Applying the Concepts

In Problems 111–114, express each number as the product of prime factors. Write the answer in exponential form.

111. 72 **112.** 675

113. 48 **114.** 200

In Problems 115–120, insert grouping symbols so that the expression has the desired value.

115. $4 \cdot 3 + 6 \cdot 2$ results in 36

116. $4 \cdot 7 - 4^2$ results in -36

117. $4 + 3 \cdot 4 + 2$ results in 42

118. $6 - 4 + 3 - 1$ results in 0

119. $6 - 4 + 3 - 1$ results in 4

120. $4 + 3 \cdot 2 - 1 \cdot 6$ results in 42

121. Cost of a TV The total amount paid for a flat-screen television that costs \$479, plus sales tax of 7.5%, is found by evaluating the expression $479 + 0.075(479)$. Evaluate this expression rounded to the nearest cent.

122. Manufacturing Cost Evaluate the expression $3000 + 6(100) - \dfrac{100^2}{1000}$ to find the weekly production cost of manufacturing 100 calculators.

△ **123. Surface Area** The surface area of a right circular cylinder whose radius is 6 inches and height is 10 inches is given approximately by $2 \cdot 3.1416 \cdot 6^2 + 2 \cdot 3.1416 \cdot 6 \cdot 10$. Evaluate this expression. Round the answer to two decimal places.

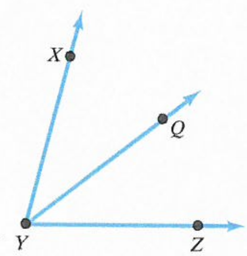
△ **124. Volume of a Cone** The volume of a cone whose radius is 3 centimeters and whose height is 12 centimeters is given approximately by $\frac{1}{3} \cdot 3.1416 \cdot 3^2 \cdot 12$. Evaluate this expression. Round the answer to two decimal places.

125. Investing If \$1000 is invested at 3% annual interest and remains untouched for 2 years, the amount of money that is in the account after 2 years is given by the expression $1000(1 + 0.03)^2$. Evaluate this expression, rounded to the nearest cent.

126. Investing If \$5000 is invested at 4.5% annual interest and remains untouched for 5 years, the amount of money that is in the account after 5 years is given by the expression $5000(1 + 0.045)^5$. Evaluate this expression, rounded to the nearest cent.

Extending the Concepts

The Angle Addition Postulate from geometry states that the measure of an angle is equal to the sum of the measures of its parts. Refer to the figure. Use the Angle Addition Postulate to answer Problems 127 and 128.



△ **127.** If the measure of $\angle XYQ = 46.5°$ and the measure of $\angle QYZ = 69.25°$, find the measure of the measure of $\angle XYZ$.

△ **128.** If the measure of $\angle QYZ = 18°$ and the measure of $\angle XYZ = 57°$, find the measure of $\angle XYQ$.

Explaining the Concepts

129. Explain the difference between -3^2 and $(-3)^2$. Identify the distinguishing characteristics of the two problems, and explain how to evaluate each expression.

1.8 Simplifying Algebraic Expressions

Objectives

1. Evaluate Algebraic Expressions
2. Identify Like Terms and Unlike Terms
3. Use the Distributive Property
4. Simplify Algebraic Expressions by Combining Like Terms

Are You Ready for This Section?

Before getting started, take this readiness quiz. If you get a problem wrong, go back to the section cited and review the material.

R1. Find the sum: $-3 + 8$ [Section 1.4, pp. 28–30]

R2. Find the difference: $-7 - 8$ [Section 1.4, pp. 31–32]

R3. Find the product: $-\frac{4}{3}(27)$ [Section 1.5, pp. 37–38]

Ready?...Answers **R1.** 5 **R2.** -15 **R3.** -36

What is algebra? The word "algebra" is derived from the Arabic word *al-jabr,* which means "restoration." Today algebra means more. **Algebra** uses symbols to represent quantities and to express general relationships that hold for all members of the set. In this course, the set of numbers referred to in the definition will usually be the set of real numbers.

1 Evaluate Algebraic Expressions

In arithmetic, we work with numbers. In algebra, we use letters such as x, y, a, b, and c to represent numbers.

Definition

When a letter represents any number from a set of numbers, it is called a **variable**.

For most of the text, we use the set of real numbers.

Definition

A **constant** is either a fixed number, such as 5, or a letter or symbol that represents a fixed number.

For example, in Einstein's Theory of Relativity, $E = mc^2$, the E and m are variables that represent total energy and mass, respectively, and c is a constant that represents the speed of light (299,792,458 meters per second).

Definition

An **algebraic expression** is any combination of variables, constants, grouping symbols, and mathematical operations such as addition, subtraction, multiplication, division, and exponents.

Some examples of algebraic expressions are

$$x - 5 \qquad \frac{1}{2}x \qquad 2y - 7 \qquad z^2 + 3 \qquad \text{and} \qquad \frac{b-1}{b+1}$$

Recall that a variable represents any number from a set of numbers. One of the procedures we perform on algebraic expressions is *evaluating an algebraic expression*.

