Instructor's Solutions Manual

to accompany

MARK DUGOPOLSKI

INTERMEDIATE

Algebra

3RD EDITION

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Instructor's Solutions Manual

to accompany

Intermediate Algebra

Third Edition

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Instructor's Solutions Manual
Intermediate Algebra

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1.1 WARM-UPS

1. False, since 5 is a counting number and $5 \notin A$.

2. False, since B has only 3 elements.

3. False, because the set has a specific number of members.

4. False, since $1 \notin B$.

5. True, since $3 \in A$.

6. True, because 3 and 4 are the only numbers that belong to both A and B.

7. True, because every member of C is also a member of B.

8. False, since $1 \in A$ but $1 \notin B$.

9. True, since $\emptyset$ is a subset of every set.

10. True, since $1 \in A$ and $1 \notin C$.

1.1 EXERCISES

1. A set is a collection of objects.

2. A finite set has a fixed number of elements and an infinite set does not.

3. A Venn diagram is used to illustrate relationships between sets.

4. The intersection of two sets consists of elements that are in both sets, while the union of two sets consists of elements that are in one, the other, or both sets.

5. A is a subset of B if every member of set A is also a member of set B.

6. The empty set is a subset of every set.

7. False, 6 is not odd.

8. False, because 8 is not odd.

9. True, because $1 \in A$ but $1 \notin B$.

10. False, A is a finite set.

11. True.

12. False, because 4 is a member of B.

13. False, because $5 \in A$.

14. True, since $6 \in B$ but $6 \notin C$.

15. False, because 0 is not a natural number.

16. False, because 2.5 is not a natural number.

17. False, because N is infinite and C is finite.

18. False, because N is infinite and A is finite.

19. $A = \{1, 3, 5, 7, 9\}$ and $B = \{2, 4, 6, 8\}$ so $A \cap B = \emptyset$.

20. $A = \{1, 3, 5, 7, 9\}$ and $B = \{2, 4, 6, 8\}$ so $A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$.

21. $A = \{1, 3, 5, 7, 9\}$ and $C = \{1, 2, 3, 4, 5\}$ so $A \cap C = \{1, 3, 5\}$.

22. $A = \{1, 3, 5, 7, 9\}$ and $C = \{1, 2, 3, 4, 5\}$ so $A \cup C = \{1, 2, 3, 4, 5, 7, 9\}$.

23. The elements of B together with those of C give us $B \cup C = \{1, 2, 3, 4, 5, 6, 8\}$.

24. The only elements that belong to both B and C are 2 and 4. So $B \cap C = \{2, 4\}$.

25. Since the empty set has no members, $A \cup \emptyset = A$.

26. Since the empty set has no members, $B \cup \emptyset = B$.

27. Since $\emptyset$ has no members in common with A, $A \cap \emptyset = \emptyset$.

28. Since the empty set has no members in common with B, $B \cap \emptyset = \emptyset$.

29. Since every member of A is also a member of N, $A \cap N = A = \{1, 3, 5, 7, 9\}$.

30. Since every member of A is a member of N, $A \cup N = N = \{1, 2, 3, \ldots\}$.

31. Since the members of A are odd and the members of B are even, they have no members in common. So $A \cap B = \emptyset$.

32. Since 1 is a member of both A and C, $A \cap C \neq \emptyset$.

33. $A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$ from problem 20.

34. Since A and B have no members in common, $A \cap B = \emptyset$.

35. Take the elements that B has in common with C to get $B \cap C = \{2, 4\}$.

36. Since the numbers 1, 2, 3, 4, 5, 6, and 8 are either members of B or C, we have $B \cup C = \{1, 2, 3, 4, 5, 6, 8\}$.

37. $3 \notin A \cap B$ since $3 \notin B$.

38. Since 3 is a member of A and 3 is a member of C, we have $3 \in A \cap C$.

39. Since 4 is in both sets, $4 \in B \cap C$.

40. Since 8 is a member of B, we have $8 \in B \cup C$.

41. True, since each member of A is a counting number.

1

42. True, since 2, 4, 6, and 8 are counting numbers.

43. True, since both 2 and 3 are members of C.

44. False, since 2 is a member of C, but 2 is not a member of A.

45. True, since $6 \in B$ but $6 \notin C$.

46. True, since 2 is a member of C, but 2 is not a member of A.

47. True, since $\emptyset$ is a subset of every set.

48. True, since the empty set is a subset of every set.

49. False, since $1 \in A$ but $1 \notin \emptyset$.

50. False, since $2 \in B$ but $2 \notin \emptyset$.

51. True, since $A \cap B = \emptyset$ and $\emptyset$ is a subset of any set.

52. True, since $B \cap C = \{2, 4\}$.

53. Using all numbers that belong to D or to E yields $D \cup E = \{2, 3, 4, 5, 6, 7, 8\}$.

54. D and E have no members in common. So $D \cap E = \emptyset$.

55. Using only numbers that belong to both D and F gives $D \cap F = \{3, 5\}$.

56. $D \cup F$ consists of numbers that are either in D or in F. So $D \cup F = \{1, 2, 3, 4, 5, 7\}$.

57. Using all numbers that belong to E or to F gives $E \cup F = \{1, 2, 3, 4, 5, 6, 8\}$.

58. The only numbers that belong to both E and F are 2 and 4. So $E \cap F = \{2, 4\}$.

59. Intersect $D \cup E$ from Exercise 53 with F to get $(D \cup E) \cap F = \{2, 3, 4, 5\}$.

60. $D \cup F = \{1, 2, 3, 4, 5, 7\}$ and $E = \{2, 4, 6, 8\}$. The only elements that these sets have in common are 2 and 4. So $(D \cup F) \cap E = \{2, 4\}$.

61. Take $E \cap F = \{2, 4\}$ together with D to get $D \cup (E \cap F) = \{2, 3, 4, 5, 7\}$.

62. $D = \{3, 5, 7\}$ and $F \cap E = \{2, 4\}$. Put all of the elements together in one set to form the union. $D \cup (F \cap E) = \{2, 3, 4, 5, 7\}$

63. Take the union of $D \cap F = \{3, 5\}$ with $E \cap F = \{2, 4\}$ to get $\{2, 3, 4, 5\}$.

64. $D \cap E = \emptyset$ and $F \cap E = \{2, 4\}$. So $(D \cap E) \cup (F \cap E) = \{2, 4\}$.

65. Intersect $D \cup E = \{2, 3, 4, 5, 6, 7, 8\}$ with $D \cup F = \{1, 2, 3, 4, 5, 7\}$ to get $\{2, 3, 4, 5, 7\}$.

66. $D \cup F = \{1, 2, 3, 4, 5, 7\}$ and $D \cup E = \{2, 3, 4, 5, 6, 7, 8\}$. So $(D \cup F) \cap (D \cup E) = \{2, 3, 4, 5, 7\}$.

67. Use $\subseteq$, since every element of D is an odd natural number.

68. The even natural numbers smaller than 9 are 2, 4, 6, and 8. So $E = \{x \mid x$ is an even natural number smaller than 9$\}$.

