-3}{4}-\frac{y+1}{2}+\frac{z-3}{2}=-\frac{5}{2}$$
$$4\left(\frac{x-3}{4}-\frac{y+1}{2}+\frac{z-3}{2}\right)=4\left(-\frac{5}{2}\right)$$
$$(x-3)-2(y+1)+2(z-3)=-10$$
$$x-3-2y-2+2z-6=-10$$
$$x-2y+2z=1$$

Now solve the equivalent system.

$$2x-2y+z=-4$$
$$6x+4y-3z=-24$$
$$x-2y+2z=1$$

Multiply the first equation by 2 and add it to the second equation.

$$\begin{array}{r} 4x-4y+2z=-8 \\ \underline{6x+4y-3z=-24} \\ 10x-z=-32 \end{array}$$

Multiply the third equation by -1 and add to the first equation.

$$\begin{array}{r} 2x-2y+z=-4 \\ \underline{-x+2y-2z=-1} \\ x-z=-5 \end{array}$$

Using the two reduced equations, we solve the system.

$$10x-z=-32$$
$$x-z=-5$$

Multiply the second equation by -1 and add it to the first.

$$\begin{array}{r} 10x-z=-32 \\ \underline{-x+z=5} \\ 9x=-27 \\ x=-3 \end{array}$$

Back-substitute to solve for z.

$$\begin{aligned} x-z&=-5 \\ -3-z&=-5 \\ -z&=-2 \\ z&=2 \end{aligned}$$

Back-substitute to solve for y.

$$\begin{aligned} x-2y+2z&=1 \\ -3-2y+2(2)&=1 \\ -3-2y+4&=1 \\ -2y&=0 \\ y&=0 \end{aligned}$$

The solution is $(-3,0,2)$ and the solution set is $\{(-3,0,2)\}$.

31. Selected points may vary, but the equation will be the same.

$$y=ax^2+bx+c$$

Use the points $(2,-2)$, $(4,1)$, and $(6,-2)$ to get the system

$$4a+2b+c=-2$$
$$16a+4b+c=1$$
$$36a+6b+c=-2$$

Multiply the first equation by -1 and add to the second equation.

$$\begin{array}{r} -4a-2b-c=2 \\ \underline{16a+4b+c=1} \\ 12a+2b=3 \end{array}$$

Multiply the first equation by -1 and add to the third equation.

$$\begin{array}{r} -4a-2b-c=2 \\ \underline{36a+6b+c=-2} \\ 32a+4b=0 \end{array}$$

Using the two reduced equations, we get the system

$$12a+2b=3$$
$$32a+4b=0$$

Multiply the first equation by -2 and add to the second equation.

$$\begin{array}{r} -24a-4b=-6 \\ \underline{32a+4b=0} \\ 8a=-6 \\ a=-\dfrac{3}{4} \end{array}$$

Back-substitute to solve for b.

$$\begin{aligned} 12a+2b&=3 \\ 12\left(-\frac{3}{4}\right)+2b&=3 \\ -9+2b&=3 \\ 2b&=12 \\ b&=6 \end{aligned}$$

Back-substitute to solve for c.

$$\begin{aligned} 4a+2b+c&=-2 \\ 4\left(-\frac{3}{4}\right)+2(6)+c&=-2 \\ -3+12+c&=-2 \\ c&=-11 \end{aligned}$$

The equation is $y=-\frac{3}{4}x^2+6x-11$.

32. Selected points may vary, but the equation will be the same.

$$y=ax^2+bx+c$$

Use the points $(3,4)$, $(4,2)$, and $(5,2)$ to get the system

$$9a+3b+c=4$$
$$16a+4b+c=2$$
$$25a+5b+c=2$$

Multiply the first equation by -1 and add to the second equation.

$$\begin{array}{r} -9a-3b-c=-4 \\ \underline{16a+4b+c=2} \\ 7a+b=-2 \end{array}$$

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Multiply the first equation by -1 and add to the third equation.

$$\begin{array}{r} -9a-3b-c=-4 \\ \underline{25a+5b+c=2} \\ 16a+2b=-2 \end{array}$$

Use the two reduced equations to get the system

$$7a+b=-2$$
$$16a+2b=-2$$

Multiply the first equation by -2 and add to the second equation.

$$\begin{array}{r} -14a-2b=4 \\ \underline{16a+2b=-2} \\ 2a=2 \\ a=1 \end{array}$$

Back-substitute to solve for b.

$$\begin{aligned} 7a+b&=-2 \\ 7(1)+b&=-2 \\ 7+b&=-2 \\ b&=-9 \end{aligned}$$

Back-substitute to solve for c.

$$\begin{aligned} 9a+3b+c&=4 \\ 9(1)+3(-9)+c&=4 \\ 9-27+c&=4 \\ c&=22 \end{aligned}$$

The equation is $y=x^2-9x+22$.

33. $ax-by-2cz=21$

$$ax+by+cz=0$$
$$2ax-by+cz=14$$

Add the first two equations.

$$\begin{array}{r} ax-by-2cz=21 \\ \underline{ax+by+cz=0} \\ 2ax-cz=21 \end{array}$$

Multiply the first equation by -1 and add to the third equation.

$$\begin{array}{r} -ax+by+2cz=-21 \\ \underline{2ax-by+cz=14} \\ ax+3cz=-7 \end{array}$$

Use the two reduced equations to get the following system:

$$2ax-cz=21$$
$$ax+3cz=-7$$

Multiply the second equation by -2 and add the equations.

$$\begin{array}{r} 2ax-cz=21 \\ \underline{-2ax-6cz=14} \\ -7cz=35 \\ z=-\dfrac{5}{c} \end{array}$$

Back-substitute to solve for x.

$$\begin{aligned} ax+3cz&=-7 \\ ax+3c\left(-\frac{5}{c}\right)&=-7 \\ ax-15&=-7 \\ ax&=8 \\ x&=\frac{8}{a} \end{aligned}$$

Back-substitute to solve for y.

$$\begin{aligned} ax+by+cz&=0 \\ a\left(\frac{8}{a}\right)+by+c\left(-\frac{5}{c}\right)&=0 \\ 8+by-5&=0 \\ by&=-3 \\ y&=-\frac{3}{b} \end{aligned}$$

The solution is $\left(\frac{8}{a},-\frac{3}{b},-\frac{5}{c}\right)$ and the solution set is $\left\{\left(\frac{8}{a},-\frac{3}{b},-\frac{5}{c}\right)\right\}$.

