CHAPTER 1 Prealgebra Review

Chapter 1 Prep Test

1. $127.1649 \approx 127.16$

2.
$$\begin{array}{r} {\scriptstyle 1\ 1\ \ } \\ 49,147 \\ 596 \\ \hline 49,743 \end{array}$$

3.
$$\begin{array}{r} {\scriptstyle 4\ 9\ 9\ 14} \\ 5\not{0}\not{0}\not{4} \\ -\ 4\ 8\ 7 \\ \hline 4\ 5\ 1\ 7 \end{array}$$

4.
$$\begin{array}{r} 407 \\ \times 28 \\ \hline 3256 \\ 8140 \\ \hline 11,396 \end{array}$$

5.
$$\begin{array}{r} 24 \\ 19\overline{)456} \\ 38 \\ \hline 76 \\ 76 \\ \hline 0 \end{array}$$

6. $8 = 2^3$

$12 = 2^2 \cdot 3$

$LCM(8,12) = 2^3 \cdot 3 = 24$

7. $16 = 2^4$

$20 = 2^2 \cdot 5$

$GCF(16,20) = 2^2 = 4$

8. $21 = 3 \cdot 7$

9. $\frac{4}{10} = \frac{2}{5}$

Section 1.1 Introduction to Integers

1. The statement is **sometimes true**. The absolute value of a number is positive unless the number is zero. The absolute value of zero is zero, which is neither positive nor negative.

2. It is **never true** that the absolute value of a number is negative.

3. The statement is **always true** because the absolute value of a number is either a positive number or zero, both of which are greater than -2.

4. The statement is **sometimes true**. The opposite of a negative number is a positive number.

5. **a.** -12 is a negative integer.

b. 18 is a positive integer.

c. -7 is a negative integer.

d. 0 is neither positive nor negative.

e. $\frac{3}{4}$ is neither a positive integer nor a negative integer.

f. 365 is a positive integer.

6. **a.** 0 < any positive number.

b. 0 > any negative number.

7. The whole numbers include the number zero (0), but the natural numbers do not.

8. The < symbol is used to indicate that one number is less than another number while the $\leq$ symbol is used to indicate that one number is less than or equal to another number.

9. The inequality -5 < -1 is read "negative 5 is less than negative one."

10. The inequality $0 \geq -4$ is read "zero is greater than or equal to negative four."

11. $-2 > -5$ because -2 lies to the right of -5 on the number line.

12. $-6 < -1$ because -6 lies to the left of -1 on the number line.

13. $-16 < 1$ because -16 lies to the left of 1 on the number line.

14. $-2 < 13$ because -2 lies to the left of 13 on the number line.

15. $3 > -7$ because 3 lies to the right of -7 on the number line.

16. $5 > -6$ because 5 lies to the right of -6 on the number line.

17. $0 > -3$ because 0 lies to the right of -3 on the number line.

18. $8 > 0$ because 8 lies to the right of 0 on the number line.

19. $-42 < 27$ because -42 lies to the left of 27 on the number line.

20. $-36 < 49$ because -36 lies to the left of 49 on the number line.

21. $21 > -34$ because 21 lies to the right of -34 on the number line.

22. $53 > -46$ because 53 lies to the right of -46 on the number line.

23. $-27 > -39$ because -27 lies to the right of -39 on the number line.

24. $-51 < -20$ because -51 lies to the left of -20 on the number line.

25. $-131 < 101$ because -131 lies to the left of 101 on the number line.

26. $127 > -150$ because 127 lies to the right of -150 on the number line.

27. If n is to the right of 5 on the number line, then n must be a positive number because all numbers to the right of 5 are positive numbers greater than 5. Only statement ***i*** is true.

28. If n is to the left of 5 on the number line, then n could be a positive number less than 5, a negative number, or zero. Statement ***iv*** is true.

29. Yes, the inequalities do represent the same order relation. The statement $6 \geq 1$ says that 6 lies to the right of 1on the number line. The statement $1 \leq 6$ says that 1 lies to the left of 6 on the number line.

30. The statement $-2 \geq -5$ is equivalent to the statement $-5 \leq -2$ because they represent the same order on the number line.

31. The natural numbers less than 9:
{1, 2, 3, 4, 5, 6, 7, 8}

32. The natural numbers less than or equal to 6: {1, 2, 3, 4, 5, 6}

33. The positive integers less than or equal to 8: {1, 2, 3, 4, 5, 6, 7, 8}

34. The positive integers less than 4: {1, 2, 3}

35. The negative integers greater than -7: {-6, -5, -4, -3, -2, -1}

36. The negative integers greater than or equal to -5: {-5, -4, -3, -2, -1}

37. The only element of A greater than 2 is the element 5.

38. The only the element 15 is greater than 7.

39. The elements of D that are less than -8 are -23 and -18.

40. The elements of C that are less than -10 are -33 and -24.

41. The elements of E that are greater than -10 are 21 and 37.

42. The elements of F that are greater than -15 are -14, 14 and 27.

43. The elements of B that are less than or equal to 0 are -52, -46 and 0.

44. The elements of A that are greater than or equal to 0 are 0, 12 and 34.

45. The elements of C that are greater than or equal to -17 are -17, 0, 4 and 29.

46. The elements of D that are less than or equal to -12 are -31 and -12.

47. The elements of A that are greater than or equal to 5 are 5, 6, 7, 8, and 9.

48. The elements of B that are greater than 6 are 7, 8, 9, 10, 11 and 12.

49. The elements of D that are less than -4 are -10, -9, -8, -7, -6 and -5.

50. The elements of C that are less than or equal to -3 are -7, -6, -5, -4 and -3.

51. The equation $|-5| = 5$ is read "the absolute value of negative five is five."

52. The statement expressed in symbols: $-(-9) = 9$

53. The opposite of 22 is -22.

54. The opposite of 45 is -45.

55. The opposite of -31 is 31.

56. The opposite of -88 is 88.

57. The opposite of -168 is 168.

58. The opposite of -97 is 97.

59. The opposite of 630 is -630.

60. The opposite of 450 is -450.

61. $-(-18) = 18$

62. $-(-30) = 30$

63. $-(49) = -49$

64. $-(67) = -67$

65. $|16| = 16$

66. $|19| = 19$

67. $|-12| = 12$

68. $|-22| = 22$

69. $-|29| = -29$

70. $-|20| = -20$

71. $-|-14| = -14$

72. $-|-18| = -18$

73. $-|0| = 0$

74. $|-30| = 30$

75. $-|34| = -34$

76. $-|-45| = -45$

77. A = {-8, -5, -2, 1, 3}

a. Opposite of each element of A: 8, 5, 2, -1, -3

b. Absolute value of each element: 8, 5, 2, 1, 3

78. B = {-11, -7, -3, 1, 5}

a. Opposite of each element of B: 11, 7, 3, -1, -5

b. Absolute value of each element: 11, 7, 3, 1, 5

79. True. The absolute value of a negative number n is greater than n because the absolute value of a negative number is a positive number and any positive number is greater than any negative number.

80. iv. If n is positive, then "$|n| = n$" is true.

81. $|-83| > |58|$ because $83 > 58$.

82. $|22| > |-19|$ because $22 > 19$.

83. $|43| < |-52|$ because $43 < 52$.

84. $|-71| < |-92|$ because $71 < 92$.

85. $|-68| > |-42|$ because $68 > 42$.

86. $|12| < |-31|$ because $12 < 31$.

87. $|-45| < |-61|$ because $45 < 61$.

88. $|-28| < |43|$ because $28 < 43$.

89. From least to greatest: $-19, -|-8|, |-5|, 6$

90. From least to greatest: $-|-7|, -4, 0, |-15|$

91. From least to greatest: $-22, -(-3), |-14|, |-25|$

92. From least to greatest: $-|-26|, -(5), -(-8), |-17|$

93. a. From the table, a temperature of 5 ° F with a 20 mph wind feels like -15 ° F. A temperature of 10F with a 15 mph wind feels like -7 ° F. So 5 ° F with a 20 mph wind feels colder.

b. From the table, a temperature of -25 ° F with a 10 mph wind feels like -47 ° F. A temperature of -15 ° F with a 20 mph wind feels like -42 ° F. So -25 ° F with a 10 mph wind feels colder.

94. a. From the table, a temperature of 5 ° F with a 25 mph wind feels like -17 ° F. A temperature of 10 ° F with a 10 mph wind feels like -4 ° F. So 10 ° F with a 10 mph wind feels warmer.

b. From the table, a temperature of - 5 ° F with a 10 mph wind feels like -22 ° F. A temperature of -15 ° F with a 5 mph wind feels like -28 ° F. So -5 ° F with a 10 mph wind feels warmer.

95. On the number line, the two points that are four units from 0 are 4 and -4.

96. On the number line, the two points that are six units from 0 are 6 and -6.

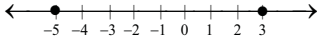
97. On the number line, the two points that are seven units from 4 are 11 and -3.

98. On the number line, the two points that are five units from -3 are 2 and -8.

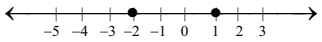
99. If a is a positive number, then $-a$ is a negative number.

100. If a is a negative number, then $-a$ is a positive number.

101. -5 < 3 because -5 is to the left of 3 on the number line. 3 > -5 because 3 is to the right of –5 on the number line.



102. 1 > -2 because 1 is to the right of -2 on the number line. -2 < 1 because -2 is to the left of 1 on the number line.



103. The opposite of the additive inverse of 7 is **7**.

104. The absolute value of the opposite of 8 is **8**.

105. The opposite of the absolute value of 8 is **-8**.

106. The absolute value of the additive inverse of -6 is **6**.

Section 1.2 Operations with Integers

1. It is **sometimes true** that the sum of two integers is larger than either of the integers being added. If two nonnegative integers are added the sum is larger than either addend.

2. It is **sometimes true** that the sum of two nonzero integers with the same sign is positive. The sum of two positive integers is positive.

3. It is **always true** that the quotient of two integers with different signs is negative.

4. It is **always true** that to find the opposite of a number, multiply the number by -1.

5. It is **always true** that if x is an integer and $4x = 0$ then $x = 0$. The only way to get a result of zero when multiplying is if there is a factor of zero.

6. In 2 – (-7) the first "-" is a **minus** and the second "-" is a **negative**.

7. In -6 – 2 the first "-" is a **negative** and the second "-" is a **minus**.

8. In -4 – (-3) the first "-" is a **negative**, the second is **minus**, and the third is a **negative**.

9. To add two numbers with the same sign, add the absolute values of the numbers. The sum will have the sign of the addends.

10. To add two numbers with different signs, find the difference in their absolute values. The answer will have the sign of the addend with the larger absolute value.

11. In the addition equation $8 + (-3) = 5$, the addends are 8 and -3 and the sum is 5.

12. From the diagram: $-2 + 5 = 3$

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

14. $-12 + (-1) = -13$

15. $-4 + (-5) = -9$

16. $-12 + (-12) = -24$

17. $6 + (-9) = -3$

18. $4 + (-9) = -5$

19. $-6 + 7 = 1$

20. $-12 + 6 = -6$

21. $2 + (-3) + (-4) = -1 + (-4) = -5$

22. $7 + (-2) + (-8) = 5 + (-8) = -3$

23. $-3 + (-12) + (-15) = -15 + (-15) = -30$

24. $9 + (-6) + (-16) = 3 + (-16) = -13$

25. $-17 + (-3) + 29 = -20 + 29 = 9$

26. $13 + 62 + (-38) = 75 + (-38) = 37$

27. $-3 + (-8) + 12 = -11 + 12 = 1$

28. $-27 + (-42) + (-18) = -69 + (-18) = -87$

29. $13 + (-22) + 4 + (-5) = -9 + 4 + (-5)$
$= -5 + (-5) = -10$

30. $-14 + (-3) + 7 + (-6) = -17 + 7 + (-6)$
$= -10 + (-6) = -16$

31. The sum $812 + (-537)$ is positive because the positive addend has the larger absolute value.

32. The sum of -57 and -31 is negative because the sum of two negative numbers is negative.

33. The word "minus" refers to the operation of subtraction. The word "negative" refers to the sign of a number.

34. To rewrite a subtraction as an addition, change the operation from subtraction to addition and change the sign of the subtrahend. So $6-(-9)=6+9$.

35. $-10-4=-10+(-4)=-14$

36. $8-(-5)=8+5=13$

37. $16-8=16+(-8)=8$

38. $12-3=12+(-3)=9$

39. $7-14=7+(-14)=-7$

40. $7-(-2)=7+2=9$

41. $3-(-4)=3+4=7$

42. $-6-(-3)=-6+3=-3$

43. $-4-(-2)=-4+2=-2$

44. $6-(-12)=6+12=18$

45. $-12-16=-12+(-16)=-28$

46. $-4-3-2=-4+(-3)+(-2)=-7+(-2)=-9$

47. $4-5-12=4+(-5)+(-12)=-1+(-12)=-13$

48. $12-(-7)-8=12+7+(-8)=11$

49. $-12-(-3)-(-15)=-12+3+15=-9+15=6$

50. $4-12-(-8)=4+(-12)+8=-8+8=0$

51. $13-7-15=13+(-7)+(-15)=6+(-15)=-9$

52. $-6+19-(-31)=-6+19+31=13+31=44$

53. $\begin{aligned}-30-(-65)-29-4&=-30+65+(-29)+(-4)\\&=35+(-29)+(-4)\\&=6+(-4)=2\end{aligned}$

54. $\begin{aligned}42-(-82)-65-7&=42+82+(-65)+(-7)\\&=124+(-65)+(-7)\\&=59+(-7)=52\end{aligned}$

55. The difference $-25-52$ will be negative. Rewriting as an addition problem yields $-25+(-52)$, the sum of two negatives, which is negative.

56. The difference 8 minus -5 is positive. $8-(-5)=8+5$, the sum of two positive numbers, which is positive.

57. **a.** The operation in 8(-7) is multiplication because there is no operation symbol between the 8 and the left parentheses.

b. The operation in 8 – 7 is subtraction because there is a space before and after the minus sign.

c. The operation in 8 – (- 7) is subtraction because there is a space before and after the minus sign.

d. The operation in $-xy$ is multiplication because there is no operation symbol between the x and the y.

e. The operation in $x(- y)$ is multiplication because there is no operation symbol between the x and the parentheses.

f. The operation in $-x - y$ is subtraction because there is a space before and after the minus sign.

58. **a.** The operation in (4)(-6) is multiplication because there is no operation symbol between the sets of parentheses.

b. The operation in 4 – (6) is subtraction because there is a space before and after the minus sign.

c. The operation in 4 – (- 6) is subtraction because there is a space before and after the minus sign.

d. The operation in $-ab$ is multiplication because there is no operation symbol between the a and the b.

e. The operation in $a(- b)$ is multiplication because there is no operation symbol between the x and the parentheses.

f. The operation in $-a - b$ is subtraction because there is a space before and after the minus sign.

59. In the equation (-10)(7)= -70, the factors are -10 and 7 and the product is 70.

60. In the equation 15(-3)= -45, the 15 and -3 are called the factors and -45 is called the product.

61. For the product (-4)(-12), the signs of the factors are the same. The sign of the product is positive. The product is 48.

62. For the product (10)(-10), the signs of the factors are different. The sign of the product is negative. The product is -100.

63. $14 \cdot 3 = 42$

64. $62 \cdot 9 = 558$

65. $5(-4) = -20$

66. $4(-7) = -28$

67. $-8(2) = -16$

68. $-9(3) = -27$

69. $(-5)(-5) = 25$

70. $(-3)(-6) = 18$

71. $(-7)(0) = 0$

72. $-32 \cdot 4 = -128$

73. $-24 \cdot 3 = -72$

74. $19(-7) = -133$

75. $6(-17) = -102$

76. $-8(-26) = 208$

77. $-4(-35) = 140$

78. $-5(23) = -115$

79. $5 \cdot 7(-2) = 35(-2) = -70$

80. $8(-6)(-1) = (-48)(-1) = 48$

81. $(-9)(-9)(2) = 81(2) = 162$

82. $-8(-7)(-4) = 56(-4) = -224$

83. $-5(8)(-3) = (-40)(-3) = 120$

84. $(-6)(5)(7) = -30(7) = -210$

85. $-1(4)(-9) = -4(-9) = 36$

86. $6(-3)(-2) = -18(-2) = 36$

87. The product of three negative integers is negative because an odd number of negative factors yields a negative.

88. The product of four positive numbers and three negative numbers is negative because an odd number of negative factors yields a negative.

89. Using a division symbol $\frac{-15}{3} = -15 \div 3$.

90. As a fraction $8 \div (-4) = \frac{8}{-4}$. The quotient is -2.

91. Division problem: $\frac{-36}{-12} = 3$.

Related multiplication problem: $3(-12) = -36$.

92. Division problem: $\frac{28}{-7} = -4$.

Related multiplication problem: $-4(-7) = 28$.

93. Division problem: $\frac{-55}{11} = -5$.

Related multiplication problem: $-5(11) = -55$.

94. Division problem: $\frac{-20}{-10} = 2$.

Related multiplication problem: $2(-10) = -20$.

95. $12 \div (-6) = -2$

96. $18 \div (-3) = -6$

97. $(-72) \div (-9) = 8$

98. $(-64) \div (-8) = 8$

99. $0 \div (-6) = 0$

100. $-49 \div 0$ *undefined*

101. $45 \div (-5) = -9$

102. $-24 \div 4 = -6$

103. $-36 \div 4 = -9$

104. $-56 \div 7 = -8$

105. $-81 \div (-9) = 9$

106. $-40 \div (-5) = 8$

107. $72 \div (-3) = -24$

108. $44 \div (-4) = -11$

109. $-60 \div 5 = -12$

110. $144 \div 9 = 16$

111. $78 \div (-6) = -13$

112. $84 \div (-7) = -12$

113. $-72 \div 4 = -18$

114. $-80 \div 5 = -16$

115. $-114 \div (-6) = 19$

116. $-128 \div 4 = -32$

117. $-130 \div (-5) = 26$

118. $(-280) \div 8 = -35$

119. The quotient $-\dfrac{520}{-13}$ is positive.

120. **a.** $-61 \div 0$ is undefined because we cannot divide by 0.

b. $0 \div 85 = 0$ because 0 divided by any nonzero number is 0.

c. $-172 \div (-4)$ is positive because the quotient of two numbers with like signs is positive.

d. $-96 \div 4$ is negative because the quotient of two numbers with unlike signs is negative.