69. Use $\in$, since 3 is a member of D.

70. Since 3 is a member of D, $\{3\} \subseteq D$.

71. Use $\cap$, since D and E have no elements in common.

72. Any member of both D and E is a member of D. So $D \cap E \subseteq D$.

73. Use $\subseteq$, since every member of $D \cap F$ is a member of F.

74. Since 3 is a member of E but not a member of F, $3 \notin E \cap F$.

75. Use $\cap$, since $8 \in E$ but not in $E \cap F$.

76. Since every member of E is a member of $E \cup F$, $E \subseteq E \cup F$.

77. Use $\cup$, since $D \cup F$ and $F \cup F$ have exactly the same members.

78. Since the members of E and F are the same as the members of F and E, we have $E \cap F = F \cap E$.

79. The set of even natural number less than 20 is $\{2, 4, 6, \ldots, 18\}$.

80. The set of natural numbers greater than 6 is $\{7, 8, 9, \ldots\}$.

81. The set of odd natural numbers greater than 11 is $\{13, 15, 17, \ldots\}$.

82. The set of odd natural numbers less than 14 is $\{1, 3, 5, \ldots, 13\}$.

83. The set of even natural numbers between 4 and 79 is $\{6, 8, 10, \ldots, 78\}$.

84. The set of odd natural numbers between 12 and 57 is $\{13, 15, 17, \ldots, 55\}$.

85. $\{x \mid x$ is a natural number between 2 and 7$\}$

86. $\{x \mid x$ is an odd natural number less than 8$\}$

87. $\{x \mid x$ is an odd natural number greater than $4\}$

88. $\{x \mid x$ is a natural number greater than $3\}$

89. $\{x \mid x$ is an even natural number between 5 and 83$\}$

90. $\{x \mid x$ is an odd natural number between 8 and 52$\}$

91. If A has n elements and B has m elements, then the union of the two sets cannot have more members than $n + m$. So the union is also finite.

92. If all elements of A are in B, and all elements of B are in A, then $A = B$. If the union is contained in the intersection, then $A = B$.

93. a) $3 \in \{1, 2, 3\}$ b) $\{3\} \subseteq \{1, 2, 3\}$
c) $\emptyset \neq \{\emptyset\}$

94. a) $\emptyset, \{1\}, \{2\}, \{1, 2\}$
b) $\emptyset, \{1\}, \{2\}, \{3\}, \{1, 2\}, \{1, 3\}, \{2, 3\}, \{1, 2, 3\}$
c) There are 16 subsets of $\{1, 2, 3, 4\}$.
d) Every time we add an element we double the number of subsets. So the number of subsets for a set of n elements is 2^n.
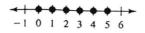
1.2 WARM-UPS

1. False, π is irrational.

2. True, the reals are made up of the rationals and the irrationals.

3. False, 0 is not irrational, it is rational.

4. False, the set of irrational numbers is a subset of the set of real numbers.

5. True, since it is a repeating decimal.

6. False, it is not repeating.

7. True, because the points on the number line correspond to the real numbers.

8. True, there is no intersection between the rationals and the irrationals.

9. False, it is a finite set.

10. True, the counting numbers are infinite and they are in the set of rational numbers.

1.2 EXERCISES

1. The integers consist of the positive and negative counting numbers and zero.

2. The rational numbers consist of all numbers that can be expressed as a ratio of integers.

3. The repeating or terminating decimal numbers are rational numbers.

4. Decimals that neither repeat nor terminate are irrational numbers.

5. The set of real numbers is the union of the rational and irrational numbers.

6. The ratio of the circumference and diameter of any circle is π.

7. True, since -6 is rational.

8. True, since $2/7$ is a rational number.

9. False, since 0 is rational.

10. True, since the smallest natural number is 1.

11. True, since a repeating decimal is rational.

12. False, since 0.00976 is a terminating decimal number and every terminating decimal number is a rational number.

13. True, since every natural number is rational.

14. False, since $1/2$ is a rational number but it is not an integer.
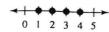
15. $\{0, 1, 2, 3, 4, 5\}$

16. The natural numbers less than 7 are 1, 2, 3, 4, 5, and 6. $\{1, 2, 3, 4, 5, 6\}$

17. $\{-4, -3, -2, -1, 0, 1, \ldots\}$

18. List the integers between 2 and 12 in set notation. $\{3, 4, 5, 6, 7, 8, 9, 10, 11\}$

19. $\{1, 2, 3, 4\}$

3

20. $\{1, 2, 3, 4, 5, \ldots\}$

0 1 2 3 4 ...

21. $\{-2, -1, 0, 1, 2, 3, 4\}$

−3 −2 −1 0 1 2 3 4 5

22. $\{-3, -2, -1, 0, 1, 2, 3, 4, 5, 6\}$

−4 −3 −2 −1 0 1 2 3 4 5 6 7

23. All of the numbers are real numbers.

24. Since $8/2 = 4$, $8/2$ is the only natural number in the set. $\{8/2\}$

25. The whole numbers include 0. $\{0, 8/2\}$

26. The integers in the set are -3, 0, and $8/2$. $\{-3, 0, 8/2\}$

27. $\{-3, -5/2, -0.025, 0, 3\frac{1}{2}, 8/2\}$

28. The irrational numbers in the set are $-\sqrt{10}$ and $\sqrt{2}$. $\{-\sqrt{10}, \sqrt{2}\}$

29. True, since every rational number is also a real number.

30. False, since the set of irrational numbers and the set of rational numbers have no numbers in common.

31. False, since 0 is not irrational.

32. True, since every integer is a rational number. Every integer can be expressed as a ratio of two integers.

33. True, because the rational numbers together with the irrational numbers make up the set of real numbers.

34. False, since the set of integers is a subset of the set of rational numbers.

35. False, since nonrepeating decimals are irrational.

36. True, since repeating decimals are rational numbers.

37. False, since repeating decimals are rational.

38. True, since nonrepeating decimals are irrational.

39. False, since repeating decimals are rational.

40. True, since repeating decimals are rational.

41. True, since π is irrational.

42. False, because π is irrational.

43. $N \subseteq W$, since every natural number is a whole number.

44. Since every integer is a rational number, $J \subseteq Q$.

45. $J \nsubseteq N$, since $-9 \in J$ but $-9 \notin N$.

46. Since rational numbers such as $1/2$ are not whole numbers, $Q \nsubseteq W$.

47. $Q \subseteq R$, since every rational number is a real number.

48. Since every irrational number is a real number, $I \subseteq R$.

49. $\emptyset \subseteq I$, since $\emptyset$ is a subset of every set.

50. Since $\emptyset$ is a subset of every set, $\emptyset \subseteq Q$.

51. $N \subseteq R$, since every natural number is a real number.

52. Since every whole number is a real number, $W \subseteq R$.

53. $5 \in J$, since 5 is an integer.

54. Since -6 is an integer, $-6 \in J$.

55. $7 \in Q$, since 7 is a rational number.

56. Since 8 is a rational number, $8 \in Q$.

57. $\sqrt{2} \in R$, since $\sqrt{2}$ is a real number.

58. Since $\sqrt{2}$ is an irrational number, $\sqrt{2} \in I$.

59. $0 \notin I$, since 0 is rational.

60. Since 0 is a rational number, $0 \in Q$.

61. $\{2, 3\} \subseteq Q$, since both 2 and 3 are rational.

62. Since 0 is not a natural number, $\{0, 1\} \nsubseteq N$.

63. $\{3, \sqrt{2}\} \subseteq R$, since both numbers are real.

64. Since $\sqrt{2}$ is not rational, $\{3, \sqrt{2}\} \nsubseteq Q$.

65. A rational number is a repeating or terminating decimal and an irrational number never repeats or terminates as a decimal number. Since $\sqrt{9} = 3$ it is rational. Since $\sqrt{3}$ is a nonterminating nonrepeating decimal number, it is irrational.

66. The only rational numbers of the form $\sqrt{n}$ for n from 1 through 100 are $\sqrt{1}$, $\sqrt{4}$,

4

$\sqrt{9}, \sqrt{16}, \sqrt{25}, \sqrt{36}, \sqrt{49}, \sqrt{64}, \sqrt{81}$, and $\sqrt{100}$.