34. $ax-by+2cz=-4$

$$ax+3by-cz=1$$
$$2ax+by+3cz=2$$

Multiply the first equation by -1 and add to the second equation.

$$\begin{array}{r} -ax+by-2cz=4 \\ \underline{ax+3by-cz=1} \\ 4by-3cz=5 \end{array}$$

Multiply the first equation by -2 and add to the third equation.

$$\begin{array}{r} -2ax+2by-4cz=8 \\ \underline{2ax+by+3cz=2} \\ 3by-cz=10 \end{array}$$

Use the two reduced equations to get the following system:

$$4by-3cz=5$$
$$3by-cz=10$$

Multiply the second equation by -3 and add to the first equation.

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$$\begin{array}{r} 4by - 3cz = 5 \\ \underline{-9by + 3cz = -30} \\ -5by = -25 \\ y = \dfrac{5}{b} \end{array}$$

Back-substitute to solve for *z*.

$$\begin{aligned} 4by - 3cz &= 5 \\ 4b\left(\frac{5}{b}\right) - 3cz &= 5 \\ 20 - 3cz &= 5 \\ -3cz &= -15 \\ z &= \frac{5}{c} \end{aligned}$$

Back-substitute to solve for *x*.

$$\begin{aligned} ax - by + 2cz &= -4 \\ ax - b\left(\frac{5}{b}\right) + 2c\left(\frac{5}{c}\right) &= -4 \\ ax - 5 + 10 &= -4 \\ ax &= -9 \\ x &= -\frac{9}{a} \end{aligned}$$

The solution is $\left(-\frac{9}{a}, \frac{5}{b}, \frac{5}{c}\right)$ and the solution set is $\left\{\left(-\frac{9}{a}, \frac{5}{b}, \frac{5}{c}\right)\right\}$.

35. **a.** $(0,5)$, $(50,31)$, $(100,15)$

b. Substituting each ordered pair gives:

$$\begin{aligned} ax^2 + bx + c &= y \\ a(0)^2 + b(0) + c &= 5 \\ a(50)^2 + b(50) + c &= 31 \\ a(100)^2 + b(100) + c &= 15 \end{aligned}$$

Simplifying gives the following system:

$$\begin{aligned} 0a + 0b + c &= 5 \\ 2500a + 50b + c &= 31 \\ 10{,}000a + 100b + c &= 15 \end{aligned}$$

36. **a.** $(10,16)$, $(20,52)$, $(40,23)$

b. Substituting each ordered pair gives:

$$\begin{aligned} ax^2 + bx + c &= y \\ a(10)^2 + b(10) + c &= 16 \\ a(20)^2 + b(20) + c &= 52 \\ a(40)^2 + b(40) + c &= 23 \end{aligned}$$

Simplifying gives the following system:

$$\begin{aligned} 10a + 10b + c &= 16 \\ 400a + 20b + c &= 52 \\ 1600a + 40b + c &= 23 \end{aligned}$$

37. **a.** Using the three ordered pairs, $(1,224)$, $(3,176)$, and $(4,104)$, we get the following system:

$$\begin{aligned} a + b + c &= 224 \\ 9a + 3b + c &= 176 \\ 16a + 4b + c &= 104 \end{aligned}$$

Multiply the first equation by -1 and add to the second equation.

$$\begin{array}{r} -a - b - c = -224 \\ \underline{9a + 3b + c = 176} \\ 8a + 2b = -48 \end{array}$$

Multiply the first equation by -1 and add to the third equation.

$$\begin{array}{r} -a - b - c = -224 \\ \underline{16a + 4b + c = 104} \\ 15a + 3b = -120 \end{array}$$

Using the two reduced equations, we get the following system:

$$\begin{aligned} 8a + 2b &= -48 \\ 15a + 3b &= -120 \end{aligned}$$

Multiply the first equation by -3 and multiply the second equation by 2, then add to the equations.

$$\begin{array}{r} -24a - 6b = 144 \\ \underline{30a + 6b = -240} \\ 6a = -96 \\ a = -16 \end{array}$$

Back-substitute to solve for *b*.

$$\begin{aligned} 8a + 2b &= -48 \\ 8(-16) + 2b &= -48 \\ -128 + 2b &= -48 \\ 2b &= 80 \\ b &= 40 \end{aligned}$$

Back-substitute to solve for *c*.

$$\begin{aligned} a + b + c &= 224 \\ -16 + 40 + c &= 224 \\ c &= 200 \end{aligned}$$

The function is $y = -16x^2 + 40x + 200$.

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b. When $x = 5$, we get

$$\begin{aligned} y &= -16(5)^2 + 40(5) + 200 \\ &= -16(25) + 200 + 200 \\ &= -400 + 400 \\ &= 0 \end{aligned}$$

After 5 seconds, the ball hits the ground.

38. a.

$$\begin{aligned} a + b + c &= 46 \\ 4a + 2b + c &= 84 \\ 9a + 3b + c &= 114 \end{aligned}$$

Multiply the first equation by –1 and add to the second.

$$\begin{aligned} -a - b - c &= -46 \\ \underline{4a + 2b + c} &= \underline{84} \\ 3a + b &= 38 \end{aligned}$$

Multiply the first equation by –1 and add to the third.

$$\begin{aligned} -a - b - c &= -46 \\ \underline{9a + 3b + c} &= \underline{114} \\ 8a + 2b &= 68 \end{aligned}$$

The system of two equations in two variables becomes:

$$\begin{aligned} 3a + b &= 38 \\ 8a + 2b &= 68 \end{aligned}$$

Multiply the first equation by –1 and add to the second equation.

$$\begin{aligned} -6a - 2b &= -76 \\ \underline{8a + 2b} &= \underline{68} \\ 2a &= -8 \\ a &= -4 \end{aligned}$$

Back-substitute –4 for a in one of the equations in two variables.

$$\begin{aligned} 3a + b &= 38 \\ 3(-4) + b &= 38 \\ -12 + b &= 38 \\ b &= 50 \end{aligned}$$

Back-substitute –4 for a and 50 for b in one of the original equations in three variables.

$$\begin{aligned} a + b + c &= 46 \\ -4 + 50 + c &= 46 \\ 46 + c &= 46 \\ c &= 0 \end{aligned}$$

The quadratic function is $f(x) = -4x^2 + 50x$.

b. $f(6) = -4(6)^2 + 50(6) = -4(36) + 300$

$= -144 + 300 = 156$

During the 6 seconds after the brakes have been applied, a car will travel 156 feet.