121. The word *drop* indicates a decrease in temperature, so at 10:00 P.M. the temperature is (85 – 20) degrees Fahrenheit, choice **ii.**

122. Since the student's average increased from 82 to 84 after the fourth test, the score on the fourth test must have been **higher** than 82.

123. $-6°C + 9°C = 3°C$

124. $-18°C + 7°C = -11°C$

125. $10°C - (-4)°C = 10°C + 4°C = 14°C$
(high temperature – low temperature)

126. $11°C - (-2)°C = 11°C + 2°C = 13°C$
(high temperature – low temperature)

127. $360°C - (-39)°C = 360°C + 39°C = 399°C$
(boiling temperature – freezing temperature)

128. $-62°C - (-71)°C = -62°C + 71°C = 9°C$
(boiling temperature – freezing temperature)

129. $5642 - (-28) = 5642 + 28 = 5670\,meters$
(Mt. Elbrus – Valdez Peninsula)

130. $6960-(-40)=6960+40=7000\,meters$

(Mt. Aconcagua – Caspian Sea)

131. $5895-(-156)=5895+156=6051\,meters$

(Mt. Kilimanjaro – Lake Assal)

132. $6194-(-86)=6194+86=6280\,meters$

(Mt. Denali – Death Valley)

133. $8850-(-411)=8850+411=9261\,meters$

(Mt. Everest – Dead Sea)

134. a. $93°F-(-14)°F=93°F+14°F=107°F$

b. $93°F-(-7)°F=93°F+7°F=100°F$

135. $$average=\frac{sum}{7}$$
$$=\frac{4+(-5)+8+0+(-9)+(-11)+(-8)}{7}$$
$$=\frac{-21}{7}=-3°C$$

136. $$avg=\frac{sum}{7}$$
$$=\frac{(-8)+(-9)+6+7+(-2)+(-14)+(-1)}{7}$$
$$=\frac{-21}{7}=-3°C$$

137. $45°F-(-4)°F=45°F+4°F=49°F$

138. $44°F-(-56)°F=44°F+56°F=100°F$

139. $16°F-(-70)°F=16°F+70°F=86°F$

140. $-12°F-(-48)°F=-12°F+48°F=36°F$

141. Lee Westwood:

$$-5+(-3)+(-4)+(-1)=-8+(-4)+(-1)$$
$$=-12+(-1)=-13$$

Anthony Kim:

$$-4+(-2)+1+(-7)=-6+1+(-7)$$
$$=-5+(-7)=-12$$

K.J. Choi:

$$-5+(-1)+(-2)+(-3)=-6+(-2)+(-3)$$
$$=-8+(-3)=-11$$

142. $|-7+12|=|5|=5$

143. $|13-(-4)|=|13+4|=|17|=17$

144. $|-13-(-2)|=|-13+2|=|-11|=11$

145. $|18-21|=|-3|=3$

146. -23, -27, -31 (subtract 4)

147. -4, -9, -14 (subtract 5)

148. 112, -224, 448 (multiply by -2)

149. -16, 4, -1 (divide by -4)

150. If the number is divisible by 3, that means that the sum of the digits in the number is divisible by 3. Rearranging the digits in any order will still yield a number divisible by 3. The largest number that can be made from those digits is **84,432**.

151. For a number to be divisible by 4, the last two digits must form a number divisible by 4. We can eliminate numbers that do not contain the digits 4, 5, 6 and 3. So our only choices are 4536, 5436, 3456, 4356, 5346, 5364. The largest of those is **5436**.

152. If a number of the form 8_4 is to be divisible by 3, then the sum 8 + _ + 4 must be a multiple of 3. The only possibilities are 804, 834, 864, and 894. There are **four** numbers that fit the criteria.

153. Statement **b** is false because $|3-4| = |-1| = 1$ and $|3| - |4| = 3 - 4 = -1$.

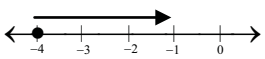
154. Statement **d** is false because $|2-5| = |-3| = 3$ and $|2| - |5| = 2 - 5 = -3$.

155. Statement **a** is true for all real numbers.

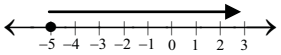
156. Statement **c** is true for all real numbers.

157. If the product $-4x$ is a positive integer, then x must be a negative integer because a product is positive only when the two factors have like signs.

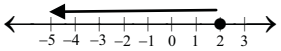
158. No, the difference between two integers is not always smaller than either of the integers. For example, $15-(-10) = 25$.

159. 

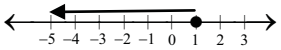
$-4+3=-1$

160. 

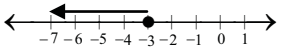
$-5+8=3$

161. 

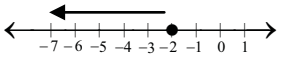
$2+(-7)=-5$

162. 

$1+(-6)=-5$

163. 

$-3+(-4)=-7$

164. 

$-2+(-5)=-7$

165. To model -7 + 4, place 7 red chips and 4 blue chips in a circle. Pair as many red and blue chips as possible. There are 3 red chips remaining, or -3. For -2 + 6, use 2 red chips and 6 blue chips. After pairing, there are 4 blue chips remaining, or +4. For -5 + (-3), use 5 red chips and then 3 more red chips. There are no red/blue pairs, so there are 8 red chips. The solution is -8.

166. Answers will vary. For example, 8 + (-11) = -3 or -6 + 3 = -3. The difference between the absolute values of the addends must be 3. The addend with the larger absolute value must be negative.

167. Answers will vary. For example, -16 – (-8) = -8 or -25 – (-17) = -8. The difference between the absolute values of the numbers being subtracted must be 8.

Section 1.3 Rational Numbers

1. This statement is **never true**. To multiply fractions, simply multiply the numerators together and multiply the denominators together.

2. It is **sometimes true** that a rational number can be written as a terminating decimal.

3. It is **always true** that an irrational number is a real number.

4. It is **always true** that 37%, 0.37, and $\frac{37}{100}$ have the same value.

5. It is **never true** that to write a decimal as a percent, the decimal is multiplied by $\frac{1}{100}$.

6. It is **always true** that -12 is an example of a number that is both an integer and a rational number.

7. To write $\frac{2}{3}$ as a decimal, divide 2 by 3. The quotient is 0.6666…, which is a repeating decimal.

8. A number such as 0.74744744474444…, whose decimal representation neither ends nor repeats, is an example of an irrational number.

9.
$$3\overline{)1.00}\quad 0.33$$
$$-9$$
$$10$$
$$-9$$
$$1$$
$\frac{1}{3} = 0.\overline{3}$

10.
$$3\overline{)2.00}\quad 0.66$$
$$18$$
$$20$$
$$-18$$
$$2$$
$\frac{2}{3} = 0.\overline{6}$

11.
$$4\overline{)1.00}\quad 0.25$$
$$-8$$
$$20$$
$$-20$$
$$0$$
$\frac{1}{4} = 0.25$

12.
$$4\overline{)3.00}\quad 0.75$$
$$28$$
$$20$$
$$-20$$
$$0$$
$\frac{3}{4} = 0.75$

13.
$$5\overline{)2.0}\quad 0.4$$
$$20$$
$$0$$
$\frac{2}{5} = 0.4$

14.
$$5\overline{)4.0}\quad 0.8$$
$$40$$
$$0$$
$\frac{4}{5} = 0.8$

15.
$$6\overline{)1.000}\quad 0.166$$
$$-6$$
$$40$$
$$-36$$
$$40$$
$$-36$$
$$4$$
$\frac{1}{6} = 0.1\overline{6}$

16. $\begin{array}{r} 0.833 \\ 6\overline{)5.000} \\ \underline{4\,8} \\ 20 \\ \underline{18} \\ 20 \\ \underline{-18} \\ 2 \end{array}$ $\frac{5}{6} = 0.8\overline{3}$

17. $\begin{array}{r} 0.125 \\ 8\overline{)1.000} \\ \underline{-8} \\ 20 \\ \underline{-16} \\ 40 \\ \underline{40} \\ 0 \end{array}$ $\frac{1}{8} = 0.125$

18. $\begin{array}{r} 0.875 \\ 8\overline{)7.000} \\ \underline{64} \\ 60 \\ \underline{56} \\ 40 \\ \underline{40} \\ 0 \end{array}$ $\frac{7}{8} = 0.875$

19. $\begin{array}{r} 0.22 \\ 9\overline{)2.00} \\ \underline{1\,8} \\ 20 \\ \underline{18} \\ 2 \end{array}$ $\frac{2}{9} = 0.\overline{2}$

20. $\frac{8}{9} = 0.\overline{8}$ $\begin{array}{r} 0.88 \\ 9\overline{)8.00} \\ \underline{72} \\ 80 \\ \underline{72} \\ 8 \end{array}$

21. $\frac{5}{11} = 0.\overline{45}$ $\begin{array}{r} 0.4545 \\ 11\overline{)5.0000} \\ \underline{44} \\ 60 \\ \underline{55} \\ 50 \\ \underline{44} \\ 6 \end{array}$

22. $\begin{array}{r} 0.909 \\ 11\overline{)10.000} \\ \underline{-99} \\ 100 \\ \underline{-\ 99} \\ 1 \end{array}$ $\frac{10}{11} = 0.\overline{90}$

23. $\begin{array}{r} 0.5833 \\ 12\overline{)7.0000} \\ \underline{60} \\ 100 \\ \underline{-96} \\ 40 \\ \underline{36} \\ 40 \\ \underline{36} \\ 4 \end{array}$ $\frac{7}{12} = 0.58\overline{3}$

24. $\begin{array}{r} 0.9166 \\ 12\overline{)11.0000} \\ \underline{108} \\ 20 \\ \underline{-12} \\ 80 \\ \underline{72} \\ 80 \\ \underline{72} \\ 8 \end{array}$ $\frac{11}{12} = 0.98\overline{6}$

25.
$$\begin{array}{r} 0.266 \\ 15\overline{)\,4.000} \\ \underline{30} \\ 100 \\ \underline{-90} \\ 100 \\ \underline{90} \\ 10 \end{array}$$
$\frac{4}{15} = 0.2\overline{6}$

26.
$$\begin{array}{r} 0.533 \\ 15\overline{)\,8.000} \\ \underline{75} \\ 50 \\ \underline{-45} \\ 50 \\ \underline{45} \\ 5 \end{array}$$
$\frac{8}{15} = 0.5\overline{3}$

27.
$$\begin{array}{r} 0.4375 \\ 16\overline{)\,7.0000} \\ \underline{64} \\ 60 \\ \underline{48} \\ 120 \\ \underline{112} \\ 80 \\ \underline{80} \\ 0 \end{array}$$
$\frac{7}{16} = 0.4375$

28.
$$\begin{array}{r} 0.9375 \\ 16\overline{)\,15.0000} \\ \underline{144} \\ 60 \\ \underline{48} \\ 120 \\ \underline{112} \\ 80 \\ \underline{80} \\ 0 \end{array}$$
$\frac{15}{16} = 0.9375$

29.
$$\begin{array}{r} 0.24 \\ 25\overline{)\,6.00} \\ \underline{50} \\ 100 \\ \underline{100} \\ 0 \end{array}$$
$\frac{6}{25} = 0.24$

30.
$$\begin{array}{r} 0.56 \\ 25\overline{)\,14.00} \\ \underline{125} \\ 150 \\ \underline{150} \\ 0 \end{array}$$
$\frac{14}{25} = 0.56$

31.
$$\begin{array}{r} 0.225 \\ 40\overline{)\,9.000} \\ \underline{80} \\ 100 \\ \underline{80} \\ 200 \\ \underline{200} \\ 0 \end{array}$$
$\frac{9}{40} = 0.225$

32.
$$\begin{array}{r} 0.525 \\ 40\overline{)\,21.000} \\ \underline{200} \\ 100 \\ \underline{80} \\ 200 \\ \underline{200} \\ 0 \end{array}$$
$\frac{21}{40} = 0.525$

33. $\frac{15}{22} = 0.6\overline{81}$

$$
\begin{array}{r}
0.68181 \\
22\overline{)15.00000} \\
\underline{132} \\
180 \\
\underline{176} \\
40 \\
\underline{22} \\
180 \\
\underline{176} \\
40 \\
\underline{22} \\
18
\end{array}
$$

34. The fraction $\frac{\sqrt{2}}{2}$ is an irrational number because an irrational number divided by a rational number is an irrational number.

35. The product of 1.762 and -8.4 will have <u>four</u> decimal places because the factors have a total of four decimal places.

36. The reciprocal of $\frac{4}{9}$ is $\frac{9}{4}$. To find the quotient $-\frac{2}{3} \div \frac{4}{9}$, find the product $-\frac{2}{3} \cdot \frac{9}{4}$. The quotient $-\frac{2}{3} \div \frac{4}{9}$ is $-\frac{3}{2}$.

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

38. $-\frac{2}{9}\left(-\frac{3}{14}\right) = \frac{\overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{3}}}{\underset{1}{\cancel{3}} \cdot 3 \cdot \underset{1}{\cancel{2}} \cdot 7} = \frac{1}{21}$

39. $\left(-\frac{3}{8}\right)\left(-\frac{4}{15}\right) = \frac{\overset{1}{\cancel{3}} \cdot \overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}}}{\underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot 2 \cdot \underset{1}{\cancel{3}} \cdot 5} = \frac{1}{10}$

40. $\frac{5}{8}\left(-\frac{7}{12}\right)\frac{16}{25} = -\frac{\overset{1}{\cancel{5}} \cdot 7 \cdot \overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}}}{\underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot 2 \cdot 3 \cdot \underset{1}{\cancel{5}} \cdot 5} = -\frac{7}{30}$

41. $\left(\frac{1}{2}\right)\left(-\frac{3}{4}\right)\left(-\frac{5}{8}\right) = \frac{15}{64}$

42. $\left(\frac{5}{12}\right)\left(-\frac{8}{15}\right)\left(-\frac{1}{3}\right) = \frac{\overset{1}{\cancel{5}} \cdot \overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}} \cdot 2}{\underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot 3 \cdot 3 \cdot \underset{1}{\cancel{5}} \cdot 3} = \frac{2}{27}$

43. $\frac{3}{8} \div \frac{1}{4} = \frac{3}{8} \cdot \frac{4}{1} = \frac{3 \cdot \overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}}}{\underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot 2} = \frac{3}{2}$

44. $\frac{5}{6} \div \left(-\frac{3}{4}\right) = \frac{5}{6} \cdot \left(-\frac{4}{3}\right) = -\frac{5 \cdot \overset{1}{\cancel{2}} \cdot 2}{\underset{1}{\cancel{2}} \cdot 3 \cdot 3} = -\frac{10}{9}$

45. $-\frac{5}{12} \div \frac{15}{32} = -\frac{5}{12} \cdot \frac{32}{15} = -\frac{\overset{1}{\cancel{5}} \cdot \overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}} \cdot 2 \cdot 2 \cdot 2}{\underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot 3 \cdot 3 \cdot \underset{1}{\cancel{5}}} = -\frac{8}{9}$

46. $\frac{1}{8} \div \left(-\frac{5}{12}\right) = \frac{1}{8} \cdot \left(-\frac{12}{5}\right) = -\frac{1 \cdot \overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}} \cdot 3}{\underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot 2 \cdot 5} = -\frac{3}{10}$

47. $-\frac{4}{9} \div \left(-\frac{2}{3}\right) = -\frac{4}{9} \cdot \left(-\frac{3}{2}\right) = \frac{\overset{1}{\cancel{2}} \cdot 2 \cdot \overset{1}{\cancel{3}}}{\underset{1}{\cancel{3}} \cdot 3 \cdot \underset{1}{\cancel{2}}} = \frac{2}{3}$

48. $-\frac{6}{11} \div \frac{4}{9} = -\frac{6}{11} \cdot \frac{9}{4} = -\frac{\overset{1}{\cancel{2}} \cdot 3 \cdot 3 \cdot 3}{11 \cdot \underset{1}{\cancel{2}} \cdot 2} = -\frac{27}{22}$

49.
$$\begin{array}{r} 3.47 \\ \times 1.2 \\ \hline 694 \\ 3470 \\ \hline 4.164 \end{array}$$
(1.2)(3.47) = 4.164

50.
$$\begin{array}{r} 6.2 \\ \times 0.8 \\ \hline 4.96 \end{array}$$
(-0.8)(6.2) = -4.96

51.
$$\begin{array}{r} 1.89 \\ \times 2.3 \\ \hline 567 \\ 3780 \\ \hline 4.347 \end{array}$$
(-1.89)(-2.3) = 4.347

52.
$$\begin{array}{r} 6.9 \\ \times 4.2 \\ \hline 138 \\ 2760 \\ \hline 28.98 \end{array}$$
(6.9)(-4.2) = -28.98

53.
$$\begin{array}{r} 1.06 \\ \times 3.8 \\ \hline 848 \\ 3180 \\ \hline 4.028 \end{array}$$
(1.06)(-3.8) = -4.028

54.
$$\begin{array}{r} 2.7 \\ \times 3.5 \\ \hline 135 \\ 810 \\ \hline 9.45 \end{array}$$
(-2.7)(-3.5) = 9.45

55. **a.** The product is negative because there are an odd number of negative factors.

b. The quotient is positive because the quotient of two numbers with like signs is positive.

