CHAPTER 1 THE REAL NUMBER SYSTEM

1.1 Fractions

1. true

2. true

3. false; the fraction $\frac{17}{51}$ is written in lowest terms as $\frac{1}{3}$.

4. false; the reciprocal of $\frac{8}{2} = 4$ is $\frac{2}{8} = \frac{1}{4}$.

5. false; *product* refers to multiplication, so the product of 8 and 2 is 16.

6. false; *difference* refers to subtraction, so the difference between 12 and 2 is 10.

7. prime

8. prime

9. composite; $2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$

10. composite; $3 \cdot 3 \cdot 11$

11. composite; $2 \cdot 7 \cdot 13 \cdot 19$

12. composite; $5 \cdot 5 \cdot 41$

13. neither

14. neither

15. composite; $2 \cdot 3 \cdot 5$

16. composite; $2 \cdot 2 \cdot 2 \cdot 5$

17. composite; $2 \cdot 2 \cdot 5 \cdot 5 \cdot 5$

18. composite; $2 \cdot 2 \cdot 5 \cdot 5 \cdot 7$

19. composite; $2 \cdot 2 \cdot 31$

20. composite; $2 \cdot 2 \cdot 2 \cdot 3 \cdot 5$

21. prime

22. prime

23. $\frac{1}{2}$

24. $\frac{1}{3}$

25. $\frac{5}{6}$

26. $\frac{4}{5}$

27. $\frac{1}{5}$

28. $\frac{1}{4}$

29. $\frac{6}{5}$

30. $\frac{12}{7}$

31. **C**

32. **A**

33. $\frac{24}{35}$

34. $\frac{50}{63}$

35. $\frac{6}{25}$

36. $\frac{4}{11}$

37. $\frac{6}{5}$, or $1\frac{1}{5}$

38. $\frac{3}{2}$, or $1\frac{1}{2}$

39. $\frac{65}{12}$, or $5\frac{5}{12}$

40. $\frac{232}{15}$, or $15\frac{7}{15}$

41. $\frac{38}{5}$, or $7\frac{3}{5}$

42. $\frac{129}{5}$, or $25\frac{4}{5}$

43. $\frac{10}{3}$, or $3\frac{1}{3}$

44. $\frac{35}{27}$, or $1\frac{8}{27}$

45. 12

46. 12

47. $\frac{1}{16}$

48. $\frac{1}{75}$

49. $\frac{35}{24}$, or $1\frac{11}{24}$

50. $\frac{100}{63}$, or $1\frac{37}{63}$

51. $\frac{84}{47}$, or $1\frac{37}{47}$

52. $\frac{23}{78}$

53. To multiply two fractions, multiply their numerators to get the numerator of the product and multiply their denominators to get the denominator of the product. For example,

$$\frac{2}{3} \cdot \frac{8}{5} = \frac{2 \cdot 8}{3 \cdot 5} = \frac{16}{15}.$$

To divide two fractions, replace the divisor with its reciprocal and then multiply. For example,

$$\frac{2}{5} \div \frac{7}{9} = \frac{2}{5} \cdot \frac{9}{7} = \frac{2 \cdot 9}{5 \cdot 7} = \frac{18}{35}.$$

54. To add or subtract two fractions that have the same denominator, add or subtract the numerators and keep the same denominator. For example,

$$\frac{7}{8} + \frac{2}{8} = \frac{7+2}{8} = \frac{9}{8} \text{ and } \frac{7}{8} - \frac{2}{8} = \frac{7-2}{8} = \frac{5}{8}.$$

To add or subtract fractions that have different denominators, write both fractions with a common denominator, and then follow the earlier procedure. For example,

$$\frac{1}{2} + \frac{1}{3} = \frac{3}{6} + \frac{2}{6} = \frac{3+2}{6} = \frac{5}{6}$$

and

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

55. $\frac{2}{3}$

56. $\frac{1}{2}$

57. $\frac{8}{9}$

58. $\frac{7}{15}$

59. $\frac{43}{8}$, or $5\frac{3}{8}$

60. $\frac{41}{6}$, or $6\frac{5}{6}$

61. $\frac{101}{20}$, or $5\frac{1}{20}$

62. $\frac{109}{12}$, or $9\frac{1}{12}$

63. $\frac{2}{3}$

64. $\frac{2}{3}$

65. $\frac{17}{36}$

66. $\frac{29}{48}$

67. $\frac{67}{20}$, or $3\frac{7}{20}$

68. $\frac{61}{45}$, or $1\frac{16}{45}$

69. $\frac{11}{12}$

70. $\frac{17}{6}$, or $2\frac{5}{6}$

71. 6 cups

72. $\frac{3}{8}$ teaspoon

73. $1\frac{1}{8}$ inches

74. $1\frac{7}{8}$ inches

75. $\frac{9}{16}$ inch

76. $\frac{3}{16}$ inch

77. $618\frac{3}{4}$ feet

78. $22\frac{7}{8}$ feet

79. $5\frac{5}{24}$ inches

80. $\frac{1}{3}$ cup

81. 8 cakes (There will be some sugar left over.)