Definition

To **evaluate an algebraic expression**, substitute a numerical value for each variable into the expression and simplify the result.

EXAMPLE 1 Evaluating an Algebraic Expression

Evaluate each expression for the given value of the variable.

(a) $2x + 5$ for $x = 8$ **(b)** $a^2 - 2a + 4$ for $a = -3$

Solution

(a) We substitute 8 for x in the expression $2x + 5$:

$$\begin{aligned} 2(8) + 5 &= 16 + 5 \\ &= 21 \end{aligned}$$

(b) We substitute -3 for a in $a^2 - 2a + 4$:

$$\begin{aligned} (-3)^2 - 2(-3) + 4 &= 9 + 6 + 4 \\ &= 19 \end{aligned}$$

EXAMPLE 2 An Algebraic Expression for Revenue

The expression $4.50x + 2.50y$ represents the total amount of money, in dollars, received at a school play, where x represents the number of adult tickets sold and y represents the number of student tickets sold. Evaluate $4.50x + 2.50y$ for $x = 50$ and $y = 82$. Interpret the result.

Solution

We substitute 50 for x and 82 for y in the expression $4.50x + 2.50y$.

$$4.50(50) + 2.50(82) = 225 + 205 = 430$$

So \$430 was collected by selling 50 adult tickets and 82 student tickets.

Quick ✓

1. When a letter represents any number from a set of numbers, it is called a ________.
2. To ________ an algebraic expression, substitute a numerical value for each variable into the expression and simplify the result.

In Problems 3 and 4, evaluate each expression for the given value of the variable.

3. $-3k + 5$ for $k = 4$
4. $-2y^2 - y + 8$ for $y = -2$
5. The Amadeus Coffee Shop creates a breakfast blend of two types of coffee. They mix x pounds of a mild coffee that sells for \$7.00 per pound with y pounds of a robust coffee that sells for \$10.00 per pound. An algebraic expression that represents the value of the breakfast blend, in dollars, is $7x + 10y$. Evaluate this expression for $x = 8$ pounds and $y = 16$ pounds

2 Identify Like Terms and Unlike Terms

Algebraic expressions consist of *terms*.

Definition

A **term** is a constant or the product of a constant and one or more variables raised to a power.

In algebraic expressions, the terms are separated by addition signs.

EXAMPLE 3 Identifying the Terms in an Algebraic Expression

Identify the terms in the following algebraic expressions.

(a) $4a^3 + 5b^2 - 8c + 12$

(b) $\frac{x}{4} - 7y + 8z$

Solution

(a) Rewrite $4a^3 + 5b^2 - 8c + 12$ so it contains only addition signs.

$$4a^3 + 5b^2 + (-8c) + 12$$

The four terms are $4a^3$, $5b^2$, $-8c$, and 12.

(b) The algebraic expression $\frac{x}{4} - 7y + 8z$ has three terms: $\frac{x}{4}$, $-7y$, and $8z$.

Quick ✓

6. *True or False* A constant by itself can be a term.

In Problems 7–9, identify the terms in each algebraic expression.

7. $5x^2 + 3xy$

8. $9ab - 3bc + 5ac - ac^2$

9. $\frac{2mn}{5} - \frac{3n}{7}$

Definition

The **coefficient** of a term is the numerical factor of the term.

For example, the coefficient of $7x$ is 7; the coefficient of $-2x^2y$ is -2. Terms that have no number as a factor, such as mn, have a coefficient of 1 since $mn = 1 \cdot mn$. The coefficient of $-y$ is -1 since $-y = -1 \cdot y$. If a term consists of just a constant, the coefficient is the number itself. For example, the coefficient of 14 is 14.

EXAMPLE 4 Determining the Coefficient of a Term

Determine the coefficient of each term:

(a) $\frac{1}{2}xy^2$ **(b)** $-\frac{t}{12}$ **(c)** ab^3 **(d)** 12

Solution

(a) The coefficient of $\frac{1}{2}xy^2$ is $\frac{1}{2}$.

(b) The coefficient of $-\frac{t}{12}$ is $-\frac{1}{12}$ because $-\frac{t}{12}$ can be written as $-\frac{1}{12} \cdot t$.

(c) The coefficient of ab^3 is 1 because ab^3 can be written as $1 \cdot ab^3$.

(d) The coefficient of 12 is 12 because the coefficient of a constant is the number itself.

Quick ✓

In Problems 10–14, determine the coefficient of each term.

10. $2z^2$ **11.** xy **12.** $-b$

13. 5 **14.** $-\frac{2}{3}z$

Sometimes we can simplify algebraic expressions by combining *like terms.*

Work Smart

Like terms can have different coefficients, but they cannot have different variables or different exponents on those variables.

Definition

Terms that have the same variable factor(s) with the same exponent(s) are called **like terms**.

For example, $3x^2$ and $-7x^2$ are like terms because both contain x^2, but $3x^2$ and $-7x^3$ are not like terms because the variable x is raised to different powers. Constant terms such as -9 and 6 are like terms.