56. $\dfrac{-24.7}{0.09} = \dfrac{-2470}{9} \approx -274.44$

$$\begin{array}{r} 274.444 \\ 9\overline{)2470.000} \\ \underline{18} \\ 67 \\ \underline{63} \\ 40 \\ \underline{36} \\ 40 \\ \underline{36} \\ 40 \\ \underline{36} \\ 4 \end{array}$$

57. $\dfrac{-1.27}{-1.7} = \dfrac{12.7}{17} \approx 0.75$

$$\begin{array}{r} 0.747 \\ 17\overline{)12.70} \\ \underline{119} \\ 80 \\ \underline{68} \\ 120 \\ \underline{119} \\ 1 \end{array}$$

58. $\dfrac{9.07}{-3.5} = \dfrac{90.7}{-35} \approx -2.59$

$$\begin{array}{r} 2.591 \\ 35\overline{)90.700} \\ \underline{70} \\ 207 \\ \underline{175} \\ 320 \\ \underline{315} \\ 50 \\ \underline{35} \\ 5 \end{array}$$

59. $\dfrac{-354.2086}{0.1719} = \dfrac{-3{,}542{,}086}{1719} \approx -2060.55$

$$
\begin{array}{r}
2060.550 \\
1719\overline{)3542086.000} \\
\underline{3438} \\
10408 \\
\underline{10314} \\
9460 \\
\underline{8595} \\
8650 \\
\underline{8595} \\
550
\end{array}
$$

60. The least common multiple of the denominators of the fractions $\frac{5}{8}, -\frac{1}{6}$ and $\frac{2}{9}$ is $\underline{72}$.

$8 = 2^3$

$6 = 2(3)$

$9 = 3^2$

$\text{LCM}(8, 6, 9) = 2^3 \cdot 3^2 = 8 \cdot 9 = 72$

61. $\dfrac{3}{14} = \dfrac{3 \cdot 2}{14 \cdot 2} = \dfrac{6}{28}$

62. $\dfrac{3}{8} + \dfrac{5}{8} = \dfrac{3+5}{8} = \dfrac{8}{8} = 1$

63. $-\dfrac{1}{4} + \dfrac{3}{4} = \dfrac{-1+3}{4} = \dfrac{2}{4} = \dfrac{1}{2}$

64. $\dfrac{7}{8} - \dfrac{3}{8} = \dfrac{7-3}{8} = \dfrac{4}{8} = \dfrac{1}{2}$

65. $-\dfrac{5}{6} - \dfrac{1}{6} = \dfrac{-5-1}{6} = \dfrac{-6}{6} = -1$

66. $-\dfrac{5}{12} - \dfrac{3}{8} = -\dfrac{10}{24} + \left(-\dfrac{9}{24}\right) = -\dfrac{19}{24}$

67. $-\dfrac{5}{6} - \dfrac{5}{9} = -\dfrac{15}{18} + \left(-\dfrac{10}{18}\right) = -\dfrac{25}{18}$

68. $-\dfrac{6}{13} + \dfrac{17}{26} = -\dfrac{12}{26} + \dfrac{17}{26}$

$= \dfrac{-12+17}{26} = \dfrac{5}{26}$

69. $-\dfrac{7}{12} + \dfrac{5}{8} = -\dfrac{14}{24} + \dfrac{15}{24}$

$= \dfrac{-14+15}{24} = \dfrac{1}{24}$

70. $-\dfrac{5}{8} - \left(-\dfrac{11}{12}\right) = -\dfrac{5}{8} + \dfrac{11}{24} = -\dfrac{15}{24} + \dfrac{22}{24}$

$= \dfrac{-15+22}{24} = \dfrac{7}{24}$

71. $\dfrac{1}{3} + \dfrac{5}{6} - \dfrac{2}{9} = \dfrac{6}{18} + \dfrac{15}{18} - \dfrac{4}{18} = \dfrac{6+15-4}{18} = \dfrac{17}{18}$

72. $\dfrac{1}{2} - \dfrac{2}{3} + \dfrac{1}{6} = \dfrac{3}{6} - \dfrac{4}{6} + \dfrac{1}{6} = \dfrac{3-4+1}{6} = \dfrac{0}{6} = 0$

73. $-\dfrac{3}{8} - \dfrac{5}{12} - \dfrac{3}{16} = -\dfrac{18}{48} - \dfrac{20}{48} - \dfrac{9}{48}$

$= \dfrac{-18-20-9}{48} = -\dfrac{47}{48}$

74. $-\dfrac{5}{16} + \dfrac{3}{4} - \dfrac{7}{8} = -\dfrac{5}{16} + \dfrac{12}{16} - \dfrac{14}{16}$

$= \dfrac{-5+12-14}{16} = -\dfrac{7}{16}$

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

76. $\dfrac{3}{4} - \left(-\dfrac{7}{12}\right) - \dfrac{7}{8} = \dfrac{18}{24} + \dfrac{14}{24} - \dfrac{21}{24}$

$= \dfrac{18+14-21}{24} = \dfrac{11}{24}$

77. $\frac{1}{3}-\frac{1}{4}-\frac{1}{5}=\frac{20}{60}-\frac{15}{60}-\frac{12}{60}$

$=\frac{20-15-12}{60}=-\frac{7}{60}$

78. $\frac{2}{3}-\frac{1}{2}+\frac{5}{6}=\frac{4}{6}-\frac{3}{6}+\frac{5}{6}=\frac{4-3+5}{6}=\frac{6}{6}=1$

79. $\frac{5}{16}+\frac{1}{8}-\frac{1}{2}=\frac{5}{16}+\frac{2}{16}-\frac{8}{16}=\frac{5+2-8}{16}=-\frac{1}{16}$

80. $\frac{5}{8}-\left(-\frac{5}{12}\right)+\frac{1}{3}=\frac{15}{24}+\frac{10}{24}+\frac{8}{24}$

$=\frac{15+10+8}{24}=\frac{33}{24}=\frac{11}{8}$

81. $\frac{1}{8}-\frac{11}{12}+\frac{1}{2}=\frac{3}{24}-\frac{22}{24}+\frac{12}{24}$

$=\frac{3-22+12}{24}=-\frac{7}{24}$

82. $-\frac{7}{9}+\frac{14}{15}+\frac{8}{21}=-\frac{245}{315}+\frac{294}{315}+\frac{120}{315}$

$=\frac{-245+294+120}{315}=\frac{169}{315}$

83.
$$\begin{array}{r} 1.09 \\ +6.20 \\ \hline 7.29 \end{array}$$

84.
$$\begin{array}{r} 32.1 \\ +6.7 \\ \hline 38.8 \end{array}$$

$-32.1-6.7=-38.8$

85.
$$\begin{array}{r} 8.179 \\ -5.13 \\ \hline 3.049 \end{array}$$

$5.13-8.179=-3.049$

86.
$$\begin{array}{r} 13.092 \\ -6.9 \\ \hline 6.192 \end{array}$$

$-13.092+6.9=-6.192$

87.
$$\begin{array}{r} 3.60 \\ -2.54 \\ \hline 1.06 \end{array}$$

$2.54-3.6=-1.06$

88.
$$\begin{array}{r} 5.43 \\ +7.925 \\ \hline 13.355 \end{array}$$

$5.43+7.925=13.355$

89.
$$\begin{array}{r} 16.92 \\ +6.925 \\ \hline 23.845 \end{array}$$

$-16.92-6.925=-23.845$

90.
$$\begin{array}{r} 8.546 \\ -3.87 \\ \hline 4.676 \end{array}$$

$-3.87+8.546=4.676$

91.
$$\begin{array}{r} 17.6920 \\ -6.9027 \\ \hline 10.7893 \end{array}$$

$6.9027-17.692=-10.7893$

92.
$$\begin{array}{r} 6.72 \\ -2.09 \\ \hline 4.63 \end{array} \qquad 2.09 - 6.72 = -4.63$$

$$\begin{array}{r} 4.63 \\ +5.4 \\ \hline 10.03 \end{array} \qquad -4.63 - 5.4 = -10.03$$

93.
$$\begin{array}{r} 16.4 \\ +3.09 \\ \hline 19.49 \end{array} \qquad 16.4 + 3.09 = 19.49$$

$$\begin{array}{r} 19.49 \\ -7.93 \\ \hline 11.56 \end{array} \qquad 19.49 - 7.93 = 11.56$$

94.
$$\begin{array}{r} 18.39 \\ -4.9 \\ \hline 13.49 \end{array} \qquad -18.38 + 4.9 = -13.49$$

$$\begin{array}{r} 13.49 \\ +23.7 \\ \hline 37.19 \end{array} \qquad -13.49 - 23.7 = -37.19$$

95.
$$\begin{array}{r} 19 \\ +3.72 \\ \hline 22.72 \end{array} \qquad 19 - (-3.72) = 22.72$$

$$\begin{array}{r} 82.75 \\ -22.72 \\ \hline 60.03 \end{array} \qquad 22.72 - 82.75 = -60.03$$

96.
$$\begin{array}{r} 3.07 \\ -2.97 \\ \hline 0.1 \end{array} \qquad -3.07 - (-2.97) = -0.1$$

$$\begin{array}{r} 17.4 \\ +0.1 \\ \hline 17.5 \end{array} \qquad -0.1 - 17.4 = -17.5$$

97.
$$\begin{array}{r} 3.09 \\ +4.6 \\ \hline 7.69 \end{array} \qquad -3.09 - 4.6 = -7.69$$

$$\begin{array}{r} 27.3 \\ +7.69 \\ \hline 34.99 \end{array} \qquad -7.69 - 27.3 = -34.99$$

98. a. Negative, because $\frac{1}{2} > \frac{1}{5}$.

b. Negative, because $|-21.765| > |15.1|$.

c. Positive, because $|0.837| > |-0.24|$.

d. Positive, because $\left|\frac{9}{10}\right| > \left|-\frac{3}{4}\right|$.

99. a. $\frac{7}{8} + \frac{4}{5} \approx 1 + 1 = 2$

b. $\frac{1}{3} + \left(-\frac{1}{2}\right) \approx 0 + 0 = 0$

c. $-0.125 + 1.25 \approx 0 + 1 = 1$

d. $-1.3 + 0.2 \approx -1 + 0 = -1$

100. a. To convert a fraction to a percent, multiply the fraction by 100%.

b. To convert a percent to a fraction, remove the percent sign and divide by 100.

101. a. To convert a decimal to a percent, multiply the decimal by 100%.

b. To convert a percent to a decimal, remove the percent sign and divide by 100.

102. Since $100\% = 100 \times 0.01 = 1$, multiplying a number by 100% is the same as multiplying the number by 1. Multiplying a number by 1 does not change the value of the number.

103. To write 80% as a fraction, remove the percent sign and multiply by $\frac{1}{100}$: $80\% = 80 \cdot \frac{1}{100} = \frac{4}{5}$

104. To write 68% as a fraction, remove the percent sign and multiply by 0.01:
$68\% = 68 \cdot 0.01 = 0.68$

105. To write $\frac{3}{10}$ as a percent, multiply by 100%:
$\frac{3}{10} = \frac{3}{10} \cdot (100\%) = \frac{300}{10}\% = 30\%$

106. To write 1.25 as a percent, multiply by 100%:
$1.25 = 1.25 \cdot 100\% = 125\%$.

107. $75\% = 75\left(\frac{1}{100}\right) = \frac{75}{100} = \frac{3}{4}$
$75\% = 75(0.01) = 0.75$

108. $40\% = 40\left(\frac{1}{100}\right) = \frac{40}{100} = \frac{2}{5}$
$40\% = 40(0.01) = 0.4$

109. $50\% = 50\left(\frac{1}{100}\right) = \frac{50}{100} = \frac{1}{2}$
$50\% = 50(0.01) = 0.5$

110. $10\% = 10\left(\frac{1}{100}\right) = \frac{10}{100} = \frac{1}{10}$
$10\% = 10(0.01) = 0.1$

111. $64\% = 64\left(\frac{1}{100}\right) = \frac{64}{100} = \frac{16}{25}$
$16\% = 16(0.01) = 0.16$

112. $88\% = 88\left(\frac{1}{100}\right) = \frac{88}{100} = \frac{22}{25}$
$88\% = 88(0.01) = 0.88$

113. $175\% = 175\left(\frac{1}{100}\right) = \frac{175}{100} = 1\frac{3}{4}$
$175\% = 175(0.01) = 1.75$

114. $160\% = 160\left(\frac{1}{100}\right) = \frac{160}{100} = 1\frac{3}{5}$
$160\% = 160(0.01) = 1.6$

115. $19\% = 19\left(\frac{1}{100}\right) = \frac{19}{100}$
$19\% = 19(0.01) = 0.19$

116. $87\% = 87\left(\frac{1}{100}\right) = \frac{87}{100}$
$87\% = 87(0.01) = 0.87$

117. $5\% = 5\left(\frac{1}{100}\right) = \frac{5}{100} = \frac{1}{20}$
$5\% = 5(0.01) = 0.05$

118. $2\% = 2\left(\frac{1}{100}\right) = \frac{2}{100} = \frac{1}{50}$
$2\% = 2(0.01) = 0.02$

119. $450\% = 450\left(\frac{1}{100}\right) = \frac{450}{100} = 4\frac{1}{2}$
$450\% = 450(0.01) = 4.5$

120. $380\% = 380\left(\frac{1}{100}\right) = \frac{380}{100} = 3\frac{4}{5}$
$380\% = 380(0.01) = 3.8$

121. $8\% = 8\left(\frac{1}{100}\right) = \frac{8}{100} = \frac{2}{25}$
$8\% = 8(0.01) = 0.08$

122. $4\% = 4\left(\frac{1}{100}\right) = \frac{4}{100} = \frac{1}{25}$
$4\% = 4(0.01) = 0.04$

123. $11\frac{1}{9}\% = \frac{100}{9}\left(\frac{1}{100}\right) = \frac{1}{9}$

124. $37\frac{1}{2}\% = \frac{75}{2}\left(\frac{1}{100}\right) = \frac{3 \cdot \overset{1}{\cancel{25}}}{2 \cdot 4 \cdot \underset{1}{\cancel{25}}} = \frac{3}{8}$

125. $31\frac{1}{4}\% = \frac{125}{4}\left(\frac{1}{100}\right) = \frac{5 \cdot \overset{1}{\cancel{25}}}{4 \cdot 4 \cdot \underset{1}{\cancel{25}}} = \frac{5}{16}$

126. $66\frac{2}{3}\% = \frac{200}{3}\left(\frac{1}{100}\right) = \frac{2 \cdot \overset{1}{\cancel{100}}}{3 \cdot \underset{1}{\cancel{100}}} = \frac{2}{3}$

127. $\frac{1}{2}\% = \frac{1}{2}\left(\frac{1}{100}\right) = \frac{1}{200}$

128. $5\frac{3}{4}\% = \frac{23}{4}\left(\frac{1}{100}\right) = \frac{23}{400}$

129. $6\frac{1}{4}\% = \frac{25}{4}\left(\frac{1}{100}\right) = \frac{\overset{1}{\cancel{25}}}{4 \cdot 4 \cdot \underset{1}{\cancel{25}}} = \frac{1}{16}$

130. $83\frac{1}{3}\% = \frac{250}{3}\left(\frac{1}{100}\right) = \frac{5 \cdot \overset{1}{\cancel{50}}}{3 \cdot 2 \cdot \underset{1}{\cancel{50}}} = \frac{5}{6}$

131. $7.3\% = 7.3(0.01) = 0.073$

132. $9.1\% = 9.1(0.01) = 0.091$

133. $15.8\% = 15.8(0.01) = 0.158$

134. $0.3\% = 0.3(0.01) = 0.003$

135. $9.15\% = 9.15(0.01) = 0.0915$

136. $121.2\% = 121.2(0.01) = 1.212$

137. $18.23\% = 18.23(0.01) = 0.1823$

138. $0.15\% = 0.15(0.01) = 0.0015$

139. $0.15 = 0.15(100\%) = 15\%$

140. $0.37 = 0.37(100\%) = 37\%$

141. $0.05 = 0.05(100\%) = 5\%$

142. $0.02 = 0.02(100\%) = 2\%$

143. $0.175 = 0.175(100\%) = 17.5\%$

144. $0.125 = 0.125(100\%) = 12.5\%$

145. $1.15 = 1.15(100\%) = 115\%$

146. $2.142 = 2.142(100\%) = 214.2\%$

147. $0.008 = 0.008(100\%) = 0.8\%$

148. $0.004 = 0.004(100\%) = 0.4\%$

149. $0.065 = 0.065(100\%) = 6.5\%$

150. $0.083 = 0.083(100\%) = 8.3\%$

151. $\frac{27}{50} = \frac{27}{50}(100\%) = \frac{2700}{50}\% = 54\%$

152. $\frac{83}{100} = \frac{83}{100}(100\%) = \frac{8300}{100}\% = 83\%$

153. $\frac{1}{3} = \frac{1}{3}(100\%) = \frac{100}{3}\% \approx 33.3\%$

154. $\frac{3}{8} = \frac{3}{8}(100\%) = \frac{300}{8}\% = 37.5\%$

155. $\frac{4}{9} = \frac{4}{9}(100\%) = \frac{400}{9}\% \approx 44.4\%$

156. $\frac{9}{20} = \frac{9}{20}(100\%) = \frac{900}{20}\% = 45\%$

157. $2\frac{1}{2} = \frac{5}{2} = \frac{5}{2}(100\%) = \frac{500}{2}\% = 250\%$

158. $1\frac{2}{7} = \frac{9}{7} = \frac{9}{7}(100\%) = \frac{900}{7}\% \approx 128.6\%$

159. $\frac{3}{8} = \frac{3}{8}(100\%) = \frac{300}{8}\% = 37\frac{1}{2}\%$

160. $\frac{3}{16} = \frac{3}{16}(100\%) = \frac{300}{16}\% = 18\frac{3}{4}\%$

161. $\frac{5}{14} = \frac{5}{14}(100\%) = \frac{500}{14}\% = 35\frac{5}{7}\%$

162. $\frac{4}{7} = \frac{4}{7}(100\%) = \frac{400}{7}\% = 57\frac{1}{7}\%$

163. $1\frac{1}{4} = \frac{5}{4} = \frac{5}{4}(100\%) = \frac{500}{4}\% = 125\%$

164. $2\frac{5}{8} = \frac{21}{8} = \frac{21}{8}(100\%) = \frac{2100}{8}\% = 262\frac{1}{2}\%$

165. $1\frac{5}{9} = \frac{14}{9} = \frac{14}{9}(100\%) = \frac{1400}{9}\% = 155\frac{5}{9}\%$

166. $1\frac{13}{16} = \frac{29}{16} = \frac{29}{16}(100\%) = \frac{2900}{16}\% = 181\frac{1}{4}\%$

167. The fraction $\frac{4}{3}$ represents a number greater than 100% because the numerator is greater than the denominator.

