Intermediate Algebra for College Students 8th edition Blitzer Solutions Manual

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INSTRUCTOR'S SOLUTIONS MANUAL

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INTERMEDIATE ALGEBRA FOR COLLEGE STUDENTS

EIGHTH EDITION

Robert Blitzer

Miami Dade College

Pearson

Intermediate Algebra for College Students 8th edition Blitzer Solutions Manual

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Chapter 1
Algebra, Mathematical Models, and Problem Solving

1.1 Check Points

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

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

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. 2013 is 13 years after 2000.

$D = \overbrace{37x^2 + 658x + 17,440}^{\text{replace } x \text{ with } 13}$

$D = 37(13)^2 + 658(13) + 17,440$

$= 37(169) + 658(13) + 17,440$

$= 6253 + 8554 + 17,440$

$= 32,247$

The formula indicates that the mean student-loan debt for college students who graduated in 2013 was \$32,247.

b. The model value, \$32,247, is more than the actual data value, \$33,050. Thus, the mathematical model overestimates by \$803.

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

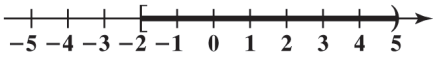
b. 7 is greater than -3; true

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

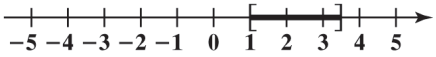
d. 5 is greater than or equal to 5; true

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

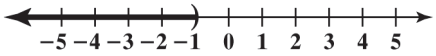
7. a. $\{x \mid -2 \le x < 5\}$



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. $4+5(9-7)^3=4+5(2)^3$
$=4+5(8)=4+40=44$

24. $6+5(8-6)^3=6+5(2)^3$
$=6+5(8)$
$=6+40=46$

25. $8^2-3(8-2)=64-3(6)$
$=64-18=46$

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

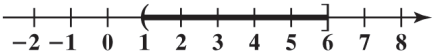
61. –2 is greater than or equal to –2; true

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

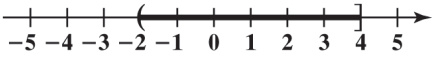
63. 2 is less than or equal to $-\frac{1}{2}$; false. 2 is greater than $-\frac{1}{2}$.

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

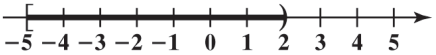
65. $\{x|1 < x \le 6\}$



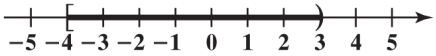
66. $\{x|-2 < x \le 4\}$



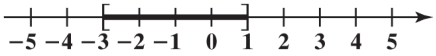
67. $\{x|-5 \le x < 2\}$



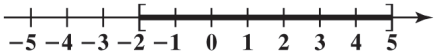
68. $\{x|-4 \le x < 3\}$



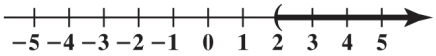
69. $\{x|-3 \le x \le 1\}$



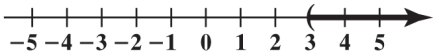
70. $\{x|-2 \le x \le 5\}$



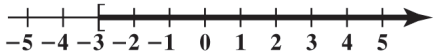
71. $\{x|x > 2\}$



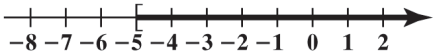
72. $\{x|x > 3\}$



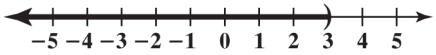
73. $\{x|x \ge -3\}$



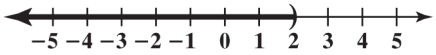
74. $\{x|x \ge -5\}$



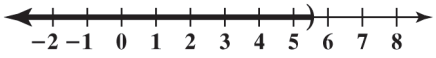
75. $\{x|x < 3\}$



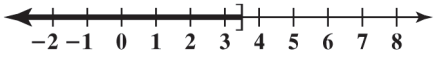
76. $\{x|x < 2\}$



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



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



79. true

80. true

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

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

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83. true

84. true

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

86. false; The value of $\{x \mid x \text{ is an integer between } -4 \text{ and } 0\} = \{-3,-2,-1\}$, 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. $W = 54 + 3.4x - 0.2x^2$
$= 54 + 3.4(2) - 0.2(2)^2$
$= 54 + 6.8 - 0.8$
$= 60$
According to the formula, 60% of American adults were in wireless only households in 2015. The formula overestimated the actual value by 1%.

94. $W = 54 + 3.4x - 0.2x^2$
$= 54 + 3.4(4) - 0.2(4)^2$
$= 54 + 13.6 - 3.2$
$= 64.4 \approx 64$
According to the formula, about 64% of American adults were in wireless households in 2017. The formula matches the the actual value.

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 2019 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. $-\left|-\dfrac{7}{10}\right|=-\dfrac{7}{10}$

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

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

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

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

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

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

87. $\begin{aligned} 8^2 - 16 \div 2^2 \cdot 4 - 3 &= 64 - 16 \div 4 \cdot 4 - 3 \\ &= 64 - 4 \cdot 4 - 3 \\ &= 64 - 16 - 3 \\ &= 48 - 3 \\ &= 45 \end{aligned}$

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

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

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

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

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

131. $x-(x+4)=x-x-4=-4$

132. $x-(8-x)=x-8+x=2x-8$

133. $6(-5x)=-30x$

134. $10(-4x)=-40x$

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

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

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

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

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. $D=4.5x^2-5(1.3x-16)$
$=4.5(6)^2-5(1.3(6)-16)$
$=203$
According to the model, college students spent \$203 billion in 2015.
The model gives the actual value displayed in the graph.

148. $D=4.5x^2-5(1.3x-16)$
$=4.5(2)^2-5(1.3(2)-16)$
$=85$
According to the model, college students spent \$85 billion in 2011.
The model underestimates the actual value displayed in the graph by \$2 billion.

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

b. $0.05(6000)+0.12(10{,}000-6000)$
$=0.05(6000)+0.12(4000)$
$=300+480=780$
$1200-0.07(6000)=1200-420$
$=780$
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.
$$\frac{9[4-(1+6)]-(3-9)^2}{5+\frac{12}{5-\frac{6}{2+1}}} = \frac{9[4-7]-(-6)^2}{5+\frac{12}{5-\frac{6}{3}}}$$
$$= \frac{9[-3]-36}{5+\frac{12}{5-2}}$$
$$= \frac{-27-36}{5+\frac{12}{3}}$$
$$= \frac{-63}{5+4}$$
$$= \frac{-63}{9}$$
$$= -7$$

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

181.
$$10 + 2(x-5)^4 = 10 + 2(7-5)^4$$
$$= 10 + 2(2)^4 = 10 + 2(16)$$
$$= 10 + 32 = 42$$

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

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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.

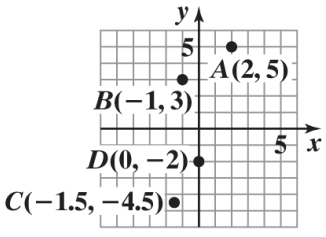
x	$y = 1 - x^2$
-3	$y = 1 - (-3)^2 = 1 - 9 = -8$
-2	$y = 1 - (-2)^2 = 1 - 4 = -3$
-1	$y = 1 - (-1)^2 = 1 - 1 = 0$
0	$y = 1 - (0)^2 = 1 - 0 = 1$
1	$y = 1 - (1)^2 = 1 - 1 = 0$
2	$y = 1 - (2)^2 = 1 - 4 = -3$
3	$y = 1 - (3)^2 = 1 - 9 = -8$

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	$y = \lvert 2 + 1 \rvert = \lvert 3 \rvert = 3$

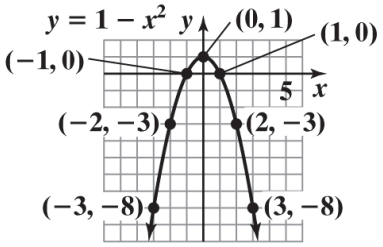
1.3 Check Points

1.



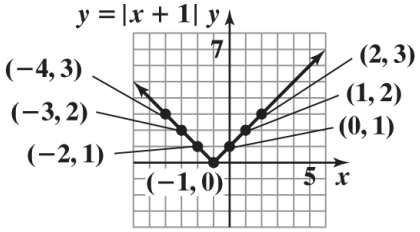
2. Make a table:

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.