EXAMPLE 5 Classifying Terms as Like or Unlike

Classify the following pairs of terms as *like* or *unlike*.

(a) $2p^3$ and $-5p^3$ **(b)** $7kr$ and $\frac{1}{4}k^2r$ **(c)** 5 and 8

Solution

(a) $2p^3$ and $-5p^3$ are *like* terms because both contain p^3.

(b) $7kr$ and $\frac{1}{4}k^2r$ are *unlike* terms because k is raised to different powers.

(c) 5 and 8 are *like* terms because both are constants.

Quick ✓

15. *True or False* Like terms can have different coefficients or different exponents on the same variable.

In Problems 16–20, tell whether the terms are like or unlike.

16. $-\frac{2}{3}p^2$ and $\frac{4}{5}p^2$ **17.** $\frac{m}{6}$ and $4m$ **18.** $3a^2b$ and $-2ab^2$

19. $8a$ and 11 **20.** -7 and 12

3 Use the Distributive Property

The *Distributive Property* will be used throughout this course and in future courses.

The Distributive Property

If a, b, and c are real numbers, then

$$a \cdot (b + c) = a \cdot b + a \cdot c$$
$$(a + b) \cdot c = a \cdot c + b \cdot c$$

That is, multiply each of the terms inside the parentheses by the factor on the outside.

Because $b - c = b + (-c)$, it is also true that $a(b - c) = a \cdot b - a \cdot c$.

EXAMPLE 6 Using the Distributive Property to Remove Parentheses

Use the Distributive Property to remove the parentheses.

(a) $3(x + 5)$ **(b)** $-\frac{1}{3}(6x - 12)$

Solution

(a) To use the Distributive Property, multiply each term in the parentheses by 3:

$$\begin{aligned} 3(x + 5) &= 3 \cdot x + 3 \cdot 5 \\ &= 3x + 15 \end{aligned}$$

Work Smart

The long name for the Distributive Property is the Distributive Property of Multiplication over Addition. This name helps to remind us that we do not distribute across multiplication. For example,

$$6x(5xy) \neq 6x \cdot 5x \cdot 6x \cdot y$$

(b) Multiply each term in the parentheses by $-\frac{1}{3}$:

$$-\frac{1}{3}(6x - 12) = -\frac{1}{3} \cdot 6x - \left(-\frac{1}{3}\right) \cdot 12$$
$$= -2x + 4$$

Quick ✓

21. $a \cdot (b + c) = a \cdot \_ + a \cdot \_$

In Problems 22–25, use the Distributive Property to remove the parentheses.

22. $6(x + 2)$

23. $-5(x + 2)$

24. $-2(k - 7)$

25. $(8x + 12)\frac{3}{4}$

4 Simplify Algebraic Expressions by Combining Like Terms

An algebraic expression that contains the sum or difference of like terms may be simplified using the Distributive Property "in reverse." When we use the Distributive Property to add coefficients of like terms, we say that we are **combining like terms.**

EXAMPLE 7 Using the Distributive Property to Combine Like Terms

Combine like terms:

(a) $2x + 7x$

(b) $x^2 - 5x^2$

Solution

(a) $2x + 7x = (2 + 7)x$
$= 9x$

(b) $x^2 - 5x^2 = (1 - 5)x^2$
$= -4x^2$

Look carefully at the results of Example 7. Notice that when we combine like terms, we add the coefficients of the like terms and keep the variables and exponents the same.

Quick ✓

26. $4x^2 + 9x^2 = (\_ + \_)x^2$

In Problems 27–29, combine like terms.

27. $3x - 8x$

28. $-5x^2 + x^2$

29. $-7x - x + 6 - 3$

Sometimes we must rearrange terms using the Commutative Property of Addition to combine like terms.

EXAMPLE 8 Combining Like Terms Using the Commutative Property

Combine like terms: $4x + 5y + 12x - 7y$

Solution

Use the Commutative Property to rearrange the terms.

$$4x + 5y + 12x - 7y = 4x + 12x + 5y - 7y$$

Use the Distributive Property "in reverse": $= (4 + 12)x + (5 - 7)y$

$= 16x + (-2y)$

Write the answer in simplest form: $= 16x - 2y$

Quick ✓

In Problems 30–33, combine like terms.

30. $3a + 2b - 5a + 7b - 4$

31. $5ac + 2b + 7ac - 5a - b$

32. $5ab^2 + 7a^2b + 3ab^2 - 8a^2b$

33. $\frac{4}{3}rs - \frac{3}{2}r^2 + \frac{2}{3}rs - 5$

Often, we need to remove parentheses by using the Distributive Property before we can combine like terms. Recall that the rules for order of operations on real numbers place multiplication before addition or subtraction. In this section, the direction **simplify** will mean to remove all parentheses and combine like terms.