168. The decimal 0.055 represents a number greater than 1% because 0.055 is 5.5% when expressed in percent notation.

169. Internet: $40\% = \frac{40}{100} = \frac{2}{5}$

170. Referral: $25\% = \frac{25}{100} = \frac{1}{4}$

171. Newspaper ad: 22% represents less than one-quarter because 25% is one quarter and $22\% < 25\%$.

172. The number -1 is an integer, a negative integer, a rational number, and a real number.

173. The number 28 is a natural number, an integer, a positive integer, a rational number, and a real number.

174. The number $-\frac{9}{34}$ is a rational number and a real number.

175. The number -7.707 is a rational number and a real number.

176. The number $5.2\overline{6}$ is a rational number and a real number.

177. The number $0.171771777...$ is an irrational number and a real number.

178. Average $= \dfrac{sum}{2} = \dfrac{\frac{5}{8}+\frac{3}{4}}{2} = \dfrac{\frac{5}{8}+\frac{6}{8}}{2}$

$= \dfrac{\frac{11}{8}}{2} = \dfrac{11}{8} \div 2$

$= \dfrac{11}{8} \cdot \dfrac{1}{2} = \dfrac{11}{16}$

179. a. $112.1°F - (-87.9°F) = 112.1°F + 87.9°F$

$= 200.0°F$

b. $44.5°C - (-66.6°C) = 44.5°C + 66.6°C$

$= 111.1°C$

180. The deficit was the greatest in the year **2010.**

181. Difference in the deficits in 1980 and 1985:

$-73.830 - (-212.308) = -73.830 + 212.308$

$= \$138.478\, billion$

182. Difference between the surplus in 1960 and the deficit in 1955:

$0.301 - (-2.993) = 0.301 + 2.993$

$= \$3.294\, billion$

183. $\dfrac{-212.308}{-53.242} = 3.987... \approx 4$ times greater

184. $Average\ per\ quarter = \dfrac{-2.842}{4}$

$= -0.7105\ billion$

$= -\$710.5\ million$

185. $-3.2°C - 0.4°C = -3.2°C + (-0.4°C)$

$= -3.6°C$

186. $x + 0.06x =$ **$1.06x$**

187. $x - 0.30x =$ **$0.70x$**

188. a. A **rational number** is a number than can be written as a ratio of integers.

b. An **irrational number** is a nonterminating, nonrepeating decimal.

c. The **real numbers** are the rationals and the irrationals combined.

189. A common denominator allows the fractions to be written as like terms that can then be added or subtracted.

It is not necessary to have a common denominator when multiplying two fractions. Multiplication does not require that we have like objects.

190. $\dfrac{17}{99} = 0.\overline{17}$; $\dfrac{45}{99} = 0.\overline{45}$; $\dfrac{73}{99} = 0.\overline{73}$;

$\dfrac{83}{99} = 0.\overline{83}$; $\dfrac{33}{99} = 0.\overline{33}$, *yes*; $\dfrac{1}{99} = 0.\overline{01}$, *yes*

191.

$\frac{2}{3}$	$-\frac{1}{6}$	0
$-\frac{1}{2}$	$\frac{1}{6}$	$\frac{5}{6}$
$\frac{1}{3}$	$\frac{1}{2}$	$-\frac{1}{3}$

192. Answers will vary.

Possible answers: $a = 2$; $b = 3$; $c = 6$

193. Answers will vary. For example:

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

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

Section 1.4 Exponents and the Order of Operations Agreement

1. nine to the fifth power: 9^5

2. y to the fourth power: y^4

3. seven to the nth power: 7^n

4. $b \cdot b \cdot b \cdot b \cdot b \cdot b \cdot b \cdot b$: b^8

5. False. $(-5)^2 = 25$, $-5^2 = -25$, and $-(5)^2 = -25$.

6. True. The expression 9^4 is in exponential form, where 9 is the base and 4 is the exponent.

7. True. To evaluate an expression means to determine what one number it is equal to.

8. True. The Order of Operations Agreement is used for natural numbers, integers, rational numbers, and real numbers.

9. In the expression $(-5)^2$, -5 is called the base and 2 is called the exponent. To evaluate $(-5)^2$, find the product (-5)(-5) = 25.

10. The exponential expression 4^3 is read "the third power of 4" or "four cubed." To evaluate 4^3, find the product (4)(4)(4) = 64.

11. $6^2 = (6)(6) = 36$

12. $7^4 = (7)(7)(7)(7) = 2401$

13. $-7^2 = -(7)(7) = -49$

14. $-4^3 = -(4)(4)(4) = -64$

15. $(-3)^2 = (-3)(-3) = 9$

16. $(-2)^3 = (-2)(-2)(-2) = -8$

17. $(-3)^4 = (-3)(-3)(-3)(-3) = 81$

18. $(-5)^3 = (-5)(-5)(-5) = -125$

19. $\left(\frac{1}{2}\right)^2 = \frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4}$

20. $\left(-\frac{3}{4}\right)^3 = \left(-\frac{3}{4}\right)\left(-\frac{3}{4}\right)\left(-\frac{3}{4}\right) = -\frac{27}{64}$

21. $(0.3)^2 = (0.3)(0.3) = 0.09$

22. $(1.5)^3 = (1.5)(1.5)(1.5) = 3.375$

23. $(-3)2^2 = (-3)(2)(2) = -12$

24. $(-5)3^4 = (-5)(3)(3)(3)(3) = -405$

25. $2^3 \cdot 3^3 \cdot (-4) = 8 \cdot 27 \cdot (-4) = -864$

26. $4^2 \cdot 3^2 \cdot (-7) = 16 \cdot 9 \cdot (-7) = -1008$

27. $\left(\frac{2}{3}\right)^2 \cdot 3^3 = \frac{4}{\cancel{9}_{1}} \cdot \cancel{27}^{3} = 12$

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

29. $(0.3)^3 \cdot 2^3 = 0.027(8) = 0.216$

30. $(0.5)^2 \cdot 3^3 = (0.25)(27) = 6.75$

31. $\left(\frac{2}{3}\right)^2 \cdot \frac{1}{4} \cdot 3^3 = \frac{\overset{1}{\cancel{4}}}{\underset{1}{\cancel{3}} \cdot \underset{1}{\cancel{3}}} \cdot \frac{1}{\underset{1}{\cancel{4}}} \cdot \frac{\overset{1}{\cancel{3}} \cdot \overset{1}{\cancel{3}} \cdot 3}{1} = \frac{3}{1} = 3$

32. $\left(\frac{3}{4}\right)^2 \cdot (-4) \cdot 2^3$

$= \frac{3 \cdot 3}{\underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}}} \cdot (-2 \cdot \overset{1}{\cancel{2}}) \cdot \overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}}$

$= -18$

33. The fifth power of negative eighteen is **negative** because the product of an odd number of negative factors is negative.

34. The product will be **positive** because 3^2 is positive and -5^3 is negative, which yields a negative. But the "-" at the beginning says to take the opposite of the product. The opposite of the negative product is positive.

35. We need an Order of Operations Agreement to ensure that there is only one way in which an expression can be correctly simplified.

36. Step 1: Perform operations inside grouping symbols.

Step 2: Simplify exponential expressions.

Step 3: Perform multiplications and divisions as they occur from left to right.

Step 4: Perform additions and subtractions as they occur from left to right.

37. $2(3^3) = 2\ (\underline{27}) = \underline{54}$

38. $3 - 5(6 - 8)^2 = 3 - 5(\underline{-2})^2 = 3 - 5(\underline{4})$

$= 3 - \underline{20} = \underline{-17}$

39. $4 - 8 \div 2 = 4 - 4 = 0$

40. $3 \cdot 2^2 - 3 = 3 \cdot 4 - 3 = 12 - 3 = 9$

41. $2(3-4) - (-3)^2 = 2(-1) - (-3)^2$

$= 2(-1) - 9$

$= -2 - 9 = -11$

42. $16 - 32 \div 2^3 = 16 - 32 \div 8 = 16 - 4 = 12$

43. $24 - 18 \div 3 + 2 = 24 - 6 + 2 = 20$

44. $8 - (-3)^2 - (-2) = 8 - 9 - (-2) = 8 - 9 + 2 = 1$

45. $16 + 15 \div (-5) - 2 = 16 + (-3) - 2 = 11$

46. $14 - 2^2 - |4 - 7| = 14 - 2^2 - |-3|$

$= 14 - 4 - 3 = 7$

47. $3 - 2[8 - (3 - 2)] = 3 - 2[8 - 1]$

$= 3 - 2[7] = 3 - 14$

$= -11$

48. $-2^2 + 4[16 \div (3 - 5)] = -2^2 + 4[16 \div (-2)]$

$= -2^2 + 4[-8]$

$= -4 + (-32)$

$= -36$

49. $6 + \frac{16 - 4}{2^2 + 2} - 2 = 6 + \frac{12}{4 + 2} - 2$

$= 6 + \frac{12}{6} - 2$

$= 6 + 2 - 2 = 6$

50. $24 \div \frac{3^2}{8 - 5} - (-5) = 24 \div \frac{9}{3} - (-5)$

$= 24 \div 3 - (-5)$

$= 8 + 5 = 13$

51. $96 \div 2[12 + (6-2)] - 3^3 = 96 \div 2[12+4] - 3^3$
$= 96 \div 2[16] - 3^3$
$= 96 \div 2[16] - 27$
$= 48[16] - 27$
$= 768 - 27 = 741$

52. $4 \cdot [16 - (7-1)] \div 10 = 4 \cdot [16-6] \div 10$
$= 4 \cdot [10] \div 10$
$= 40 \div 10 = 4$

53. $16 \div 2 - 4^2 - (-3)^2 = 16 \div 2 - 16 - 9$
$= 8 - 16 - 9 = -17$

54. $18 \div \left|9 - 2^3\right| + (-3) = 18 \div |9-8| + (-3)$
$= 18 \div 1 + (-3)$
$= 18 + (-3) = 15$

55. $16 - 3(8-3)^2 \div 5 = 16 - 3(5)^2 \div 5$
$= 16 - 3(25) \div 5$
$= 16 - 75 \div 5$
$= 16 - 15 = 1$

56. $4(-8) \div [2(7-3)^2] = 4(-8) \div [2(4)^2]$
$= 4(-8) \div [2(16)]$
$= 4(-8) \div [32]$
$= -32 \div 32 = -1$

57. $\dfrac{(-10)+(-2)}{6^2 - 30} \div |2-4| = \dfrac{-12}{36-30} \div |-2|$
$= \dfrac{-12}{6} \div 2 = -2 \div 2 = -1$

58. $16 - 4 \cdot \dfrac{3^3 - 7}{2^3 + 2} - (-2)^2 = 16 - 4 \cdot \dfrac{27-7}{8+2} - (-2)^2$
$= 16 - 4 \cdot \dfrac{20}{10} - (-2)^2$
$= 16 - 4 \cdot 2 - 4 = 16 - 8 - 4$
$= 4$

59. $0.3(1.7 - 4.8) + (1.2)^2 = 0.3(-3.1) + 1.44$
$= -0.93 + 1.44 = 0.51$

60. $(1.65 - 1.05)^2 \div 0.4 + 0.8 = (0.60)^2 \div 0.4 + 0.8$
$= 0.36 \div 0.4 + 0.8$
$= 0.9 + 0.8 = 1.7$

61. $\dfrac{3}{8} \div \left|\dfrac{5}{6} + \dfrac{2}{3}\right| = \dfrac{3}{8} \div \left|\dfrac{5}{6} + \dfrac{4}{6}\right| = \dfrac{3}{8} \div \left|\dfrac{9}{6}\right|$
$= \dfrac{3}{8} \div \dfrac{9}{6} = \dfrac{3}{8} \cdot \dfrac{6}{9}$
$= \dfrac{\overset{1}{\cancel{3}}}{\underset{1}{\cancel{2} \cdot 2 \cdot 2}} \cdot \dfrac{\overset{1}{\cancel{2}}}{\underset{1}{\cancel{3}}} = \dfrac{1}{4}$

62. $\left(\dfrac{3}{4}\right)^2 - \left(\dfrac{1}{2}\right)^3 \div \dfrac{3}{5} = \dfrac{9}{16} - \dfrac{1}{8} \div \dfrac{3}{5}$
$= \dfrac{9}{16} - \dfrac{1}{8} \cdot \dfrac{5}{3} = \dfrac{9}{16} - \dfrac{5}{24}$
$= \dfrac{27}{48} - \dfrac{10}{48} = \dfrac{17}{48}$

63. Statement **iii** because
$9 - 2^2(1-5) = 9 - 2^2(-4) = 9 - 4(-4)$.

64. Statement **ii** because
$15 + 15 \div 3 - 4^2 = 15 + 5 - 16$.

65. To simplify Exercise 55, first perform the subtraction inside the parentheses. Then simplify the exponential expression. Next multiply and divide from left to right. Finally, subtract.

66. $(0.9)^3 < 1^5$ because $0.729 < 1$.

67. $(-3)^3 > (-2)^5$ because $-27 > -32$.

68. $(-1.1)^2 > (0.9)^2$ because $1.21 > 0.81$.

69. $\dfrac{10^{12}\ operations}{76.4\times10^{9}\ operations\ per\ \text{sec}} \approx 13\ \text{sec}$

70. One million, or 100^3, will be in column A. The cubes of an arithmetic sequence starting at 1 and increasing by 3 will reach 100^3.

71. Answers may vary.

a. possible answer: r = ½

b. possible answer: $r = 0$ or $r = 1$

c. possible answer: $r = 2$ or $r = 4$

72. The two numbers are **25** and **16**.

73. Since $4^2 = 16$, the last digit in 34^{202} will be 6.

74. Since $3^2 = 9$, the last digit in 23^{502} will be 9.

75. Since $7^2 = 49$, the last digit in 27^{622} will be 9.

76. a. $3\cdot(15-2\cdot3)-36\div3=15$

b. $4\cdot2^2-(12+24\div6)-5=-5$

Section 1.5 Concepts from Geometry

1. True. Perpendicular lines form four 90° angles.

2. True. The sum of the measures of two straight angles is 360°.

3. True. Every square is a parallelogram.

4. False. Perimeter is measured in length units.

5. An angle whose measure is 58° is **less than** the measure of a right angle.

6. An angle whose measure is 123° is **less than** the measure of a straight angle.

7. If $\angle A$ and $\angle B$ are complementary angles, then $m\angle A + m\angle B = \underline{90}\,°$.

8. If $\angle C$ and $\angle D$ are supplementary angles, then $m\angle C + m\angle D = \underline{180}\,°$.

9. If $\angle E$ is a right angle, then $m\angle E = \underline{90}\,°$.

10. If $\angle F$ is a straight angle, then $m\angle F = \underline{180}\,°$.

11. At 3 o'clock the measure of the smaller angle between the hands of the analog clock is 90°, which is **less than** 120°.

12. Since it takes the hour hand 12 hours to move through 360°, it travels through **30°** in one hour.

13. Complement of 62° = 90° - 62° = 28°

14. Complement of 13° = 90° - 13° = 77°

15. Supplement of 48° = 180° - 48° = 132°

16. Supplement of 106° = 180° - 106° = 74°

17. Complement of 7° = 90° - 7° = 83°

18. Complement of 76° = 90° - 76° = 14°

19. Supplement of 89° = 180° - 89° = 91°

20. Supplement of 21° = 180° - 21° = 159°

21. $m\angle AOC = m\angle AOB - m\angle COB$
$= 180° - 48° = 132°$

22. $m\angle COB = m\angle AOB - m\angle AOC$
$= 180° - 79° = 101°$

23. $m\angle x = 90° - 39° = 51°$

24. $m\angle x = 90° - 29° = 61°$

25. $m\angle AOB = m\angle AOC + m\angle COB$
$= 32° + 45° = 77°$

26. $m\angle AOB = m\angle AOC + m\angle COB$
$= 86° + 38° = 124°$

27. $m\angle AOC = m\angle AOB - m\angle COB$
$= 138° - 59° = 79°$

28. $m\angle AOC = m\angle AOB - m\angle COB$
$= 154° - 22° = 132°$

29. $m\angle A = 360° - 68° = 292°$

30. $m\angle A = 360° - 211° = 149°$

31. A plane figure that has three sides is called a triangle.

32. The name of a parallelogram in which all angles are the same measure is a rectangle.

33. $perimeter = side\ 1 + side\ 2 = side\ 3$
$= 2.51 + 4.08 + 3.12 = 9.71cm$

34. $perimeter = side\ 1 + side\ 2 = side\ 3$
$= 4\,ft\ 5in + 5\,ft\ 3in + 6\,ft\ 11in$
$= 15\,ft\ 19in = 16\,ft\ 7in$

35. $perimeter = 2 \cdot length + 2 \cdot width$
$= 2(4\,ft\ 8in) + 2(2\,ft\ 5in)$
$= 8\,ft\ 16in + 4\,ft\ 10in$
$= 12\,ft\ 26in = 14\,ft\ 2in$

36. $perimeter = 2 \cdot length + 2 \cdot width$
$= 2(5) + 2(8) = 10 + 16 = 26m$

37. $perimeter = 4 \cdot side = 4(13) = 52in$

38. $perimeter = 4 \cdot side = 4(34) = 136cm$

39. $circumference = 2 \cdot \pi \cdot radius$
$= 2(3.14)21 = 131.88cm$

40. $circumference = 2 \cdot \pi \cdot radius$
$= 2(3.14)3.4 = 21.352m$

41. $radius = \frac{1}{2} \cdot diameter = \frac{1}{2} \cdot 1.2 = 0.6m$
$circumference = 2 \cdot \pi \cdot radius$
$= 2(3.14)0.6 = 3.768m$

42. $circumference = 2 \cdot \pi \cdot radius$
$= 2(3.14)7.5 = 47.1in$

43. *cost for framing = (perimeter in ft)(cost per ft)*
$perimeter = 2 \cdot length + 2 \cdot width$
$= 2 \cdot 5 + 2 \cdot 3 = 16\,feet$
$price = (16\,feet)(\$4.81/\,ft) = \$76.96$

44. *cost of border = (perimeter in feet)(cost per foot)*
$perimeter = 4 \cdot side = 4 \cdot 5 = 20\,ft$
$price = (20\,feet)(\$4.86/\,ft) = \$97.20$

45. *cost of binding = (circumference in ft)(cost / ft)*

$circumference = 2 \cdot \pi \cdot radius$

$= 2 \cdot (3.14) 3 = 18.84\, feet$

$price = (18.84\, feet)(\$1.05 /\ ft) = \$19.78$

46. *cost of system = (circumference in ft)(cost/ ft)*

$circumference = 2 \cdot \pi \cdot radius$

$= 2 \cdot (3.14) 2 = 12.56\, feet$

$price = (12.56\, feet)(\$2.46 /\ ft) = \$30.90$

47. The first square has a perimeter of 8 units, the second has a perimeter of 10 units, the third has a perimeter of 12 units, the next four squares have perimeters of 14, 16, 18, 20 units. The eighth square has a perimeter of 22 units.