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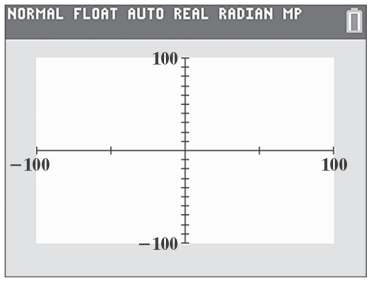
5. The minimum x-value is –100, the maximum x-value is 100, and the distance between consecutive tick marks is 50. The minimum y-value is –100, the maximum y-value is 100, and the distance between consecutive tick marks is 10.



1.3 Concept and Vocabulary Check

1. x-axis

2. y-axis

3. origin

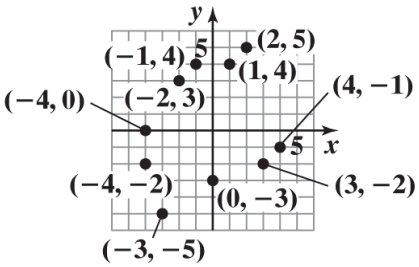
4. quadrants; four

5. x-coordinate; y-coordinate

6. solution; satisfies

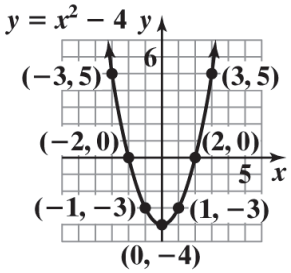
1.3 Exercise Set

1. – 10.



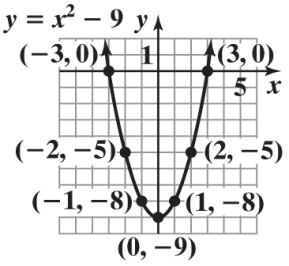
11.

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	$(3,0)$



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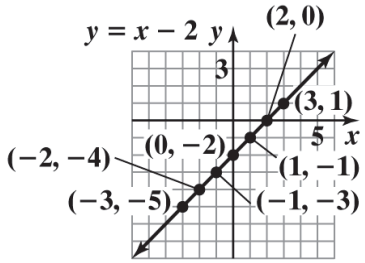
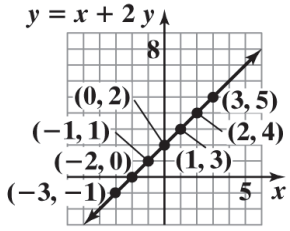
13.

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



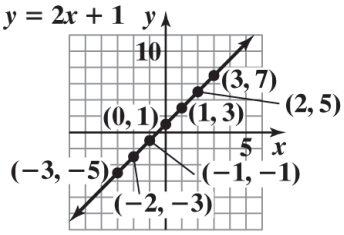
14.

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



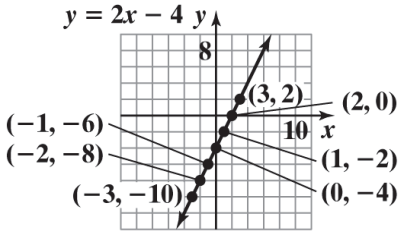
15.

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



16.

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



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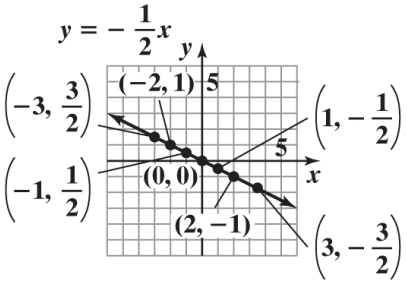
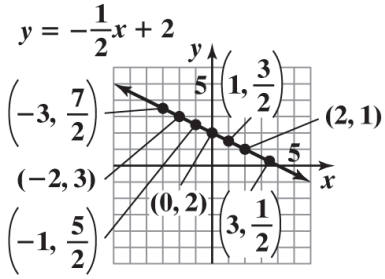
17.

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



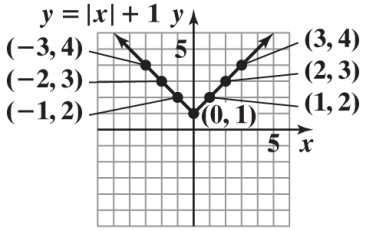
18.

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



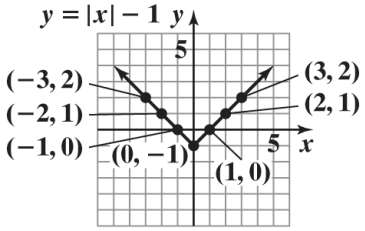
19.

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	$(3, 2)$



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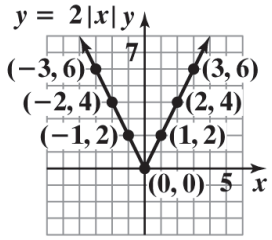
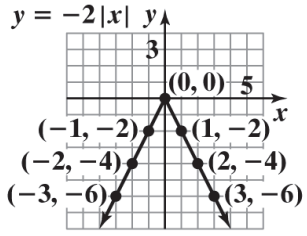
21.

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



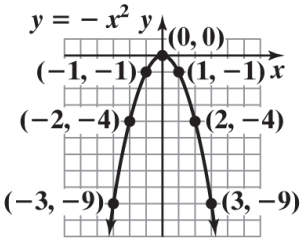
22.

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



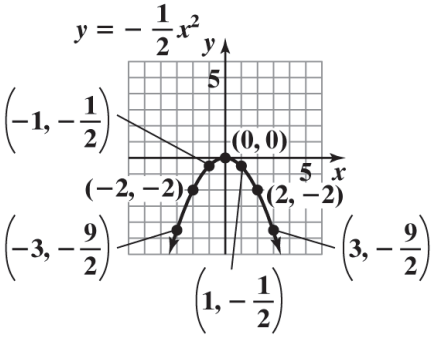
23.

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	$(3, -\frac{9}{2})$



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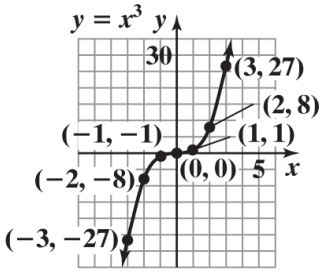
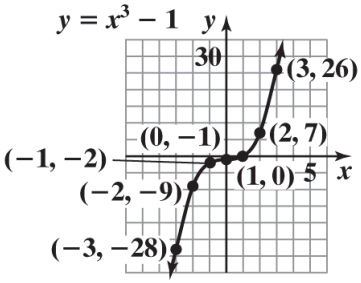
25.

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



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 $(0,0)$.

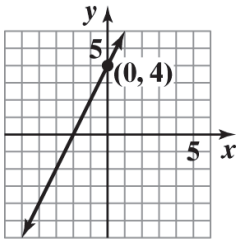
35. $(2,0)$

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. $y = 2x + 4$



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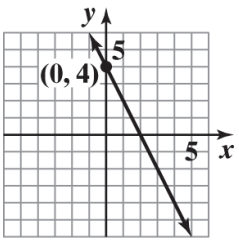
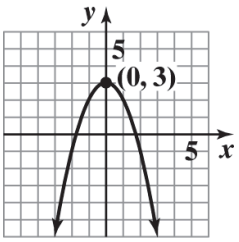
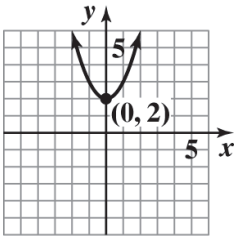
40. $y = 4 - 2x$



41. $y = 3 - x^2$

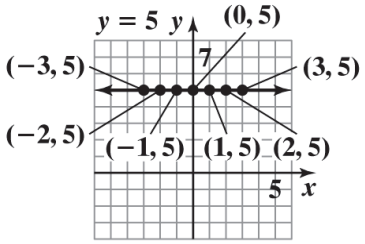


42. $y = x^2 + 2$



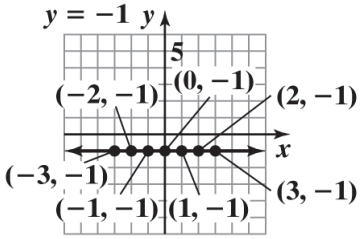
43.