EXAMPLE 9 Combining Like Terms Using the Distributive Property

Simplify the algebraic expression: $3 - 4(2x + 3) - (5x + 1)$

Solution

First, we use the Distributive Property to remove parentheses.

$$3 - 4(2x + 3) - (5x + 1) = 3 - 8x - 12 - 5x - 1$$

Rearrange terms using the Commutative Property of Addition: $= -8x - 5x + 3 - 12 - 1$

Combine like terms: $= -13x - 10$

Work Smart

Remember that multiplication comes before subtraction. In the first step of Example 9, do not compute $3 - 4$ first to obtain $-1(2x + 3)$.

Quick ✓

34. Explain what it means to simplify an algebraic expression.

In Problems 35–38, simplify each expression.

35. $3x + 2(x - 1) - 7x + 1$

36. $m + 2n - 3(m + 2n) - (7 - 3n)$

37. $2(a - 4b) - (a + 4b) + b$

38. $\frac{1}{2}(6x + 4) - \frac{1}{3}(12 - 9x)$

Work Smart: Study Skills

Selected problems in the exercise sets are in green. For extra help, worked solutions to these problems are in MyMathLab.

Simplifying an Algebraic Expression

Step 1: Remove any parentheses using the Distributive Property.

Step 2: Combine any like terms.

1.8 Exercises

MyMathLab® MathXL® PRACTICE

Exercise numbers in green have complete video solutions in MyMathLab.

Problems **1–38** *are the* Quick ✓s *that follow the* EXAMPLES.

Building Skills

In Problems 39–50, evaluate each expression using the given values of the variables. See Objective 1.

39. $2x + 5$ for $x = 4$

40. $3x + 7$ for $x = 2$

41. $x^2 + 3x - 1$ for $x = 3$

42. $n^2 - 4n + 3$ for $n = 2$

43. $4 - k^2$ for $k = -5$

44. $-2p^2 + 5p + 1$ for $p = -3$

45. $\frac{9x - 5y}{x + y}$ for $x = 3, y = 5$

46. $\dfrac{3y + 2z}{y - z}$ for $y = 4, z = -2$

47. $(x + 3y)^2$ for $x = 3, y = -4$

48. $(a - 2b)^2$ for $a = 1, b = 2$

49. $b^2 - 4ac$ for $a = 1, b = 4, c = 3$

50. $\dfrac{a^2 - 4}{a^2 + 5a - 14}$ for $a = -3$

In Problems 51–54, for each expression, identify the terms and then name the coefficient of each term. See Objective 2.

51. $2x^3 + 3x^2 - x + 6$ **52.** $3m^4 - m^3n^2 + 4n - 1$

53. $z^2 + \dfrac{2y}{3}$ **54.** $t^3 - \dfrac{t}{4}$

In Problems 55–62, determine whether the terms are like or unlike. See Objective 2.

55. $8x$ and 8 **56.** $11p$ and 11

57. 54 and -21 **58.** -13 and 38

59. $12b$ and $-b$ **60.** $6a^2$ and $-3a^2$

61. r^2s and rs^2 **62.** x^2y^3 and y^2x^3

In Problems 63–70, use the Distributive Property to remove the parentheses. See Objective 3.

63. $3(m + 2)$ **64.** $3(4s + 2)$

65. $(3n^2 + 2n - 1)6$ **66.** $(6a^4 - 4a^2 + 2)3$

67. $-(x - y)$ **68.** $-5(k - n)$

69. $(8x - 6y)\left(-\dfrac{1}{2}\right)$ **70.** $(20a - 15b)\left(-\dfrac{2}{5}\right)$

In Problems 71–98, simplify each expression by using the Distributive Property to remove parentheses and combining like terms. See Objective 4.

71. $5x - 2x$ **72.** $14k - 11k$

73. $4z - 6z + 8z$ **74.** $9m - 8m + 2m$

75. $2m + 3n + 8m + 7n$ **76.** $x + 2y + 5x + 7y$

77. $0.3x^7 + x^7 + 0.9x^7$ **78.** $1.7n^4 - n^2 + 2.1n^4$

79. $-3y^6 + 13y^6$ **80.** $-7p^5 + 2p^5$

81. $-(6w + 12y - 13z)$ **82.** $-(-6m + 9n - 8p)$

83. $5(k + 3) - 8k$ **84.** $3(7 - z) - z$

85. $7n - (3n + 8)$ **86.** $18m - (6 + 9m)$

87. $(7 - 2x) - (x + 4)$ **88.** $(3k + 1) - (4 - k)$

89. $(7n - 8) - (3n - 6)$ **90.** $(5y - 6) - (11y + 8)$

91. $-6(n - 3) + 2(n + 1)$

92. $-9(7r - 6) + 9(10r + 3)$

93. $\dfrac{2}{3}x + \dfrac{1}{6}x$ **94.** $\dfrac{3}{5}y + \dfrac{7}{10}y$

95. $\dfrac{1}{2}(8x + 5) - \dfrac{2}{3}(6x + 12)$

96. $\dfrac{1}{5}(60 - 15x) + \dfrac{3}{4}(12 - 4x)$

97. $2(0.5x + 9) - 3(1.5x + 8)$

98. $3(0.2x + 6) - 5(1.6x + 1)$

Mixed Practice

In Problems 99–110, (a) evaluate the expression for the given value(s) of the variable(s) before combining like terms, (b) simplify the expression by combining like terms and then evaluate the expression for the given value(s) of the variable(s). Compare your results.