67. a) Find the decimal representations with a calculator. Note that each decimal is repeating. b) The number of digits that repeats is the same as the number of nines in the denominator.

1.3 WARM-UPS

1. True, since $-6 + 6 = 0$.
2. True, -5 and 5 are opposites of each other.
3. False, $|6| = 6$.
4. True, since $b - a = b + (-a)$.
5. True, because the product of two numbers with opposite signs is negative.
6. False, since $6 + (-4) = 2$.
7. False, since $-3 - (-6) = -3 + 6 = 3$.
8. False, since $6 \div (-1/2) = 6(-2) = -12$.
9. False, since division by zero is undefined.
10. True, because 0 divided by any nonzero number is 0.

1.3 EXERCISES

1. The absolute value of a number is the number's distance from 0 on the number line.
2. Add their absolute values, then affix the sign of the original numbers.
3. Subtract their absolute values and use the sign of the number with the larger absolute value.
4. The difference $a - b$ is defined as $a + (-b)$.
5. Multiply their absolute values, then affix a positive sign if the original numbers have the same sign and a negative sign if the original numbers have opposite signs.
6. The quotient $a \div b$ is defined as $a \cdot \frac{1}{b}$.
7. $|-34| = -(-34) = 34$
8. $|17| = 17$, because 17 is positive.
9. $|0| = 0$
10. $|-15| = -(-15) = 15$
11. $|-6| - |-6| = 6 - 6 = 0$
12. $|8| - |-8| = 8 - 8 = 0$
13. $-|-9| = -9$
14. $-|-3| = -[-(-3)] = -[3] = -3$
15. $-(-9) = 9$

16. $-(-(8)) = -(-8) = 8$
17. $-(-(-3)) = -(3) = -3$
18. $-(-(-2)) = -(2) = -2$
19. $(-5) + 9 = 9 - 5 = 4$
20. $(-3) + 10 = 10 - 3 = 7$
21. $(-4) + (-3) = -(4 + 3) = -7$
22. $(-15) + (-11) = -(15 + 11) = -26$
23. $-6 + 4 = -(6 - 4) = -2$
24. $5 + (-15) = -(15 - 5) = -10$
25. $7 + (-17) = -(17 - 7) = -10$
26. $-8 + 13 = 13 - 8 = 5$
27. $(-11) + (-15) = -(11 + 15) = -26$
28. $-18 + 18 = 0$
29. $18 + (-20) = -(20 - 18) = -2$
30. $7 + (-19) = -(19 - 7) = -12$
31. $-14 + 9 = -(14 - 9) = -5$
32. $-6 + (-7) = -(6 + 7) = -13$
33. $-4 + 4 = 0$
34. $-7 + 9 = 9 - 7 = 2$
35. $-\frac{1}{10} + \frac{1}{5} = \frac{1}{5} - \frac{1}{10} = \frac{2}{10} - \frac{1}{10} = \frac{1}{10}$

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

37. $\frac{1}{2} + \left(-\frac{2}{3}\right) = \frac{3}{6} + \left(-\frac{4}{6}\right) = -\frac{1}{6}$

38. $\frac{3}{4} + \frac{1}{2} = \frac{3}{4} + \frac{1}{2} = \frac{3}{4} + \frac{2}{4} = \frac{5}{4}$

39. $-15 + 0.02 = -(15.00 - 0.02)$
$$= -14.98$$

40. $0.45 + (-1.3) = -(1.30 - 0.45) = -0.85$
41. $-2.7 + (-0.01) = -(2.70 + 0.01)$
$$= -2.71$$

42. $0.8 + (-1) = -(1.0 - 0.8) = -0.2$
43. $47.39 + (-44.587) = 2.803$
44. $0.65357 + (-2.375) = -1.72143$
45. $0.2351 + (-0.5) = -0.2649$
46. $-1.234 + (-4.756) = -5.99$
47. $7 - 10 = -(10 - 7) = -3$
48. $8 - 19 = -(19 - 8) = -11$
49. $-4 - 7 = -4 + (-7) = -11$
50. $-5 - 12 = -(5 + 12) = -17$

5

51. $7 - (-6) = 7 + 6 = 13$

52. $3 - (-9) = 3 + 9 = 12$

53. $-1 - 5 = -1 + (-5) = -6$

54. $-4 - 6 = -4 + (-6) = -(4 + 6) = -10$

55. $-12 - (-3) = -12 + 3 = -9$

56. $-15 - (-6) = -15 + 6 = -(15 - 6)$
$$= -9$$

57. $20 - (-3) = 20 + 3 = 23$

58. $50 - (-70) = 50 + 70 = 120$

59. $\frac{9}{10} - \left(-\frac{1}{10}\right) = \frac{9}{10} + \frac{1}{10} = 1$

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

61. $1 - \frac{3}{2} = \frac{2}{2} - \frac{3}{2} = -\frac{1}{2}$

62. $-\frac{1}{2} - \left(-\frac{1}{3}\right) = -\frac{1}{2} + \frac{1}{3} = -\left(\frac{3}{6} - \frac{2}{6}\right)$
$$= -\frac{1}{6}$$

63. $2.00 - 0.03 = 1.97$

64. $-0.02 - 3 = -(3.00 + 0.02) = -3.02$

65. $5.3 - (-2) = 5.3 + 2 = 7.3$

66. $-4.1 - 0.13 = -(4.10 + 0.13) = -4.23$

67. $-2.44 - 48.29 = -50.73$

68. $-8.8 - 9.164 = -17.964$

69. $-3.89 - (-5.16) = 1.27$

70. $0 - (-3.5) = 3.5$

71. $(25)(-3) = -(25 \cdot 3) = -75$

72. $(5)(-7) = -(5 \cdot 7) = -35$

73. $\left(-\frac{1}{3}\right)\left(-\frac{1}{2}\right) = \frac{1}{6}$

74. $\left(-\frac{1}{2}\right)\left(-\frac{6}{7}\right) = \frac{6}{14} = \frac{3}{7}$

75. $(0.3)(-0.3) = -0.09$

76. $(-0.1)(-0.5) = (0.1)(0.5) = 0.05$

77. $(-0.02)(-10) = 0.02(10) = 0.2$

78. $(0.05)(-2.5) = -0.125$

79. The reciprocal of 20 is $\frac{1}{20}$ or 0.05.

80. The reciprocal of -5 is $-\frac{1}{5}$ or -0.2

81. The reciprocal of $-\frac{6}{5}$ is $-\frac{5}{6}$.

82. The reciprocal of $-\frac{1}{8}$ is -8.

83. The reciprocal of -0.3 is $-\frac{1}{0.3}$ or $-\frac{10}{3}$.

84. The reciprocal of 0.125 is $\frac{1}{0.125}$, $\frac{1}{1/8}$, or 8.

85. $-6 \div 3 = -2$

86. $84 \div (-2) = -42$

87. $30 \div (-0.8) = -37.5$

88. $(-9)(-6) = 54$

89. $(-0.8)(0.1) = -0.08$

90. $7 \div (-0.5) = -(7 \div 0.5) = -14$

91. $(-0.1) \div (-0.4) = 0.25$

92. $(-18) \div (-0.9) = 18 \div 0.9 = 20$

93. $9 \div \left(-\frac{3}{4}\right) = 9\left(-\frac{4}{3}\right) = -\frac{36}{3} = -12$

94. $-\frac{1}{3} \div \left(-\frac{5}{8}\right) = -\frac{1}{3}\left(-\frac{8}{5}\right) = \frac{8}{15}$