82. 10 chairs (There will be some fabric left over.)

83. $16\frac{5}{8}$ yards

84. $10\frac{2}{3}$ cups

85. $3\frac{3}{8}$ inches

86. $\frac{5}{16}$ inch

87. $\frac{7}{100}$

88. $\frac{79}{100}$

89. more than $4\frac{19}{25}$ million

90. **(a)** Morse **(b)** Hampton **(c)** Hampton **(d)** O'Connor **(e)** Tobin and Vetere; $\frac{1}{2}$

91. **(a)** $\frac{1}{2}$ **(b)** $\frac{1}{4}$ **(c)** $\frac{1}{3}$ **(d)** $\frac{1}{6}$

92. **B**

1.2 Exponents, Order of Operations, and Inequality

1. false; $4 + 3(8 - 2) = 4 + 3 \cdot 6 = 4 + 18 = 22$. The common error leading to 42 is adding 4 to 3 and then multiplying by 6. One must follow the order of operations.

2. false; $3^3 = 3 \cdot 3 \cdot 3 = 27$

3. false; the correct interpretation is $4 = 16 - 12$.

4. false; the correct interpretation is $6 = 10 - 4$.

5. 49

6. 16

7. 144

8. 196

9. 64

10. 125

11. 1000

12. 1331

13. 81

14. 1296

15. 1024

16. 243

17. $\frac{16}{81}$

18. $\frac{27}{64}$

19. 0.064

20. 0.0625

21. Write the base as a factor the number of times indicated by the exponent. For example, $6^3 = 6 \cdot 6 \cdot 6 = 216$.

22. For *any* number of factors of 1, the product must be 1.

23. 32

24. 100

25. 58

26. 53

27. 22.2

28. 9.4

29. $\frac{49}{30}$, or $1\frac{19}{30}$

30. $\frac{17}{6}$, or $2\frac{5}{6}$

31. 12

32. 74

33. 13

34. 10

35. 26

36. 16

37. 4

38. 12

39. 42

40. 82

41. 5

42. 23

43. 95

44. 1308

45. 90

46. 144

47. 14

48. 64

49. 9

50. 9

51. Begin by squaring 2. Then subtract 1, to get a result of $4 - 1 = 3$ within the parentheses. Next, raise 3 to the third power to get $3^3 = 27$. Multiply this result by 3 to obtain 81. Finally, add this result to 4 to get 85, the final answer.

52. 4

53. $16 \leq 16$; true

54. $18 \leq 18$; true

55. $61 \leq 60$; false

56. $47 \geq 48$; false

57. $0 \geq 0$; true

58. $10 \leq 11$; true

59. $45 \geq 46$; false

60. $55 \geq 57$; false

61. $66 > 72$; false

62. $58 \leq 58$; true

63. $2 \geq 3$; false

64. $2 \leq 2$; true

65. $3 \geq 3$; true

66. $7 \leq 7$; true

67. $15 = 5 + 10$

68. $12 = 20 - 8$

69. $9 > 5 - 4$

70. $10 > 6 + 1$

71. $16 \neq 19$

72. $3 \neq 4$

73. $\frac{1}{2} \leq \frac{2}{4}$

74. $\frac{1}{3} \leq \frac{3}{9}$

75. Seven is less than nineteen; true

76. Nine is less than ten; true

77. Three is not equal to six; true

78. Nine is not equal to thirteen; true

79. "Eight is greater than or equal to eleven; false

80. Four is less than or equal to two; false

81. Answers will vary. One example is

$$5 + 3 \geq 2 \cdot 2.$$

82. Answers will vary. One example is

$$5 - 2 \leq 6 \div 3.$$

It is false because it says that $3 \leq 2$, and actually $3 > 2$. By changing the 3 on the right side to 2, the statement becomes $3 \leq 3$, which is true.

83. $30 > 5$

84. $4 < 8$

85. $1.3 \leq 2.5$

86. $5.3 \geq 4.1$

87. is younger than

88. is taller than

89. **(a)** $14.7 - 40 \cdot 0.13$

(b) 9.5

(c) 8.075; walking (5 mph)

90. **(a)** $14.7 - 55 \cdot 0.11$

(b) 8.65

(c) 7.3525; swimming

91. Answers will vary.

92. **(a)** Alaska, Texas, California, Idaho

(b) Texas, Wyoming, Maine, Missouri

(c) Alaska, Texas, California, Idaho, Missouri

93. 1998, 1999, and 2000

94. 2001

95. $3 \cdot (6+4) \cdot 2 = 60$

96. $2 \cdot (8-1) \cdot 3 = 42$

97. $10 - (7-3) = 6$

98. $15 - (10-2) = 7$

99. $(8+2)^2 = 100$

100. $(4+2)^2 = 36$

1.3 Variables, Expressions, and Equations

1. 10

2. 8

3. $12 + x$; 21

4. 4

5. no

6. expression; equation

7. $2x^3 = 2 \cdot x \cdot x \cdot x$, while $2x \cdot 2x \cdot 2x = (2x)^3$.