99. $5x + 3x; x = 4$ **100.** $8y + 2y; y = -3$

101. $-2a^2 + 5a^2; a = -3$ **102.** $4b^2 - 7b^2; b = 5$

103. $4z - 3(z + 2); z = 6$

104. $8p - 3(p - 4); p = 3$

105. $5y^2 + 6y - 2y^2 + 5y - 3; y = -2$

106. $3x^2 + 8x - x^2 - 6x; x = 5$

107. $\dfrac{1}{2}(4x - 2) - \dfrac{2}{3}(3x + 9); x = 3$

108. $\dfrac{1}{5}(5x - 10) - \dfrac{1}{6}(6x + 12); x = -2$

109. $3a + 4b - 7a + 3(a - 2b); a = 2, b = 5$

110. $-4x - y + 2(x - 3y); x = 3, y = -2$

Applying the Concepts

In Problems 111–116, evaluate each expression using the given values of the variables.

111. $\dfrac{1}{2}h(b + B); h = 4, b = 5, B = 17$

112. $\dfrac{1}{2}h(b + B); h = 9, b = 3, B = 12$

113. $\dfrac{a - b}{c - d}; a = 6, b = 3, c = -4, d = -2$

114. $\dfrac{a - b}{c - d}; a = -5, b = -2, c = 7, d = 1$

115. $b^2 - 4ac; a = 7, b = 8, c = 1$

116. $b^2 - 4ac; a = 2, b = 5, c = 3$

117. Renting a Truck The cost of renting a truck from Hamilton Truck Rental is \$59.95 per day plus \$0.15 per mile. The expression $59.95 + 0.15m$ represents the cost of renting a truck for one day and driving it m miles. Evaluate $59.95 + 0.15m$ for $m = 125$.

118. Renting a Car The cost of renting a compact car for one day from CMH Auto is \$29.95 plus \$0.17 per mile. The expression $29.95 + 0.17m$ represents the total daily cost. Evaluate the expression $29.95 + 0.17m$ for $m = 245$.

119. Ticket Sales The Center for Science and Industry sells adult tickets for \$12 and children's tickets for \$7. The expression $12a + 7c$ represents the total revenue from selling a adult tickets and c children's tickets. Evaluate the algebraic expression $12a + 7c$ for $a = 156$ and $c = 421$.

120. Ticket Sales A community college theatre group sold tickets to a recent production. Student tickets cost \$5, and nonstudent tickets cost \$8. The algebraic expression $5s + 8n$ represents the total revenue from selling s student tickets and n nonstudent tickets. Evaluate $5s + 8n$ for $s = 76$ and $n = 63$.

△ **121. Rectangle** The width of a rectangle is w yards, and the length of the rectangle is $(3w - 4)$ yards. The perimeter of the rectangle is given by the algebraic expression $2w + 2(3w - 4)$.

(a) Simplify the algebraic expression $2w + 2(3w - 4)$.

(b) Determine the perimeter of a rectangle whose width w is 5 yards.

△ **122. Rectangle** The length of a rectangle is l meters, and the width of the rectangle is $(l - 11)$ meters. The perimeter of the rectangle is given by the algebraic expression $2l + 2(l - 11)$.

(a) Simplify the expression $2l + 2(l - 11)$.

(b) Determine the perimeter of a rectangle whose length l is 15 meters.

123. Finance Novella invested some money in two investment funds. She placed s dollars in stocks that yield 5.5% annual interest and b dollars in bonds that yield 3.25% annual interest. Evaluate the expression $0.055s + 0.0325b$ for $s = \$2950$ and $b = \$2050$. Round your answer to the nearest cent.

124. Finance Jonathan received an inheritance from his grandparents. He invested x dollars in a Certificate of Deposit that pays 2.95% and y dollars in an off-shore oil drilling venture that is expected to pay 12.8%. Evaluate the algebraic expression $0.0295x + 0.128y$ for $x = \$2500$ and $y = \$1000$.

Extending the Concepts

125. Simplify the algebraic expression (cleverly!!) using the Distributive Property—in reverse!
$2.75(-3x^2 + 7x - 3) - 1.75(-3x^2 + 7x - 3)$

126. Simplify the algebraic expression using the Distributive Property in reverse.
$11.23(7.695x + 81.34) + 8.77(7.695x + 81.34)$

Explaining the Concepts

127. Explain why the sum $2x^2 + 4x^2$ is *not* equivalent to $6x^4$. What is the correct answer?

128. Use $x = 4$ and $y = 5$ to answer parts (a), (b), and (c).

(a) Evaluate $x^2 + y^2$.

(b) Evaluate $(x + y)^2$.