95. $-\frac{2}{3}\left(-\frac{9}{10}\right) = \frac{2}{3} \cdot \frac{9}{10} = \frac{18}{30} = \frac{3}{5}$

96. $\frac{1}{2}\left(-\frac{2}{5}\right) = -\left(\frac{1}{2} \cdot \frac{2}{5}\right) = -\frac{1}{5}$

97. $(0.25)(-365) = -91.25$

98. $7.5 \div (-0.15) = -50$

99. $(-51) \div (-0.003) = 17{,}000$

100. $(-2.8)(5.9) = -16.52$

101. $-62 + 13 = -(62 - 13) = -49$

102. $-88 + 39 = -(88 - 39) = -49$

103. $-32 - (-25) = -32 + 25 = -7$

104. $-71 - (-19) = -71 + 19 = -52$

105. $|-15| = -(-15) = 15$

106. $-|-75| = -(75) = -75$

107. $\frac{1}{2}(-684) = -342$

108. $\frac{1}{3}(-123) = -41$

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

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

111. $-57 \div 19 = -3$

112. $0 \div (-36) = 0$

113. $|-17| + |-3| = 17 + 3 = 20$

114. $64 - |-12| = 64 - 12 = 52$

115. $0 \div (-0.15) = 0$

116. $-20 \div \left(-\frac{8}{3}\right) = 20 \cdot \frac{3}{8} = \frac{60}{8} = \frac{15}{2}$

117. $27 \div (-0.15) = -180$

118. $33 \div (-0.2) = -165$

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

120. $-\frac{2}{3} + \frac{1}{6} = -\left(\frac{2}{3} - \frac{1}{6}\right) = -\left(\frac{4}{6} - \frac{1}{6}\right)$
$$= -\frac{3}{6} = -\frac{1}{2}$$

121. $-63 + |8| = -63 + 8 = -55$

122. $|-34| - 27 = 34 - 27 = 7$

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

6

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

125. $-\frac{1}{2} - 19 = -\frac{1}{2} - \frac{38}{2} = -\frac{39}{2}$

126. $-\frac{1}{3} - 22 = -\frac{1}{3} - \frac{66}{3} = -\frac{67}{3}$

127. $28 - 0.01 = 27.99$

128. $55 - 0.1 = 54.9$

129. $-29 - 0.3 = -29.3$

130. $-0.241 - 0.3 = -0.541$

131. $(-2)(0.35) = -0.7$

132. $(-3)(0.19) = -0.57$

133. $(-10)(-0.2) = 2$

134. $\left(-\frac{1}{2}\right)(-50) = 25$

135. $85,000 + (-45,000) + (-2300)$
$+ (-1500) + 1200 + 2(3,500) = 44,400$
Net worth is $44,400.

136. Before recession: $15.6 + (-23.3) + 8.5$
$= 0.8$ million, or $800,000 net worth. After
recession: $15.6 + -23.3 + 4.8 = -2.9$, or
$-$2.9 million net worth.

137. $14° - (-6°) = 20°$

138. $-20° - (-31°) = 11°\,C$

139. $-282 - (-1296) = 1014\,\text{ft}$

140. $29,028 - (-36,201) = 65,229\,\text{ft}$

141. We learn addition first, because
subtraction is defined in terms of addition.

142. The multiplicative inverse of a is $1/a$.
Zero is the only number for which $1/a$ is
undefined.

1.4 WARM-UPS

1. False, $2^3 = 8$.

2. True, because $2^2 = 4$ and $-1 \cdot 2^2 = -4$.

3. True, since $-2^2 = -(2^2) = -4$.

4. False, since $6 + 3 \cdot 2 = 6 + 6 = 12$.

5. False, since $(6 + 3) \cdot 2 = 9 \cdot 2 = 18$.

6. False, since $(6 + 3)^2 = 9^2 = 81$.

7. True, since $6 + 3^2 = 6 + 9 = 15$.

8. True, since $(-3)^3 = -27$ and $-3^3 = -27$.

9. False, since $|-3 - (-2)| = |-1| = 1$.

10. False, since $|7 - 8| = 1$ and
$|7| - |8| = 7 - 8 = -1$.

1.4 EXERCISES

1. An arithmetic expression is the result of
writing numbers in a meaningful combination
with the ordinary operations of arithmetic.

2. An expression is called a sum, difference,
product, or quotient if the last operation to be
performed is addition, subtraction,
multiplication, or division, respectively.

3. Grouping symbols are used to indicate the
order in which operations are to be performed.

4. An exponential expression is an expression
of the form a^n.

5. The order of operations tells us the order in
which to perform operations when grouping
symbols are omitted.

6. The value of -3^2 is -9 and the value of
$(-3)^2$ is 9.

7. $(-3 \cdot 4) - (2 \cdot 5) = -12 - 10 = -22$

8. $|-3 - 2| - |2 - 6| = 5 - 4 = 1$

9. $4[5 - |3 - (2 \cdot 5)|] = 4[5 - 7] = -8$

10. $-2|(-3 \cdot 4) - 6| = -2|-18| = -36$

11. $(6 - 8)(|2 - 3| + 6) = (-2)(7) = -14$

12. $-5(6 + [(5 - 7) - 4]) = -5(6 + [-6])$
$= 0$

13. $2^5 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 32$

14. $3^4 = 3 \cdot 3 \cdot 3 \cdot 3 = 81$

15. $(-1)^4 = (-1)(-1)(-1)(-1) = 1$

16. $(-1)^5 = (-1)(-1)(-1)(-1)(-1) = -1$

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

18. $\left(-\frac{1}{2}\right)^6$
$= \left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right) = \frac{1}{64}$

19. $\sqrt{49} = 7$

20. $\sqrt{100} = 10$

21. $\sqrt{36 + 64} = \sqrt{100} = 10$

22. $\sqrt{25 - 9} = \sqrt{16} = 4$

23. $\sqrt{4(7 + 9)} = \sqrt{64} = 8$

24. $\sqrt{(11 + 2)(18 - 5)} = \sqrt{169} = 13$

25. $4 - 6 \cdot 2 = 4 - 12 = -8$

26. $8 - 3 \cdot 9 = 8 - 27 = -(27 - 8) = -19$

27. $5 - 6(3 - 5) = 5 - 6(-2)$
$= 5 + 12 = 17$

28. $8 - 3(4 - 6) = 8 - 3(-2) = 8 - (-6)$
$= 8 + 6 = 14$

7

29. $\left(\frac{1}{3} - \frac{1}{2}\right)\left(\frac{1}{4} - \frac{1}{2}\right) = \left(-\frac{1}{6}\right)\left(-\frac{1}{4}\right)$
$= \frac{1}{24}$

30. $\left(\frac{1}{2} - \frac{1}{4}\right)\left(\frac{1}{2} - \frac{3}{4}\right) = \left(\frac{1}{4}\right)\left(-\frac{1}{4}\right)$
$= -\frac{1}{16}$

31. $-3^2 + (-8)^2 + 3 = -9 + 64 + 3 = 58$

32. $-6^2 + (-3)^3 = -36 - 27 = -63$

33. $-(2 - 7)^2 = -(-5)^2 = -25$

34. $-(1 - 3 \cdot 2)^3 = -(1 - 6)^3 = -(-5)^3$
$= -(-125) = 125$

35. $-5^2 \cdot 2^3 = -25 \cdot 8 = -200$

36. $2^4 - 4^2 = 16 - 16 = 0$

37. $(-5)(-2)^3 = -5(-8) = 40$

38. $(-1)(2 - 8)^3 = (-1)(-6)^3 = -1(-216)$
$= 216$

39. $-(3^2 - 4)^2 = -(9 - 4)^2 = -5^2 = -25$

40. $-(6 - 2^3)^4 = -(6 - 8)^4 = -(-2)^4$
$= -16$

41. $-60 \div 10 \cdot 3 \div 2 \cdot 5 \div 6$
$= -6 \cdot 3 \div 2 \cdot 5 \div 6$
$= -18 \div 2 \cdot 5 \div 6$
$= -9 \cdot 5 \div 6$
$= -45 \div 6 = -7.5$

