

In general, we can state the following.

Definition

For any rational number a except 0, and for all whole numbers m ,

$$a^{-m} = \frac{1}{a^m}$$

EXAMPLES

Express using positive exponents.

7 $4^{-2} = \frac{1}{4^2}$

8 $m^{-3} = \frac{1}{m^3}$

9 $ab^{-1} = a \cdot \frac{1}{b} = \frac{a}{b}$

The exponent affects only b .

Try This Express using positive exponents.

- i. 2^{-2} j. y^{-4} k. $3c^{-2}$

You know that any nonzero number divided by itself equals 1. For $\frac{a^2}{a^2} = 1$. Using the rule given above, we also find that $\frac{a^2}{a^2} = a^{2-2} =$ state the following about zero as an exponent.

Definition

$a^0 = 1$ for any rational number a except 0.

EXAMPLES

Simplify.

10 $3^{-2} = \frac{1}{3^2} = \frac{1}{9}$

11 $1^{-4} = \frac{1}{1^4} = 1$

12 $p^0 = 1$ Any nonzero number to the 0 power = 1.

Try This Simplify.

- l. 4^{-2} m. 1^{-10} n. 3^0

* Answers to pg. 207

Try This

- i. $\frac{1}{2^2}$
j. $\frac{1}{y^4}$
k. $\frac{3}{c^2}$
l. $\frac{1}{16}$
m. 1
n. 1

Exercises

1. 2^7
2. 3^7
3. 8^{14}
4. n^{23}
5. x^7
6. y^{16}
7. n^4
8. z^{14}
9. x^4
10. a^{14}
11. m^7
12. p^3

13. x^7
14. y^9
15. a^9
16. b^{10}
17. a^8b^7
18. x^7y^3
19. $p^3q^4r^5$
20. $x^9y^9z^{12}$
21. $5^2s^4t^4$
22. $2^2x^3y^4$
23. 7^3
24. 4^4
25. 8^6

26. 9^{13}
27. 1
28. 1
29. y^4
30. x
31. 1
32. h^3
33. 1
34. x^2
35. a^2b^3
36. x
37. $4x^2$
38. 6^2a^3

39. $\frac{1}{3^2}$
40. $\frac{1}{6^3}$
41. $\frac{1}{x^4}$
42. $\frac{1}{n^6}$
43. $\frac{3}{a}$
44. $\frac{1}{3x}$
45. $\frac{1}{2y}$
46. $\frac{4}{x^3}$

5-1 Exercises



Look for worked-out examples at the Prentice Hall Web site.
www.phschool.com

3. PRA LESSON QUIZ

Simplify.

- $5^6 \cdot 5^4$
- $m^4 \cdot m^5$
- $(a^2b^6)(a^4b^3)$

Express using positive exponents

- 7^{-1}
- 8^{-2}
- x^{-5}

Assignment Guide

To provide flexible scheduling lesson can be split into parts
 ▼ Core 1–22, 59, 60, 71–74
 Extension 76–78, 87–93
 ▼ Core 23–58, 61–70, 75
 Extension 79–86, 94, 95

Use Mixed Review to maintain

A
Simplify. Express using exponents.

- | | | | |
|------------------------------|-------------------------------|-------------------------------------|---------------------------------------|
| 1. $2^4 \cdot 2^3$ | 2. $3^5 \cdot 3^2$ | 3. $8^5 \cdot 8^9$ | 4. $n^3 \cdot n^{20}$ |
| 5. $x^4 \cdot x^3$ | 6. $y^7 \cdot y^9$ | 7. $n^3 \cdot n$ | 8. $z^7 \cdot z^7$ |
| 9. $x^3 \cdot x^1$ | 10. $a^6 \cdot a^8$ | 11. $m^7 \cdot m^0$ | 12. $p \cdot p \cdot p$ |
| 13. $x^4 \cdot x^2 \cdot x$ | 14. $y^2 \cdot y^4 \cdot y^3$ | 15. $a^3 \cdot a^4 \cdot a \cdot a$ | 16. $b \cdot b^5 \cdot b^2 \cdot b^2$ |
| 17. $(a^3b^6)(a^5b)$ | 18. $(x^2y)(x^5y^2)$ | 19. $(p^2q^3r^2)(pqr^3)$ | |
| 20. $(x^7y^4z^4)(x^2y^5z^8)$ | 21. $(5s^2t^3)(5s^2t)$ | 22. $(2xy^2)(2x^2y^2)$ | |
| 23. $\frac{7^5}{7^2}$ | 24. $\frac{4^7}{4^3}$ | 25. $\frac{8^{12}}{8^6}$ | 26. $\frac{9^{15}}{9^2}$ |
| 27. $\frac{6^4}{6^4}$ | 28. $\frac{2^7}{2^7}$ | 29. $\frac{y^9}{y^5}$ | 30. $\frac{x^{12}}{x^{11}}$ |
| 31. $\frac{g^5}{g^5}$ | 32. $\frac{h^4}{h}$ | 33. $\frac{m^8}{m^8}$ | 34. $\frac{x^7}{x^5}$ |
| 35. $\frac{a^3b^4}{ab}$ | 36. $\frac{x^8y}{x^7y}$ | 37. $\frac{4^3x^3}{4^2x}$ | 38. $\frac{6^4a^5b}{6^2a^2b}$ |