8. The first is an expression indicating subtraction, $x - 5$, while the second is a statement relating 5 and x, $5 < x$.

9. The exponent 2 applies only to its base, which is x.

10. 3; To equal 9, $2x$ must equal 6, and thus x must equal 3.

11. Answers will vary. Two such pairs are $x = 0$, $y = 6$ and $x = 1$, $y = 4$. To find a pair, choose one number, substitute it for a variable, and then calculate the value for the other variable.

12. The value for y is 3. If x is 4, then $3x = 12$, and 3 subtracted from 12 equals 9.

13. **(a)** 13 **(b)** 15

14. **(a)** 3 **(b)** 5

15. **(a)** 20 **(b)** 30

16. **(a)** 28 **(b)** 42

17. **(a)** 64 **(b)** 144

18. **(a)** 80 **(b)** 180

19. **(a)** $\frac{5}{3}$ **(b)** $\frac{7}{3}$

20. **(a)** $\frac{2}{5}$ **(b)** $\frac{4}{5}$

21. **(a)** $\frac{7}{8}$ **(b)** $\frac{13}{12}$

22. **(a)** $\frac{5}{4}$ **(b)** $\frac{23}{18}$

23. **(a)** 52 **(b)** 114

24. **(a)** 24 **(b)** 48

25. **(a)** 25.836 **(b)** 38.754

26. **(a)** 11.84 **(b)** 26.64

27. **(a)** 24 **(b)** 28

28. **(a)** 17 **(b)** 21

29. **(a)** 12 **(b)** 33

30. **(a)** 10 **(b)** 14

31. **(a)** 6 **(b)** $\frac{9}{5}$

32. **(a)** 5 **(b)** 13

33. **(a)** $\frac{4}{3}$ **(b)** $\frac{13}{6}$

34. **(a)** $\frac{13}{20}$ **(b)** $\frac{29}{20}$

35. **(a)** $\frac{2}{7}$ **(b)** $\frac{16}{27}$

36. **(a)** 5 **(b)** 18

37. **(a)** 12 **(b)** 55

38. **(a)** 28 **(b)** 26

39. **(a)** 1 **(b)** $\frac{28}{17}$

40. **(a)** $\frac{5}{13}$ **(b)** $\frac{2}{29}$

41. **(a)** 3.684 **(b)** 8.841

42. **(a)** 3.964 **(b)** 5.941

43. $12x$

44. $9x$

45. $x + 7$

46. $x + 13$

47. $x - 2$

48. $x - 8$

49. $7 - x$

50. $14 - x$

51. $x - 6$

52. $6 - x$

53. $\dfrac{12}{x}$

54. $\dfrac{x}{12}$

55. $6(x - 4)$

56. $9(x+5)$

57. "Please excuse me, but I would like to point out that one *solves* an equation, but *simplifies* an expression. You might change 'Solve' to 'Simplify'."

58. No, *and* is a connective word (technically a *conjunction*) that joins the two factors: the number and 6.

59. yes

60. yes

61. no

62. no

63. yes

64. yes

65. yes

66. yes

67. yes

68. yes

69. $x+8=18;\ 10$

70. $x-3=1;\ 4$

71. $16-\frac{3}{4}x=13;\ 4$

72. $\frac{6}{5}x+2=14;\ 10$

73. $2x+1=5;\ 2$

74. $3x=6;\ 2$

75. $3x=2x+8;\ 8$

76. $\dfrac{12}{x}=\dfrac{1}{3}x;\ 6$

77. expression

78. expression

79. equation

80. equation

81. equation

82. expression

83. 64.9 years

84. 68.5 years

85. 72.8 years

86. 78.1 years

1.4 Real Numbers and the Number Line

1. 2,845,000

2. 9; 14

3. -2809

4. -6320

5. $-2.4;\ 5.2$

6. $-891.5;\ 796.3$

7. 52.59

8. -14.67

9. 4

10. One example is 3.85. There are others.

11. 0

12. One example is 5. There are others.

13. One example is $\sqrt{12}$. There are others.

14. 0

15. true

16. false

17. true

18. true

19. **(a)** 3, 7

(b) 0, 3, 7

(c) -9, 0, 3, 7

(d) $-9,\ -1\frac{1}{4},\ -\frac{3}{5},\ 0,\ 3,\ 5.9,\ 7$

(e) $-\sqrt{7},\ \sqrt{5}$

(f) All are real numbers.

20. **(a)** 3

(b) 0, 3

(c) $-5,\ -1,\ 0,\ 3$

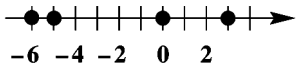
(d) $-5.3,\ -5,\ -1,\ -\frac{1}{9},\ 0,\ 1.2,\ 1.8,\ 3$

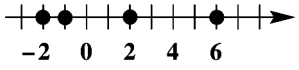
(e) $-\sqrt{3},\ \sqrt{11}$

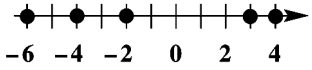
(f) All are real numbers.