42. $75 \div (-5)(-3) \div \frac{1}{2} \cdot 6$
$= -15(-3) \div \frac{1}{2} \cdot 6$
$= 45 \div \frac{1}{2} \cdot 6$
$= 90 \cdot 6 = 540$

43. $5.5 - 2.3^4 = -22.4841$

44. $5.3^2 - 4 \cdot 6.1 = 3.69$

45. $(1.3 - 0.31)(2.9 - 4.88) = -1.9602$

46. $(6.7 - 9.88)^3 = -32.157432$

47. $-388.8 \div (13.5)(9.6) = -276.48$

48. $(-4.3)(5.5) \div (3.2)(-1.2) = 8.86875$

49. $\frac{2 - 6}{9 - 7} = \frac{-4}{2} = -2$

50. $\frac{9 - 12}{4 - 5} = \frac{-3}{-1} = 3$

51. $\frac{-3 - 5}{6 - (-2)} = \frac{-8}{8} = -1$

52. $\frac{-14 - (-2)}{-3 - 3} = \frac{-14 + 2}{-6} = \frac{-12}{-6} = 2$

53. $\frac{4 + 2 \cdot 7}{3 \cdot 2 - 9} = \frac{18}{-3} = -6$

54. $\frac{-6 - 2(-3)}{8 - 3(-3)} = \frac{-6 + 6}{8 + 9} = \frac{0}{17} = 0$

55. $\frac{-3^2 - (-9)}{2 - 3^2} = \frac{-9 + 9}{2 - 9} = \frac{0}{-7} = 0$

56. $\frac{-2^4 - 5}{3^2 - 2^4} = \frac{-16 - 5}{9 - 16} = \frac{-21}{-7} = 3$

57. $3^2 - 4(-1)(-4) = 9 - 16 = -7$

58. $\sqrt{(-1)^2 - 4(3)(-4)} = \sqrt{1 - 4(-12)}$
$= \sqrt{1 + 48} = 7$

59. $\frac{-1 - 3}{-1 - (-4)} = \frac{-4}{-1 + 4} = -\frac{4}{3}$

60. $\frac{3 - (-4)}{3 - (-1)} = \frac{7}{4}$

61. $(-1 - 3)(-1 + 3) = (-4)(2) = -8$

62. $(-1 - (-4))(-1 + (-4))$
$= (-1 + 4)(-5)$
$= (3)(-5) = -15$

63. $\sqrt{(-4)^2 - 2(-4) + 1} = \sqrt{16 + 8 + 1}$
$= 5$

64. $(3)^2 - 2(3) - 3 = 9 - 6 - 3 = 0$

65. $\frac{2}{-1} + \frac{3}{-4} - \frac{1}{-4} = -\frac{4}{2} - \frac{1}{2} = -\frac{5}{2}$

66. $\frac{-4}{-1} + \frac{-4}{3} - \frac{-1}{3} = 4 - \frac{4}{3} + \frac{1}{3}$
$= 4 - \frac{3}{3} = 4 - 1 = 3$

67. $|-1 - 3| = |-4| = 4$

68. $|3 + (-4)| = |-1| = 1$

69. $\frac{-6 - 4}{-7 - 2} = \frac{-10}{-9} = \frac{10}{9}$

70. $\frac{-3 - (-3)}{-5 - 4} = \frac{0}{-9} = 0$

71. $\frac{2 - (-1)}{1 - (-3)} = \frac{3}{4}$

72. $\frac{5 - (-2)}{6 - 2} = \frac{7}{4}$

73. $\frac{5.6 - 2.4}{4.7 - 5.9} = -2.67$

74. $\frac{6.9 - (-5.7)}{4.2 - 3.5} = 18$

75. $-2^2 + 5(3)^2 = -4 + 45 = 41$

76. $-3^2 + 3(6)^2 = -9 + 108 = 99$

77. $(-2 + 5)3^2 = 3 \cdot 9 = 27$

78. $(-3 + 3)6^2 = 0 \cdot 36 = 0$

79. $\sqrt{5^2 - 4(1)(6)} = \sqrt{25 - 24} = 1$

80. $\sqrt{6^2 - 4(2)(4)} = \sqrt{36 - 32} = 2$

81. $[13 + 2(-5)]^2 = 3^2 = 9$

82. $[6 + 2(-4)]^2 = [-2]^2 = 4$

83. $\dfrac{4 - (-1)}{-3 - 2} = \dfrac{5}{-5} = -1$

84. $\dfrac{2 - (-3)}{3 - 5} = \dfrac{5}{-2} = -\dfrac{5}{2}$

85. $3(-2)^2 - 5(-2) + 4 = 12 + 10 + 4 = 26$

86. $3(-1)^2 + 5(-1) - 6 = 3 - 5 - 6 = -8$

87. $-4\left(\dfrac{1}{2}\right)^2 + 3\left(\dfrac{1}{2}\right) - 2$
$= -4\left(\dfrac{1}{4}\right) + \dfrac{3}{2} - 2$
$= -\dfrac{2}{2} + \dfrac{3}{2} - \dfrac{4}{2} = -\dfrac{3}{2}$

88. $8\left(\dfrac{1}{2}\right)^2 - 6\left(\dfrac{1}{2}\right) + 1 = 8 \cdot \dfrac{1}{4} - 3 + 1$
$= 2 - 3 + 1 = 0$

89. $-\dfrac{1}{2} \mid 6 - 2 \mid = -\dfrac{1}{2}(4) = -2$

90. $-\dfrac{1}{3} \mid 9 - 6 \mid = -\dfrac{1}{3} \mid 3 \mid$
$= -\dfrac{1}{3} \cdot 3 = -1$

91. $\dfrac{1}{2} - \dfrac{1}{3} \mid \dfrac{1}{4} - \dfrac{1}{2} \mid = \dfrac{1}{2} - \dfrac{1}{3} \cdot \dfrac{1}{4}$
$= \dfrac{1}{2} - \dfrac{1}{12} = \dfrac{5}{12}$

92. $\dfrac{1}{3} - \dfrac{1}{2} \mid \dfrac{1}{3} - \dfrac{1}{2} \mid = \dfrac{1}{3} - \dfrac{1}{2} \cdot \dfrac{1}{6}$
$= \dfrac{1}{3} - \dfrac{1}{12} = \dfrac{1}{4}$

93. $\mid 6 - 3 \cdot 7 \mid + \mid 7 - 5 \mid$
$= \mid -15 \mid + \mid 2 \mid$
$= 17$

94. $\mid 12 - 4 \mid - \mid 3 - 4 \cdot 5 \mid$
$= \mid 8 \mid - \mid 3 - 20 \mid$
$= 8 - \mid -17 \mid = 8 - 17 = -9$

95. $3 - 7[4 - (2 - 5)] = 3 - 7[4 + 3]$
$= 3 - 49 = -46$

96. $9 - 2[3 - (4 + 6)] = 9 - 2[-7] = 9 + 14$
$= 23$

97. $3 - 4(2 - \mid 4 - 6 \mid) = 3 - 4(2 - 2) = 3$

98. $3 - (\mid -4 \mid - \mid -5 \mid) = 3 - (-1)$
$= 3 + 1 = 4$

99. $4[2 - (5 - \mid -3 \mid)^2] = 4[2 - (2^2)]$
$= 4[-2] = -8$

100. $[5 - (-3)]^2 + [4 - (-2)]^2 = 8^2 + 6^2$
$= 100$

101. $0.65(220 - 25) - 0.65(220 - 65) = 26$
The target heart rate for a 25-yr old woman is 26 beats per minute larger than the target heart rate for a 65 yr-old woman. A woman's target heart rate is 115 at about 43 years of age.