48. A square with a side of 1 foot (12 inches) has a perimeter of 48 inches. A rectangle measuring 2 inches by 1 inch has a perimeter of 6 inches. The **square** has the greater perimeter.

49. The formula for the area of a rectangle is Area = length · width.

50. The formula for the area of a parallelogram is Area = base · height.

51. $area = length \cdot width = 4 \cdot 8 = 32\, ft^2$

52. $area = length \cdot width = (3.4)(5.6) = 19.04 cm^2$

53. $area = base \cdot height = 14 \cdot 27 = 378 cm^2$

54. $area = base \cdot height = 7 \cdot 18 = 126\, ft^2$

55. $area = \pi \cdot radius^2 = 3.14(4^2)$

$= 3.14(16) = 50.24 in^2$

56. $area = \pi \cdot radius^2 = 3.14(8.2^2)$

$= 3.14(67.24) = 211.1336 m^2$

57. $area = side^2 = 4.1^2 = 16.81 m^2$

58. $area = side^2 = 5^2 = 25\, yd^2$

59. $area = \frac{1}{2} \cdot base \cdot height = \frac{1}{2} \cdot 7 \cdot 15 = 52.5 cm^2$

60. $area = \frac{1}{2} \cdot base \cdot height = \frac{1}{2} \cdot 8 \cdot 13 = 52 in^2$

61. $area = \pi \cdot radius^2 = 3.14(8.5^2)$

$= 3.14(72.25) = 226.865 in^2$

62. $area = \pi \cdot radius^2 = 3.14(1.8^2)$

$= 3.14(3.24) = 10.1736 m^2$

63. *cost of carpeting = (area of floors in yd^2)(cost/ yd^2)*

$area = 400{,}000\, ft^2 \cdot \left(\frac{1 yd^2}{9\, ft^2} \right)$

$= 44{,}444.4\, yd^2$

$price = (44{,}444.4\, yd^2)(\$36 /\ yd^2)$

$= \$1{,}600{,}000$

64. *water used = (area in ft^2)(0.1 gal/day/ft^2)*

$area\ of\ lawn = 33(42) = 1386 square\ feet$

$water\ used = (1386\, ft^2)(0.1 gal / day /\ ft^2)$

$= 138.6 gal / day$

65. The room is a square with sides measuring 18 feet or 6 yards.

$area = side^2 = 6^2 = 36\, yd^2$

66. *cost = (area in square ft)(cost per square ft)*

$area = \pi \cdot radius^2$

$area = (3.14)15^2 = 706.5 square\ inches$

$price = (706.5 \text{in}^2)\left(\frac{1\, ft^2}{144 in^2}\right)(\$35 / ft^2)$

$price \approx \$172$

67. *cost of window = (area in ft ^{2})(cost per ft^2)*

$area = \pi \cdot radius^2$

$area = (3.14)2^2 = 12.56 square\ feet$

$price = (12.56 square\ feet)(\$48 / square\ foot)$

$price \approx \$603$

68. *cost for walls= (total area in ft^2)(cost per ft^2)*

$area = 2 \cdot 18 \cdot 8 + 2 \cdot 14 \cdot 8 - 125 = 387\, ft^2$

$price = (387\, ft^2)(\$2.56 / ft^2) = \$990.72$

69. $area = length \cdot width = 150 \cdot 70 = 10,500 mi^2$

70. Doubling the length and width of a rectangle will make the area of the resulting rectangle **4 times larger**. If $A = length(width)$ and we replace *length* and *width* with 2*length* and 2*width*, then the product becomes 4*length(width)*.

71. By trial-and-error, we find that the rectangle with perimeter of 20 units with the greatest possible area measures **5 units by 5 units**.

72. The perimeter of the figure is the sum of the circumferences of the semicircles on the ends of the figure and the two straight sides.

$perimeter = 2 \cdot \pi \cdot radius + length + length$

$= (2)(3.14)(20) + 70 + 70 = 265.6m$

The area of this figure is the sum of the areas of the semicircles and the rectangular section in the middle.

$area = 2 \cdot \frac{1}{2} \cdot \pi \cdot radius^2 + (length)(width)$

$= (3.14)(20^2) + (70)(40) = 4056 m^2$

73. $perimeter = sum\ of\ lengths\ of\ sides$

$= 60 + 12 + 42 + 16 + 18 + 28 = 176\, ft$

$area = sum\ of\ areas\ of\ smaller\ rectangles$

$= 60(12) + 18(16) = 1008\, ft^2$

74. The length of outer rectangle is 90m.
The shaded area is four rectangles that each measure 80 m by 5 m.

$shaded\ area = 4(80)(5) = 1600 m^2$

75. The area of the shaded portion is the area of the square minus the sum of the areas of the four triangles in the corners.

$area\ of\ square = side^2$

$= 4^2 = 16\, ft^2$

$area\ of\ corners = 4 \cdot \frac{1}{2} \cdot 2 \cdot 2$

$= 8\ ft^2$

$shaded\ area = 16 - 8 = 8\ ft^2$

76. a. $area = \frac{1}{2} \cdot height(base1 + base2)$

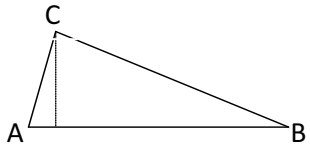
$= \frac{1}{2} \cdot 6(5+8) = 3(13) = 39in^2$

b. $area = \frac{1}{2} \cdot height(base1 + base2)$

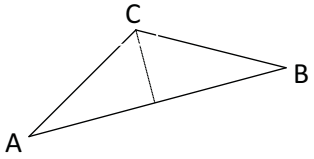
$= \frac{1}{2} \cdot 6(13+16) = 3(29) = 87in^2$

77. Cutting out the triangle and placing it on the other side of the parallelogram does not change the area of the figure. The new figure is a rectangle whose length is *b* and whose width is *h*. The area of the rectangle and of the parallelogram is *bh*.

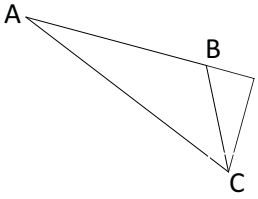
78. a.



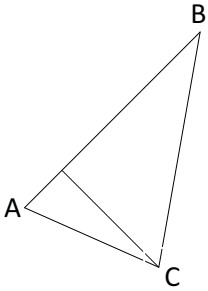
b.



c.



d.



Chapter 1 Review Exercises

1. Natural numbers less than 7: {1, 2, 3, 4, 5, 6}

2. $\frac{5}{8} = 0.625 = 62.5\%$

3. $-|-4| = -4$

4. $16 - (-30) - 42 = 16 + 30 + (-42) = 4$

5. $area = \frac{1}{2} \cdot base \cdot height = \frac{1}{2} \cdot 4 \cdot 9 = 18cm^2$

6. $\frac{7}{9} = 0.777... = 0.\overline{7}$

7. $(6.02)(-0.89) = -5.3578$

8. $\frac{-10+2}{2+(-4)} \div 2 + 6 = \frac{-8}{-2} \div 2 + 6 = 4 \div 2 + 6 = 2 + 6 = 8$

9. The opposite of -4 is **4**.

10. $16 - 30 = 16 + (-30) = -14$

11. $0.672 = 67.2\%$

12. $79\frac{1}{2}\% = \frac{159}{2} \cdot \frac{1}{100} = \frac{159}{200}$

13. $-72 \div 8 = -9$

14. $\frac{17}{20} = 17 \div 20 = 0.85$

15. $\frac{5}{12} \div \left(-\frac{5}{6}\right) = \frac{\overset{1}{\cancel{5}}}{\underset{2}{\cancel{12}}} \cdot \left(-\frac{\overset{1}{\cancel{6}}}{\underset{1}{\cancel{5}}}\right) = -\frac{1}{2}$

16. $3^2 - 4 + 20 \div 5 = 9 - 4 + 20 \div 5 = 9 - 4 + 4 = 9$

17. $m\angle AOB = m\angle AOC - m\angle BOC$
$= 82° - 45° = 37°$

18. -22 + 14 + (-8) = -8 + (-8) = -16

19. $(-5)(-6)(3) = (30)(3) = 90$

20. $6.039 - 12.92 = 6.039 + (-12.92) = -6.881$

21. Elements of A less than or equal to -3: -5 and 3

22. 7% = 0.07

23. $\frac{3}{4}(4)^2 = \frac{3}{4}(16) = 12$

24. -2 > -40 because -2 lies to the right of -40 on the number line.

25. 13 + (-16) = -3

26. Complement of 56° = 90° - 56° = 34°

27. $-\frac{2}{5} + \frac{7}{15} = -\frac{6}{15} + \frac{7}{15} = \frac{1}{15}$

28. $(-3^3) \cdot 2^2 = -27(4) = -108$

29. $2\frac{7}{9} = \frac{25}{9} \cdot 100\% = \frac{2500}{9}\%$
$= 277.777...\% \approx 277.8\%$

30. 240% = 2.4

31. Supplement of 28° = 180° - 28° = 152°

32. $96 \div (-12) = -8$

33. $area = \pi \cdot radius^2 = 3.14(3^2) = 28.26m^2$

34. $2^3 \div 4 - 2(2 - 7) = 2^3 \div 4 - 2(-5)$
$= 8 \div 4 - 2(-5) = 2 + 10 = 12$

35. $|-3| = 3$

36. $1\frac{2}{3} = \frac{5}{3} \cdot 100\% = \frac{500}{3}\% = 166\frac{2}{3}\%$

37. **a.** Opposites: 12, 8, 1, -7

b. Absolute values: 12, 8, 1, 7

38. $\frac{7}{11} = 7 \div 11 = 0.6363... = 0.\overline{63}$

39.
$$\begin{array}{r} 11.53 \\ 23\overline{)265.40} \\ \underline{23} \\ 35 \\ \underline{23} \\ 124 \\ \underline{115} \\ 90 \\ \underline{69} \\ 21 \end{array}$$
so $\frac{0.2654}{-0.023} = \frac{265.4}{-23} \approx -11.5$

40. $(7-2)^2 - 5 - 3 \cdot 4 = 5^2 - 5 - 3 \cdot 4 = 25 - 5 - 12 = 8$

41. -12 + 8 + (-4) = -8

42. $-\frac{5}{8} + \frac{1}{6} = -\frac{15}{24} + \frac{4}{24} = -\frac{11}{24}$

43. Elements of *D* greater than -19: -17, -9, 0, 4

44. 0.002 = 0.2%

45. $-4^2 \cdot \left(\frac{1}{2}\right)^2 = -16 \cdot \left(\frac{1}{4}\right) = -4$

46. -1.329 + 4.89 = 3.561

47. $-|17| = -17$

48. $-5 - 22 - (-13) - 19 - (-6)$
$= -5 + (-22) + 13 + (-19) +$
$= -27$

49. $\left(\frac{1}{\cancel{3}_1}\right)\left(-\frac{\cancel{2}^1 \cdot \cancel{2}^1}{5}\right)\left(\frac{\cancel{3}^1}{\cancel{2}_1 \cdot \cancel{2}_1 \cdot 2}\right) = -\frac{1}{10}$

50. -43 < -34 because -43 is to the left of -34 on the number line.

51. $perimeter = 2 \cdot length + 2 \cdot width$
$= 2(12) + 2(10) = 42in$

52. $(-2)^3 \cdot 4^2 = -8(16) = -128$

53. 0.075 = 7.5%

54. $\frac{19}{35} \cdot 100\% = \frac{1900}{35} = 54\frac{10}{35}\% = 54\frac{2}{7}\%$

55. 14 + (-18) + 6 + (-20) = -18

56. -4(-8)(12)(0) = 0

57. $2^3 - 7 + 16 \div (-3 + 5) = 2^3 - 7 + 16 \div 2$
$= 8 - 7 + 8 = 9$

58. $\frac{3}{4} + \frac{1}{2} - \frac{3}{8} = \frac{6}{8} + \frac{4}{8} - \frac{3}{8} = \frac{7}{8}$

59. $-128 \div (-8) = 16$

60. -57 < 28 because -57 lies to the left of 28 on the number line.

61. $\left(-\frac{1}{3}\right)^3 \cdot 9^2 = -\frac{1}{27} \cdot 81 = -3$

62. $-7 + (-3) + (-12) + 16 = -6$

63. 5(-2)(10)(-3)=300

64. Negative integers greater than -4: {-3, -2, -1}

65. *cost of flower bed = (area in ft²)(cost per ft²)*
$area = length \cdot width = (8)12 = 96 square\ feet$
$price = (96 square\ feet)(\$2.51 / square\ foot)$
$= \$240.96$

66. $-6°C + 14°C = 8°C$

67. $average = \frac{sum}{3} = \frac{-8 + 7 + (-5)}{3} = \frac{-6}{3} = -2°C$

68. $record\ high - record\ low = 63°F - (-45°F)$
$= 63°F + 45°F = 108°F$

69. $-13°C + 7°C = -6°C$

70. $Venus - Pluto = 480°C - (-234°C)$
$= 480°C + 234°C = 714°C$

Chapter Test

1. $55\% = \frac{55}{100} = \frac{11}{20}$

2. Elements of *B* less than -5: -8 and -6

3. $m\angle x = 94° - 47° = 47°$

4. $\frac{3}{20} = 3 \div 20 = 0.15$

5. $\frac{\overset{1}{\cancel{3}}}{\underset{1}{\cancel{2}} \cdot 2}\left(-\frac{\overset{1}{\cancel{2}}}{\underset{1}{\cancel{3}} \cdot 7}\right) = -\frac{1}{14}$ **6.** $-75 \div 5 = -15$

7. $\left(-\frac{2}{3}\right)^3 3^2 = -\frac{2 \cdot 2 \cdot 2}{\underset{1}{\cancel{3}} \cdot \underset{1}{\cancel{3}} \cdot 3} \cdot \overset{1}{\cancel{3}} \cdot \overset{1}{\cancel{3}} = -\frac{8}{3}$

8. -7 + (-3) + 12 = 2

9. Positive integers less than or equal to 6:
{1, 2, 3, 4, 5, 6}

10. $(1.59)100\% = 159\%$

11. $|-29| = 29$

12. -47 > -68 because -47 lies to the right of -68 on the number line.

13. $-\frac{4}{9} - \frac{5}{6} = -\frac{8}{18} + \left(-\frac{15}{18}\right) = -\frac{23}{18}$

14. $area = base \cdot height = 10(9) = 90cm^2$

15. $8 + \frac{12-4}{3^2-1} - 6 = 8 + \frac{8}{8} - 6 = 8 + 1 - 6 = 3$

16. $-\frac{5}{8} \div \left(-\frac{3}{4}\right) = -\frac{5}{\underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot 2} \cdot \left(-\frac{\overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}}}{3}\right) = \frac{5}{6}$

17. $\frac{3}{13} \cdot 100\% = \frac{300}{13}\% \approx 23.1\%$

18. 6.2% = 0.062

19. 13 – (-5) – 4 = 13 + 5 + (-4) = 14

20. $\frac{13}{30} = 0.4333... = 0.4\overline{3}$

21. (-0.9)(2.7) = - 2.43

22. Complement of 28 ° = 90 ° - 28 ° = 62 °

23. $2^2 \cdot (-4)^2 \cdot 10 = 4 \cdot 16 \cdot 10 = 640$

24. $-|-34| = -34$

25. $circumference = \pi \cdot diameter$
$= (3.14)27 = 84.78in$

26. **a.** Opposites: 17, 6, -5, -9
b. Absolute values: 17, 6, 5, 9

27. $\frac{16}{23} \cdot 100\% = \frac{1600}{23}\% = 69\frac{13}{23}\%$

28. $-18.354 + 6.97 = -11.384$

29. $-4(8)(-5) = 160$

30. $9(-4) \div [2(8-5)^2] = 9(-4) \div [2 \cdot 3^2]$
$= 9(-4) \div [2 \cdot 9]$
$= 9(-4) \div 18$
$= -36 \div 18 = -2$

31. $-8°C + 12°C = 4°C$

32. $average = \dfrac{sum}{4} = \dfrac{-61+(-58)+(-49)+(-24)}{4}$

$= \dfrac{-192}{4} = -48°F$

33. *cost of fencing = (perimeter in ft)(cost per* ft^2*)*

$perimeter = 2 \cdot length + 2 \cdot width$

$= 2(150) + 2(200) = 700\ feet$

$price = (700\ feet)(\$6.52 / foot) = \$4564$

CHAPTER 2 Variable Expressions

Chapter 2 Prep Test

1. $-12-(-15)=-12+15=3$

2. $-36\div(-9)=4$

3. $-\frac{3}{4}+\frac{5}{6}=-\frac{3}{4}\cdot\frac{3}{3}+\frac{5}{6}\cdot\frac{2}{2}$

$=-\frac{9}{12}+\frac{10}{12}$

$=\frac{-9+10}{12}=\frac{1}{12}$

4. Reciprocal of $-\frac{9}{4}$: $-\frac{4}{9}$

5. $\left(-\frac{3}{4}\right)\div\left(-\frac{5}{2}\right)=\left(-\frac{3}{\cancel{4}_{2}}\right)\cdot\left(-\frac{\overset{1}{\cancel{2}}}{5}\right)=\frac{3}{10}$

6. $-2^4=-2\cdot2\cdot2\cdot2=-16$

7. $\left(\frac{2}{3}\right)^3=\frac{2}{3}\cdot\frac{2}{3}\cdot\frac{2}{3}=\frac{8}{27}$

8. $3\cdot4^2=3\cdot4\cdot4=3\cdot16=48$

9. $7-2\cdot3=7-6=1$

10. $5-7(3-2^2)=5-7(3-4)$

$=5-7(-1)$

$=5+7$

$=12$

Section 2.1 Evaluating Variable Expressions

1. It is **always true** that $3x^2$ is a variable expression.

2. It is **never true** that the terms of $8y^3 - 4y$ are $8y^3$ and $4y$.

3. It is **sometimes true** that for the expression x^5, the value of x is 1.

4. It is **always true** that the Order of Operations Agreement is used in evaluating a variable expression.

5. It is **always true** that the result of evaluating a variable expression is a single number.

6. To identify the terms of the variable expression $3x^2 - 4x - 7$, first write subtraction as addition of the opposite: $3x^2 + (-4x) + (-7)$. The terms of $3x^2 - 4x - 7$ are $3x^2$, $-4x$, and -7.