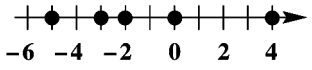
21. The *natural numbers* are the numbers with which we count. An example is 1. The *whole numbers* are the natural numbers with 0 also included. An example is 0. The *integers* are the whole numbers and their negatives. An example is -1. The *rational numbers* are the numbers that can be represented by a quotient of integers with denominator not 0, such as $\frac{1}{2}$. The *irrational numbers*, such as $\sqrt{2}$, cannot be represented as a quotient of integers. The *real numbers* include all positive numbers, negative numbers, and zero. All the numbers listed are real.

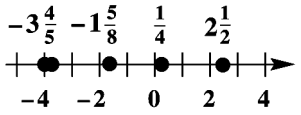
22. The decimal representation of a rational number will either terminate or repeat.

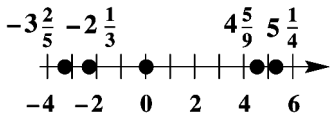
23. 

24. 

25. 

26. 

27. 

28. 

29. **(a)** A **(b)** A **(c)** B **(d)** B

30. 2, 2, 2, -2

31. **(a)** 4 **(b)** 4

32. **(a)** 8 **(b)** 8

33. **(a)** -6 **(b)** 6

34. **(a)** -11 **(b)** 11

35. 6

36. 15

37. $-\frac{2}{3}$

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

39. 3

40. -3

41. -12

42. -14

43. -7

44. -16

45. 3

46. $|-2|$, or 2

47. $|-3.5|$, or 3.5

48. $|-8.9|$, or 8.9

49. $-|-6|$, or -6

50. $-|-3|$, or -3

51. $|5-3|$, or 2

52. $|7-2|$, or 5

53. true

54. false

55. true

56. true

57. true

58. true

59. false

60. false

61. true

62. false

63. false

64. false

65. petroleum refineries, 2002 to 2003

66. electronic computer manufacturing, 2002 to 2003

67. construction machinery manufacturing, 2002 to 2003

68. telephone apparatus manufacturing and electronic computer manufacturing

In Exercises 69-74, answers will vary.

69. $\frac{1}{2}$, $\frac{5}{8}$, and $1\frac{3}{4}$

70. -1, $-\frac{3}{4}$, -5

71. $-3\frac{1}{2}$, $-\frac{2}{3}$, $\frac{3}{7}$

72. $\frac{1}{2}$, $-\frac{2}{3}$, $\frac{2}{7}$

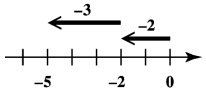
73. $\sqrt{5}$, π, $-\sqrt{3}$

74. $\frac{2}{3}$, $\frac{5}{6}$, $\frac{5}{2}$

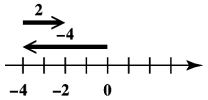
75. This is not true. The absolute value of 0 is 0, and 0 is not positive. A more accurate way of describing absolute value is to say that *absolute value is never negative,* or *absolute value is always nonnegative*.

76. true

1.5 Adding and Subtracting Real Numbers

1. negative 

2. zero (0)

3. negative 

4. -3; 5

5. To add two numbers with the same sign, add their absolute values and keep the same sign for the sum. For example, $3 + 4 = 7$ and $-3 + (-4) = -7$. To add two numbers with different signs, subtract the smaller absolute value from the larger absolute value, and use the sign of the number with the larger absolute value. For example, $6 + (-4) = 2$ and $(-6) + 4 = -2$.

6. To subtract $a - b$, write as $a + (-b)$ and follow the rules for addition.

7. -8

8. -11

9. -12

10. -16

11. 2

12. 3

13. -2

14. -4

15. 8.9

16. 8.8

17. 12

18. -5

19. 5

20. 5

21. 2

22. -1

23. -9

24. 0

25. 0

26. -4

27. $\frac{1}{2}$

28. $\frac{71}{100}$

29. $-\frac{19}{24}$

30. $\frac{3}{10}$

31. $-\frac{3}{4}$

32. $\frac{17}{8}$, or $2\frac{1}{8}$

33. -7.7

34. -16.6

35. -8

36. -24

37. 0

38. -19

39. -20

40. 9

41. -3

42. -5

43. -4

44. -5

45. -8

46. -15

47. -14

48. -27

49. 9

50. 14

51. -4

52. -2

53. 4

54. 4

55. $\frac{3}{4}$

56. $\frac{5}{3}$, or $1\frac{2}{3}$

57. $-\frac{11}{8}$, or $-1\frac{3}{8}$

58. $-\frac{4}{3}$, or $-1\frac{1}{3}$

59. $\frac{15}{8}$, or $1\frac{7}{8}$

60. $\frac{43}{40}$, or $1\frac{3}{40}$

61. 11.6

62. 17.3

63. -9.9

64. -13

65. 10

66. 0

67. -5

68. -9

69. 11

70. 12

71. -10

72. -5

73. 22

74. 9

75. -2

76. -3

77. -6

78. -10

79. -12

80. -5

81. -5.90617

82. -7.86944

83. $-5 + 12 + 6$; 13

84. $-3 + 5 + (-12)$; -10

85. $[-19 + (-4)] + 14$; -9

86. $(-18 + 11) + (-2)$; -9

87. $[-4 + (-10)] + 12$; -2

88. $[-7 + (-13)] + 14$; -6

89. $\left[\frac{5}{7} + \left(-\frac{9}{7}\right)\right] + \frac{2}{7}$; $-\frac{2}{7}$