102. Target heart rate for 20-yr old man is $0.75(220 - 20) = 150$. Target heart rate for 50-yr old man is $0.75(220 - 50) = 127.5$. A man's target heart rate is 115 at about 67 years of age.

103. The perimeter is $2(34) + 2(18)$ or 104 feet.

104. The area of the property is $0.5 \cdot 150(260 + 220)$ or 36,000 ft^2.

105. a) Using the graph, the investment amounts to approximately \$60,000.

b) The investment amounts to $10,000(1 + 0.062)^{30}$ or \$60,776.47.

106. The amount invested in 1987 was $\dfrac{252,000}{(1 + 0.07)^{18}}$ or \$74,557.71.

107. a) According to the graph she owes approximately \$5,500.

b) The actual amount owed when the payments start is $4000(1 + 0.08)^4$ or \$5441.96.

108. In 15 years after 1990, the average cost of a one-year stay in nursing home will be $29,930(1.05)^{15}$ or \$62,222.

109. $29,930(1.08)^{15} - 62,222 = 32,721$
Using the formula in this exercise, a one-year stay costs \$32,721 more.

110. $5(5(5 \cdot 3 + 6) + 4) + 7$
$= 5(5(21) + 4) + 7$
$= 5(105 + 4) + 7$
$= 5 \cdot 109 + 7$
$= 552$

$3 \cdot 5^3 + 6 \cdot 5^2 + 4 \cdot 5 + 7$
$= 375 + 150 + 20 + 7$
$= 552$

These expressions are the same, because you can factor the second to make it appear the same as the first:

$3 \cdot 5^3 + 6 \cdot 5^2 + 4 \cdot 5 + 7$
$= 5(3 \cdot 5^2 + 6 \cdot 5 + 4) + 7$
$= 5(5(3 \cdot 5 + 6) + 4) + 7$

1.5 WARM-UPS

1. True, because of the commutative properties.

2. False, since $8 \div (4 \div 2) = 4$ and $(8 \div 4) \div 2 = 2$.

3. False, since $10 \div 2 = 5$ and $2 \div 10 = 0.2$.

4. False, since $5 - 3 = 2$ and $3 - 5 = -2$.

5. False, since $10 - (7 - 3) = 6$ and $(10 - 7) - 3 = 0$.

6. False, since $4(6 \div 2) = 12$ and $(4 \cdot 6) \div (4 \cdot 2) = 3$.

7. True, since $(0.02)(50) = 1$.

8. True, because of Warm-up number 2.

9. False, because if $x = 0$ we get $3 = 0$.

10. True, because $\dfrac{1 \text{ car}}{0.04 \text{ hours}} = \dfrac{25 \text{ cars}}{1 \text{ hour}}$.

1.5 EXERCISES

1. The commutative property of addition says that $a + b = b + a$ and the commutative property of multiplication says that $a \cdot b = b \cdot a$.

2. The associative property of addition says that $(a + b) + c = a + (b + c)$.

3. The commutative property of addition says that you get the same result when you add two numbers in either order. The associative property of addition has to do with which two numbers are added first when adding three numbers.

4. The distributive property says that $a(b + c) = ab + ac$.

5. Zero is the additive identity because adding zero to a number does not change the number.

6. One is the multiplicative identity because multiplying a number by 1 does not change the number.

7. $9 - 4 + 6 - 10 = 15 - 14 = 1$

8. $-3 + 4 - 12 + 9 = -15 + 13 = -2$

9. $6 - 10 + 5 - 8 - 7 = 11 - 25 = -14$

10. $5 - 11 + 6 - 9 + 12 - 2 = -22 + 23$
$$= 1$$

11. $-4 - 11 + 6 - 8 + 13 - 20 = -43 + 19$
$$= -24$$

12. $-8 + 12 - 9 - 15 + 6 - 22 + 3$
$$= -54 + 21 = -33$$

13. $-3.2 + 1.4 - 2.8 + 4.5 - 1.6$
$$= -7.6 + 5.9 = -1.7$$

14. $4.4 - 5.1 + 3.6 - 2.3 + 8.1$
$$= -7.4 + 16.1 = 8.7$$

15. $3.27 - 11.41 + 5.7 - 12.36 - 5$
$$= 8.97 - 28.77 = -19.8$$

16. $4.89 - 2.1 + 7.58 - 9.06 - 5.34$
$$= 12.47 - 16.5 = -4.03$$

17. $4(x - 6) = 4 \cdot x - 4 \cdot 6 = 4x - 24$

18. $5(a - 1) = 5 \cdot a - 5 \cdot 1 = 5a - 5$

19. $2m + 10 = 2 \cdot m + 2 \cdot 5 = 2(m + 5)$

20. $3y + 9 = 3 \cdot y + 3 \cdot 3 = 3(y + 3)$

21. $a(3 + t) = 3a + at$

22. $b(y + w) = by + bw$

23. $-2(w - 5) = -2w - (-10) = -2w + 10$

24. $-4(m - 7) = -4 \cdot m - (-4)(7)$
$$= -4m + 28$$

25. $-2(3 - y) = -6 - (-2y) = -6 + 2y$

26. $-5(4 - p) = -5 \cdot 4 - (-5)p = -20 + 5p$

27. $5x - 5 = 5 \cdot x - 5 \cdot 1 = 5(x - 1)$

28. $3y + 3 = 3y + 3 \cdot 1 = 3(y + 1)$

29. $-1(-2x - y) = (-1)(-2x) - (-1)y$
$$= 2x + y$$

30. $-1(-4y - w) = -1(-4y) - (-1)w$
$$= 4y + w$$

31. $-3(-2w - 3y) = -3(-2w) - (-3)3y$
$$= 6w + 9y$$

32. $-4(-x - 6) = -4(-x) - (-4)6$
$$= 4x + 24$$

33. $3y - 15 = 3 \cdot y - 3 \cdot 5 = 3(y - 5)$

34. $5x + 10 = 5 \cdot x + 5 \cdot 2 = 5(x + 2)$

35. $3a + 9 = 3 \cdot a + 3 \cdot 3 = 3(a + 3)$

36. $7b - 49 = 7b - 7 \cdot 7 = 7(b - 7)$

37. $\frac{1}{2}(4x + 8) = \frac{4}{2}x + \frac{8}{2} = 2x + 4$

38. $\frac{1}{3}(3x + 6) = \frac{1}{3} \cdot 3x + \frac{1}{3} \cdot 6 = x + 2$

39. $-\frac{1}{2}(2x - 4) = -\frac{2}{2}x + \frac{4}{2} = -x + 2$

40. $-\frac{1}{3}(9x - 3) = -\frac{1}{3} \cdot 9x - \left(-\frac{1}{3}\right)(3)$
$$= -3x + 1$$