7. $mn^2 - m = (-2)(5)^2 - (-2)$ Replace m with -2 and n with 5.

$= (-2)(25) - (-2)$

$= -50 - (-2)$

$= -50 + 2$

$= -48$

8. Terms: $2x^2$, $5x$, $\underline{-8}$

9. Terms: $-3n^2$, $-4n$, $\underline{7}$

10. Terms: $\underline{6}$, $\underline{-a^4}$

11. Variable terms: $9\underline{b^2}$, $-4\underline{ab}$, $\underline{a^2}$

12. Variable terms: $7\underline{x^2y}$, $6\underline{xy^2}$

13. Variable terms: $-8\underline{n}$, $-3\underline{n^2}$

14. Coefficients: 1, -9

15. Coefficients: 12, -8, -1

16. Coefficients: 1, -4, -1

17. The phrase "evaluate a variable expression" means to substitute the given values of the variables into the variable expression and then use the Order of Operations Agreement to simplify the resulting expression.

18. "The value of the variable" is the number that the variable represents. "The value of the variable expression" is the result obtained when the variables in the expression are replaced with numerical values and the resulting numerical expression is simplified.

19. $3a + 2b = 3(2) + 2(3)$
$= 6 + 6 = 12$

20. $a - 2c = 2 - 2(-4)$
$= 2 + 8 = 10$

21. $-a^2 = -(2)^2 = -4$

22. $2c^2 = 2(-4)^2 = 2(16) = 32$

23. $-3a + 4b = -3(2) + 4(3)$
$= -6 + 12 = 6$

24. $3b - 3c = 3(3) - 3(-4)$
$= 9 + 12 = 21$

25. $b^2 - 3 = (3)^2 - 3 = 9 - 3 = 6$

26. $-3c + 4 = -3(-4) + 4$
$= 12 + 4 = 16$

27. $16 \div (2c) = 16 \div [2(-4)]$
$= 16 \div (-8) = -2$

28. $6b \div (-a) = 6(3) \div (-2)$
$= 18 \div (-2) = -9$

29. $bc \div (2a) = (3)(-4) \div [2(2)]$
$= -12 \div 4 = -3$

30. $-2ab \div c = -2(2)(3) \div (-4)$
$= -12 \div (-4) = 3$

31. $a^2 - b^2 = (2)^2 - (3)^2$
$= 4 - 9 = -5$

32. $b^2 - c^2 = (3)^2 - (-4)^2$
$= 9 - 16 = -7$

33. $(a + b)^2 = (2 + 3)^2 = 5^2 = 25$

34. $b^2 - 4ac = (3)^2 - 4(2)(-4)$
$= 9 - 4(2)(-4)$
$= 9 + 32 = 41$

35. $2a - (c + a)^2 = 2(2) - [(-4) + (2)]^2$
$= 2(2) - [-2]^2$
$= 2(2) - 4$
$= 4 - 4 = 0$

36. $(b-a)^2+4c=[(3)-(2)]^2+4(-4)$
$=1^2+4(-4)$
$=1+4(-4)$
$=1-16=-15$

37. $b^2-\dfrac{ac}{8}=(3)^2-\dfrac{(2)(-4)}{8}$
$=(3)^2-\dfrac{-8}{8}$
$=9+1=10$

38. $\dfrac{5ab}{6}-3cb=\dfrac{5(2)(3)}{6}-3(-4)(3)$
$=\dfrac{30}{6}-3(-4)(3)$
$=5+36=41$

39. $(b-2a)^2+bc=[(3)-2(2)]^2+(3)(-4)$
$=[3-4]^2+(3)(-4)$
$=[-1]^2+(3)(-4)$
$=1-12=-11$

40. $\dfrac{b+c}{d}=\dfrac{(4)+(-1)}{3}=\dfrac{3}{3}=1$

41. $\dfrac{d-b}{c}=\dfrac{(3)-(4)}{-1}=\dfrac{-1}{-1}=1$

42. $\dfrac{2d+b}{-a}=\dfrac{2(3)+(4)}{-(-2)}=\dfrac{6+4}{2}=\dfrac{10}{2}=5$

43. $\dfrac{b+2d}{b}=\dfrac{(4)+2(3)}{4}$
$=\dfrac{4+6}{4}=\dfrac{10}{4}$
$=\dfrac{5}{2}$

44. $\dfrac{b-d}{c-a}=\dfrac{(4)-(3)}{(-1)-(-2)}=\dfrac{1}{1}=1$

45. $\dfrac{2c-d}{-ad}=\dfrac{2(-1)-(3)}{-(-2)(3)}$
$=\dfrac{-2-3}{6}=-\dfrac{5}{6}$

46. $(b+d)^2-4a=[(4)+(3)]^2-4(-2)$
$=7^2-4(-2)$
$=49+8=57$

47. $(d-a)^2-3c=[(3)-(-2)]^2-3(-1)$
$=5^2-3(-1)$
$=25+3=28$

48. $(d-a)^2\div 5=[(3)-(-2)]^2\div 5$
$=5^2\div 5=25\div 5=5$

49. $(b-c)^2\div 5=[(4)-(-1)]^2\div 5$
$=5^2\div 5=25\div 5=5$

50. $b^2-2b+4=(4)^2-2(4)+4$
$=16-8+4=12$

51. $a^2-5a-6=(-2)^2-5(-2)-6$
$=4+10-6=8$

52. $\dfrac{bd}{a}\div c=\dfrac{(4)(3)}{-2}\div(-1)$
$=\dfrac{12}{-2}\div(-1)$
$=-6\div(-1)=6$

53. $\dfrac{2ac}{b}\div(-c)=\dfrac{2(-2)(-1)}{(4)}\div[-(-1)]$
$=\dfrac{4}{4}\div 1=1\div 1=1$

54. $2(b+c)-2a=2[(4)+(-1)]-2(-2)$
$=2(3)-2(-2)$
$=6+4=10$

55. $3(b-a)-bc = 3[(4)-(-2)]-(4)(-1)$
$= 3(6)-4(-1)$
$= 18+4 = 22$

56. $\dfrac{b-2a}{bc^2-d} = \dfrac{(4)-2(-2)}{(4)(-1)^2-(3)}$
$= \dfrac{4+4}{4(1)-3} = \dfrac{4+4}{4-3}$
$= \dfrac{8}{1} = 8$

57. $\dfrac{b^2-a}{ad+3c} = \dfrac{(4)^2-(-2)}{(-2)(3)+3(-1)}$
$= \dfrac{16+2}{-6-3} = \dfrac{18}{-9}$
$= -2$

58. $\dfrac{1}{3}d^2 - \dfrac{3}{8}b^2 = \dfrac{1}{3}(3)^2 - \dfrac{3}{8}(4)^2$
$= \dfrac{1}{3}(9) - \dfrac{3}{8}(16)$
$= 3-6 = -3$

59. $\dfrac{5}{8}a^4 - c^2 = \dfrac{5}{8}(-2)^4 - (-1)^2$
$= \dfrac{5}{8}(16) - 1 = 10-1 = 9$

60. $\dfrac{-4bc}{2a-b} = \dfrac{-4(4)(-1)}{2(-2)-(4)}$
$= \dfrac{16}{-4-4}$
$= \dfrac{-16}{-8} = 2$

61. $\dfrac{abc}{b-d} = \dfrac{(-2)(4)(-1)}{(4)-(3)} = \dfrac{8}{1} = 8$

62. $a^3 - 3a^2 + a = (-2)^3 - 3(-2)^2 + (-2)$
$= -8 - 3(4) + (-2)$
$= -8 - 12 - 2$
$= -22$

63. $d^3 - 3d - 9 = (3)^3 - 3(3) - 9$
$= 27 - 3(3) - 9$
$= 27 - 9 - 9 = 9$

64. $3dc - (4c)^2 = 3(3)(-1) - [4(-1)]^2$
$= 3(3)(-1) - (-4)^2$
$= 3(3)(-1) - 16$
$= -9 - 16 = -25$

65. $c^2 - ab = (-0.8)^2 - (2.7)(-1.6)$
$= 0.64 - (2.7)(-1.6)$
$= 0.64 + 4.32$
$= 4.96$

66. $(a+b)^2 - c = [(2.7)+(-1.6)]^2 - (-0.8)$
$= (1.1)^2 + 0.8$
$= 1.21 + 0.8$
$= 2.01$

67. $\dfrac{b^3}{c} - 4a = \dfrac{(-1.6)^3}{(-0.8)} - 4(2.7)$
$= \dfrac{-4.096}{-0.8} - 4(2.7)$
$= 5.12 - 10.8$
$= -5.68$

68. The result will be **negative** because the numerator is negative and the denominator is positive. The ratio of a negative and a positive is negative.

69. **a.** No, V cannot be a whole number because it is the product of a whole number and an irrational number, which is irrational.

b. No, the exact volume cannot be V cm^2 because volume is measured in cubic units.

70. $V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi(8.5)^3$
$= \frac{4}{3}\pi(614.125)$
$\approx 2572.4 cm^3$

71. $V = \pi r^2 h$
$= \pi(1.25)^2(5.25)$
$= \pi(1.5625)(5.25)$
$= 25.8 in^3$

72. $A = 2\pi r^2 + 2\pi rh$
$= 2\pi(3.75)^2 + 2\pi(3.75)(9.5)$
$= 312.2 ft^2$

73. $A = \frac{1}{2}h(b+B)$
$= \frac{1}{2}(6.75)(17.5+10.25)$
$= \frac{1}{2}(6.75)(27.75)$
$= 93.7 cm^2$

74. $V = \frac{1}{3}\pi r^2 h$
$= \frac{1}{3}\pi(0.5)^2(2.75)$
$= 0.7 in^2$

75. $V = \pi r^2 h$
$= \pi(3.5)^2(12.6)$
$\approx 484.9 m^3$

76. $z = a^2 - 2a$
$= (-3)^2 - 2(-3)$
$= 9 + 6 = 15$
$z^2 = 15^2 = 225$

77. $a = 3x^2 - 4x - 5$
$= 3(-2)^2 - 4(-2) - 5$
$= 3(4) - 4(-2) - 5$
$= 12 + 8 - 5 = 15$
$3a - 4 = 3(15) - 4$
$= 45 - 4 = 41$

78. $c = a^2 + b^2 = (2)^2 + (-2)^2 = 4 + 4 = 8$
$c^2 - 4 = 8^2 - 4 = 64 - 4 = 60$

79. $d = 3w^2 - 2v = 3(-1)^2 - 2(3)$
$= 3(1) - 2(3) = 3 - 6 = -3$
$d^2 - 4d = (-3)^2 - 4(-3) = 9 + 12 = 21$

80. $|2a + 3b| = |2(-2) + 3(-3)| = |-4 + (-9)|$
$= |-13| = 13$

81. $|-4ab| = |-4(-2)(-3)| = |-24| = 24$

82. $|5a - b| = |5(-2) - (-3)| = |-10 + 3| = |-7| = 7$

83. $3^x - x^3 = 3^2 - 2^3 = 9 - 8 = 1$

84. $2^y - y^2 = 2^3 - 3^2 = 8 - 9 = -1$.

85. $z^y = (-2)^3 = -8$

86. $z^x = (-2)^2 = 4$

87. $x^x - y^y = 2^2 - 3^3 = 4 - 27 = -23$

88. $y^{(x^2)} = 3^{(2^2)} = 3^4 = 81$

89. **a. 4** is the first natural number for which 3^x is greater than x^3.

b. 5 is the first natural number for which 4^x is greater than x^4.

c. 6 is the first natural number for which 5^x is greater than x^5.

d. 7 is the first natural number for which 6^x is greater than x^6.

Conjecture: $n^x > x^n$ if $x \geq n + 1$

90. Final bill = $T + 100$

91. Recorded grade = $G + 8$

92. Total cost = $34N$

93. Niece's age = $A - 16$

Section 2.2 Simplifying Variable Expressions

1. The only pair of terms that are like terms are in part **iv**. The variable parts are exactly the same.

2. **a.** The additive inverse of $4xy$ is $-4xy$.

b. The additive inverse of $-6b^2$ is $6b^2$.

c. The additive inverse of $-cd$ is cd.

3. The statement is **true** because of the Multiplication Property of One.

4. The statement is **true** because of the Commutative Property of Multiplication.

5. The statement is **false** because of the Inverse Property of Multiplication.

6. The statement is **true** because of the Associative Property of Multiplication.

7. The statement is **false** because like terms must have exactly the same variable parts, not necessarily the same coefficients.

8. The statement is **true**. To add like terms, add the coefficients; the variable part remains unchanged.

9. The fact that two terms can be added in either order is called the Commutative Property of Addition.

10. The fact that three or more factors can be multiplied by grouping them in any order is called the Associative Property of Multiplication.

11. The Inverse Property of Multiplication tells us that the product of a number and its reciprocal (or multiplicative inverse) is one.

12. The Inverse Property of Addition tells us that the sum of a number and its opposite or additive inverse) is zero.

13. Commutative Property of Multiplication:

$2 \cdot 5 = 5 \cdot 2$

14. Commutative Property of Addition:

$9 + 17 = 17 + 9$

15. Associative Property of Multiplication:

$(4 \cdot 5) \cdot 6 = 4 \cdot (5 \cdot 6)$

16. Associative Property of Addition:

$(4 + 5) + 6 = 4 + (5 + 6)$

17. The Distributive Property: $2(4 + 3) = 8 + 6$

18. The Addition Property of Zero: $-7+0=-7$

19. The Inverse Property of Addition: $8+(-8)=0$

20. The Inverse Property of Multiplication:

$\frac{1}{-5}(-5)=1$

21. The Multiplication Property of One: $-4\cdot 1=-4$

22. The Multiplication Property of Zero: $12\cdot 0=0$

23. The Inverse Property of Addition

24. The Inverse Property of Multiplication

25. The Commutative Property of Addition

26. The Addition Property of Zero

27. The Associative Property of Addition

28. The Distributive Property

29. The Commutative Property of Multiplication

30. The Multiplication Property of Zero

31. The Associative Property of Multiplication

32. The Multiplication Property of One

33. *Like terms* are terms that have exactly the same variable parts. The terms $5xy$ and $-3xy$ are like terms. The terms $5xy$ and $3x^2$ are not like terms.