39. Let x = hours Chemical Engineering Majors study per week
Let y = hours Mathematics Majors study per week.
Let z = hours Psychology Majors study per week.

$$\begin{aligned} x + y + z &= 52 \\ x - y &= 6 \\ x - z &= 8 \end{aligned}$$

Solve the second equation for y.

$$\begin{aligned} x - y &= 6 \\ -y &= -x + 6 \\ y &= x - 6 \end{aligned}$$

Solve the third equation for z.

$$\begin{aligned} x - z &= 8 \\ -z &= -x + 8 \\ z &= x - 8 \end{aligned}$$

Substitute the expressions for x and z into the first equation and solve for y.

$$\begin{aligned} x + y + z &= 52 \\ x + \overbrace{(x - 6)}^{y} + \overbrace{(x - 8)}^{z} &= 52 \\ x + x - 6 + x - 8 &= 52 \\ 3x - 14 &= 52 \\ 3x &= 66 \\ x &= 22 \end{aligned}$$

Back-substitute to solve for y and z.

$$\begin{aligned} y &= x - 6 \\ &= 22 - 6 \\ &= 16 \end{aligned}$$

$$\begin{aligned} z &= x - 8 \\ &= 22 - 8 \\ &= 14 \end{aligned}$$

The average hours spent studying per week:
Chemical Engineering Majors:22 hours;
Mathematics Majors 16 hours; Pshchology Majors 14 hours

40. Let x = hours Physics Majors study per week
Let y = hours English Majors study per week.
Let z = hours Sociology Majors study per week.

$$\begin{aligned} x + y + z &= 50 \\ x - y &= 4 \\ x - z &= 6 \end{aligned}$$

Solve the second equation for y.

$$\begin{aligned} x - y &= 4 \\ -y &= -x + 4 \\ y &= x - 4 \end{aligned}$$

Solve the third equation for z.

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$$\begin{aligned} x - z &= 6 \\ -z &= -x + 6 \\ z &= x - 6 \end{aligned}$$

Substitute the expressions for x and z into the first equation and solve for y.

$$\begin{aligned} x \quad + \quad y \quad + \quad z \quad &= 50 \\ x + (\overbrace{x-4}^{y}) + (\overbrace{x-6}^{z}) &= 50 \\ x + x - 4 + x - 6 &= 50 \\ 3x - 10 &= 50 \\ 3x &= 60 \\ x &= 20 \end{aligned}$$

Back-substitute to solve for y and z.

$$\begin{aligned} y &= x - 4 \\ &= 20 - 4 \\ &= 16 \\ z &= x - 6 \\ &= 20 - 6 \\ &= 14 \end{aligned}$$

The average hours spent studying per week: Physics Majors: 20 hours; English Majors 16 hours; Sociology Majors 14 hours

41. Let x = the amount invested at 8%.
Let y = the amount invested at 10%.
Let z = the amount invested at 12%.

$$\begin{aligned} x + y + z &= 6700 \\ 0.08x + 0.10y + 0.12z &= 716 \\ z - x - y &= 300 \end{aligned}$$

Rewrite the system in $Ax + By + Cz = D$ form.

$$\begin{aligned} x + \quad y + \quad z &= 6700 \\ 0.08x + 0.10y + 0.12z &= 716 \\ -x - \quad y + \quad z &= 300 \end{aligned}$$

Add the first and third equations to find z.

$$\begin{array}{r} x + y + z = 6700 \\ \underline{-x - y + z = \ \ 300} \\ 2z = 7000 \\ z = 3500 \end{array}$$

Back-substitute 3500 for z to obtain two equations in two variables.

$$\begin{aligned} x + y + z &= 6700 \\ x + y + 3500 &= 6700 \\ x + y &= 3200 \end{aligned}$$

$$\begin{aligned} 0.08x + 0.10y + 0.12(3500) &= 716 \\ 0.08x + 0.10y + 420 &= 716 \\ 0.08x + 0.10y &= 296 \end{aligned}$$

The system of two equations in two variables becomes:

$$\begin{aligned} x + \quad y &= 3200 \\ 0.08x + 0.10y &= 296 \end{aligned}$$

Multiply the second equation by –10 and add it to the first equation.

$$\begin{array}{r} x + \ \ y = \ \ 3200 \\ \underline{-0.8x + -y = -2960} \\ 0.2x = 240 \\ x = 1200 \end{array}$$

Back-substitute 1200 for x in one of the equations in two variables.

$$\begin{aligned} x + y &= 3200 \\ 1200 + y &= 3200 \\ y &= 2000 \end{aligned}$$

\$1200 was invested at 8%, \$2000 was invested at 10%, and \$3500 was invested at 12%.