41. The reciprocal of $\frac{1}{2}$ is 2 because $2 \cdot \frac{1}{2} = 1$.

42. The multiplicative inverse of $\frac{1}{3}$ is 3, because $3 \cdot \frac{1}{3} = 1$.

43. The reciprocal of 1 is 1 because $1 \cdot 1 = 1$.

44. The reciprocal of -1 is -1 because $-1(-1) = 1$.

45. The reciprocal of 6 is $\frac{1}{6}$, because $6 \cdot \frac{1}{6} = 1$.

46. The reciprocal of 8 is $\frac{1}{8}$, because $8 \cdot \frac{1}{8} = 1$.

47. Since $0.25 = \frac{1}{4}$, its reciprocal is 4.

48. Since $0.75 = \frac{3}{4}$, the reciprocal of 0.75 is $\frac{4}{3}$.

49. Since $-0.7 = -\frac{7}{10}$, its reciprocal is $-\frac{10}{7}$.

50. Since $-0.9 = -\frac{9}{10}$, its reciprocal is $-\frac{10}{9}$.

51. Since $-1.8 = -\frac{18}{10}$ or $-\frac{9}{5}$, the reciprocal of -1.8 is $-\frac{5}{9}$.

52. Since $-2.6 = -\frac{26}{10}$ or $-\frac{13}{5}$ the reciprocal of -2.6 is $-\frac{5}{13}$.

53. $\frac{1}{2.3} + \frac{1}{5.4} \approx 0.6200$

54. $\frac{1}{13.5} - \frac{1}{4.6} \approx -0.1433$

55. $\dfrac{\frac{1}{4.3}}{\frac{1}{5.6} + \frac{1}{7.2}} \approx 0.7326$

56. $\dfrac{\frac{1}{4.5} - \frac{1}{5.6}}{\frac{1}{3.2} + \frac{1}{2.7}} \approx 0.0639$

57. $\dfrac{1 \text{ mile}}{0.0006897 \text{ hours}} \approx 1450$ mph

58. $\dfrac{1 \text{ mile}}{0.000456 \text{ hours}} \approx 2193$ mph

59. $\frac{1}{0.01}$ bt/hr $+ \frac{1}{0.02}$ bt/hr $+ \frac{1}{0.015}$ bt/hr ≈ 217 buttons per hour

60. $\frac{1}{36.5}$ house/hr $+ \frac{1}{30}$ house/hour ≈ 0.06 house per hour

61. Commutative property of addition

62. The commutative property justifies the equation $x \cdot 5 = 5x$.

63. Distributive property

64. The associative property justifies the equation $a(3b) = (a \cdot 3)b$.

65. Associative property of multiplication

66. The distributive property justifies the equation $3(x - 1) = 3x - 3$.

67. Multiplicative inverse property

68. The commutative property of addition justifies the equation $0.3 + 9 = 9 + 0.3$.

69. Commutative property of multiplication

70. The multiplication property of 0 justifies the equation $0 \cdot 52 = 0$.

71. Multiplicative identity

72. The numbers 0.1 and 10 are reciprocals of each other. So the multiplicative inverse property justifies the equation $(0.1)(10) = 1$.

73. Distributive property

74. Zero is the additive identity. The additive identity property justifies the equation $8 + 0 = 8$.

75. Additive inverse property

76. One is the multiplicative identity. So the identity property justifies the equation $1 \cdot y = y$.

77. Multiplication property of zero

78. The distributive property justifies the equation $5x + 5 = 5(x + 1)$.

79. Distributive property

80. The distributive property justifies the equation $ab + 3ac = a(b + 3c)$.

81. $5 + w = w + 5$

82. $2x + 2 = 2 \cdot x + 2 \cdot 1 = 2(x + 1)$

83. $5(xy) = (5x)y$

84. $x + \frac{1}{2} = \frac{1}{2} + x$

85. $\frac{1}{2}x - \frac{1}{2} = \frac{1}{2}x - \frac{1}{2} \cdot 1 = \frac{1}{2}(x - 1)$

86. $3(x - 7) = 3x - 21$

87. $6x + 9 = 3 \cdot 2x + 3 \cdot 3 = 3(2x + 3)$

88. $(x + 7) + 3 = x + (7 + 3)$

89. Since 8 and 0.125 are reciprocals, $8(0.125) = 1$.

90. $-1(a - 3) = -1 \cdot a - (-1)3$
$ = -a + 3$

91. $0 = 5(0)$

92. $8 \cdot (1) = 8$

93. $0.25(4) = 1$

94. $45(1) = 45$

95. Fortunately, the order in which the groceries are placed does not affect the

total bill, because of the commutative and associative properties of addition.

96. Six percent of the total should be the same amount of tax as finding 6% of each item and then adding the results, because of the distributive property. Actually, there might be a slight difference due to rounding.

1.6 WARM-UPS

1. True by the distributive property.
2. False, because $-4x + 8 = -4(x - 2)$.
3. True, because multiplying by -1 is equivalent to finding the opposite.
4. True, by the distributive property.
5. False, $(2x)(5x) = 10x^2$
6. True because of the distributive property.
7. False, $a + a = 2a$.
8. False, $b \cdot b = b^2$.
9. False, because 1 and $7x$ are not like terms.
10. True, because the like terms are combined correctly.

1.6 EXERCISES

1. A term is a single number or a product of a number and one or more variables.
2. Like terms contain the same variables with the same powers.
3. The coefficient of a term is the number preceding the variables.
4. The distributive property is used to combine like terms.
5. You can multiply and divide unlike terms.
6. You can remove parentheses preceded by a negative sign by taking the opposite of every term in the parentheses.
7. $(45 \cdot 2) \cdot 100 = 90 \cdot 100 = 9000$
8. $25(300) = (25 \cdot 3)100 = 75 \cdot 100 = 7500$
9. $\frac{4}{3}(0.75) = \frac{4}{3} \cdot \frac{3}{4} = 1$
10. $5(0.2) = 5 \cdot \frac{2}{10} = 5 \cdot \frac{1}{5} = 1$
11. $427 + (68 + 32) = 427 + 100 = 527$
12. $(194 + 78) + 22 = 194 + (78 + 22)$
$ = 194 + 100 = 294$

13. $47 \cdot 4 + 47 \cdot 6 = 47(4 + 6) = 470$
14. $53 \cdot 3 + 53 \cdot 7 = 53(3 + 7) = 53 \cdot 10$
$ = 530$
15. $19 \cdot 2 \cdot 5 \cdot \frac{1}{5} = 19 \cdot 2 \cdot 1 = 19 \cdot 2 = 38$
16. $17 \cdot 4 \cdot 2 \cdot \frac{1}{4} = 17 \cdot 2 \cdot 4 \cdot \frac{1}{4} = 17 \cdot 2 \cdot 1$
$\phantom{17 \cdot 4 \cdot 2 \cdot \frac{1}{4}} = 34$
17. $120 \cdot 4 \cdot 100 = 480 \cdot 100 = 48{,}000$
18. $150 \cdot 300 = 150 \cdot 3 \cdot 100 = 45{,}000$
19. $13 \cdot 377 \cdot 0 = 0$
20. $(456 \cdot 8)\frac{1}{8} = 456\left(8 \cdot \frac{1}{8}\right) = 456 \cdot 1 = 456$
21. $348 + (5 + 45) = 348 + 50 = 398$
22. $(135 + 38) + 12 = 135 + (38 + 12)$
$ = 135 + 50 = 185$
23. $\frac{2}{3} \cdot 1.5 = \frac{2}{3} \cdot \frac{3}{2} = 1$
24. $(1.25)(0.8) = \frac{5}{4} \cdot \frac{4}{5} = 1$
25. $17 \cdot 101 - 17 \cdot 1 = 17(101 - 1) = 1700$
26. $33 \cdot 2 - 12 \cdot 33 = 33(2 - 12) = -330$
27. $354 + (7 + 3) + (8 + 2)$
$ = 354 + 10 + 10 = 374$
28. $564 + 35 + 65 + 72 + 28$
$ = 564 + 100 + 100$
$ = 764$
29. $(567 + 874)(0) = 0$
30. $(567^2 + 48)[3(-5) + 15]$
$ = (567^2 + 48)[0] = 0$
31. $-4n + 6n = (-4 + 6)n = 2n$
32. $-3a + 15a = 15a - 3a = 12a$
33. $3w - (-4w) = 3w + 4w = 7w$
34. $3b - (-7b) = 3b + 7b = 10b$
35. $4mw^2 - 15mw^2 = (4 - 15)mw^2$
$ = -11mw^2$
36. $2b^2x - 16b^2x = (2 - 16)b^2x = -14b^2x$
37. $-5x - (-2x) = -5x + 2x = -3x$
38. Not like terms: $-11 - 7t$
39. Not like terms: $-4 - 7z$
40. $-19m - (-3m) = -19m + 3m$
$ = -16m$
41. $4t^2 + 5t^2 = (4 + 5)t^2 = 9t^2$
42. Not like terms: $5a + 4a^2$
43. Not like terms: $-4ab + 3a^2b$
44. $-7x^2y + 5x^2y = (-7 + 5)x^2y = -2x^2y$
45. $9mn - mn = (9 - 1)mn = 8mn$
46. $3cm - cm = 3cm - 1cm = 2cm$