34. The phrase "simplify a variable expression" means to combine the like terms.

35. The terms $3x$ and $5x$ are like terms because they have the same variable parts.

36. The terms $-7a$ and $-4a$ are like terms because they have the same variable parts.

37. $5a-8a=5a+(-8a)$
$=[5+(-8)]a$ (*Distributive*)
$=-3a$

38. $6xy-6x+7xy=6xy+7xy-6x$ (*Commutative*)
$=(6+7)xy-6x$
$=13xy-6x$

39. $6x+8x=(6+8)x=14x$

40. $12x+13x=(12+13)x=25x$

41. $9a-4a=9a+(-4)a=[9+(-4)]a=5a$

42. $12a-3a=12a+(-3a)=[12+(-3)]a=9a$

43. $4y-10y=4y+(-10y)=[4+(-10)]y=-6y$

44. $8y-6y=8y+(-6)y=[8+(-6)]y=2y$

45. $-3b-7$

46. $-12y-3$

47. $-12a+17a=(-12+17)a=5a$

48. $-3a+12a=(-3+12)a=9a$

49. $5ab - 7ab = 5ab + (-7ab) = [5 + (-7)]ab = -2ab$

50. $9ab - 3ab = 9ab + (-3ab) = [9 + (-3)]ab = 6ab$

51. $-12xy + 17xy = (-12 + 17)xy = 5xy$

52. $-15xy + 3xy = (-15 + 3)xy = -12xy$

53. $-3ab + 3ab = (-3 + 3)ab = 0ab = 0$

54. $-7ab + 7ab = (-7 + 7)ab = 0ab = 0$

55. $-\frac{1}{2}x - \frac{1}{3}x = -\frac{1}{2}x + \left(-\frac{1}{3}x\right) = \left[-\frac{1}{2} + \left(-\frac{1}{3}\right)\right]x$
$= \left[-\frac{3}{6} + \left(-\frac{2}{6}\right)\right]x = -\frac{5}{6}x$

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

57. $\frac{3}{8}x^2 - \frac{5}{12}x^2 = \left[\frac{3}{8} + \left(-\frac{5}{12}\right)\right]x^2$
$= \left[\frac{9}{24} + \left(-\frac{10}{24}\right)\right]x^2 = -\frac{1}{24}x^2$

58. $\frac{2}{3}y^2 - \frac{4}{9}y^2 = \left[\frac{2}{3} + \left(-\frac{4}{9}\right)\right]y^2$
$= \left[\frac{6}{9} + \left(-\frac{4}{9}\right)\right]y^2 = \frac{2}{9}y^2$

59. $3x + 5x + 3x = (3 + 5 + 3)x = 11x$

60. $8x + 5x + 7x = (8 + 5 + 7)x = 20x$

61. $5a - 3a + 5a = (5 - 3 + 5)a = 7a$

62. $10a - 17a + 3a = [10 + (-17) + 3]a = -4a$

63. $-5x^2 - 12x^2 + 3x^2 = [-5 + (-12) + 3]x^2 = -14x^2$

64. $-y^2 - 8y^2 + 7y^2 = [-1 + (-8) + 7]y^2 = -2y^2$

65. $7x - 8x + 3y = [7 + (-8)]x + 3y = -x + 3y$

66. $8y - 10x + 8x = 8y + (-10 + 8)x$
$= 8y - 2x = -2x + 8y$

67. $7x - 3y + 10x = 7x + 10x - 3y$
$= (7 + 10)x - 3y = 17x - 3y$

68. $8y + 8x - 8y = 8y - 8y + 8x$
$= (8 - 8)y + 8x = 0y + 8x = 8x$

69. $3a - 7b - 5a + b = 3a - 5a - 7b + b$
$= [3 + (-5)]a + (-7 + 1)b$
$= -2a - 6b$

70. $-5b + 7a - 7b + 12a = 7a + 12a - 5b - 7b$
$= (7 + 12)a + [-5 + (-7)]b$
$= 19a - 12b$

71. $3x - 8y - 10x + 4x = 3x - 10x + 4x - 8y$
$= [3 + (-10) + 4]x - 8y$
$= -3x - 8y$

72. $3y - 12x - 7y + 2y = -12x + [3 + (-7) + 2]y$
$= -12x - 2y$

73. $x^2 - 7x - 5x^2 + 5x = x^2 - 5x^2 - 7x + 5x$
$= [1 + (-5)]x^2 + (-7 + 5)x$
$= -4x^2 - 2x$

74. $3x^2 + 5x - 10x^2 - 10x = 3x^2 - 10x^2 + 5x - 10x$
$= [3 + (-10)]x^2 + [5 + (-10)]x$
$= -7x^2 - 5x$

75. **a.** The coefficient of a^2 will be **negative**.
b. The coefficient of a will be **positive.**
c. The constant term will be **0**.

76. Expressions **iv** and **v** are equivalent to
$-10x$ $-10y$ $-10y - 10x$.

77. $4(-12x) = [4(-12)]x = -48x$
Use the **Associative** Property of Multiplication to group the factors.

78. $\left(\frac{1}{2}a^2\right)\left(-\frac{3}{2}\right) = \left(-\frac{3}{2}\right)\left(\frac{1}{2}a^2\right)$
$= \left(-\frac{3}{2}\cdot\frac{1}{2}\right)a^2 = -\frac{3}{4}a^2$

79. $4(3x) = (4\cdot 3)x = 12x$

80. $12(5x) = (12\cdot 5)x = 60x$

81. $-3(7a) = (-3\cdot 7)a = -21a$

82. $-2(5a) = (-2\cdot 5)a = -10a$

83. $-2(-3)y = [(-2)(-3)]y = 6y$

84. $-5(-6y) = [(-5)(-6)]y = 30y$

85. $(4x)2 = 2(4x) = (2\cdot 4)x = 8x$

86. $(6x)12 = 12(6x) = (12\cdot 6)x = 72x$

87. $(3a)(-2) = (-2)(3a) = (-2\cdot 3)a = -6a$

88. $(7a)(-4) = (-4)(7a) = (-4\cdot 7)a = -28a$

89. $(-3b)(-4) = (-4)(-3b) = [(-4)(-3)]b = 12b$

90. $(-12b)(-9) = (-9)(-12b) = [(-9)(-12)]b = 108b$

91. $-5(3x^2) = (-5\cdot 3)x^2 = -15x^2$

92. $-8(7x^2) = (-8\cdot 7)x^2 = -56x^2$

93. $\frac{1}{3}(3x^2) = \left(\frac{1}{3}\cdot 3\right)x^2 = x^2$

94. $\frac{1}{5}(5a) = \left(\frac{1}{5}\cdot 5\right)a = a$

95. $\frac{1}{8}(8x) = \left(\frac{1}{8}\cdot 8\right)x = x$

96. $-\frac{1}{4}(-4a) = \left[\left(-\frac{1}{4}\right)(-4)\right]a = a$

97. $-\frac{1}{7}(-7n) = \left[\left(-\frac{1}{7}\right)(-7)\right]n = n$

98. $\frac{3x}{4}\cdot\frac{4}{3} = \left(\frac{4}{3}\cdot\frac{3}{4}\right)x = x$

99. $\frac{12x}{5}\cdot\frac{5}{12}=\left(\frac{5}{12}\cdot\frac{12}{5}\right)x=x$

100. $(-6y)\left(-\frac{1}{6}\right)=\left(-\frac{1}{6}\right)(-6y)=\left[\left(-\frac{1}{6}\right)(-6)\right]y=y$

101. $(-10n)\left(-\frac{1}{10}\right)=\left(-\frac{1}{10}\right)(-10n)$
$=\left[\left(-\frac{1}{10}\right)\cdot(-10)\right]n$
$=n$

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

103. $\frac{1}{7}(14x)=\left(\frac{1}{7}\cdot 14\right)x=2x$

104. $-\frac{1}{5}(10x)=\left(-\frac{1}{5}\cdot 10\right)x=-2x$

105. $-\frac{1}{7}(16x)=\left(-\frac{1}{8}\cdot 16\right)x=-2x$

106. $-\frac{2}{3}(12a^2)=\left(-\frac{2}{3}\cdot 12\right)a^2=-8a^2$

107. $-\frac{5}{8}(24a^2)=\left(-\frac{5}{8}\cdot 24\right)a^2=-15a^2$

108. $-\frac{1}{2}(-16y)=\left(-\frac{1}{2}\cdot(-16)\right)y=8y$

109. $-\frac{3}{4}(-8y)=\left[\left(-\frac{3}{4}\right)(-8)\right]y=6y$

110. $(16y)\left(\frac{1}{4}\right)=\left(\frac{1}{4}\right)(16y)=\left(\frac{1}{4}\cdot 16\right)y=4y$

111. $(33y)\left(\frac{1}{11}\right)=\left(\frac{1}{11}\right)(33y)=\left(\frac{1}{11}\cdot 33\right)y=3y$

112. $(-6x)\left(\frac{1}{3}\right)=\left(\frac{1}{3}\right)(-6x)=\left[\frac{1}{3}(-6)\right]x=-2x$

113. $(-10x)\left(\frac{1}{5}\right)=\left(\frac{1}{5}\right)(-10x)=\left[\frac{1}{5}(-10)\right]x=-2x$

114. $(-8a)\left(-\frac{3}{4}\right)=\left(-\frac{3}{4}\right)(-8a)=\left[-\frac{3}{4}(-8)\right]a=6a$

115. After multiplying by a proper fraction, the coefficient will be **less than one** because the product of two fractions that are each less than one will be a number that is also less than one.

116. After multiplying by a non-zero whole number, the coefficient will be **less than zero** because the product of a negative number and a whole number will be negative. All negative numbers are less than zero.

117. $2(4x-3)=(2)(4x)-(2)(3)=8x-6$

118. $5(2x-7)=(5)(2x)-(5)(7)=10x-35$

119. $-2(a+7)=(-2)(a)+(-2)(7)=-2a-14$

120. $-5(a+16)=(-5)(a)+(-5)(16)=-5a-80$

121. $-3(2y-8)=(-3)(2y)-(-3)(8)=-6y+24$

122. $-5(3y-7) = (-5)(3y) - (-5)(7) = -15y + 35$

123. $-(x+2) = (-1)(x) + (-1)(2) = -x - 2$

124. $-(x+7) = (-1)(x) + (-1)(7) = -x - 7$

125. $(5-3b)7 = (5)(7) - (3b)(7) = 35 - 21b$

126. $(10-7b)2 = (10)(2) - (7b)(2) = 20 - 14b$

127. $-3(3-5x) = (-3)(3) - (-3)(5x) = -9 + 15x$

128. $-5(7-10x) = (-5)(7) - (-5)(10x) = -35 + 50x$

129. $3(5x^2+2x) = (3)(5x^2) + (3)(2x) = 15x^2 + 6x$

130. $6(3x^2+2x) = (6)(3x^2) + (6)(2x) = 18x^2 + 12x$

131. $-2(-y+9) = (-2)(-y) + (-2)(9) = 2y - 18$

132. $-5(-2x+7) = (-5)(-2x) + (-5)(7) = 10x - 35$

133. $(-3x-6)5 = (-3x)(5) - (6)(5) = -15x - 30$

134. $(-2x+7)7 = (-2x)(7) + (7)(7) = -14x + 49$

135. $2(-3x^2-14) = (2)(-3x^2) - (2)(14) = -6x^2 - 28$

136. $5(-6x^2-3) = (5)(-6x^2) - (5)(3) = -30x^2 - 15$

137. $-3(2y^2-7) = (-3)(2y^2) - (-3)(7) = -6y^2 + 21$

138. $-8(3y^2-12) = (-8)(3y^2) - (-8)(12)$
$= -24y^2 + 96$

139. $3(x^2+2x-6) = (3)(x^2) + (3)(2x) - (3)(6)$
$= 3x^2 + 6x - 18$

140. $4(x^2-3x+5) = (4)(x^2) - (4)(3x) + (4)(5)$
$= 4x^2 - 12x + 20$

141. $-2(y^2-2y+4) = (-2)(y^2) - (-2)(2y) + (-2)(4)$
$= -2y^2 + 4y - 8$

142. $-3(y^2-3y-7) = (-3)(y^2) - (-3)(3y) - (-3)(7)$
$= -3y^2 + 9y + 21$

143. $2(-a^2-2a+3) = (2)(-a^2) - (2)(2a) + (2)(3)$
$= -2a^2 - 4a + 6$

144. $4(-3a^2-5a+7) = (4)(-3a^2) - (4)(5a) + (4)(7)$
$= -12a^2 - 20a + 28$

145. $-5(-2x^2-3x+7)$
$= (-5)(-2x^2) - (-5)\cdot 3x + (-5)\cdot 7$
$= 10x^2 + 15x - 35$

146. $-3(-4x^2+3x-4)$
$= (-3)(-4x^2) + (-3)(3x) - (-3)(4)$
$= 12x^2 - 9x + 12$

147. $-(3a^2+5a-4)$
$= (-1)(3a^2) + (-1)(5a) - (-1)(4)$
$= -3a^2 - 5a + 4$

148. $-(8b^2-6b+9) = (-1)(8b^2) - (-1)(6b) + (-1)(9)$
$= -8b^2 + 6b - 9$

149. After being multiplied by a negative the constant term will be **positive**. The constant term in the original expression is negative, so multiplying by a negative yields a positive product.

150. When an expression with three terms is multiplied by a constant, the product also has **three** terms.

151. When simplifying $4(3a - 7) + 2(a - 3)$, the first step is to use the Distributive Property to remove parentheses:

$$4(3a - 7) + 2(a - 3) = \underline{12}a - \underline{28} + \underline{2}a - \underline{6}$$

152. When simplifying $12m - (m - 3)$, the first step is to remove parentheses and change the sign of each term inside the parentheses:

$$12m - \underline{m} + \underline{3}$$

153. $4x - 2(3x + 8) = 4x - 6x - 16 = -2x - 16$

154. $6a - (5a + 7) = 6a - 5a - 7 = a - 7$

155. $9 - 3(4y + 6) = 9 - 12y - 18 = -12y - 9$

156. $10 - 2(11x - 3) = 10 - 22x + 6 = -22x + 16$

157. $5n - (7 - 2n) = 5n - 7 + 2n = 7n - 7$

158. $8 - (12 + 4y) = 8 - 12 - 4y = -4y - 4$

159. $3(x + 2) - 5(x - 7) = 3x + 6 - 5x + 35 = -2x + 41$

160. $2(x - 4) - 4(x + 2) = 2x - 8 - 4x - 8 = -2x - 16$

161. $3(a - b) - 4(a + b) = 3a - 3b - 4a - 4b = -a - 7b$

162. $2(a + 2b) - (a - 3b) = 2a + 4b - a + 3b = a + 7b$

163. $4[x - 2(x - 3)] = 4[x - 2x + 6]$
$= 4[-x + 6] = -4x + 24$

164. $2[x + 2(x + 7)] = 2[x + 2x + 14]$
$= 2[3x + 14] = 6x + 28$

165. $-3[2x - (x + 7)] = -3[2x - x - 7]$
$= -3[x - 7]$
$= -3x + 21$

166. $-2[3x - (5x - 2)] = -2[3x - 5x + 2]$
$= -2[-2x + 2]$
$= 4x - 4$

167. $2x - 3[x - 2(4 - x)] = 2x - 3[x - 8 + 2x]$
$= 2x - 3[3x - 8]$
$= 2x - 9x + 24$
$= -7x + 24$

168. $-7x + 3[x - 7(3 - 2x)] = -7x + 3[x - 21 + 14x]$
$= -7x + 3[15x - 21]$
$= -7x + 45x - 63$
$= 38x - 63$

169. $2x + 3(x - 2y) + 5(3x - 7y) = 2x + 3x - 6y + 15x - 35y$
$= 20x - 41y$

170. $5y - 2(y - 3x) + 2(7x - y) = 5y - 2y + 6x + 14x - 2y$
$= 20x + y$

171. $12 - 7(y - 9) = 12 - 7y + 63$

Expression **iii** is equivalent.

172. $7[3b+5(b-6)] = 7[3b+5b-30]$

Expression **ii** is equivalent.

173. A number that has no reciprocal is 0.

174. A number that is its own reciprocal is 1 or -1.

175. The additive inverse of $a - b$ is

$-(a-b) = -a + b$.

176. Answers may vary. One example: opening the car door and getting in the car.

177. a. False. $10 \div 5 \neq 5 \div 10$

b. False. $(10 \div 5) \div 2 \neq 10 \div (5 \div 2)$

c. False. $(9-5)-2 \neq 9-(5-2)$

d. False. $10-5 \neq 5-10$

e. True.

178. a. Yes the operation is commutative.

$$a \otimes b = (a \cdot b) - (a+b) = ab - a - b$$
$$b \otimes a = (b \cdot a) - (b+a) = ba - b - a$$
$$= ab - a - b = a \otimes b$$

b. No the operation is not associative because regrouping leads to a different result.

$$a \otimes b = (a \cdot b) - (a+b) = ab - a - b$$
$$a \cdot (b-a) + b = ab - a^2 + b \neq ab - a - b$$

179. Reading from the addition table, $\Delta + \ddagger = \lozenge$.

180. Reading from the addition table, $\lozenge + \lozenge = \lozenge$.

181. Inspection of the addition table reveals that ◊ is the additive identity element because each sum with ◊ as an addend yields the other addend.

182. The commutative property applies because if the addends are reversed the sums do not change.

183. The sum of opposites is the additive identity element, ◊. Inspection of the table reveals that the sum $\ddagger + \Delta = \lozenge$. So, $-\Delta = \ddagger$.

184. The sum of opposites is the additive identity element, ◊. Inspection of the table reveals that the sum $\Delta + \ddagger = \lozenge$. So, $-\ddagger = \Delta$.

185. From problem #183, we know that $-\Delta = \ddagger$. The sum then becomes $\ddagger + \ddagger - \lozenge$. Moving from left to right: $\Delta - \lozenge$. From the table, $-\lozenge = \lozenge$ and $\Delta + \lozenge = \Delta$.

186. Expressions **i, ii, iv** and **v** are equivalent because the all simplify to be $\mathbf{10x + 4}$.

Section 2.3 Translating Verbal Expressions into Variable Expressions

1. The statement is **false**. The correct translation of "five less than n" is "$n - 5$."

2. The statement is **false.** A variable expression does not contain an equals sign but an equation does.

3. The statement is **false**. If the sum of two numbers is 12 and one of the numbers is x, then the other number is correctly expressed as $12 - x$.

4. The statement is **false.** The word *total* indicates addition, while the word *times* indicated multiplication.

5. The statement is **true.**

6. *Sum* indicates addition and *times* indicated multiplication.

7. *Less than* indicated subtraction and *quotient* indicated division.

8. *Total* indicates addition and *divided by* indicates division.

9. *Subtracted from* indicates subtraction, *product* indicates multiplication, and *cube* indicates an exponent.

10. $19 - d$

11. $6 + c$

12. $r - 12$

13. $w + 55$

14. $28a$

15. $16 + y$

16. $5(n - 7)$

17. $b^2 - 30$

18. $y - 3y$

19. $\frac{4}{5}m + 18$

20. $-6b$

21. $9 + \frac{t}{5}$

22. $\frac{4}{p - 6}$

23. $7(r + 8)$

24. $\frac{x - 9}{2x}$

25. $a(a + 13)$

26. $-4s - 21$

27. $\frac{1}{2}z^2 + 14$

28. $\frac{d + 8}{d}$

29. $9m^3 + m^2$

30. $\frac{3}{8}(t + 15)$

31. $s - \frac{s}{2}$

32. $w + \frac{7}{w}$

33. $c^2 - (c + 14)$

34. $d + (16d - 3)$

35. $8(b + 5)$

36. $\frac{n}{19}$

37. $13 - n$

38. $n + 40$

39. $\frac{3}{7}n$

40. $(n - 90)^2$

41. $\frac{2n}{5}$

42. $15n - 8$

43. $n(n + 10)$

44. $7n + 14$

45. $\frac{3}{4 + n}$

46. $\frac{12}{n + 2}$

47. $n^2 + 3n$

48. $n - (n^3 - 10)$

49. $7n^2 - 4$

50. $80 - 13n$

51. $n^3 - 12n$

52. $25n^2 - 9$ is (**iii**), nine subtracted from the product of 25 and the square of a number.