90. $[-1.25 + (-4.75)] + 1.85$; -4.15

91. $4 - (-8)$; 12

92. $7 - (-14)$; 21

93. $-2 - 8$; -10

94. $-13 - 9$; -22

95. $[9 + (-4)] - 7$; -2

96. $[12 + (-7)] - 14$; -9

97. $[8 - (-5)] - 12$; 1

98. $[9 - (-2)] - 19$; -8

99. $-\$3.6$ billion

100. \$7.8 billion

101. \$28.2 billion

102. \$32.4 billion

103. 50,395 feet

104. 37,486 feet

105. 1345 feet

106. 8274 feet

107. 136 feet

108. 10,956 feet

109. -12

110. 16

111. $-56°$F

112. 113°F

113. $-69°$F

114. 14,776 feet

115. -184 meters

116. 31,900 feet

117. **(a)** 11.3%

(b) Americans spent more money than they earned, which means they had to dip into savings or increase borrowing.

118. \$649 billion

119. \$2169

120. \$219

121. 17

122. 28

123. \$1045.55

124. \$1122.26

125. \$323.83

126. \$712.39

127. positive

128. negative

129. positive

130. negative

1.6 Multiplying and Dividing Real Numbers

1. greater than 0

2. less than 0

3. less than 0

4. less than 0

5. greater than 0

6. less than 0

7. equal to 0

8. less than 0

9. undefined; 0; Examples include $\frac{1}{0}$, which is undefined, and $\frac{0}{1}$, which equals 0.

10. C

11. -12

12. -12

13. 12

14. 16

15. 120

16. -45

17. -33

18. -45

19. -2.38

20. -1.104

21. $\frac{5}{12}$

22. $\frac{25}{32}$

23. $-\frac{1}{6}$

24. $-\frac{2}{3}$

25. 6

26. 10

27. $-32, -16, -8, -4, -2, -1, 1, 2, 4, 8, 16, 32$

28. $-36, -18, -12, -9, -6, -4, -3, -2, -1, 1, 2, 3, 4, 6, 9, 12, 18, 36$

29. $-40, -20, -10, -8, -5, -4, -2, -1, 1, 2, 4, 5, 8, 10, 20, 40$

30. $-50, -25, -10, -5, -2, -1, 1, 2, 5, 10, 25, 50$

31. $-31, -1, 1, 31$

32. $-17, -1, 1, 17$

33. 3

34. 5

35. -5

36. -2

37. 7

38. 5

39. -6

40. -2

41. $\frac{32}{3}$, or $10\frac{2}{3}$

42. $\frac{7}{18}$

43. -4

44. 20

45. 0

46. 0

47. undefined

48. undefined

49. -11

50. -2

51. -2

52. 7

53. 35

54. 15

55. 6

56. 8

57. -18

58. -105

59. 67

60. 36

61. -8

62. -21

63. 3

64. 5

65. 7

66. 24

67. 4

68. 3

69. -1

70. -2

71. 4

72. -3

73. -3

74. 10

75. negative

76. positive

77. 47

78. 68

79. 72

80. -228

81. $-\frac{78}{25}$

82. 1

83. 0

84. 0

85. -23

86. -6

87. 2

88. 0

89. $9 + (-9)(2)$; -9

90. $-12 + 4(-7)$; -40

91. $-4 - 2[(-1)(6)]$; 8

92. $-1 - 2(-8)(2)$; 31

93. $(1.5)(-3.2) - 9$; -13.8

94. $(4.2)(-8.5) - 3$; -38.7

95. $12[9 - (-8)]$; 204

96. $-3[3 - (-7)]$; -30

97. $\dfrac{-12}{-5 + (-1)}$; 2

98. $\dfrac{-20}{-8 + (-2)}$; 2

99. $\dfrac{15 + (-3)}{4(-3)}$; -1

100. $\dfrac{-18 + (-6)}{2(-4)}$; 3

101. $\frac{2}{3}[8 - (-1)]$; 6

102. $\frac{3}{4}(-8 + 12)$; 3

103. $0.20(-5 \cdot 6)$; -6

104. $0.30(-8 \cdot 5)$; -12

105. $\left(\frac{1}{2} + \frac{5}{8}\right)\left(\frac{3}{5} - \frac{1}{3}\right)$; $\frac{3}{10}$

106. $\left(\frac{3}{4} + \frac{1}{2}\right)\left(\frac{2}{3} - \frac{1}{6}\right)$; $\frac{5}{8}$

107. $\dfrac{-\frac{1}{2}\left(\frac{3}{4}\right)}{-\frac{2}{3}}$; $\dfrac{9}{16}$

108. $\dfrac{-\frac{2}{3}\left(-\frac{1}{5}\right)}{\frac{1}{7}}$; $\dfrac{14}{15}$

109. $\dfrac{x}{3} = -3$; -9

110. $\dfrac{x}{4} = -1$; -4

111. $x - 6 = 4$; 10

112. $x - 7 = 2$; 9

113. $x + 5 = -5$; -10

114. $x + 6 = -3$; -9

115. $8\frac{2}{5}$

116. $3\frac{1}{5}$

117. 2

118. -7

119. 0

120. The average will be positive if the sum of all the numbers is positive, and it will be negative if the sum of all the numbers is negative.