42. Let x = the amount invested at 10%.
Let y = the amount invested at 12%.
Let z = the amount invested at 15%.

$$\begin{aligned} x + y + z &= 17000 \\ 0.10x + 0.12y + 0.15z &= 2110 \\ x + z &= y + 1000 \end{aligned}$$

Rewrite the system in $Ax + By + Cz = D$ form.

$$\begin{aligned} x + \quad y + \quad z &= 17000 \\ 0.10x + 0.12y + 0.15z &= 2110 \\ x - \quad y + \quad z &= 1000 \end{aligned}$$

Multiply the first equation by –1 and add to the third equation.

$$\begin{array}{r} -x - y - z = -17000 \\ \underline{x - y + z = \quad 1000} \\ -2y \quad = -16000 \\ y \quad = \quad 8000 \end{array}$$

Back-substitute 9000 for y to obtain two equations in two variables.

$$\begin{aligned} x + y + z &= 17000 \\ x + 8000 + z &= 17000 \\ x + z &= 9000 \end{aligned}$$

$$\begin{aligned} 0.10x + 0.12y + 0.15z &= 2110 \\ 0.10x + 0.12(8000) + 0.15z &= 2110 \\ 0.10x + 960 + 0.15z &= 2110 \\ 0.10x + 0.15z &= 1150 \end{aligned}$$

The system of two equations in two variables becomes:

$$\begin{aligned} x + \quad z &= 9000 \\ 0.10x + 0.15z &= 1150 \end{aligned}$$

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Multiply the second equation by –10 and add it to the first equation.

$$\begin{array}{r} x + \quad z = \quad 9000 \\ \underline{-x - 1.5z = -11500} \\ -0.5z = -2500 \\ z = \quad 5000 \end{array}$$

Back-substitute 5000 for x to find z.

$$\begin{aligned} x + z &= 9000 \\ x + 5000 &= 9000 \\ x &= 4000 \end{aligned}$$

There was \$4000 invested at 10%, \$8000 invested at 12%, and \$5000 invested at 15%.

43. Let x = the number of \$8 tickets.
Let y = the number of \$10 tickets.
Let z = the number of \$12 tickets.

$$\begin{aligned} x + \quad y + \quad z &= 400 \\ 8x + 10y + 12z &= 3700 \\ x + \quad y \quad &= 7z \end{aligned}$$

Rewrite the system in $Ax + By + Cz = D$ form.

$$\begin{aligned} x + \quad y + \quad z &= 400 \\ 8x + 10y + 12z &= 3700 \\ x + \quad y - 7z &= 0 \end{aligned}$$

Multiply the first equation by –1 and add to the third equation.

$$\begin{array}{r} -x - y - z = -400 \\ \underline{x + y - 7z = \quad 0} \\ -8z = -400 \\ z = 50 \end{array}$$

Back-substitute 50 for z in two of the original equations to obtain two of equations in two variables.

$$\begin{aligned} x + y + z &= 400 \\ x + y + 50 &= 400 \\ x + y &= 350 \end{aligned}$$

$$\begin{aligned} 8x + 10y + 12z &= 3700 \\ 8x + 10y + 12(50) &= 3700 \\ 8x + 10y + 600 &= 3700 \\ 8x + 10y &= 3100 \end{aligned}$$

The system of two equations in two variables becomes:

$$\begin{aligned} x + \quad y &= 350 \\ 8x + 10y &= 3100 \end{aligned}$$

Multiply the first equation by –8 and add to the second equation.

$$\begin{array}{r} -8x - 8y = -2800 \\ \underline{8x + 10y = \quad 3100} \\ 2y = 300 \\ y = 150 \end{array}$$

Back-substitute 50 for z and 150 for y in one of the original equations in three variables.

$$\begin{aligned} x + y + z &= 400 \\ x + 150 + 50 &= 400 \\ x + 200 &= 400 \\ x &= 200 \end{aligned}$$

There were 200 \$8 tickets, 150 \$10 tickets, and 50 \$12 tickets sold.

44. Let x = the number of \$2 packages sold.
Let y = the number of \$3 packages sold.
Let z = the number of \$4 packages sold.

$$\begin{aligned} x + \quad y + \quad z &= 12 \\ 6x + 12y + 24z &= 162 \\ 2x + \quad 3y + \quad 4z &= 35 \end{aligned}$$

Multiply the first equation by –6 and add to the second equation.

$$\begin{array}{r} -6x - 6y - 6z = -72 \\ \underline{6x + 12y + 24z = 162} \\ 6y + 18z = 90 \end{array}$$

Multiply the first equation by –6 and add to the second equation.

$$\begin{array}{r} -2x - 2y - 2z = -24 \\ \underline{2x + 3y + 4z = \quad 35} \\ y + 2z = 11 \end{array}$$

The system of two equations in two variables is as follows.

$$\begin{aligned} 6y + 18z &= 90 \\ y + \quad 2z &= 11 \end{aligned}$$

Multiply the second equation by –6 and add to the first equation.

$$\begin{array}{r} 6y + 18z = \quad 90 \\ \underline{-6y - 12z = -66} \\ 6z = 24 \\ z = 4 \end{array}$$

Back-substitute 4 for z in one of the equations in two variables.

$$\begin{aligned} y + 2z &= 11 \\ y + 2(4) &= 11 \\ y + 8 &= 11 \\ y &= 3 \end{aligned}$$

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Back-substitute 3 for y and 4 for z in one of the original equations in three variables.

$$\begin{aligned} x+y+z &= 12 \\ x+3+4 &= 12 \\ x+7 &= 12 \\ x &= 5 \end{aligned}$$

There were 5 \$2 packages, 3 \$3 packages, and 4 \$4 packages sold.

45. Let A = the number of servings of A.
Let B = the number of servings of B.
Let C = the number of servings of C.

$$\begin{aligned} 40A+200B+400C &= 660 \\ 5A+\ \ 2B+\ \ 4C &= 25 \\ 30A+\ \ 10B+300C &= 425 \end{aligned}$$

Multiply the second equation by –8 and add to the first equation to obtain an equation in two variables.

$$\begin{aligned} 40A+200B+400C &= 660 \\ \underline{-40A-\ \ 16B-\ \ 32C} &\underline{= -200} \\ 184B+368C &= 460 \end{aligned}$$

Multiply the second equation by –6 and add to the third equation to obtain an equation in two variables.

$$\begin{aligned} -30A-12B-\ \ 24C &= -150 \\ \underline{30A+10B+300C} &\underline{= 425} \\ -2B+276C &= 275 \end{aligned}$$