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



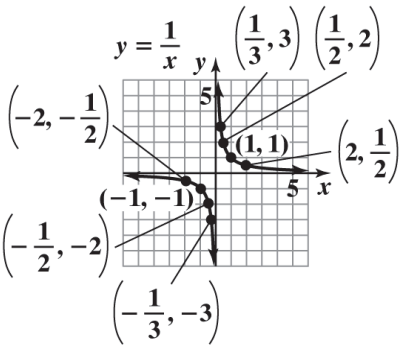
44.

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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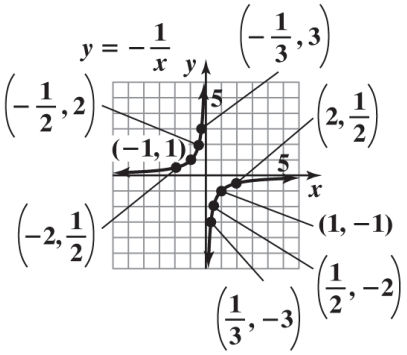
46.

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 88%, in 2015 and 2016.

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

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 or 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.

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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. $\big[12-(13-17)\big]-\big[9-(6-10)\big]$
$=\big[12-(-4)\big]-\big[9-(-4)\big]$
$=[12+4]-[9+4]=16-13=3$

85. $6x-5(4x+3)-10=6x-20x-15-10$
$=(6-20)x-(15+10)$
$=-14x-25$

86. $4x-3=5x+6$
$4(-9)-3=5(-9)+6$
$-36-3=-45+6$
$-39=-39$
The statement is true for $x=-9$.

87. $13-3(x+2)$
$=13-3x-6$
$=7-3x$

88. $10\left(\dfrac{3x+1}{2}\right)$
$=\dfrac{10}{1}\cdot\dfrac{3x+1}{2}$
$=5(3x+1)$
$=15x+5$

1.4 Check Points

1. $4x+5=29$
$4x+5-5=29-5$
$4x=24$
$\dfrac{4x}{4}=\dfrac{24}{4}$
$x=6$
The solution set is $\{6\}$.
Check:
$4x+5=29$
$4(6)+5=29$
$24+5=29$
$29=29$

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

3. $2(x-3)-17=13-3(x+2)$
$2x-6-17=13-3x-6$
$2x-23=7-3x$
$2x+3x=7+23$
$5x=30$
$\dfrac{5x}{5}=\dfrac{30}{5}$
$x=6$
The solution set is $\{6\}$.
Check:
$2(x-3)-17=13-3(x+2)$
$2(6-3)-17=13-3(6+2)$
$2(3)-17=13-3(8)$
$6-17=13-24$
$-11=-11$

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4.
$$\frac{x+5}{7}+\frac{x-3}{4}=\frac{5}{14}$$
$$28\left(\frac{x+5}{7}+\frac{x-3}{4}\right)=28\left(\frac{5}{14}\right)$$
$$\frac{28}{1}\left(\frac{x+5}{7}\right)+\frac{28}{1}\left(\frac{x-3}{4}\right)=\frac{28}{1}\left(\frac{5}{14}\right)$$
$$4(x+5)+7(x-3)=2(5)$$
$$4x+20+7x-21=10$$
$$11x-1=10$$
$$11x=10+1$$
$$11x=11$$
$$\frac{11x}{11}=\frac{11}{11}$$
$$x=1$$
The solution set is $\{1\}$.
Check:
$$\frac{x+5}{7}+\frac{x-3}{4}=\frac{5}{14}$$
$$\frac{1+5}{7}+\frac{1-3}{4}=\frac{5}{14}$$
$$\frac{6}{7}+\frac{-2}{4}=\frac{5}{14}$$
$$\frac{24}{28}+\frac{-14}{28}=\frac{10}{28}$$
$$\frac{10}{28}=\frac{10}{28}$$

5.
$$4x-7=4(x-1)+3$$
$$4x-7=4x-4+3$$
$$4x-7=4x-1$$
$$-7=-1$$
This equation is an inconsistent equation and thus has no solution.
The solution set is $\{\ \}$.

6.
$$7x+9=9(x+1)-2x$$
$$7x+9=9x+9-2x$$
$$7x+9=7x+9$$
$$9=9$$
This equation is an identity and all real numbers are solutions.
The solution set is $\{x|x \text{ is a real number}\}$ or $(-\infty,\infty)$ or $\mathbb{R}$.

7.
$$T=359x+3183$$
$$11{,}440=359x+3183$$
$$11{,}440-3183=359x$$
$$8257=359x$$
$$\frac{8257}{359}=\frac{359x}{359}$$
$$23=x$$
The average cost of tuition and fees at public colleges will reach \$11,440 in the school year ending 23 years after 2000, or 2023.

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.
$$5x+3=18$$
$$5x+3-3=18-3$$
$$5x=15$$
$$\frac{5x}{5}=\frac{15}{5}$$
$$x=3$$
The solution set is $\{3\}$.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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 $\{24\}$.

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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 $\{-12\}$.

36. $5+\frac{x-2}{3}=\frac{x+3}{8}$

$24\left(5+\frac{x-2}{3}\right)=24\left(\frac{x+3}{8}\right)$

$120+8(x-2)=3(x+3)$

$120+8x-16=3x+9$

$104+8x=3x+9$

$104+5x=9$

$5x=-95$

$x=-19$

The solution set is $\{-19\}$.

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37. $\dfrac{x+1}{3} = 5 - \dfrac{x+2}{7}$

$21\left(\dfrac{x+1}{3}\right) = 21\left(5 - \dfrac{x+2}{7}\right)$

$7(x+1) = 105 - 3(x+2)$

$7x + 7 = 105 - 3x - 6$

$7x + 3x + 7 = 105 - 3x + 3x - 6$

$10x + 7 = 99$

$10x = 92$

$x = \dfrac{92}{10} = \dfrac{46}{5}$

The solution set is $\left\{\dfrac{46}{5}\right\}$.

38. $\dfrac{3x}{5} - \dfrac{x-3}{2} = \dfrac{x+2}{3}$

$30\left(\dfrac{3x}{5} - \dfrac{x-3}{2}\right) = 30\left(\dfrac{x+2}{3}\right)$

$6(3x) - 15(x-3) = 10(x+2)$

$18x - 15x + 45 = 10x + 20$

$3x + 45 = 10x + 20$

$45 = 7x + 20$

$25 = 7x$

$\dfrac{25}{7} = x$

The solution set is $\left\{\dfrac{25}{7}\right\}$.

39. $5x + 9 = 9(x+1) - 4x$

$5x + 9 = 9x + 9 - 4x$

$5x + 9 = 5x + 9$

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

40. $4x + 7 = 7(x+1) - 3x$

$4x + 7 = 7x + 7 - 3x$

$4x + 7 = 4x + 7$

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

41. $3(y+2) = 7 + 3y$

$3y + 6 = 7 + 3y$

$3y - 3y + 6 = 7 + 3y - 3y$

$6 = 7$

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

The equation is inconsistent.

42. $4(y+5) = 21 + 4y$

$4y + 20 = 21 + 4y$

$20 = 21$

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

The equation is inconsistent.

43. $10x + 3 = 8x + 3$

$10x - 8x + 3 = 8x - 8x + 3$

$2x = 0$

$x = 0$

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

44. $5x + 7 = 2x + 7$

$3x + 7 = 7$

$3x = 0$

$x = 0$

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

45. $\dfrac{1}{2}(6z + 20) - 8 = 2(z - 4)$

$3z + 10 - 8 = 2z - 8$

$3z + 2 = 2z - 8$

$z + 2 = -8$

$z = -10$

The solution set is $\{-10\}$. The equation is conditional.

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

$2z + 4 = 4z + 6 - 8$

$2z + 4 = 4z - 2$

$-2z = -6$

$z = 3$

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

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

$-4x - 6 + 6x = 7 + 2x$

$2x - 6 = 7 + 2x$

$-6 = 7$

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

The equation is inconsistent.