121. **(a)** 6 is divisible by 2.

(b) 9 is not divisible by 2.

122. **(a)** $4 + 7 + 9 + 9 + 2 + 3 + 2 = 36$ is divisible by 3.

(b) $2 + 4 + 4 + 3 + 8 + 7 + 1 = 29$ is not divisible by 3.

123. **(a)** 64 is divisible by 4.

(b) 35 is not divisible by 4.

124. **(a)** 5 is divisible by 5.

(b) 3 is not divisible by 5.

125. **(a)** 2 is divisible by 2 and $1 + 5 + 2 + 4 + 8 + 2 + 2 = 24$ is divisible by 3.

(b) Although 0 is divisible by 2, $2 + 8 + 7 + 3 + 5 + 9 + 0 = 34$ is not divisible by 3.

126. **(a)** 296 is divisible by 8.

(b) 623 is not divisible by 8.

127. **(a)** $4 + 1 + 1 + 4 + 1 + 0 + 7 = 18$ is divisible by 9.

(b) $2 + 2 + 8 + 7 + 3 + 2 + 1 = 25$ is not divisible by 9.

128. **(a)** $4 + 2 + 5 + 3 + 5 + 2 + 0 = 21$ is divisible by 3 and 20 is divisible by 4.

(b) $4 + 2 + 4 + 9 + 4 + 7 + 4 = 34$ is not divisible by 3 and this is sufficient to show that the number is not divisible by 12.

Summary Exercises on Operations with Real Numbers

1. -16

2. 4

3. 0

4. -24

5. -17

6. 76

7. -18

8. 90

9. 38

10. 4

11. -5

12. 5

13. $-\frac{7}{2}$, or $-3\frac{1}{2}$

14. 4

15. 13

16. $\frac{5}{4}$, or $1\frac{1}{4}$

17. 9

18. $\frac{37}{10}$, or $3\frac{7}{10}$

19. 0

20. 25

21. 14

22. undefined

23. -4

24. $\frac{6}{5}$, or $1\frac{1}{5}$

25. -1

26. $\frac{52}{37}$, or $1\frac{15}{37}$

27. $\frac{17}{16}$, or $1\frac{1}{16}$

28. $-\frac{2}{3}$

29. 3.33

30. 1.02

31. -13

32. 0

33. 24

34. -7

35. 37

36. -3

37. -1

38. $\frac{1}{2}$

39. $-\frac{5}{13}$

40. 5

41. $-\frac{8}{27}$

42. 4

1.7 Properties of Real Numbers

1. -12; commutative property

2. 8; commutative property

3. 3; commutative property

4. -12; commutative property

5. 7; associative property

6. 3; associative property

7. 8; associative property

8. 4; associative property

9. **(a) B (b) F (c) C (d) I (e) B**
(f) D, F (g) B (h) A (i) G (j) H

10. The commutative property allows us to change the *order* of terms in a sum and factors in a product. The associative property allows us to change the *grouping* of the terms in a sum and the factors in a product.

11. commutative property

12. commutative property

13. associative property

14. associative property

15. associative property

16. associative property

17. inverse property

18. inverse property

19. inverse property

20. inverse property

21. identity property

22. identity property

23. commutative property

24. commutative property

25. distributive property

26. distributive property

27. identity property

28. identity property

29. distributive property

30. distributive property

31. The identity properties allow us to perform an operation so that the result is the number we started with. The inverse properties allow us to perform an operation that gives an identity element as a result.

32. The distributive property of multiplication with respect to addition says that a factor can be "distributed" to each term in a sum. For example, $3(x+y) = 3x + 3y$ and $-4(x+2y+3z) = -4x - 8y - 12z$.

33. identity property

34. No. For example, $2 + (3 \times 4) \neq (2+3) \times (2+4)$.

35. 150

36. 250

37. 2010

38. 3020

39. 400

40. 100

41. 1400

42. 3000

43. 11

44. 13

45. 0

46. 0

47. -0.38

48. -0.73

49. 1

50. 1

51. Subtraction is not associative.

52. Division is not associative.

53. The expression following the first equals sign should be $-3(4) - 3(-6)$. The student forgot that 6 should be preceded by a $-$ sign. The correct work is

$$\begin{aligned} -3(4-6) &= -3(4) - 3(-6) \\ &= -12 + 18 \\ &= 6. \end{aligned}$$

54. We must multiply $\frac{3}{4}$ by 1 in the form of a fraction, $\frac{3}{3}$: $\frac{3}{4} \cdot \frac{3}{3} = \frac{9}{12}$.