The system of two equations in two variables becomes:

$$\begin{aligned} 184B+368C &= 460 \\ -2B+276C &= 275 \end{aligned}$$

Multiply the second equation by 92 and eliminate B.

$$\begin{aligned} 184B+\ \ 368C &= 460 \\ \underline{-184B+25392C} &\underline{= 25300} \\ 25760C &= 25760 \\ C &= 1 \end{aligned}$$

Back-substitute 1 for C in one of the equations in two variables.

$$\begin{aligned} -2B+276C &= 275 \\ -2B+276(1) &= 275 \\ -2B+276 &= 275 \\ -2B &= -1 \\ B &= \frac{1}{2} \end{aligned}$$

Back-substitute 1 for C and $\frac{1}{2}$ for B in one of the original equations in three variables.

$$\begin{aligned} 5A+2B+4C &= 25 \\ 5A+2\left(\frac{1}{2}\right)+4(1) &= 25 \\ 5A+1+4 &= 25 \\ 5A+5 &= 25 \\ 5A &= 20 \\ A &= 4 \end{aligned}$$

To meet the requirements, 4 ounces of Food A, $\frac{1}{2}$ ounce of Food B, and 1 ounce of Food C should be used.

46. Let C = the number of Children's desks.
Let O = the number of Office desks.
Let D = the number of Deluxe desks.

$$\begin{aligned} 2C+3O+2D &= 100 \\ 2C+\ \ O+3D &= 100 \\ C+\ \ O+2D &= 65 \end{aligned}$$

Multiply the third equation by –2 and add to the first.

$$\begin{aligned} 2C+3O+2D &= 100 \\ \underline{-2C-2O-4D} &\underline{= -130} \\ O-2D &= -30 \end{aligned}$$

Multiply the third equation by –2 and add to the second.

$$\begin{aligned} 2C+\ \ O+3D &= 100 \\ \underline{-2C-2O-4D} &\underline{= -130} \\ -O-D &= -30 \end{aligned}$$

The system of two equations in two variables is as follows.

$$\begin{aligned} O-2D &= -30 \\ -O-\ \ D &= -30 \end{aligned}$$

Add the equations to eliminate O.

$$\begin{aligned} O-2D &= -30 \\ \underline{-O-\ \ D} &\underline{= -30} \\ -3D &= -60 \\ D &= 20 \end{aligned}$$

Back-substitute 20 for D in one of the equations in two variables.

$$\begin{aligned} O-2D &= -30 \\ O-2(20) &= -30 \\ O-40 &= -30 \\ O &= 10 \end{aligned}$$

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Back-substitute 20 for D and 10 for O in one of the original equations in three variables.

$$\begin{aligned} C+O+2D &= 65 \\ C+10+2(20) &= 65 \\ C+10+40 &= 65 \\ C+50 &= 65 \\ C &= 15 \end{aligned}$$

Each week, the company should produce 15 Children's models, 10 Office models and 20 Deluxe models.

47. – 53. Answers will vary.

54. does not make sense; Explanations will vary. Sample explanation: The third variable could possibly have the same variable as one of the other two.

55. does not make sense; Explanations will vary. Sample explanation: A system of linear equations in three variables can contain an equation of the form $y = mx + b$. For this equation, the coefficient of z is 0.

56. makes sense

57. makes sense

58. false; Changes to make the statement true will vary. A sample change is: The given ordered triple is one solution to the equation, but there are an infinite number of other ordered triples which satisfy the equation.

59. false; Changes to make the statement true will vary. A sample change is: The equation is not satisfied by the given point.

$$\begin{aligned} x-y-z &= -6 \\ 2-(-3)-5 &= -6 \\ 2+3-5 &= -6 \\ 0 &= -6, \text{ false} \end{aligned}$$

60. true

61. false; Changes to make the statement true will vary. A sample change is: The given equation in four variables can be satisfied by real numbers. For example, the given equation can be satisfied by (2, 0, 0, 0).

62.
$$\begin{aligned} x+y+z &= 180 \\ (2x+5)+y &= 180 \\ (2x-5)+z &= 180 \end{aligned}$$

Rewrite the system in standard form as

$$\begin{aligned} x+y+z &= 180 \\ 2x+y &= 175 \\ 2x+z &= 185 \end{aligned}$$

Multiply the first equation by -1 and add to the second equation to obtain an equation with two variables.

$$\begin{aligned} -x-y-z &= -180 \\ 2x+y \quad &= 175 \\ \hline x-z &= -5 \end{aligned}$$

Combine this equation with the third equation to make a system of two equations.

$$\begin{aligned} x-z &= -5 \\ 2x+z &= 185 \\ \hline 3x &= 180 \\ x &= 60 \end{aligned}$$

Back-substitute to find z.

$$\begin{aligned} x-z &= -5 \\ 60-z &= -5 \\ -z &= -65 \\ z &= 65 \end{aligned}$$

Back-substitute to find y.

$$\begin{aligned} x+y+z &= 180 \\ 60+y+65 &= 180 \\ y &= 55 \end{aligned}$$

The angles measure $55°$, $60°$, and $65°$.

63. Let t = the number of triangles.
Let r = the number of rectangles.
Let p = the number of pentagons.

From the problem, we have the following three equations.

$$\begin{aligned} t+r+p &= 40 \\ 3t+4r+5p &= 153 \\ 2r+5p &= 72 \end{aligned}$$

Multiply the first equation by –3 and add it to the second to eliminate t.

$$\begin{aligned} -3t-3r+-3p &= -120 \\ 3t+4r+5p &= 153 \\ \hline r+2p &= 33 \end{aligned}$$

This gives us a system with two equations in two variables.

$$\begin{aligned} 2r+5p &= 72 \\ r+2p &= 33 \end{aligned}$$

Multiply the second equation by –2 and add to eliminate r.

$$\begin{array}{r} 2r+5p=\ \ 72 \\ \underline{-2r-4p=-66} \\ p=6 \end{array}$$

Back-substitute 6 for p in one of the equations in two variables.

$$r+2p=33$$
$$r+2(6)=33$$
$$r+12=33$$
$$r=21$$

Back-substitute 21 for r and 6 for p to find t.

$$t+r+p=40$$
$$t+21+6=40$$
$$t+27=40$$
$$t=13$$

There are 13 triangles, 21 rectangles, and 6 pentagons.