Express using positive exponents.

- | | | | |
|---------------|-----------------|-----------------|---------------|
| 39. 3^{-2} | 40. 6^{-3} | 41. x^{-4} | 42. n^{-6} |
| 43. $3a^{-1}$ | 44. $(3x)^{-1}$ | 45. $(2y)^{-1}$ | 46. $4x^{-3}$ |
| 47. $5c^{-4}$ | 48. $8m^{-1}$ | 49. $(3a)^{-1}$ | 50. cd^{-2} |

Mental Math Simplify. Express without using exponents.

- | | | | |
|--------------|--------------|--------------|--------------|
| 51. 4^{-2} | 52. 8^{-1} | 53. 5^{-3} | 54. 1^{-4} |
| 55. 5^0 | 56. 2^{-4} | 57. 10^0 | 58. x^0 |

B
Simplify.

- | | | | |
|-----------------------|-----------------------|-----------------------------|-------------------------------|
| 59. $(-2)^4(-2)^2$ | 60. $(-5)^2(-5)$ | 61. $\frac{(-3)^6}{(-3)^4}$ | 62. $\frac{(-10)^7}{(-10)^6}$ |
| 63. $\frac{4^3}{4^5}$ | 64. $\frac{3^4}{3^6}$ | 65. $\frac{(-2)^2}{(-2)^5}$ | 66. $\frac{(-5)^3}{(-5)^4}$ |

Simplify. Express using (a) negative exponents; (b) positive exponents.

- | | | | |
|-----------------------|---------------------|-----------------------|--------------------------|
| 67. $\frac{x^3}{x^7}$ | 68. $\frac{y}{y^4}$ | 69. $\frac{a^2}{a^6}$ | 70. $\frac{m^5}{m^{10}}$ |
|-----------------------|---------------------|-----------------------|--------------------------|

Evaluate each expression.

- | | |
|--|---|
| 71. $x^5 \cdot x^3$ for $x = 2$ | 72. $10^m \cdot 10^n$ for $m = 2$ and $n = 4$ |
| 73. $a^3 \cdot a^2 \cdot a$ for $a = -2$ | 74. $2^a \cdot 2^b \cdot 2^c$ for $a = 3, b = 2, c = 2$ |

* Answers
on page 206

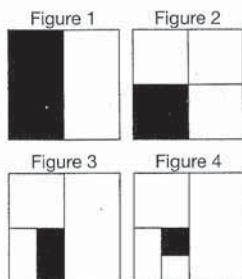
5-1 Exponents 207

- $\frac{5}{c^4}$
- $\frac{8}{m}$
- $\frac{1}{3a}$
- $\frac{c}{d^2}$
- $\frac{1}{16}$
- $\frac{1}{8}$
- $\frac{1}{125}$
- 1
- 1

- $\frac{1}{16}$
- 1
- 1
- 64
- 125
- 9
- 10
- $\frac{1}{16}$
- $\frac{1}{9}$
- $-\frac{1}{8}$
- $-\frac{1}{5}$

- (a) x^{-4}
- (b) $\frac{1}{x^4}$
- (a) y^{-3}
- (b) $\frac{1}{y^3}$
- (a) a^{-4}
- (b) $\frac{1}{a^4}$
- (a) m^{-5}
- (b) $\frac{1}{m^5}$

- 256
- 1,000,000
- 64
- 128



75. **Multi-Step Problem** Use the figures at the left.
- What fraction of each figure is shaded?
 - Rewrite each fraction in part (a) as a power of 2.
 - Mathematical Reasoning** What pattern occurs in your answers to part (b)?
 - If the pattern were to continue to Figure 10, what portion of the square would be shaded?