55. 85

56. 114

57. $4t + 12$

58. $5w + 20$

59. $-8r - 24$

60. $-11x - 44$

61. $-5y + 20$

62. $-9g + 36$

63. $-16y - 20z$

64. $-4b - 8a$

65. $8(z + w)$

66. $4(s + r)$

67. $7(2v + 5r)$

68. $13(5w + 4p)$

69. $24r + 32s - 40y$

70. $10u - 6v + 14w$

71. $-24x - 9y - 12z$

72. $-10x + 25y - 30z$

73. $5(x + 3)$

74. $9(p + 2)$

75. $-4t - 3m$

76. $-9x - 12y$

77. $5c + 4d$

78. $13x + 15y$

79. $q - 5r + 8s$

80. $z - 5w + 9y$

81. Answers will vary; for example, "putting on your socks" and "putting on your shoes."

82. Answers will vary; for example, "defective merchandise counter."

83. 0

84. $-3(5) + (-3)(-5)$

85. -15

86. We must interpret $(-3)(-5)$ as 15, since it is the additive inverse of -15.

87. **(a)** No

(b) distributive property

88. **(a)** No

(b) distributive property

1.8 Simplifying Expressions

1. **C**

2. **C**

3. **A**

4. **B**

5. $4r + 11$

6. $7t + 14$

7. $5 + 2x - 6y$

8. $8 + 3s - 18t$

9. $-7 + 3p$

10. $-17 + 14r$

11. $2 - 3x$

12. $1 - 8x$

13. -12

14. -23

15. 5

16. -3

17. 1

18. 1

19. -1

20. -1

21. $\frac{1}{5}$

22. $\frac{2}{3}$

23. like

24. like

25. unlike

26. unlike

27. like

28. like

29. unlike

30. unlike

31. The student made a sign error when applying the distribution property.

$$7x - 2(3 - 2x) = 7x - 2(3) - 2(-2x)$$

The correct answer is $11x - 6$.

32. Apples and oranges are examples of unlike fruits, just like x and y are unlike terms. We cannot add x and y to get an expression any simpler than $x + y$; we cannot add, for example, 2 apples and 3 oranges to obtain 5 fruits that are all alike.

33. $17y$

34. $27m$

35. $-6a$

36. $-12z$

37. $13b$

38. $31x$

39. $7k + 15$

40. $3 + 19z$

41. $-4y$

42. $3k - 10$

43. $2x + 6$

44. $-5r - 10$

45. $14 - 7m$

46. $1 - 7z$

47. $-17 + x$

48. $p - 4$

49. $23x$

50. $-2r + 5$

51. $-\frac{1}{3}t - \frac{28}{3}$

52. $\frac{49}{6}x - 9$

53. $9y^2$

54. $-13m^3$

55. $-14p^3 + 5p^2$

56. $11y^3 - 7y^2$

57. $8x + 15$

58. $24y - 29$

59. $5x + 15$

60. $6x + 30$

61. $-4y + 22$

62. $-5t + 61$

63. $-\frac{3}{2}y + 16$

64. $-\frac{19}{10}t + 21$

65. $-16y + 63$

66. $10t - 44$

67. $4r + 15$

68. $-14y + 13$

69. $12k - 5$

70. $13p - 13$

71. $-2k - 3$

72. $-3r - 3$

73. $4k - 7$

74. $-48j + 10$

75. $-23.7y - 12.6$

76. $43.2t - 28.8$

77. $(x + 3) + 5x$; $6x + 3$

78. $(x + 6) + 6x$; $7x + 6$

79. $(13 + 6x) - (-7x)$; $13 + 13x$

80. $(14 + 8x) - 5x$; $14 + 3x$

81. $2(3x + 4) - (-4 + 6x)$; 12

82. $3(12 + 8x) - (6 + 9x)$; $30 + 15x$

83. Wording will vary. One example is "the difference between 9 times a number and the sum of the number and 2."

84. Wording will vary. One example is "the difference between twice the sum of three times a number and 5, and twice the sum of the number and 4."

85. $1000 + 5x$ (dollars)

86. $750 + 3y$ (dollars)

87. $1000 + 5x + 750 + 3y$ (dollars)

88. $1750 + 5x + 3y$ (dollars)

Chapter 1 Review Exercises

1. $\frac{3}{4}$

2. $\frac{59}{16}$, or $3\frac{11}{16}$

3. $\frac{9}{40}$

4. 150

5. 625

6. $\frac{27}{125}$

7. 0.0004

8. 0.001

9. 27

10. 399

11. 39

12. 5

13. true

14. true

15. false

16. $13 < 17$

17. $5 + 2 \neq 10$

18. **(a)** 1995, 1997, 1998, 2002, 2003, 2004

(b) 1996, 1999, 2000

(c) 3988 thousand

19. 30

20. 60

21. 14

22. 13

23. $x + 6$

24. $8 - x$

25. $6x - 9$

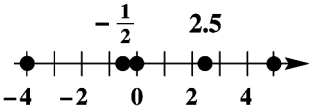
26. $12 + \frac{3}{5}x$

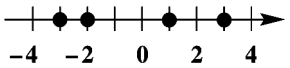
27. yes

28. no

29. $2x - 6 = 10$; 8

30. $4x = 8$; 2

31. 