64. Let x = height of the table.
Let y = length of the wood blocks.
Let z = width of the wood blocks.

From the problem, we have the following two equations.

$$x+y-z=32$$
$$x-y+z=28$$

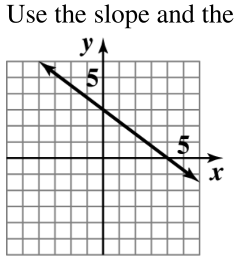
Add the two equations.

$$\begin{array}{r} x+y-z=32 \\ \underline{x-y+z=28} \\ 2x\qquad\ =60 \\ x=30 \end{array}$$

The height of the table is 30 centimeters.

65. $f(x)=-\dfrac{3}{4}x+3$

Use the slope and the y–intercept to graph the line.

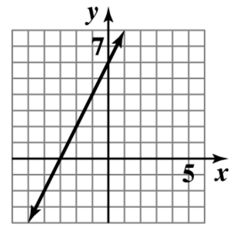


66. $-2x+y=6$

Rewrite the equation in slope-intercept form.

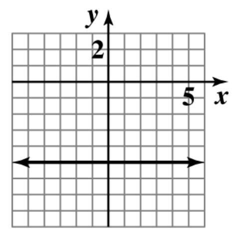
$$-2x+y=6$$
$$y=2x+6$$

Use the slope and the y–intercept to graph the line.



67. $f(x)=-5$

This line is the horizontal line, $y=-5$.



68. $x+2y=-1$

$$y=\ 1$$

The value for y is given and thus the value of x can be found by back-substitution.

$$x+2y=-1$$
$$x+2(1)=-1$$
$$x+2=-1$$
$$x=-3$$

The solution is $(-3,\ 1)$ and the solution set is $\{(-3,\ 1)\}$.

69. $x+y+2z=19$

$$y+2z=13$$
$$z=5$$

The value for y is given and the other variables be found by back-substitution.

$$y+2z=13$$
$$y+2(5)=13$$
$$y+10=13$$
$$y=3$$

$$x+y+2z=19$$
$$x+(3)+2(5)=19$$
$$x+13=19$$
$$x=6$$

The solution is $(6,3,5)$ and the solution set is $\{(6,3,5)\}$.

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70. $\begin{bmatrix} 1 & 2 & -1 \\ 4 & -3 & -15 \end{bmatrix}$

$$\begin{bmatrix} 1 & 2 & -1 \\ 4+(-4)(1) & -3+(-4)(2) & -15+(-4)(-1) \end{bmatrix} = \begin{bmatrix} 1 & 2 & -1 \\ 0 & -11 & -11 \end{bmatrix}$$

Mid-Chapter Check Point – Chapter 3

1. $x = 3y - 7$

$4x + 3y = 2$

Since the first equation is solved for x already, we will use substitution.

Let $x = 3y - 7$ in the second equation and solve for y.

$4(3y - 7) + 3y = 2$

$12y - 28 + 3y = 2$

$15y = 30$

$y = 2$

Substitute this value for y in the first equation.

$x = 3(2) - 7 = 6 - 7 = -1$

The solution is $(-1, 2)$ and the solution set is $\{(-1, 2)\}$.

2. $3x + 4y = -5$

$2x - 3y = 8$

Multiply the first equation by 3 and the second equation by 4, then add the equations.

$9x + 12y = -15$

$8x - 12y = 32$

$17x = 17$

$x = 1$

Back-substitute to solve for y.

$3x + 4y = -5$

$3(1) + 4y = -5$

$3 + 4y = -5$

$4y = -8$

$y = -2$

The solution is $(1, -2)$ and the solution set is $\{(1, -2)\}$.

3. $\dfrac{2x}{3} + \dfrac{y}{5} = 6$

$\dfrac{x}{6} - \dfrac{y}{2} = -4$

Multiply the first equation by 15 and the second equation by 6 to eliminate the fractions.

$15\left(\dfrac{2x}{3} + \dfrac{y}{5}\right) = 15(6)$

$10x + 3y = 90$

$6\left(\dfrac{x}{6} - \dfrac{y}{2}\right) = 6(-4)$

$x - 3y = -24$

We now need to solve the equivalent system.

$10x + 3y = 90$

$x - 3y = -24$

Add the two equations to eliminate y.

$10x + 3y = 90$

$x - 3y = -24$

$11x = 66$

$x = 6$

Back-substitute to solve for y.

$x - 3y = -24$

$6 - 3y = -24$

$-3y = -30$

$y = 10$

The solution is $(6, 10)$ and the solution set is $\{(6, 10)\}$.

4. $y = 4x - 5$

$8x - 2y = 10$

Since the first equation is already solved for y, we will use substitution.

Let $y = 4x - 5$ in the second equation and solve for x.

$8x - 2(4x - 5) = 10$

$8x - 8x + 10 = 10$

$10 = 10$

This statement is an identity. The system is dependent so there are an infinite number of solutions. The solution set is

$\{(x, y) \mid y = 4x - 5\}$ or $\{(x, y) \mid 8x - 2y = 10\}$.

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5. $2x+5y=3$

$3x-2y=1$

Multiply the first equation by 3 and the second equation by -2, then add the equations.

$$\begin{aligned} 6x+15y&=9\\ \underline{-6x+4y}&\underline{=-2}\\ 19y&=7\\ y&=\frac{7}{19}\end{aligned}$$

Back-substitute to solve for *x*.

$$\begin{aligned} 2x+5y&=3\\ 2x+5\left(\frac{7}{19}\right)&=3\\ 2x+\frac{35}{19}&=3\\ 2x&=\frac{22}{19}\\ x&=\frac{11}{19}\end{aligned}$$

The solution is $\left(\frac{11}{19},\frac{7}{19}\right)$ and the solution set is $\left\{\left(\frac{11}{19},\frac{7}{19}\right)\right\}$.