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

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

49. $y+3(4y+2)=6(y+1)+5y$
$y+12y+6=6y+6+5y$
$13y+6=11y+6$
$2y+6=6$
$2y=0$
$y=0$

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

50. $9y-3(6-5y)=y-2(3y+9)$
$9y-18+15y=y-6y-18$
$24y-18=-5y-18$
$29y-18=-18$
$29y=0$
$y=0$

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: $4(x-2)+2=4x-2(2-x)$
$4x-8+2=4x-4+2x$
$4x-6=6x-4$
$-2x-6=-4$
$-2x=2$
$x=-1$

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

56. Solve: $2(x-6)=3x+2(2x-1)$
$2x-12=3x+4x-2$
$2x-12=7x-2$
$-5x-12=-2$
$-5x=10$
$x=-2$

Now, evaluate x^2-x for $x=-2$:
$x^2-x=(-2)^2-(-2)$
$=4-(-2)=4+2=6$

57. Solve for x: $\dfrac{3(x+3)}{5}=2x+6$
$3(x+3)=5(2x+6)$
$3x+9=10x+30$
$-7x+9=30$
$-7x=21$
$x=-3$

Solve for y: $-2y-10=5y+18$
$-7y-10=18$
$-7y=28$
$y=-4$

Now, evaluate $x^2-(xy-y)$ for $x=-3$ and $y=-4$:
$x^2-(xy-y)=(-3)^2-[-3(-4)-(-4)]$
$=(-3)^2-[12-(-4)]$
$=9-(12+4)=9-16=-7$

58. Solve for x: $\dfrac{13x-6}{4}=5x+2$
$13x-6=4(5x+2)$
$13x-6=20x+8$
$-7x-6=8$
$-7x=14$
$x=-2$

Solve for y: $5-y=7(y+4)+1$
$5-y=7y+28+1$
$5-y=7y+29$
$5-8y=29$
$-8y=24$
$y=-3$

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

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

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

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

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 $\{0\}$.

65. $4x+13-\left\{2x-\left[4(x-3)-5\right]\right\}=2(x-6)$

$$\begin{aligned}4x+13-\left\{2x-\left[4x-12-5\right]\right\}&=2x-12\\4x+13-\left\{2x-\left[4x-17\right]\right\}&=2x-12\\4x+13-\left\{2x-4x+17\right\}&=2x-12\\4x+13-\left\{-2x+17\right\}&=2x-12\\4x+13+2x-17&=2x-12\\6x-4&=2x-12\\4x-4&=-12\\4x&=-8\\x&=-2\end{aligned}$$

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

66. $-2\left\{7-\left[4-2(1-x)+3\right]\right\}=10-\left[4x-2(x-3)\right]$

$$\begin{aligned}-2\left\{7-\left[4-2+2x+3\right]\right\}&=10-\left[4x-2x+6\right]\\-2\left\{7-\left[2x+5\right]\right\}&=10-\left[2x+6\right]\\-2\left\{7-2x-5\right\}&=10-2x-6\\-2\left\{-2x+2\right\}&=-2x+4\\4x-4&=-2x+4\\6x-4&=4\\6x&=8\\x&=\frac{8}{6}=\frac{4}{3}\end{aligned}$$

The solution set is $\left\{\frac{4}{3}\right\}$.

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67. a. Model 1: $T = 801x + 14,554$
$= 801(16) + 14,554$
$= 27,370$

Model 2: $T = 5x^2 + 714x + 14,758$
$T = 5(16)^2 + 714(16) + 14,758$
$= 27,462$

Model 1 estimates the cost in 2016 to be \$27,370 which means Model 1 underestimates by \$572.
Model 2 estimates the cost in 2016 to be \$27,462 which means Model 2 underestimates by \$480.

b. $T = 801x + 14,554$
$31,375 = 801x + 14,554$
$16,821 = 801x$
$\frac{16,821}{801} = \frac{801x}{801}$
$21 = x$

Tuition and fees will average \$31,375 at private four-year colleges in the school year ending 21 years after 2000, or 2021.

68. a. Model 1: $T = 801x + 14,554$
$= 801(14) + 14,554$
$= 25,768$

Model 2: $T = 5x^2 + 714x + 14,758$
$T = 5(14)^2 + 714(14) + 14,758$
$= 25,734$

Model 1 estimates the cost in 2012 to be \$25,768 which means Model 1 overestimates by \$61.
Model 2 estimates the cost in 2012 to be \$25,734 which means Model 2 overestimates by \$27.

b. $T = 801x + 14,554$
$32,977 = 801x + 14,554$
$18,423 = 801x$
$\frac{18,423}{801} = \frac{801x}{801}$
$23 = x$

Tuition and fees will average \$32,977 at private four-year colleges in the school year ending 23 years after 2000, or 2023.

69. a. \$22,000

b. $C = 442x + 12,969$
$= 442(20) + 12,969$
$= \$21,809$

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.

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.

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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.

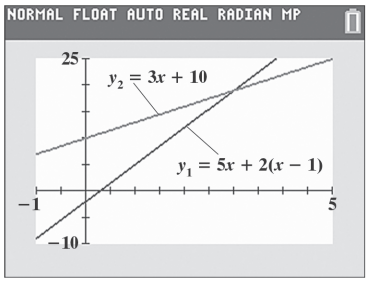
74.
$$C = 442x + 12{,}969$$
$$25{,}345 = 442x + 12{,}969$$
$$12{,}376 = 442x$$
$$\frac{12{,}376}{442} = \frac{442x}{442}$$
$$28 = x$$

Model 1 predicts the cost will be \$25,345 28 years after 1990, or 2018.

75. – 85. Answers will vary.

86. $5x + 2(x-1) = 3x + 10$

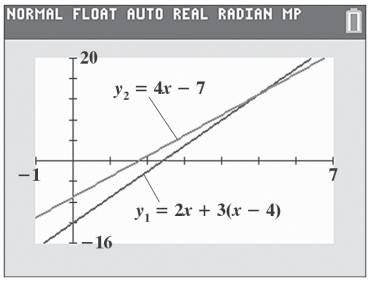
Let $y_1 = 5x + 2(x-1)$ and let $y_2 = 3x + 10$.



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

87. $2x + 3(x-4) = 4x - 7$

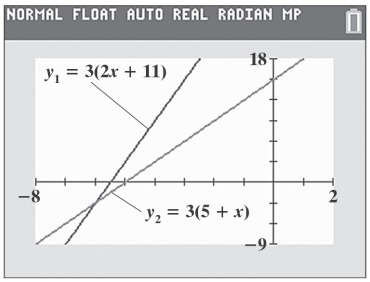
Let $y_1 = 2x + 3(x-4)$ and let $y_2 = 4x - 7$.



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

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

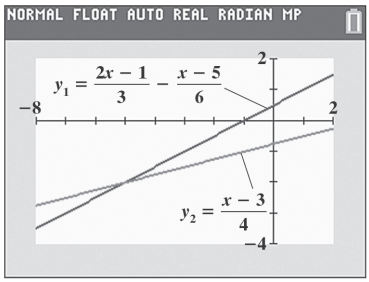
Let $y_1 = 3(2x + 11)$ and let $y_2 = 3(5 + x)$.



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

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

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



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.

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

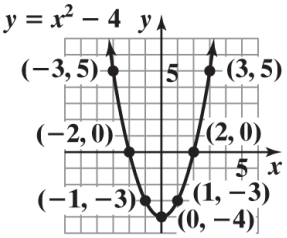
When $b = 2$, the solution set is $\{-6\}$.

102.
$$\begin{aligned} -\frac{1}{5} - \left(-\frac{1}{2}\right) &= -\frac{1}{5} + \frac{1}{2} = -\frac{1}{5}\cdot\frac{2}{2} + \frac{1}{2}\cdot\frac{5}{5} \\ &= -\frac{2}{10} + \frac{5}{10} = \frac{3}{10} \end{aligned}$$

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

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.
$$\begin{aligned} 3x - 4 &= 32 \\ 3x &= 36 \\ x &= 12 \end{aligned}$$

The number is 12.