32. 

33. rational numbers, real numbers

34. irrational numbers, real numbers

35. -10

36. -9

37. $-\frac{3}{4}$

38. $-|23|$

39. true

40. true

41. true

42. true

43. **(a)** 9 **(b)** 9

44. **(a)** 0 **(b)** 0

45. **(a)** -6 **(b)** 6

46. **(a)** $\frac{5}{7}$ **(b)** $\frac{5}{7}$

47. 12

48. -3

49. -19

50. -7

51. -6

52. -4

53. -17

54. $-\frac{29}{36}$

55. -21.8

56. -14

57. -10

58. -19

59. -11

60. -1

61. 7

62. $-\frac{43}{35}$, or $-1\frac{8}{35}$

63. 10.31

64. -12

65. 2

66. -3

67. $(-31+12)+19;\ 0$

68. $[-4+(-8)]+13;\ 1$

69. $-4-(-6);\ 2$

70. $[4+(-8)]-5;\ -9$

71. -2

72. -1

73. \$26.25

74. $-10°\text{F}$

75. $-\$29$

76. $-10°$

77. 38

78. 10,919.05

79. 36

80. -105

81. $\frac{1}{2}$

82. 10.08

83. -20

84. -10

85. -24

86. -35

87. 4

88. -20

89. $-\frac{3}{4}$

90. 11.3

91. -1

92. 2

93. 1

94. 0.5

95. -18

96. -18

97. 125

98. -423

99. $-4(5)-9;\ -29$

100. $\frac{5}{6}[12+(-6)];\ 5$

101. $\dfrac{12}{8+(-4)};\ 3$

102. $\dfrac{-20(12)}{15-(-15)};\ -8$

103. $8x=-24;\ -3$

104. $\dfrac{x}{3}=-2;\ -6$

105. 32

106. -3

107. identity property

108. identity property

109. inverse property

110. inverse property

111. associative property

112. associative property

113. distributive property

114. commutative property

115. $7(y+2)$

116. $-48+12t$

117. $3(2s+5y)$

118. $4r-5s$

119. $25-(5-2)=22$ and $(25-5)-2=18$.

Because different groupings lead to different results, we conclude that in general subtraction is not associative.

120. $180\div(15\div 5)=60$ and $(180\div 15)\div 5=\frac{12}{5}$.

Because different groupings lead to different results, we conclude that in general division is not associative.

121. $11m$

122. $16p^2$

123. $16p^2+2p$

124. $-4k+12$

125. $-2m+29$

126. $-5k-1$

127. $-2(3x)-7x;\ -13x$

128. $(5+4x)+8x;\ 5+12x$

129. 16

130. $\frac{25}{36}$

131. $\frac{8}{3}$, or $2\frac{2}{3}$

132. $-\frac{1}{24}$

133. 2

134. 77.6

135. $-\frac{3}{2}$, or $-1\frac{1}{2}$

136. 11

137. $-\frac{28}{15}$, or $-1\frac{13}{15}$

138. 24

139. $8x^2 - 21y^2$

140. $16t - 36$

141. Dividing 0 *by* a nonzero number gives a quotient of 0. However, dividing a number *by* 0 is undefined.

142. It is not correct, because it does not consider the operation involved. Multiplying two negative numbers gives a positive number, but adding two negative numbers gives a negative number.

143. $5(x + 7)$; $5x + 35$

144. $-47°$F

Chapter 1 Test

1. $\frac{7}{11}$

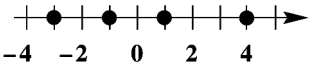
2. $\frac{241}{120}$, or $2\frac{1}{120}$

3. $\frac{19}{18}$, or $1\frac{1}{18}$

4. **(a)** 492 million **(b)** 861 million

5. true

6.



7. rational numbers, real numbers

8. If -8 and -1 are both graphed on a number line, we see that the point for -8 is to the *left* of the point for -1. This indicates that -8 is *less than* -1.

9. $\frac{-6}{2 + (-8)}$; 1

10. 4

11. $-\frac{17}{6}$, or $-2\frac{5}{6}$

12. 2

13. 6

14. 108

15. 3

16. $\frac{30}{7}$, or $4\frac{2}{7}$

17. 6

18. 4

19. -70

20. 3

21. 7000 meters

22. 15

23. **(a)** -1.86 (million students)

(b) -1.25 (million students)

(c) 1.59 (million students)

(d) 0.83 (million students)

24. **B**

25. **D**

26. **E**

27. **A**

28. **C**

29. distributive property

30. **(a)** -18 **(b)** -18

(c) The distributive property assures us that the answers must be the same, because $a(b + c) = ab + ac$ for all a, b, c.

31. $21x$

32. $15x - 3$