53. $32 - \frac{a}{7}$ translates into all three of the phrases.

54. The phrase "the total of one-half of a number and three-fourths of the number" can be translated as $\left(\frac{1}{2}\right)n + \left(\frac{3}{4}\right)n$. This expression simplifies to $\frac{5}{4}n$.

55. The phrase "the difference between twelve times a number and fifteen times the number" can be translated as $12n - 15n$. This expression simplifies to $-3n$.

56. $n + (n + 10)$ simplifies to $2n + 10$.

57. $5n + n$ simplifies to $6n$.

58. $n - (9 - n)$ simplifies to $2n - 9$.

59. $(n + 11) + 8$ simplifies to $n + 19$.

60. $n - (n + 14)$ simplifies to -14.

61. $(n + 9) + 4$ simplifies to $n + 13$.

62. $2(3n + 40)$ simplifies to $6n + 80$.

63. $7(5n)$ simplifies to $35n$.

64. $16\left(\frac{1}{4}n\right)$ simplifies to $4n$.

65. $17n + 2n$ simplifies to $19n$.

66. $9n - 2n$ simplifies to $7n$.

67. $n + 12n$ simplifies to $13n$.

68. $(n - 5) + 19$ simplifies to $n + 14$.

69. $3(n^2 + 4)$ simplifies to $3n^2 + 12$.

70. $7n - n$ simplifies to $6n$.

71. $\frac{3}{4}(16n + 4)$ simplifies to $12n + 3$.

72. $14n - 7n$ simplifies to $7n$.

73. $16 - (n + 9)$ simplifies to $-n + 7$.

74. $(8 - n) - 11$ simplifies to $-n - 3$.

75. $6(n + 8)$ simplifies to $6n + 48$.

76. $4(n + 20)$ simplifies to $4n + 80$.

77. $7 - (n + 2)$ simplifies to $-n + 5$.

78. $(n + 10) - 3$ simplifies to $n + 7$.

79. $\frac{1}{3}(n + 6n)$ simplifies to $\frac{7n}{3}$.

80. $2\left(\frac{4n}{8}\right)$ simplifies to n.

81. $(n - 6) + (n + 12)$ simplifies to $2n + 6$.

82. $(3 - 2n) + (n + 4)$ simplifies to $-n + 7$.

83. $(n - 20) + (n + 9)$ simplifies to $2n - 11$.

84. $(7 + n) + 2(n - 2)$ simplifies to $3n + 3$.

85. The sum of two numbers is 25. To express both numbers in terms of the same variable, let x be one number. Then the other number is $\underline{25 - x}$.

86. The length of a rectangle is five times the width. To express the length and width in terms of the same variable, let W be the width. Then the length is $\underline{5W}$.

87. The width of a rectangle is one-half the length. To express the length and width in terms of the same variable, let L be the length. Then the width is $\frac{1}{2}L$.

88. An electrician's bill is \$195 for materials and \$75 an hour for labor. To express the total amount of the bill in terms of the number of hours of labor, let h be the total number of hours of labor. Then the cost of the labor is $\underline{75h}$, so the total amount for the materials and labor is $\underline{195 + 75h}$.

89. Let x be one number; the other number is $18 - x$.

90. Let x be one number; the other number is $20 - x$.

91. Let d be the diameter of Dione; the other diameter is $d + 253$.

92. Let d be the noise level, in decibels, of the car horn; the noise level of the siren is $d + 10$.

93. Let G be the number of genes in the roundworm genome; the genes in the human genome is $G + 11{,}000$.

94. Let T be U2's ticket sales; the Springsteen ticket sales will be $T - 28{,}500{,}000$.

95. Let N be the total number of Americans; then Americans who want to explore Mars is $\frac{3}{4}N$.

96. Let N be the number of bones in your body; then $\frac{1}{4}N$ is the number of bones in the foot.

97. Let s be the number of points awarded for a safety; then the points awarded for a touchdown is $3s$.

98. Let N be the number of U.S. undergraduate students; then $0.46N$ is the number in community colleges.

99. Let B be the attendance at major league Basketball games; then $B + 50{,}000{,}000$ is the attendance at major league baseball games.

100. Let W be the width of the rectangle; then the width is $2W + 5$.

101. Let L be the measure of the largest angle; then the smallest angle is $\frac{1}{2}L - 10$.

102. Let h be the number of overtime hours worked; then the weekly pay is $1172 + 38h$.

103. Let h be the number of hours of labor; then the amount of the bill is $238 + 89h$.

104. Let L be the length of one piece; then the other pieces are L and $12 - L$.

105. Let n be either the number of nickels or the number of dimes; the other is then $35 - n$.

106. Let x be the distance traveled by the slower car; then the distance of the other car is $200 - x$.

107. There are twice as many hydrogen atoms. This is expressed as $2x$.

108. The wire is bent so that there are four equal sized pieces. Each side of the square measures $\frac{1}{4}x$.

109. The distance that the rope moves is $\frac{3}{5}x$.

110. $5x + 8$ is the sum of 8 and 5 times a number. $5(x + 8)$ is 5 times the sum of a number and 8.

111. Variables are used to represent unknown quantities and the value can change according to the context of the problem.

112. "The difference between x and 5" means that 5 is subtracted from x. In "5 less than x", 5 is being subtracted from x. The similarity between the expressions is that they both express subtraction.

113. Answers will vary. Examples include: the sum of p and 8; p increased by 8; the total of p and 8; p more than 8; 8 more than p.

114. Answers will vary. Examples include: 16 less than d; d decreased by 16; the difference between d and 16; 16 subtracted from d.

115. Answers will vary. Examples include: the product of 4 and c; 4 times c; 4 multiplied by c.

116. Answers will vary. Examples include: the quotient of y and 5; y divided by 5; the ratio of y to 5.

117. a. Complete the table.

Figure Number	Number of Tiles
1	5
2	7
3	9
4	11
5	13
6	15
7	17

b. The number of tiles in the nth figure will be $n + n + 3$ or $2n + 3$.

Chapter 2 Review Exercises

1. $-7y^2 + 6y^2 - (-2y^2) = (-7 + 6 + 2)y^2 = y^2$

2. $(12x)\left(\frac{1}{4}\right) = \left(\frac{1}{4}\right)(12x) = \left(\frac{1}{4} \cdot 12\right)x = 3x$

3. $\frac{2}{3}(-15a) = \left[\left(\frac{2}{3}\right)(-15)\right]a = -10a$

4. $-2(2x - 4) = -4x + 8$

5. $5(2x + 4) - 3(x - 6) = 10x + 20 - 3x + 18 = 7x + 38$

6. $a^2 - 3b = (2)^2 - 3(-4) = 4 + 12 = 16$

7. -9 + 9 = 0

8. $-4(-9y) = [(-4)(-9)]y = 36y$

9. $-2(-3y + 9) = 6y - 18$

10. $3[2x - 3(x - 2y)] + 3y = 3[2x - 3x + 6y] + 3y$
$= 3[-x + 6y] + 3y$
$= -3x + 18y + 3y$
$= -3x + 21y$

11. $-4(2x^2 - 3y^2) = -8x^2 + 12y^2$

12. $3x - 5x + 7x = (3 - 5 + 7)x = 5x$

13. $b^2 - 3ab = (-2)^2 - 3(3)(-2) = 4 + 18 = 22$

14. $\frac{1}{5}(10x) = \left(\frac{1}{5} \cdot 10\right)x = 2x$

15. $5(3-7b)=15-35b$

16. $2x+3[4-(3x-7)]=2x+3[4-3x+7]$
$=2x+3[11-3x]$
$=2x+33-9x$
$=-7x+33$

17. The Commutative Property of Multiplication

18. $3(8-2x)=24-6x$

19. $-2x^2-(-3x^2)+4x^2=(-2+3+4)x^2=5x^2$

20. $-3x-2(2x-7)=-3x-4x+14=-7x+14$

21. $-3(3y^2-3y-7)=-9y^2+9y+21$

22. $-2[x-2(x-y)]+5y=-2[x-2x+2y]+5y$
$=-2[-x+2y]+5y$
$=2x-4y+5y$
$=2x+y$

23. $\dfrac{-2ab}{2b-a}=\dfrac{-2(-4)(6)}{2(6)-(-4)}=\dfrac{48}{16}=3$

24. $(-3)(-12y)=36y$

25. $4(3x-2)-7(x+5)=12x-8-7x-35=5x-43$

26. $(16x)\left(\dfrac{1}{8}\right)=2x$

27. $-3(2x^2-7y^2)=-3(2x^2)-(-3)(7y^2)$
$=-6x^2+21y^2$

28. $3(a-c)-2ab=3[2-(-4)]-2(2)(3)$
$=3[2+4]-2(2)(3)$
$=3(6)-2(2)(3)$
$=18-12=6$

29. $2x-3(x-2)=2x-3x+6=-x+6$

30. $2a-(-3b)-7a-5b=2a+3b-7a-5b$
$=-5a-2b$

31. $-5(2x^2-3x+6)=-10x^2+15x-30$

32. $3x-7y-12x=-9x-7y$

33. $\dfrac{1}{2}(12a)=\left(\dfrac{1}{2}\cdot 12\right)a=6a$

34. $2x+3[x-2(4-2x)]=2x+3[x-8+4x]$
$=2x+3[5x-8]$
$=2x+15x-24$
$=17x-24$

35. $3x+(-12y)-5x-(-7y)=3x+(-12y)+(-5x)+7y$
$=-2x-5y$

36. $\left(-\dfrac{5}{6}\right)(-36b)=\left(-\dfrac{5}{6}(-36)\right)b=30b$

37. $(6+3)7=42+21$

38. $4x^2+9x-6x^2-5x=-2x^2+4x$

39. $-\dfrac{3}{8}(16x^2)=\left(-\dfrac{3}{8}\cdot 16\right)x^2=-6x^2$

40. $-3[2x-(7x-9)] = -3[2x-7x+9]$
$= -3[-5x+9]$
$= 15x-27$

41. $-(8a^2-3b^2) = -8a^2+3b^2$

42. The Multiplication Property of Zero

43. "b decreased by the product of seven and b" translates to $\boldsymbol{b-7b}$.

44. "The sum of a number and twice the square of the number" translates to $n+2n^2$.

45. "Three less than the quotient of six and a number" translates to $\frac{6}{n}-3$.

46. "Ten divided by the difference between y and two" translates to $\frac{10}{y-2}$.

47. "Eight times the quotient of twice a number and sixteen" translates to $8\left(\frac{2n}{16}\right)=n$.

48. "The product of four and the sum of two and five times a number" translates to $4(2+5n)=8+20n$.

49. Let h be the height of the triangle; then the base is $h+15$.

50. Let b be the amount of either espresso beans or mocha java beans; then the other is $20-b$.

Chapter 2 Test

1. $(9y)4 = 4(9y) = (4\cdot 9)y = 36y$

2. $7x+5y-3x-8y = (7x-3x)+(5y-8y) = 4x-3y$

3. $8n-(6-2n) = 8n-6+2n = 10n-6$

4. $3ab-(2a)^2 = 3(-2)(-3)-[2(-2)]^2$
$= 3(-2)(-3)-[-4]^2$
$= 3(2)(-3)-16$
$= 18-16 = 2$

5. The Multiplication Property of One

6. $-4(-x+10) = 4x-40$

7. $\frac{2}{3}x^2-\frac{7}{12}x^2 = \left(\frac{2}{3}-\frac{7}{12}\right)x^2$
$= \left(\frac{8}{12}-\frac{7}{12}\right)x^2 = \frac{1}{12}x^2$

8. $(-10x)\left(-\frac{2}{5}\right) = \left(-\frac{2}{5}\right)(-10x)$
$= \left[-\frac{2}{5}(-10)\right]x$
$= 4x$

9. $(-4y^2+8)6 = -24y^2+48$

10. $-19+19 = 0$

11. $\frac{-3ab}{2a+b} = \frac{-3(-1)(4)}{2(-1)+4} = \frac{12}{-2+4} = \frac{12}{2} = 6$

12. $5(x+y)-8(x-y) = 5x+5y-8x+8y$
$= -3x+13y$

13. $6b - 9b + 4b = (6 - 9 + 4)b = b$

14. $13(6a) = (13 \cdot 6)a = 78a$

15. $3(x^2 - 5x + 4) = 3x^2 - 15x + 12$

16. $4(b - a) + bc = 4(-3 - 2) + (-3)(4)$
$= 4(-5) + (-3)(4)$
$= -20 - 12 = -32$

17. $6x - 3(y - 7x) + 2(5x - y)$
$= 6x - 3y + 21x + 10x - 2y$
$= 37x - 5y$

18. "The quotient of eight more than n and seventeen" translates to $\frac{n+8}{17}$.

19. "The difference between the sum of a and b and the square of b" translates to $(a + b) - b^2$

20. "The sum of the square of a number and the product of the number and eleven" translates to $n^2 + 11n$.

21. "Twenty times the sum of a number and nine" is $20(n + 9) = 20n + 180$.

22. "Two more than a number added to the difference between the number and three" is $(n - 3) + (n + 2) = 2n - 1$.

23. "A number minus the product of one-fourth and twice the number" is $n - \frac{1}{4}(2n) = n - \frac{1}{2}n = \frac{1}{2}n$.

24. Let d be the distance from Earth to the sun; then the distance from Neptune to the sun is $30d$.

25. Let L be the length of one piece; then the length of the other piece is $9 - L$.

Cumulative Review Exercises

1. $-4 + 7 + (-10) = 3 + (-10) = -7$

2. $-16 - (-25) - 4 = -16 + 25 + (-4) = 9 + (-4) = 5$

3. $(-2)(3)(-4) = (-6)(-4) = 24$

4. $-60 \div 12 = -5$

5. $1\frac{1}{4} = \frac{5}{4} = 1.25$

$$\begin{array}{r} 1.25 \\ 4\overline{)5.00} \\ \underline{40} \\ 100 \\ \underline{100} \\ 0 \end{array}$$

6. $60\% = 60 \cdot \frac{1}{100} = \frac{\cancel{20}^{1} \cdot 3}{1} \cdot \frac{1}{\cancel{20}_{1} \cdot 5} = \frac{3}{5}$

$60\% = 60(0.01) = 0.6$

7. Negative integers greater than or equal to -4:

{-4, -3, -2, -1}

8. $\frac{2}{25} = \frac{2}{25} \cdot 100\% = \frac{2}{\cancel{25}_{1}} \cdot \frac{\cancel{100}^{4}}{1}\% = 8\%$

9. $\frac{7}{12}-\frac{11}{16}-\left(-\frac{1}{3}\right)=\frac{28}{48}-\frac{33}{48}+\frac{16}{48}=\frac{11}{48}$

10. $\frac{5}{12}\div\left(\frac{3}{2}\right)=\frac{5}{\cancel{12}_{6}}\cdot\frac{\overset{1}{\cancel{2}}}{3}=\frac{5}{18}$

11. $\left(-\frac{9}{16}\right)\left(\frac{8}{27}\right)\left(-\frac{3}{2}\right)=\frac{\overset{1}{\cancel{3}}\cdot\overset{1}{\cancel{3}}\cdot\overset{1}{\cancel{2}}\cdot\overset{1}{\cancel{2}}\cdot\overset{1}{\cancel{2}}\cdot\overset{1}{\cancel{3}}}{\underset{1}{\cancel{2}}\cdot\underset{1}{\cancel{2}}\cdot\underset{1}{\cancel{2}}\cdot 2\cdot\underset{1}{\cancel{3}}\cdot\underset{1}{\cancel{3}}\cdot\underset{1}{\cancel{3}}\cdot 2}=\frac{1}{4}$

12. $-3^2\cdot\left(-\frac{2}{3}\right)^3=-\overset{1}{\cancel{9}}\left(-\frac{8}{\cancel{27}_{3}}\right)=\frac{8}{3}$

13. $-2^5\div(3-5)^2-(-3)=-2^5\div(-2)^2-(-3)$
$=-32\div 4-(-3)$
$=-8+3=-5$

14. $\left(-\frac{3}{4}\right)^2-\left(\frac{3}{8}-\frac{11}{12}\right)=\left(-\frac{3}{4}\right)^2-\left(\frac{9}{24}-\frac{22}{24}\right)$
$=\left(-\frac{3}{4}\right)^2-\left(-\frac{13}{24}\right)$
$=\frac{9}{16}+\frac{13}{24}$
$=\frac{27}{48}+\frac{26}{24}=\frac{53}{24}$

15. $a-3b^2=4-3(-2)^2$
$=4-3(4)$
$=4-12$
$=-8$

16. $-2x^2-(-3x^2)+4x^2=-2x^2+3x^2+4x^2=5x^2$

17. $8a-12b-9a=8a-9a-12b=-a-12b$

18. $\frac{1}{3}(9a)=\left(\frac{1}{3}\cdot 9\right)a=3a$

19. $\left(-\frac{5}{8}\right)(-32b)=\left(-\frac{5}{8}(-32)\right)b=20b$

20. $5(4-2x)=20-10x$

21. $-3(-2y+7)=6y-21$

22. $-2(3x^2-4y^2)=-6x^2+8y^2$

23. $-4(2y^2-5y-8)=-8y^2+20y+32$

24. $-4x-3(2x-5)=-4x-6x+15=-10x+15$

25. $3(4x-1)-7(x+2)=12x-3-7x-14=5x-17$

26. $3x+2[x-4(2-x)]=3x+2[x-8+4x]$
$=3x+2[5x-8]$
$=3x+10x-16$
$=13x-16$

27. $3[4x-2(x-4y)]+5y=3[4x-2x+8y]+5y$
$=3[2x+8y]+5y$
$=6x+24y+5y$
$=6x+29y$

28. "The difference between six and the product of a number and twelve" translates to $6-12n$.

29. "The total of five and the difference between a number and seven" translates to $5+(n-7)$.

30. Let w be the speed of the wildebeest; then the speed of the peregrine falcon is $4w$.