6. $\frac{x}{12}-y=\frac{1}{4}$

$4x-48y=16$

Solve the first equation for *y*.

$$\begin{aligned} \frac{x}{12}-y&=\frac{1}{4}\\ -y&=-\frac{x}{12}+\frac{1}{4}\\ y&=\frac{x}{12}-\frac{1}{4}\end{aligned}$$

Let $y=\frac{x}{12}-\frac{1}{4}$ in the second equation and solve for *x*.

$$\begin{aligned} 4x-48\left(\frac{x}{12}-\frac{1}{4}\right)&=16\\ 4x-4x+12&=16\\ 12&=16\end{aligned}$$

This statement is a contradiction. The system is inconsistent so there is no solution. The solution is $\{\ \}$ or $\varnothing$.

7. $2x-y+2z=-8$

$x+2y-3z=9$

$3x-y-4z=3$

Multiply the first equation by 2 and add to the second equation.

$$\begin{aligned} 4x-2y+4z&=-16\\ \underline{x+2y-3z}&\underline{=9}\\ 5x+z&=-7\end{aligned}$$

Multiply the first equation by -1 and add to the third equation.

$$\begin{aligned} -2x+y-2z&=8\\ \underline{3x-y-4z}&\underline{=3}\\ x-6z&=11\end{aligned}$$

Use the two reduced equations to get the following system:

$5x+z=-7$

$x-6z=11$

Multiply the first equation by 6 and add to the second equation.

$$\begin{aligned} 30x+6z&=-42\\ \underline{x-6z}&\underline{=11}\\ 31x&=-31\\ x&=-1\end{aligned}$$

Back-substitute to solve for *z*.

$$\begin{aligned} 5x+z&=-7\\ 5(-1)+z&=-7\\ -5+z&=-7\\ z&=-2\end{aligned}$$

Back-substitute to solve for *y*.

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

The solution is $(-1,2,-2)$ and the solution set is $\{(-1,2,-2)\}$.

8. $x \quad -3z=-5$

$2x-y+2z=16$

$7x-3y-5z=19$

Multiply the second equation by -3 and add to the third equation.

$$\begin{aligned} -6x+3y-6z&=-48\\ \underline{7x-3y-5z}&\underline{=19}\\ x-11z&=-29\end{aligned}$$

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Use this reduced equation and the original first equation to obtain the following system:

$$x - 3z = -5$$
$$x - 11z = -29$$

Multiply the second equation by -1 and add to the first equation.

$$\begin{aligned} x - 3z &= -5 \\ \underline{-x + 11z} &\underline{= 29} \\ 8z &= 24 \\ z &= 3 \end{aligned}$$

Back-substitute to solve for x.

$$\begin{aligned} x - 3z &= -5 \\ x - 3(3) &= -5 \\ x - 9 &= -5 \\ x &= 4 \end{aligned}$$

Back-substitute to solve for y.

$$\begin{aligned} 2x - y + 2z &= 16 \\ 2(4) - y + 2(3) &= 16 \\ 8 - y + 6 &= 16 \\ -y &= 2 \\ y &= -2 \end{aligned}$$

The solution is $(4, -2, 3)$ and the solution set is $\{(4, -2, 3)\}$.

9. Graph the two lines by using the intercepts.

$2x - y = 4$

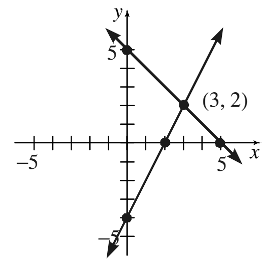
x-intercept: $$\begin{aligned} 2x - y &= 4 \\ 2x - 0 &= 4 \\ 2x &= 4 \\ x &= 2 \end{aligned}$$

y-intercept: $$\begin{aligned} 2x - y &= 4 \\ 2(0) - y &= 4 \\ -y &= 4 \\ y &= -4 \end{aligned}$$

$x + y = 5$

x-intercept: $$\begin{aligned} x + y &= 5 \\ x + 0 &= 5 \\ x &= 5 \end{aligned}$$

y-intercept: $$\begin{aligned} x + y &= 5 \\ 0 + y &= 5 \\ y &= 5 \end{aligned}$$



The solution of the system is the intersection point of the graphs. Therefore, the solution is $(3, 2)$ and the solution set is $\{(3, 2)\}$.

10. Graph the two lines by using the slope and y-intercept.

$y = x + 3$

y-intercept: $b = 3$

slope: $m = 1 = \frac{1}{1}$

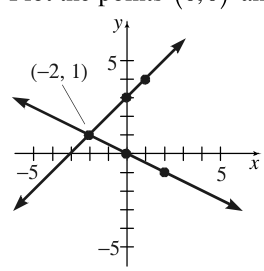
Plot the points $(0, 3)$ and $(0 + 1, 3 + 1) = (1, 4)$

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

y-intercept: $b = 0$

slope: $m = -\frac{1}{2} = \frac{-1}{2}$

Plot the points $(0, 0)$ and $(0 + 2, 0 - 1) = (2, -1)$.



The solution of the system is the intersection point of the graphs. Therefore, the solution is $(-2, 1)$ and the solution set is $\{(-2, 1)\}$.

11. **a.** $C(x) = 400{,}000 + 20x$

b. $R(x) = 100x$

c. $$\begin{aligned} P(x) &= R(x) - C(x) \\ &= 100x - (400{,}000 + 20x) \\ &= 80x - 400{,}000 \end{aligned}$$

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d. The break-even point is the point where cost and revenue are the same. We need to solve the system

$$y = 400{,}000 + 20x$$
$$y = 100x$$

Let $y = 400{,}000 + 20x$ in the second equation and solve for x.

$$400{,}000 + 20x = 100x$$
$$400{,}000 = 80x$$
$$5000 = x$$

Back-substitute to solve for y.

$$y = 100x$$
$$= 100(5000)$$
$$= 500{,}000$$

Thus, the break-even point is $(5000,\ 500{,}000)$.

The company will break even when it produces and sells 5000 PDAs. At this level, the cost and revenue will both be \$500,000.