Error Analysis Find and correct each error in Exercises 76 and 77.

76. $(3x^2)(2x^5) = 6x^{2 \cdot 5} = 6x^{10}$ 77. $x^5 \cdot x \cdot x^2 = x^{5+2} = x^7$

78. **TEST PREP** If $5^{x+1} = 125$, what is the value of x ?

- A. 2 B. 3 C. 4 D. 5

Simplify.

79. $\frac{4^2 \cdot 4^5}{4^3}$ 80. $\frac{2^5 \cdot 3^4}{2^2 \cdot 3^2}$ 81. $\frac{a^2 \cdot b^3}{a^2 \cdot b^5}$ 82. $\frac{m^5 \cdot n^6}{m^2 \cdot m^2}$

83. $4^{-1} \cdot 4^5$ 84. $\frac{(-3)}{(-3)^{-4}}$ 85. $\frac{x^6 \cdot x^{-2}}{x^2}$ 86. $\frac{a^{-2} \cdot b^{-3}}{a^4 \cdot b^{-1}}$

87. **Critical Thinking** Is $(a + b)^m = a^m + b^m$ true for all numbers? If yes, justify your answer. If no, give a counterexample.

Challenge

Write each of the following as a power of 2.

88. 16 89. 4^3 90. 8^2 91. $4^3 \cdot 8 \cdot 16$

92. Write $2^8 \cdot 16^3 \cdot 64$ as a power of 4.

93. Write $9 \cdot 27 \cdot 3 \cdot 81$ as a power of 3.

Simplify.

94. $\frac{\left(\frac{1}{c}\right)^4}{\left(\frac{1}{c}\right)^5}$ 95. $\frac{\left(\frac{a}{b}\right)^3}{\left(\frac{a}{b}\right)^6}$

Mixed Review

Simplify. 96. $3[8 - 2(t + 3)]$ 97. $(5m + 6n) - (6m + 9n)$

98. $6a - 9a(4a + 3)$ 99. $7a(a + 2) + 3a^2 + 2a^2 - 28$

Write as an algebraic expression. 100. the difference of w and 4

101. 8 less than the product of a and c 102. twice the sum of m and n

Solve. 103. $m - 422 = -53$ 104. $21t = -693$

105. $6(m + 3) = 10m - 2$ 106. $\frac{3}{4}c + 4 = \frac{1}{4}c - 2$

107. Frank needs a new shirt and sweater and wants to spend at most \$45. If he finds a shirt for \$18, how much can he spend on a sweater?

Exercises

1. $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}$
2. $2^{-1}, 2^{-2}, 2^{-3}, 2^{-4}$

∴ 2 raised to the opposite of the figure number

3. 2^{-10}

The exponents were multiplied when they should have been added.

$(3x^2)(2x^5) = 6x^{2+5} = 6x^7$

When the exponents were added, the exponent of the x term, which is 1, was not included.

$x^5 \cdot x \cdot x^2 = x^{5+1+2} = x^8$

78. A

79. 256

80. 72

81. b^{-2} or $\frac{1}{b^2}$

82. mn^6

83. 256

84. -243

85. x^2

86. $\frac{1}{a^6 b^2}$

87. No; let

$a = 1, b = 2, m = 3, 27 \neq 9$

88. 2^4

89. 2^6

90. 2^6

91. 2^{13}

92. 4^{13}

93. 3^{10}

94. c

95. $\frac{b^3}{a^3}$

98. $-21a - 36a^2$

99. $12a^2 + 14a$

100. $w - 4$

101. $ac - 8$

102. $2(m + n)$

103. 369

104. -33

105. 5

106. -12

107. \$27 or less

Mixed Review

96. $6 - 6t$

97. $-m - 3n$

3. PRACTICE/ASSESS

LESSON QUIZ

Simplify.

- $(7^6)^3$
 7^{18}
- $(w^4)^9$
 w^{36}
- $(6x)^3$
 $6^3x^3 = 216x^3$
- $(3y^3)^4$
 $3^4y^{12} = 81y^{12}$
- $(2a^2b^4)^5$
 $2^5a^{10}b^{20} = 32a^{10}b^{20}$
- $\left(\frac{x^3}{4}\right)^3$
 $\frac{(x^3)^3}{4^3} = \frac{x^9}{4^3} = \frac{x^9}{64}$

Assignment Guide

To provide flexible scheduling, this lesson can be split into parts.