(c) Are the results the same? Is $(x + y)^2$ equal to $x^2 + y^2$? Explain your response.

Chapter 1 Activity: The Math Game

Focus: Applying order of operations and simplifying expressions
Time: 10 minutes
Group size: 2–4

- The instructor will announce when the groups may begin solving the problems to the right.
- When your group has completed all of the problems, ask the instructor to check the answers. The instructor will tell you how many answers are correct, but not which ones.
- The first group to complete all of the problems correctly will win a prize, as determined by the instructor.

1. Evaluate: $-8 \div 2^2 \cdot 6 + (-2)^3$

2. Evaluate: $\dfrac{6(-3) + 4^2}{25 + 4(-9 + 4)}$

3. Evaluate: $x^3 - x^2$ for $x = -3$

4. Evaluate: $\dfrac{(x + 2y)^2}{xy}$ for $x = 1, y = -2$

5. Simplify: $-2(4x + 3) - (5x - 1)$

6. Simplify: $\dfrac{3}{4}(8x^2 + 16) - 2x^2 + 3x$

Chapter 1 Review

Section 1.2 Fractions, Decimals, and Percents

KEY CONCEPTS

- To find the least common multiple (LCM) of two numbers, (1) factor each number as the product of prime factors; (2) write the factor(s) that the numbers share, if any; (3) write down the remaining factors the greatest number of times that the factors appear in any number. The product of the factors is the LCM.
- To write a fraction in lowest terms, find the common factors between the numerator and denominator, and use the fact that $\frac{a \cdot c}{b \cdot c} = \frac{a}{b}$ to divide out the common factors.
- To round a decimal, identify the specified place value in the decimal. If the digit to the right is 5 or more, add 1 to the digit; if the digit to the right is 4 or less, leave the digit as it is. Then drop the digits to the right of the specified place value.
- To convert a fraction to a decimal, divide the numerator of the fraction by the denominator of the fraction until the remainder is 0 or the remainder repeats.
- To convert a decimal to a fraction, identify the place value of the denominator, write the decimal as a fraction using the given denominator, and write in lowest terms.
- To convert a percent to a decimal, move the decimal point two places to the left and drop the % symbol.
- To convert a decimal to a percent, move the decimal point two places to the right and add the % symbol.

KEY TERMS

Factor
Product
Prime
Composite
Prime factorization
Multiple
Least Common Multiple (LCM)
Numerator
Denominator
Equivalent fractions
Least Common Denominator (LCD)
Terminating decimal
Repeating decimal
Percent

You Should Be Able To...	EXAMPLE	Review Exercises
1 Factor a number as a product of prime factors (p. 8)	Example 1	1–4
2 Find the least common multiple of two or more numbers (p. 9)	Examples 2 and 3	5, 6
3 Write equivalent fractions (p. 10)	Examples 4 and 5	7–10
4 Write a fraction in lowest terms (p. 12)	Example 6	11–13
5 Round decimals (p. 13)	Example 7	14, 15
6 Convert between fractions and decimals (p. 14)	Examples 8 and 9	16–22
7 Convert between percents and decimals (p. 15)	Examples 10 and 11	23–31

In Problems 1–4. factor each number as a product of primes, if possible.

1. 75 **2.** 87
3. 81 **4.** 17

In Problems 5 and 6, find the LCM of the numbers.

5. 18 and 24 **6.** 4, 8, and 18

In Problems 7 and 8, write each number with the given denominator.

7. Write $\frac{7}{15}$ with the denominator 30.

8. Write 3 with the denominator 4.

In Problems 9 and 10, write equivalent fractions with the least common denominator.

9. $\frac{1}{6}$ and $\frac{3}{8}$ **10.** $\frac{9}{16}$ and $\frac{7}{24}$

In Problems 11–13, write each fraction in lowest terms.

11. $\frac{25}{60}$ **12.** $\frac{125}{250}$ **13.** $\frac{96}{120}$

In Problems 14 and 15, round each number to the given place.

14. 21.7648 to the neared hundredth

15. 14.91 to the nearest one (unit)

16. Write $\frac{8}{9}$ as a repeating decimal.

17. Write $\frac{9}{32}$ as a terminating decimal.

In Problems 18 and 19, write each fraction as a decimal rounded to the indicated place.

18. $\frac{11}{6}$ to the nearest hundredth.

19. $\frac{19}{8}$ to the nearest tenth.

In Problems 20–22, write each decimal as a fraction in lowest terms.

20. 0.6 **21.** 0.375 **22.** 0.864

In Problems 23–26, write each percent as a decimal.

23. 41% **24.** 760%

25. 9.03% **26.** 0.35%

In Problems 27–30, write each decimal as a percent.

27. 0.23 **28.** 1.17

29. 0.045 **30.** 3

31. A student earns 12 points out of a total of 20 points on a quiz.

(a) Express this score as a fraction in lowest terms.

(b) Express this score as a percentage.