12. Let x = the number of roses.
Let y = the number of carnations.

$$x + y = 20$$
$$3x + 1.5y = 39$$

Solve the first equation for x.

$$x + y = 20$$
$$x = 20 - y$$

Substitute this expression for x in the second equation and solve for y.

$$3(20 - y) + 1.5y = 39$$
$$60 - 3y + 1.5y = 39$$
$$-1.5y = -21$$
$$y = 14$$

Back-substitute to solve for x.

$$x = 20 - y = 20 - 14 = 6$$

There are 6 roses and 14 carnations in the bouquet.

13. Let x = the amount invested at 5%.
Let y = the amount invested at 6%.

$$x + y = 15{,}000$$
$$0.05x + 0.06y = 837$$

Solve the first equation for x.

$$x + y = 15{,}000$$
$$x = 15{,}000 - y$$

Substitute this expression for x in the second equation and solve for y.

$$0.05(15{,}000 - y) + 0.06y = 837$$
$$750 - 0.05y + 0.06y = 837$$
$$0.01y = 87$$
$$y = 8700$$

Back-substitute to solve for x.

$$x = 15{,}000 - y$$
$$= 15{,}000 - 8700$$
$$= 6300$$

You invested \$6300 at 5% and \$8700 at 6%.

14. Let x = gallons of 13% nitrogen.
Let y = gallons of 18% nitrogen.

$$x + y = 50$$
$$0.13x + 0.18y = 0.16(50)$$

or

$$x + y = 50$$
$$0.13x + 0.18y = 8$$

Solve the first equation for x.

$$x + y = 50$$
$$x = 50 - y$$

Substitute this expression for x in the second equation and solve for y.

$$0.13(50 - y) + 0.18y = 8$$
$$6.5 - 0.13y + 0.18y = 8$$
$$0.05y = 1.5$$
$$y = 30$$

Back-substitute to solve for x.

$$x = 50 - y = 50 - 30 = 20$$

The manager should mix 20 gallons of the 13% nitrogen with 30 gallons of the 18% nitrogen.

15. Let w = the rate of the water (current).
Let r = your average rowing rate.
For this problem we will make use of the distance traveled formula: $d = r \cdot t$
In addition, remember that when you go *with* the current you add the rate of the current to your rowing rate. If you go *against* the current, you subtract the rate of the current from your rowing rate.

With this in mind, we obtain the following system:

$$9 = (r + w)(2)$$
$$9 = (r - w)(6)$$

or

$$2r + 2w = 9$$
$$6r - 6w = 9$$

Multiply the first equation by 3 and add the two equations.

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$$\begin{array}{r} 6r+6w=27 \\ \underline{6r-6w=9} \\ 12r=36 \\ r=3 \end{array}$$

Back-substitute to solve for w.

$$\begin{aligned} 2r+2w&=9 \\ 2(3)+2w&=9 \\ 6+2w&=9 \\ 2w&=3 \\ w&=1.5 \end{aligned}$$

Your rowing rate in still water is 3 miles per hour; the rate of the current is 1.5 miles per hour.

16. Let x = the amount invested at 2%.
Let y = the amount invested at 5%.

$$\begin{aligned} x+y&=8000 \\ 0.05y&=0.02x+85 \end{aligned}$$

Multiply the second equation by 20.

$$\begin{aligned} x+y&=8000 \\ y&=0.4x+1700 \end{aligned}$$

Let $y=0.4x+1700$ in the first equation and solve for x.

$$\begin{aligned} x+(0.4x+1700)&=8000 \\ 1.4x&=6300 \\ x&=4500 \end{aligned}$$

Back-substitute to solve for y.

$$\begin{aligned} x+y&=8000 \\ 4500+y&=8000 \\ y&=3500 \end{aligned}$$

You invested \$4500 at 2% and \$3500 at 5%.

17. Using the points $(-1,0)$, $(1,4)$, and $(2,3)$ in the equation $y=ax^2+bx+c$, we get the following system of equations:

$$\begin{aligned} a-b+c&=0 \\ a+b+c&=4 \\ 4a+2b+c&=3 \end{aligned}$$

Add the first two equations.

$$\begin{array}{r} a-b+c=0 \\ \underline{a+b+c=4} \\ 2a+2c=4 \end{array}$$

Multiply the first equation by 2 and add to the third equation.

$$\begin{array}{r} 2a-2b+2c=0 \\ \underline{4a+2b+c=3} \\ 6a+3c=3 \end{array}$$

Using the two reduced equations, we get the following system of equations:

$$\begin{aligned} 2a+2c&=4 \\ 6a+3c&=3 \end{aligned}$$

Multiply the first equation by -3 and add to the second equation.

$$\begin{array}{r} -6a-6c=-12 \\ \underline{6a+3c=3} \\ -3c=-9 \\ c=3 \end{array}$$

Back-substitute to solve for a.

$$\begin{aligned} 2a+2c&=4 \\ 2a+2(3)&=4 \\ 2a+6&=4 \\ 2a&=-2 \\ a&=-1 \end{aligned}$$

Back-substitute to solve for b.

$$\begin{aligned} a+b+c&=4 \\ -1+b+3&=4 \\ b&=2 \end{aligned}$$

The equation is $y=-x^2+2x+3$.

18. Let n = the number of nickels.
Let d = the number of dimes.
Let q = the number of quarters.
From the problem statement, we have

$$\begin{aligned} n+d+q&=26 \\ 0.05n+0.10d+0.25q&=4.00 \\ q&=n+d-2 \end{aligned}$$

If we multiply the second equation by 20 and rearrange the third equation, we get the following equivalent system:

$$\begin{aligned} n+d+q&=26 \\ n+2d+5q&=80 \\ n+d-q&=2 \end{aligned}$$

Multiply the first equation by -1 and add to the second equation.

$$\begin{array}{r} -n-d-q=-26 \\ \underline{n+2d+5q=80} \\ d+4q=54 \end{array}$$

Multiply the third equation by -1 and add to the first equation.

$$\begin{array}{r} n+d+q=26 \\ \underline{-n-d+q=-2} \\ 2q=24 \\ q=12 \end{array}$$

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