47. $x^3y - 3x^3y = 1x^3y - 3x^3y = -2x^3y$

48. $s^4t - 5s^4t = 1s^4t - 5s^4t = -4s^4t$

49. $-kz^6 - kz^6 = -1kz^6 + (-1kz^6)$
$$= -2kz^6$$

50. $m^7w - m^7w = 0$

51. $4(7t) = (4 \cdot 7)t = 28t$

52. $-3(4r) = (-3 \cdot 4)r = -12r$

53. $(-2x)(-5x) = (-2)(-5)x \cdot x = 10x^2$

54. $(-3h)(-7h) = (-3)(-7)h \cdot h = 21h^2$

55. $(-h)(-h) = (-1)(-1)h \cdot h = h^2$

56. $x(-x) = x(-1x) = -1 \cdot x \cdot x = -1x^2$
$$= -x^2$$

57. $7w(-4) = -4 \cdot 7w = -28w$

58. $-5t(-1) = (-5)(-1)t = 5t$

59. $-x(1 - x) = -x \cdot 1 - (-x)(x)$
$$= -x + x^2$$

60. $-p(p - 1) = -p \cdot p - (-p)1 = -p^2 + p$

61. $5k \cdot 5k = 5 \cdot 5 \cdot k \cdot k = 25k^2$

62. $(-4y)(-4y) = (-4)(-4)y \cdot y = 16y^2$

63. $3 \cdot \frac{y}{3} = 3 \cdot \frac{1}{3} \cdot y = 1 \cdot y = y$

64. $5z\left(\frac{z}{5}\right) = 5z \cdot \frac{1}{5}z = 5 \cdot \frac{1}{5} \cdot z \cdot z = z^2$

65. $9 \cdot \frac{2y}{9} = 9 \cdot \frac{1}{9} \cdot 2y = 1 \cdot 2y = 2y$

66. $8\left(\frac{y}{8}\right) = 8 \cdot \frac{1}{8} \cdot y = y$

67. $\frac{6x^3}{2} = \frac{6}{2}x^3 = 3x^3$

68. $\frac{-8x^2}{4} = \frac{-8}{4} \cdot x^2 = -2x^2$

69. $\frac{3x^2y + 15x}{3} = \frac{3x^2y}{3} + \frac{15x}{3} = x^2y + 5x$

70. $\frac{6xy^2 - 8w}{2} = \frac{6xy^2}{2} - \frac{8w}{2} = 3xy^2 - 4w$

71. $\frac{2x - 4}{-2} = \frac{2x}{-2} - \frac{4}{-2} = -x + 2$

72. $\frac{-6x - 9}{-3} = \frac{-6x}{-3} - \frac{9}{-3} = 2x - (-3)$
$$= 2x + 3$$

73. $\frac{-xt + 10}{-2} = \frac{-xt}{-2} + \frac{10}{-2} = \frac{1}{2}xt - 5$

74. $\frac{-2xt^2 + 8}{-4} = \frac{-2xt^2}{-4} + \frac{8}{-4} = \frac{1}{2}xt^2 - 2$

75. $a - (4a - 1) = a - 4a + 1 = -3a + 1$

76. $5x - (2x - 7) = 5x - 2x + 7 = 3x + 7$

77. $6 - (x - 4) = 6 - x + 4 = 10 - x$

78. $9 - (w - 5) = 9 - w + 5 = 14 - w$

79. $4m + 6 - m - 5 = 3m + 1$

80. $5 - 6t - (3t + 4) = 5 - 6t - 3t - 4$
$$= 1 - 9t$$

81. $-5b + at - 7b = -12b + at$

82. $-4x^2 - (-7x^2 + 2y) = -4x^2 + 7x^2 - 2y$
$$= 3x^2 - 2y$$

83. $t^2 - 5w + 2w + t^2 = 2t^2 - 3w$

84. $n^2 - 6m - (-n^2 - 2m)$
$$= n^2 - 6m + n^2 + 2m$$
$$= 2n^2 - 4m$$

85. $x^2 - x^2 + y^2 + z = y^2 + z$

86. $5w - (6w - 3xy - zy)$
$$= 5w - 6w + 3xy + zy$$
$$= 3xy + zy - w$$

87. $(2x + 7x) + (3 + 5) = 9x + 8$

88. $(3x + 4x) + (5 + 12) = 7x + 17$

89. $(-3x + 4) + (5x - 6) = 2x - 2$

90. $(-4x + 11) + (6x - 8) = 2x + 3$

91. $4a^2 - 5c - 6a^2 + 7c = -2a^2 + 2c$

92. $3x^2 - 4 - (x^2 - 5) = 3x^2 - 4 - x^2 + 5$
$$= 2x^2 + 1$$

93. $5t^2 - 15w + 6w + 2t^2 = 7t^2 - 9w$

94. $6(xy^2 + 2) - 5(-xy^2 - 1)$
$$= 6xy^2 + 12 + 5xy^2 + 5$$
$$= 11xy^2 + 17$$

95. $-7m + 3m - 12 + 5m = m - 12$

96. $-6m + 4(m - 3) + 7m$
$$= -6m + 4m - 12 + 7m$$
$$= 5m - 12$$

97. $8 - 7k^3 - 21 - 4 = -7k^3 - 17$

98. $6 + 5(k^3 - 2) - k^3 + 5$
$$= 6 + 5k^3 - 10 - k^3 + 5 = 4k^3 + 1$$

99. $x - 0.04x - 0.04(50) = 0.96x - 2$

100. $x - 0.03(x + 500)$
$$= 1.00x - 0.03x - 15$$
$$= 0.97x - 15$$

101. $0.10x + 0.5 - 0.04x - 2 = 0.06x - 1.5$

102. $0.06x + 0.14(x + 200)$
$$= 0.06x + 0.14x + 28$$
$$= 0.20x + 28 = 0.2x + 28$$

103. $3k + 5 - 6k + 8 - k + 3 = -4k + 16$

104. $5w - 2 + 4(w - 3) - 6(w - 1)$
$$= 5w - 2 + 4w - 12 - 6w + 6$$
$$= 3w - 8$$

105. $5.7 - 4.5x + (4.5)(3.9) - 5.42$
$$= -4.5x + 17.83$$

106. $0.04(5.6x - 4.9) + 0.07(7.3x - 34)$
$$= 0.224x - 0.196 + 0.511x - 2.38$$
$$= 0.735x - 2.576$$

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