Section 1.3 The Number Systems and the Real Number Line

KEY CONCEPTS

- $a < b$ means a is to the left of b on a real number line.
- $a = b$ means a and b are in the same position on a real number line.
- $a > b$ means a is to the right of b on a real number line.
- $|a|$ is the distance from 0 to a on a real number line.

KEY TERMS

Set	Real number line
Elements	Origin
Empty set	Scale
Natural numbers	Coordinate
Counting numbers	Negative real numbers
Whole numbers	Zero
Integers	Positive real numbers
Rational number	Sign
Irrational number	Inequality symbols
Real numbers	Absolute value

You Should Be Able To...	EXAMPLE	Review Exercises
1 Classify numbers (p. 19)	Example 2	32–41, 57, 58
2 Plot points on a real number line (p. 22)	Example 3	42
3 Use inequalities to order real numbers (p. 23)	Example 4	43–47, 51–56
4 Compute the absolute value of a real number (p. 24)	Example 5	48–50, 55, 56

In Problems 32–35, write each set.

32. A is the set of whole numbers less than 7.

33. B is the set of natural numbers less than or equal to 3.

34. C is the set of integers greater than -3 and less than or equal to 5

35. D is the set of whole numbers less than 0.

In Problems 36–41, use the set

$$\left\{-6, -3.25, 0, 5.030030003\ldots, \frac{9}{3}, 11, \frac{5}{7}\right\}.$$

List all the elements that are

36. natural numbers

37. whole numbers

38. integers

39. rational numbers

40. irrational numbers

41. real numbers

42. Plot the points $\{-3, -\frac{4}{3}, 0, 2, 3.5\}$ on a real number line.

In Problems 43–47, determine whether the statement is True or False.

43. $-3 > -1$

44. $5 \leq 5$

45. $-5 \leq -3$

46. $\frac{1}{2} = 0.5$

47. $\frac{2}{3} > \frac{5}{6}$

In Problems 48–50, evaluate each expression.

48. $-\left|\frac{1}{2}\right|$

49. $|-7|$

50. $-|-6|$

In Problems 51–56, replace the ? with the correct symbol: $>, <, =$.

51. $\frac{1}{4}$? 0.25

52. -6 ? 0

53. 0.83 ? $\frac{3}{4}$

54. $\frac{-2}{|-2|}$? $-|-1|$

55. $|-4|$? $|-3|$

56. $\frac{4}{5}$? $\left|-\frac{5}{6}\right|$

57. Explain the difference between a rational number and an irrational number. Be sure that your explanation includes a discussion of terminating decimals and nonterminating decimals.

58. What do we call the set of positive integers?

Section 1.4 Adding, Subtracting, Multiplying, and Dividing Integers

KEY CONCEPTS

- **Rules of Signs for Multiplying Two Integers**
  1. The product of two positive integers is positive.
  2. The product of one positive integer and one negative integer is negative.
  3. The product of two negative integers is positive.
- **Rules of Signs for Dividing Two Integers**
  1. The quotient of two positive integers is positive. That is, $\frac{+a}{+b} = \frac{a}{b}$.
  2. The quotient of one positive integer and one negative integer is negative. That is, $\frac{-a}{b} = \frac{a}{-b} = -\frac{a}{b}$.
  3. The quotient of two negative integers is positive. That is, $\frac{-a}{-b} = \frac{a}{b}$.

KEY TERMS

Operations
Sum
Difference
Product
Quotient
Mixed number
Additive inverse
Opposite
Evaluate
Factors
Dividend
Divisor
Multiplicative inverse
Reciprocal
Ratio
Golden ratio

You Should Be Able To...	EXAMPLE	Review Exercises
1 Add integers (p. 28)	Examples 1 through 6	59–66, 71, 72, 89, 90, 93, 99, 100, 102
2 Determine the additive inverse of a number (p. 30)	Example 7	87, 88
3 Subtract integers (p. 31)	Examples 8 through 10	67–72, 91, 92, 94, 99–101
4 Multiply integers (p. 32)	Examples 11 and 12	73–78, 95, 96, 102
5 Divide integers (p. 33)	Example 14	79–86, 97, 98

In Problems 59–86, perform the indicated operation.

59. $-2 + 9$

60. $6 + (-10)$

61. $-23 + (-11)$

62. $-120 + 25$

63. $-|-2 + 6|$

64. $-|-15| + |-62|$

65. $-110 + 50 + (-18) + 25$

66. $-28 + (-35) + (-52)$

67. $-10 - 12$

68. $18 - 25$

69. $-11 - (-32)$

70. $0 - (-67)$

71. $34 - 18 + 10$

72. $-49 - 8 + 21$

73. $-6(-2)$

74. $4(-10)$

75. $13(-86)$

76. $-19(423)$

77. $(11)(13)(-5)$

78. $(-53)(-21)(-10)$

79. $\dfrac{-20}{-4}$

80. $\dfrac{60}{-5}$

81. $\dfrac{|-55|}{11}$

82. $-\left|\dfrac{-100}{4}\right|$

83. $\dfrac{120}{-15}$

84. $\dfrac{64}{-20}$

85. $\dfrac{-180}{54}$

86. $\dfrac{-450}{105}$

In Problems 87 and 88, determine the additive inverse of each number.