106. $x + 44$

107. $20{,}000 - 2500x$

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

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. $(6-9)(8-12)\div\frac{5^2+4\div 2}{8^2-9^2+8}$
$=(-3)(-4)\div\frac{25+2}{64-81+8}$
$=(-3)(-4)\div\frac{27}{-9}$
$=(-3)(-4)\div(-3)$
$=12\div(-3)$
$=-4$

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

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

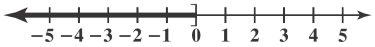
$$=\frac{3(-8)}{-12}$$

$$=\frac{-24}{-12}$$

$$=2$$

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

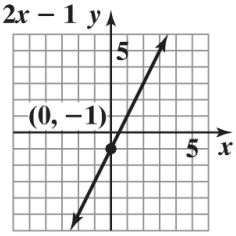
16. $\{x|x\le 0\}$



17.

x	(x,y)
−2	−5
−1	−3
0	−1
1	1
2	3

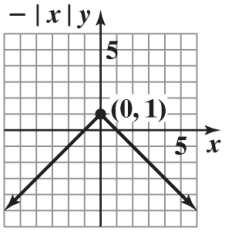
$y=2x-1$



18.

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

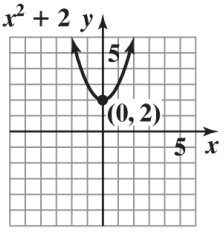
$y=1-|x|$



19.

x	(x,y)
−2	6
−1	3
0	2
1	3
2	6

$y=x^2+2$



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.

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1.5 Check Points

1. Let x = the average yearly salary, in thousands, of women with an associate's degree
Let $x + 15$ = the average yearly salary, in thousands, of women with an bachelor's degree
Let $x + 32$ = the average yearly salary, in thousands, of women with a master's degree

$$x+(x+15)+(x+32)=158$$
$$x+x+15+x+32=158$$
$$3x+47=158$$
$$3x=111$$
$$x=37$$

$x = 37$, associate's degree: \$37,000
$x+15 = 52$, bachelor's degree: \$52,000
$x+32 = 69$, master's degree: \$69,000

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.

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

8.

$$\frac{W}{2}-3H=53$$
$$\frac{W}{2}=53+3H$$
$$2\left(\frac{W}{2}\right)=2(53+3H)$$
$$W=106+6H$$

9.

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

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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.

11.
$y_1 - y_2 = 2$
$(13x - 4) - (5x + 10) = 2$
$13x - 4 - 5x - 10 = 2$
$8x - 14 = 2$
$8x = 16$
$x = 2$

12.
$y_1 - y_2 = 3$
$(10x + 6) - (12x - 7) = 3$
$10x + 6 - 12x + 7 = 3$
$-2x + 13 = 3$
$-2x = -10$
$x = 5$

13.
$y_1 = 8y_2 + 14$
$10(2x - 1) = 8(2x + 1) + 14$
$20x - 10 = 16x + 8 + 14$
$20x - 10 = 16x + 22$
$4x = 32$
$x = 8$

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14.
$$y_1 = 12y_2 - 51$$
$$9(3x-5) = 12(3x-1) - 51$$
$$27x - 45 = 36x - 12 - 51$$
$$27x - 45 = 36x - 63$$
$$27x - 36x = 45 - 63$$
$$-9x = -18$$
$$x = 2$$

15.
$$3y_1 - 5y_2 = y_3 - 22$$
$$3(2x+6) - 5(x+8) = (x) - 22$$
$$6x + 18 - 5x - 40 = x - 22$$
$$x - 22 = x - 22$$
$$-22 = -22$$
x is satisfied by all real numbers.

16.
$$2y_1 - 3y_2 = 4y_3 - 8$$
$$2(2.5) - 3(2x+1) = 4(x) - 8$$
$$5 - 6x - 3 = 4x - 8$$
$$-6x + 2 = 4x - 8$$
$$-6x - 4x = -8 - 2$$
$$-10x = -10$$
$$x = 1$$

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.
$$x + (x+21) + (x+79) = 229$$
$$x + x + 21 + x + 79 = 229$$
$$3x + 100 = 229$$
$$3x = 129$$
$$x = 43$$
$$x + 21 = 64$$
$$x + 79 = 122$$
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.
$$x + (x+767) + (x+268) = 1731$$
$$x + x + 767 + x + 268 = 1731$$
$$3x + 1035 = 1731$$
$$3x = 696$$
$$x = 232$$
$$x + 767 = 999$$
$$x + 268 = 500$$
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.
$$x + 2x + (x-8) = 180$$
$$4x - 8 = 180$$
$$4x = 188$$
$$x = 47$$
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 $39°$.

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.
$$x + 3x + (x-35) = 180$$
$$x + 3x + x - 35 = 180$$
$$5x - 35 = 180$$
$$5x = 215$$
$$x = 43$$
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.
$$x + (x+1) + (x+2) = 180$$
$$3x + 3 = 180$$
$$3x = 177$$
$$x = 59$$
If $x = 59$, then $x + 1 = 60$ and $x + 2 = 61$. Thus, the measures of the three angles are $59°$, $60°$, and $61°$.

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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.

$$x + (x + 2) + (x + 4) = 180$$
$$3x + 6 = 180$$
$$3x = 174$$
$$x = 58$$

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.

$$31 + 2.4x = 91$$
$$2.4x = 91 - 31$$
$$2.4x = 60$$
$$x = \frac{60}{2.4}$$
$$x = 25$$

91% of American adults will view college education as essential 25 years after 2000, or 2025.

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

$$45 - 1.7x = 11$$
$$-1.7x = 11 - 45$$
$$-1.7x = -34$$
$$x = \frac{-34}{-1.7}$$
$$x = 20$$

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.

$$23 - 0.28x = 0$$
$$-0.28x = -23$$
$$\frac{-0.28x}{-0.28} = \frac{-23}{-0.28}$$
$$x \approx 82$$

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

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

$$23 - 0.28x = 5$$
$$-0.28x = -18$$
$$\frac{-0.28x}{-0.28} = \frac{-18}{-0.28}$$
$$x \approx 64$$

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.

$$(3x - 84) - x = 228$$
$$3x - 84 - x = 228$$
$$2x - 84 = 228$$
$$2x = 312$$
$$x = 156$$
$$3x - 84 = 384$$

births: 384,000
deaths: 156,000

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

c. $\frac{320 \text{ million}}{83 \text{ million}} \approx 4$
It will take about 4 years.

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. $\frac{320 \text{ million}}{83 \text{ million}} \approx 4$
It will take about 4 years.

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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
$13,300 + 1000(9) = 26,800 - 500(9)$
$= 22,300$ 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.

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.

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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.

48. Let g = the gross amount of the paycheck.
Yearly Salary $= 2(12)g + 750$
$33150 = 24g + 750$
$32400 = 24g$
$1350 = g$
The gross amount of each paycheck is \$1350.

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

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

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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)

$$y_2 - y_1 = m(x_2 - x_1)$$
$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

63. (from physics)

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

64. (from statistics)

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

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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)

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

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)

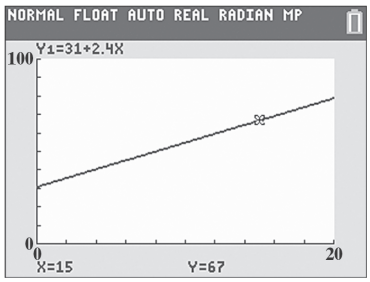
$$IR + Ir = E$$
$$I(R + r) = E$$
$$I = \frac{E}{R + r}$$

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.

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.

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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 $t = \dfrac{I}{pr}$.

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.