87. 13

88. -45

In Problems 89–98, write the expression using mathematical symbols, and then evaluate the expression.

89. -43 plus 101

90. 45 plus -28

91. -10 minus -116

92. 74 minus 56

93. the sum of 13 and -8

94. the difference between -60 and -10

95. -21 multiplied by -3

96. 54 multiplied by -18

97. -34 divided by -2

98. -49 divided by 14

99. Football Matt Forte had three possessions of the football within the first few minutes of the game. On his first possession he gained 20 yards, on his second possession he lost 6 yards, and on his third possession he gained 12 yards. What was his total yardage?

100. Temperature On a winter day in Detroit, Michigan, the temperature was 10°F in the morning. The temperature rose 12°F in the afternoon and then fell 25°F by midnight. What was the temperature at midnight in Detroit?

101. Temperature One day in Bismarck, North Dakota, the high temperature was 6°F above zero and the low temperature was 18°F below zero. What was the difference between the high and low temperatures on that day in Bismarck?

102. Test Score Ms. Rosen awards 5 points for each correct multiple-choice question and awards 8 points for each correct free-response question. On one of Ms. Rosen's tests, Sarah got 11 multiple-choice questions correct and 4 free-response questions correct. What was Sarah's test score?

Section 1.5 Adding, Subtracting, Multiplying, and Dividing Rational Numbers

KEY CONCEPTS

- **Multiplying Fractions**

$$\frac{a}{b}\cdot\frac{c}{d}=\frac{a\cdot c}{b\cdot d} \quad \text{where } b \text{ and } d \neq 0$$

- **Dividing Fractions**

$$\frac{a}{b}\div\frac{c}{d}=\frac{a}{b}\cdot\frac{d}{c}=\frac{a\cdot d}{b\cdot c} \quad \text{where } b, c, d \neq 0$$

- **Adding or Subtracting Fractions with the Same Denominator**

$$\frac{a}{c}+\frac{b}{c}=\frac{a+b}{c} \quad \text{where } c \neq 0$$

$$\frac{a}{c}-\frac{b}{c}=\frac{a-b}{c}=\frac{a+(-b)}{c} \quad \text{where } c \neq 0$$

- **Adding or Subtracting Fractions with Unlike Denominators**

Step 1: Find the LCD of the fractions.
Step 2: Find equivalent fractions with the LCD by multiplying by a fraction equivalent to 1.
Step 3: Add or subtract the numerators, and write the result over the common denominator.
Step 4: Simplify the result.

KEY TERMS

Least common denominator

You Should Be Able To...	EXAMPLE	Review Exercise
1 Multiply rational numbers in fraction al form (p. 37)	Example 1	103–106, 136
2 Divide rational numbers in fractional form (p. 38)	Example 2	107–110
3 Add or subtract rational numbers in fractional form (p. 39)	Examples 3 through 7	111–122, 137
4 Add, subtract, multiply, or divide rational numbers in decimal form (p. 43)	Examples 8 through 11	123–135, 138

In Problems 103–122, perform the indicated operation. Write in lowest terms.

103. $\frac{2}{3}\cdot\frac{15}{8}$

104. $-\frac{3}{8}\cdot\frac{10}{21}$

105. $\frac{5}{8}\cdot\left(-\frac{2}{25}\right)$

106. $5\cdot\left(-\frac{3}{10}\right)$

107. $\frac{24}{17}\div\frac{18}{3}$

108. $-\frac{5}{12}\div\frac{10}{16}$

109. $-\frac{27}{10}\div 9$

110. $20\div\left(-\frac{5}{8}\right)$

111. $\frac{2}{9}+\frac{1}{9}$

112. $-\frac{6}{5}+\frac{4}{5}$

113. $\frac{5}{7}-\frac{2}{7}$

114. $\frac{7}{5}-\left(-\frac{8}{5}\right)$

115. $\frac{3}{10}+\frac{1}{20}$

116. $\frac{5}{12}+\frac{4}{9}$

117. $-\frac{7}{35}-\frac{2}{49}$

118. $\frac{5}{6}-\left(-\frac{1}{4}\right)$

119. $-2-\left(-\frac{5}{12}\right)$

120. $-5+\frac{9}{4}$

121. $-\frac{1}{10}+\left(-\frac{2}{5}\right)+\frac{1}{2}$

122. $-\frac{5}{6}-\frac{1}{4}+\frac{3}{24}$

In Problems 123–134, perform the indicated operation.

123. $30.3 + 18.2$

124. $-43.02 + 18.36$

125. $201.37 - 118.39$

126. $-35.1 - 18.64$

127. $(-0.04)(-2.01)$

128. $(87.3)(-2.98)$

129. $\frac{69.92}{3.8}$

130. $-\frac{1.08318}{0.042}$

131. $12.5 - 18.6 + 8.4$

132. $-13.5 + 10.8 - 20.2$