95.

$$V = C - \frac{C - S}{L}N$$
$$V = C - \left(\frac{C - S}{L}\right)\frac{N}{1}$$
$$V = C - \frac{CN - SN}{L}$$
$$V = \frac{CL}{L} - \frac{CN - SN}{L}$$
$$V = \frac{CL - CN + SN}{L}$$
$$LV = CL - CN + SN$$
$$LV - SN = CL - CN$$
$$LV - SN = C(L - N)$$
$$C = \frac{LV - SN}{L - N}$$

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

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

98. $$\frac{2x}{3}-\frac{8}{3}=x$$
$$3\left(\frac{2x}{3}-\frac{8}{3}\right)=3(x)$$
$$2x-8=3x$$
$$-8=x$$
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. $\dfrac{b^7}{b^3}=\dfrac{\not{b}\cdot\not{b}\cdot\not{b}\cdot b\cdot b\cdot b\cdot b}{\not{b}\cdot\not{b}\cdot\not{b}}=b^4$

b. $\dfrac{b^8}{b^2}=\dfrac{\not{b}\cdot\not{b}\cdot b\cdot b\cdot b\cdot b\cdot b\cdot b}{\not{b}\cdot\not{b}}=b^6$

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

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

1.6 Check Points

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

b. $$\left(4x^3y^4\right)\left(10x^2y^6\right)=4\cdot 10\cdot x^3\cdot x^2\cdot y^4\cdot y^6$$
$$=40x^{3+2}y^{4+6}$$
$$=40x^5y^{10}$$

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

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

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

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

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

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

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

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

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

$$= \left(-3x^{-6}y\right)(-2)^2 \left(x^3\right)^2 \left(y^4\right)^2$$
$$= -3 \cdot x^{-6} \cdot y \cdot 4 \cdot x^6 \cdot y^8$$
$$= -12 \cdot x^{-6+6} \cdot y^{1+8}$$
$$= -12x^0 y^9$$
$$= -12y^9$$

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

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

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

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

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

6. $2^4 \cdot 2^2 = 2^{2+4} = 2^6 = 64$

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

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

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

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

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

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

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

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

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

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

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

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

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. $\left(-3x^7\right)^2 = (-3)^2\,x^{7\cdot 2} = 9x^{14}$

62. $\left(-4x^9\right)^2 = (-4)^2\,x^{9\cdot 2} = 16x^{18}$

63. $\left(2xy^2\right)^3 = 8x^{(1\cdot 3)}y^{(2\cdot 3)} = 8x^3y^6$

64. $\left(3x^2y\right)^4 = 3^4x^{(2\cdot 4)}y^4 = 81x^8y^4$

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

66. $\left(-3x^4y^6\right)^2 = (-3)^2\,x^{(4\cdot 2)}y^{(6\cdot 2)} = 9x^8y^{12}$

67. $\left(-3x^{-2}\right)^{-3} = (-3)^{-3}\left(x^{-2}\right)^{-3}$

$$= \frac{x^6}{(-3)^3} = \frac{x^6}{-27} = -\frac{x^6}{27}$$

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

69. $\left(5x^3y^{-4}\right)^{-2} = 5^{-2}\left(x^3\right)^{-2}\left(y^{-4}\right)^{-2}$

$$= 5^{-2}x^{-6}y^8 = \frac{y^8}{25x^6}$$

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. $\left(-2x^{-5}y^4z^2\right)^{-4} = (-2)^{-4}\,x^{20}y^{-16}z^{-8}$

$$= \frac{x^{20}}{(-2)^4\,y^{16}z^8}$$

$$= \frac{x^{20}}{16y^{16}z^8}$$

72. $\left(-2x^{-4}y^5z^3\right)^{-4} = (-2)^{-4}\,x^{16}y^{-20}z^{-12}$

$$= \frac{x^{16}}{(-2)^4\,y^{20}z^{12}} = \frac{x^{16}}{16y^{20}z^{12}}$$

73. $\left(\dfrac{2}{x}\right)^4 = \dfrac{2^4}{x^4} = \dfrac{16}{x^4}$

74. $\left(\dfrac{y}{2}\right)^5 = \dfrac{y^5}{2^5} = \dfrac{y^5}{32}$

75. $\left(\dfrac{x^3}{5}\right)^2 = \dfrac{x^{(3\cdot 2)}}{5^2} = \dfrac{x^6}{25}$

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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. $\frac{6x^2}{2x^{-8}} = 3x^{2-(-8)} = 3x^{2+8} = 3x^{10}$

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. $\frac{x^{-10}}{x^4} = x^{-10-4} = x^{-14} = \frac{1}{x^{14}}$

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103. $\dfrac{30x^2y^5}{-6x^8y^{-3}} = -5x^{2-8}y^{5-(-3)}$

$= -5x^{-6}y^8 = -\dfrac{5y^8}{x^6}$

104. $\dfrac{24x^2y^{13}}{-2x^5y^{-2}} = -12x^{2-5}y^{13-(-2)}$

$= -12x^{-3}y^{15} = -\dfrac{12y^{15}}{x^3}$

105. $\dfrac{-24a^3b^{-5}c^5}{-3a^{-6}b^{-4}c^{-7}} = 8a^{3-(-6)}b^{-5-(-4)}c^{5-(-7)}$

$= 8a^9b^{-1}c^{12} = \dfrac{8a^9c^{12}}{b}$

106. $\dfrac{-24a^2b^{-2}c^8}{-8a^{-5}b^{-1}c^{-3}} = 3a^{2-(-5)}b^{-2-(-1)}c^{8-(-3)}$

$= 3a^7b^{-1}c^{11}$

$= \dfrac{3a^7c^{11}}{b}$

107. $\left(\dfrac{x^3}{x^{-5}}\right)^2 = \left(x^{3-(-5)}\right)^2 = \left(x^8\right)^2 = x^{16}$

108. $\left(\dfrac{x^4}{x^{-11}}\right)^3 = \left(x^{4-(-11)}\right)^3 = \left(x^{15}\right)^3 = x^{45}$

109. $\left(\dfrac{-15a^4b^2}{5a^{10}b^{-3}}\right)^3 = \left(-3a^{4-10}b^{2-(-3)}\right)^3$

$= \left(-3a^{-6}b^{2+3}\right)^3$

$= \left(-3a^{-6}b^5\right)^3$

$= (-3)^3\left(a^{-6}\right)^3\left(b^5\right)^3$

$= -27a^{-18}b^{15}$

$= -\dfrac{27b^{15}}{a^{18}}$

110. $\left(\dfrac{-30a^{14}b^8}{10a^{17}b^{-2}}\right)^3 = \left(-3a^{14-17}b^{8-(-2)}\right)^3$

$= \left(-3a^{-3}b^{10}\right)^3$

$= -27a^{-9}b^{30} = -\dfrac{27b^{30}}{a^9}$

111. $\left(\dfrac{3a^{-5}b^2}{12a^3b^{-4}}\right)^0 = 1$

Recall the Zero Exponent Rule.

112. $\left(\dfrac{4a^{-5}b^3}{12a^3b^{-5}}\right)^0 = 1$

113. $\left(\dfrac{x^{-5}y^8}{3}\right)^{-4} = \dfrac{x^{(-5)(-4)}y^{8(-4)}}{3^{-4}}$

$= \dfrac{x^{20}y^{-32}}{3^{-4}} = \dfrac{3^4x^{20}}{y^{32}} = \dfrac{81x^{20}}{y^{32}}$

114. $\left(\dfrac{x^6y^{-7}}{2}\right)^{-3} = \dfrac{x^{-18}y^{21}}{2^{-3}} = \dfrac{8y^{21}}{x^{18}}$

115. $\left(\dfrac{20a^{-3}b^4c^5}{-2a^{-5}b^{-2}c}\right)^{-2} = \left(10a^{-3-(-5)}b^{4-(-2)}c^{5-1}\right)^{-2}$

$= \dfrac{1}{\left(10a^2b^6c^4\right)^2}$

$= \dfrac{1}{10^2a^{2(2)}b^{6(2)}c^{4(2)}}$

$= \dfrac{1}{100a^4b^{12}c^8}$

116. $\left(\dfrac{-2a^{-4}b^3c^{-1}}{3a^{-2}b^{-5}c^{-2}}\right)^{-4} = \left(\dfrac{-2a^{-4-(-2)}b^{3-(-5)}c^{-1-(-2)}}{3}\right)^{-4}$

$= \left(\dfrac{-2a^{-2}b^8c}{3}\right)^{-4}$

$= \dfrac{(-2)^{-4}a^8b^{-32}c^{-4}}{3^{-4}}$

$= \dfrac{3^4a^8}{(-2)^4b^{32}c^4}$

$= \dfrac{81a^8}{16b^{32}c^4}$

117. $\dfrac{9y^4}{x^{-2}} + \left(\dfrac{x^{-1}}{y^2}\right)^{-2} = 9x^2y^4 + \dfrac{x^{(-1)(-2)}}{y^{2(-2)}}$

$= 9x^2y^4 + \dfrac{x^2}{y^{-4}}$

$= 9x^2y^4 + x^2y^4$

$= 10x^2y^4$

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118. $\dfrac{7x^3}{y^{-9}}+\left(\dfrac{x^{-1}}{y^3}\right)^{-3}=7x^3y^9+\dfrac{x^{(-1)(-3)}}{y^{3(-3)}}$

$=7x^3y^9+\dfrac{x^3}{y^{-9}}$

$=7x^3y^9+x^3y^9$

$=8x^3y^9$

119. $\left(\dfrac{3x^4}{y^{-4}}\right)^{-1}\left(\dfrac{2x}{y^2}\right)^3=\dfrac{3^{-1}x^{4(-1)}}{y^{(-4)(-1)}}\cdot\dfrac{2^3x^{1\cdot3}}{y^{2\cdot3}}$

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

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

$=\dfrac{8x^{-1}}{3y^{10}}$

$=\dfrac{8}{3xy^{10}}$

120. $\left(\dfrac{2^{-1}x^{-2}y}{x^4y^{-1}}\right)^{-2}\left(\dfrac{xy^{-3}}{x^{-3}y}\right)^3$

$=\dfrac{2^{(-1)(-2)}x^{(-2)(-2)}y^{1(-2)}}{x^{4(-2)}y^{(-1)(-2)}}\cdot\dfrac{x^{1\cdot3}y^{-3\cdot3}}{x^{-3\cdot3}y^{1\cdot3}}$

$=\dfrac{2^2x^4y^{-2}}{x^{-8}y^2}\cdot\dfrac{x^3y^{-9}}{x^{-9}y^3}$

$=4x^{4-(-8)}y^{-2-2}\cdot x^{3-(-9)}y^{-9-3}$

$=4x^{12}y^{-4}\cdot x^{12}y^{-12}$

$=4x^{12+12}y^{-4+(-12)}$

$=4x^{24}y^{-16}$

$=\dfrac{4x^{24}}{y^{16}}$

121. $\left(-4x^3y^{-5}\right)^{-2}\left(2x^{-8}y^{-5}\right)=\dfrac{2x^{-8}y^{-5}}{\left(-4x^3y^{-5}\right)^2}$

$=\dfrac{2x^{-8}y^{-5}}{(-4)^2x^{3\cdot2}y^{-5\cdot2}}$

$=\dfrac{2x^{-8}y^{-5}}{16x^6y^{-10}}$

$=\dfrac{y^{-5-(-10)}}{8x^{6-(-8)}}$

$=\dfrac{y^5}{8x^{14}}$

122. $\left(-4x^{-4}y^5\right)^{-2}\left(-2x^5y^{-6}\right)=\dfrac{-2x^5y^{-6}}{\left(-4x^{-4}y^5\right)^2}$

$=\dfrac{-2x^5y^{-6}}{(-4)^2x^{-4\cdot2}y^{5\cdot2}}$

$=-\dfrac{2x^5y^{-6}}{16x^{-8}y^{10}}$

$=-\dfrac{x^{5-(-8)}}{8y^{10-(-6)}}$

$=-\dfrac{x^{13}}{8y^{16}}$

123. $\dfrac{\left(2x^2y^4\right)^{-1}\left(4xy^3\right)^{-3}}{\left(x^2y\right)^{-5}\left(x^3y^2\right)^4}$

$=\dfrac{\left(x^2y\right)^5}{\left(2x^2y^4\right)^1\left(4xy^3\right)^3\left(x^3y^2\right)^4}$

$=\dfrac{x^{2\cdot5}y^{1\cdot5}}{\left(2x^2y^4\right)\left(4^3x^{1\cdot3}y^{3\cdot3}\right)\left(x^{3\cdot4}y^{2\cdot4}\right)}$

$=\dfrac{x^{10}y^5}{\left(2x^2y^4\right)\left(64x^3y^9\right)\left(x^{12}y^8\right)}$

$=\dfrac{x^{10}y^5}{128x^{2+3+12}y^{4+9+8}}$

$=\dfrac{x^{10}y^5}{128x^{17}y^{21}}$

$=\dfrac{1}{128x^{17-10}y^{21-5}}=\dfrac{1}{128x^7y^{16}}$

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124. $$\frac{\left(3x^3y^2\right)^{-1}\left(2x^2y\right)^{-2}}{\left(xy^2\right)^{-5}\left(x^2y^3\right)^3}$$
$$=\frac{\left(xy^2\right)^5}{\left(3x^3y^2\right)^1\left(2x^2y\right)^2\left(x^2y^3\right)^3}$$
$$=\frac{x^{1\cdot5}y^{2\cdot5}}{\left(3x^3y^2\right)\left(2^2x^{2\cdot2}y^2\right)\left(x^{2\cdot3}y^{3\cdot3}\right)}$$
$$=\frac{x^5y^{10}}{\left(3x^3y^2\right)\left(4x^4y^2\right)\left(x^6y^9\right)}$$
$$=\frac{x^5y^{10}}{12x^{3+4+6}y^{2+2+9}}$$
$$=\frac{x^5y^{10}}{12x^{13}y^{13}}=\frac{1}{12x^{13-5}y^{13-10}}=\frac{1}{12x^8y^3}$$

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. $A=1000\cdot2^t=1000\cdot2^{-3}$
$$=1000\cdot\frac{1}{2^3}=1000\cdot\frac{1}{8}=125$$
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. $A=1000\cdot2^t=1000\cdot2^{-2}$
$$=1000\cdot\frac{1}{2^2}=1000\cdot\frac{1}{4}=250$$
Two weeks ago the aphid population was 250.

127. a. $N=\dfrac{25}{1+24\cdot2^{-t}}=\dfrac{25}{1+24\cdot2^{-0}}$
$$=\frac{25}{1+24\cdot1}=\frac{25}{25}=1$$
One person started the rumor.

b. $N=\dfrac{25}{1+24\cdot2^{-t}}=\dfrac{25}{1+24\cdot2^{-4}}$
$$=\frac{25}{1+\frac{24}{2^4}}=\frac{25}{1+\frac{24}{16}}=\frac{25}{1+1.5}=\frac{25}{2.5}=10$$
After 4 minutes, 10 people in the class had heard the rumor.

128. a. $N=\dfrac{25}{1+24\cdot2^{-t}}=\dfrac{25}{1+24\cdot2^{-0}}$
$$=\frac{25}{1+24\cdot1}=\frac{25}{25}=1$$
One person started the rumor.

b. $N=\dfrac{25}{1+24\cdot2^{-t}}=\dfrac{25}{1+24\cdot2^{-4}}$
$$=\frac{25}{1+\frac{24}{2^6}}=\frac{25}{1+\frac{24}{64}}=\frac{25}{1+0.375}=\frac{25}{1.375}\approx18$$
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 $(4,10)$.

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.

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

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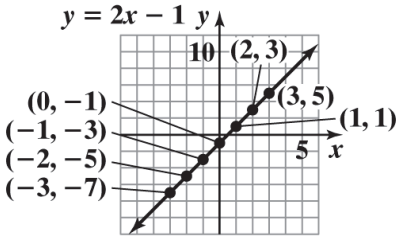
162.

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.

$P = 2(\text{length}) + 2(\text{width})$

$230 = 2(2w - 5) + 2w$

$230 = 4w - 10 + 2w$

$230 = 6w - 10$

$240 = 6w$

$40 = w$

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.** $(7.1 \times 10^5)(5 \times 10^{-7}) = (7.1 \times 5) \times (10^5 \times 10^{-7})$

$= 35.5 \times 10^{-2} = 3.55 \times 10^{-1}$

b. $\dfrac{1.2 \times 10^6}{3 \times 10^{-3}} = \left(\dfrac{1.2}{3}\right) \times \left(\dfrac{10^6}{10^{-3}}\right)$

$= 0.4 \times 10^{6-(-3)} = 0.4 \times 10^9 = 4 \times 10^8$

5. $\dfrac{3.33 \times 10^{12}}{3.24 \times 10^8} = \left(\dfrac{3.33}{3.24}\right) \times \left(\dfrac{10^{12}}{10^8}\right)$

$\approx 1.0278 \times 10^{12-8}$

$= 1.0278 \times 10^4 = 10{,}278$

The per capita tax was about \$10,728 in 2016.

6. $d = rt$

$d = (1.55 \times 10^3)(20{,}000)$

$d = (1.55 \times 10^3)(2 \times 10^4)$

$d = (1.55 \times 2) \times (10^3 \times 10^4)$

$d = 3.1 \times 10^7$

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. $\left(3\times10^{4}\right)\left(2.1\times10^{3}\right) = (3\times2.1)\left(10^{4}\times10^{3}\right)$
$= 6.3\times10^{4+3}$
$= 6.3\times10^{7}$

32. $\left(2\times10^{4}\right)\left(4.1\times10^{3}\right) = 8.2\times10^{7}$

33. $\left(1.6\times10^{15}\right)\left(4\times10^{-11}\right) = (1.6\times4)\left(10^{15}\times10^{-11}\right)$
$= 6.4\times10^{15+(-11)}$
$= 6.4\times10^{4}$

34. $\left(1.4\times10^{15}\right)\left(3\times10^{-11}\right) = 4.2\times10^{4}$

35. $\left(6.1\times10^{-8}\right)\left(2\times10^{-4}\right) = (6.1\times2)\left(10^{-8}\times10^{-4}\right)$
$= 12.2\times10^{-8+(-4)}$
$= 12.2\times10^{-12}$
$= 1.22\times10^{-11}$

36. $\left(5.1\times10^{-8}\right)\left(3\times10^{-4}\right) = 15.3\times10^{-12}$
$= 1.53\times10^{-11}$

37. $\left(4.3\times10^{8}\right)\left(6.2\times10^{4}\right)$
$= (4.3\times6.2)\left(10^{8}\times10^{4}\right)$
$= 26.66\times10^{8+4}$
$= 26.66\times10^{12}$
$= 2.666\times10^{13} \approx 2.67\times10^{13}$

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38. $\left(8.2\times10^{8}\right)\left(4.6\times10^{4}\right)$
$= 37.72\times10^{8+4} = 37.72\times10^{12}$
$= 3.772\times10^{13} \approx 3.77\times10^{13}$

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. $\dfrac{1.2\times10^{4}}{2\times10^{-2}} = 0.6\times10^{4-(-2)} = 0.6\times10^{6}$
$= \left(6\times10^{-1}\right)\times10^{6} = 6\times10^{5}$

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. $\dfrac{0.00072\times0.003}{0.00024} = \dfrac{\left(7.2\times10^{-4}\right)\left(3\times10^{-3}\right)}{2.4\times10^{-4}}$
$= \dfrac{7.2\times3}{2.4}\times\dfrac{10^{-4}\cdot10^{-3}}{10^{-4}}$
$= 9\times10^{-3}$

50. $\dfrac{66000\times0.001}{0.003\times0.002} = \dfrac{\left(6.6\times10^{4}\right)\left(1\times10^{-3}\right)}{\left(3\times10^{-3}\right)\left(2\times10^{-3}\right)}$
$= \dfrac{6.6\times10^{1}}{6\times10^{-6}}$
$= 1.1\times10^{1-(-6)}$
$= 1.1\times10^{7}$

51. $\left(2\times10^{-5}\right)x = 1.2\times10^{9}$
$x = \dfrac{1.2\times10^{9}}{2\times10^{-5}}$
$= \dfrac{1.2}{2}\times\dfrac{10^{9}}{10^{-5}}$
$= 0.6\times10^{9-(-5)}$
$= 0.6\times10^{14}$
$= 6\times10^{13}$

52. $\left(3\times10^{-2}\right)x = 1.2\times10^{4}$
$x = \dfrac{1.2\times10^{4}}{3\times10^{-2}}$
$= \dfrac{1.2}{3}\times\dfrac{10^{4}}{10^{-2}}$
$= 0.4\times10^{4-(-2)}$
$= 0.4\times10^{6} = 4\times10^{5}$

53. $\dfrac{x}{2\times10^{8}} = -3.1\times10^{-5}$
$x = \left(2\times10^{8}\right)\left(-3.1\times10^{-5}\right)$
$= \left[2\cdot(-3.1)\right]\times\left(10^{8}\cdot10^{-5}\right)$
$= -6.2\times10^{8+(-5)} = -6.2\times10^{3}$

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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. $x-\left(7.2\times10^{18}\right) = 9.1\times10^{18}$

$$\begin{aligned} x &= \left(9.1\times10^{18}\right)+\left(7.2\times10^{18}\right) \\ &= \left(9.1+7.2\right)\times10^{18} \\ &= 16.3\times10^{18} \\ &= 1.63\times10^{19} \end{aligned}$$

56. $x-\left(5.3\times10^{-16}\right) = 8.4\times10^{-16}$

$$\begin{aligned} x &= \left(8.4\times10^{-16}\right)+\left(5.3\times10^{-16}\right) \\ &= \left(8.4+5.3\right)\times10^{-16} \\ &= 13.7\times10^{-16} \\ &= 1.37\times10^{-15} \end{aligned}$$

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. 160 billion $= 160,000,000,000 = 1.6\times10^{11}$

Jeff Bezos is worth $\$1.6\times10^{11}$.

60. 97 billion $= 97,000,000,000 = 9.7\times10^{10}$

Bill Gates is worth $\$9.7\times10^{10}$.

61. $88.3\times10^{9}-61\times10^{9} = \left(88.3-61\right)\times10^{9}$

$$\begin{aligned} &= 27.3\times10^{9} \\ &= 2.73\times10^{10} \end{aligned}$$

Warren Buffett's worth exceeds Mark Zuckerberg worth by $\$2.73\times10^{10}$.

62. $61\times10^{9}+58.4\times10^{9} = \left(61+58.4\right)\times10^{9}$

$$\begin{aligned} &= 119.4\times10^{9} \\ &= 1.194\times10^{11} \end{aligned}$$

Mark Zuckerberg's and Larry Ellison's combined worth is $\$1.194\times10^{11}$.

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.

65. 8 billion $= 8\times10^{9}$

$$\begin{aligned} \frac{8\times10^{9}}{3.2\times10^{7}} &= \frac{8}{3.2}\times\frac{10^{9}}{10^{7}} \\ &= 2.5\times10^{9-7} \\ &= 2.5\times10^{2} = 250 \end{aligned}$$

$2.5\times10^{2} = 250$ 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.

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67. a. $\dfrac{519\times10^9}{48\times10^6}\approx10.813\times10^3$

$=\$1.0813\times10^4$

$=\$10{,}813$

b. $\dfrac{\$10{,}813}{12}\approx\$901$

68. a. $\dfrac{33\times10^9}{25.7\times10^6}\approx1.284\times10^3$

$=\$1284$

b. $\dfrac{\$1284}{12}\approx\$107$

69. Medicaid: $\dfrac{198\times10^9}{53.4\times10^6}\approx3.708\times10^3$

$=\$3708$

Medicare: $\dfrac{294\times10^9}{42.3\times10^6}\approx6.950\times10^3$

$=\$6950$

Medicare provides a greater per person benefit by \$3242.

70. $\dfrac{7.2\times10^6}{3.66\times10^8}\approx1.97\times10^{-2}=0.0197\approx0.02$

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. $\dfrac{365\text{ days}}{1\text{ year}}\cdot\dfrac{24\text{ hours}}{1\text{ day}}$

$=8760$ hours/year

$=8.76\times10^3$ hours/year

$\dfrac{8.76\times10^3\text{ hours}}{1\text{ year}}\cdot\dfrac{60\text{ minutes}}{1\text{ hour}}$

$=525.6\times10^3$ minutes/year

$=5.256\times10^5$ minutes/year

$\dfrac{5.256\times10^5\text{ minutes}}{1\text{ year}}\cdot\dfrac{60\text{ seconds}}{1\text{ minute}}$

$=315.36\times10^5$ seconds/year

$=3.1536\times10^7$ 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

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:
$\dfrac{8\times10^{30}}{4\times10^{-5}}=2\times10^{30-(-5)}=2\times10^{35}$, not 2×10^{25}.

87. false; Changes to make the statement true will vary.
A sample change is:
$\left(7\times10^5\right)+\left(2\times10^{-3}\right)=700{,}000+0.002$
$=700{,}000.002,$ not $9\times10^2=900.$

88. true

89. true

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