▼ Core 1–12
Extension 68–73, 78–81,

▼ Connections
Core 13–67
Extension 74–77

Use Mixed Review to maintain skills.



Look for worked-out examples at the Prentice Hall Web site.
www.phschool.com

5-2 Exercises

A

Simplify.

- | | | | |
|------------------------------------|------------------------------------|--------------------------------------|--------------------------------------|
| 1. $(2^5)^2$ | 2. $(3^4)^3$ | 3. $(5^2)^3$ | 4. $(6^8)^9$ |
| 5. $(y^5)^9$ | 6. $(x^3)^5$ | 7. $(m^8)^4$ | 8. $(n^5)^{12}$ |
| 9. $(a^6)^5$ | 10. $(y^7)^7$ | 11. $(p^{10})^{10}$ | 12. $(w^{12})^7$ |
| 13. $(3y)^4$ | 14. $(2t)^5$ | 15. $(7y)^3$ | 16. $(8x)^4$ |
| 17. $(5m)^2$ | 18. $(4y)^5$ | 19. $(7x)^4$ | 20. $(12a)^3$ |
| 21. $(2m^2)^2$ | 22. $(4n^3)^2$ | 23. $(5y^4)^3$ | 24. $(3x^5)^4$ |
| 25. $(-6t^2)^3$ | 26. $(-10b^6)^2$ | 27. $(8k^4)^3$ | 28. $(7x^5)^3$ |
| 29. $(2x^8y^3)^2$ | 30. $(3mn^4)^3$ | 31. $(\frac{1}{2}2x^2y^4)^3$ | 32. $(-3m^4)^2$ |
| 33. $(4x^2y^3z)^4$ | 34. $(2m^5n^4p^3)^3$ | 35. $\left(\frac{3}{a}\right)^3$ | 36. $\left(\frac{7}{x}\right)^2$ |
| 37. $\left(\frac{x^2}{4}\right)^4$ | 38. $\left(\frac{y^5}{3}\right)^2$ | 39. $\left(\frac{m^4}{n^2}\right)^3$ | 40. $\left(\frac{a^8}{b^4}\right)^3$ |

B

Simplify.

- | | | |
|--|--|--|
| 41. $\left(\frac{3 \cdot 2^2}{5}\right)^3$ | 42. $\left(\frac{5 \cdot 2^4}{3}\right)^2$ | 43. $\left(\frac{xy^2}{z}\right)^3$ |
| 44. $\left(\frac{ab^4}{c}\right)^3$ | 45. $\left(\frac{-2x^2y^6}{5}\right)^2$ | 46. $\left(\frac{3x^3y^3}{2}\right)^4$ |
| 47. $\left(\frac{-4m^2n^5}{3}\right)^3$ | 48. $\left(\frac{-5p^4q^3}{2}\right)^3$ | 49. $[(-x^5)^6]^2$ |
| 50. $[(-y)^{18}]^2$ | 51. $\left(\frac{-x}{3y}\right)^3$ | 52. $\left(\frac{2c}{-y}\right)^4$ |
| 53. $\left(\frac{x^2y}{z}\right)^3$ | 54. $\left(\frac{m}{n^4p}\right)^3$ | 55. $\left(\frac{-3a^2b^4}{4c^3}\right)^2$ |
| 56. $\left(\frac{2m^5n^5}{p^4}\right)^3$ | 57. $(2n)^4\left(\frac{3}{2}n\right)^3$ | 58. $(4x^3)^2 + (2y^4)^2$ |
| 59. $(7a)(4a) - (3a)^2$ | 60. $(-2y^2)^3 + 4y(2y^5)$ | 61. $(-3z^4)^2 - (-5z^3)^2$ |
| 62. $(6cd^2)^2 + 3cd(cd^3)$ | 63. $3z^3(2z^4) - (-5z^3)^2$ | 64. $b^2(a^3b)^2 + a^2(a^2b^2)^2$ |
| 64. $b^2(a^3b)^2 + a^2(a^2b^2)^2$ | 65. $(3c^4)^2(2c)$ | 66. $(-2x^2y^3)^4(xy)^3$ |
| 66. $(-2x^2y^3)^4(xy)^3$ | 67. $(-3a^2b^4)^3(4a^3b)^2$ | |
68. **Critical Thinking** Does $(a^m)^n = (a^n)^m$ for all rational numbers m and n ? If yes, explain why. If no, provide a counterexample.
69. **TEST PREP** If $y = 2^x$, which of the following equals $4y$?
 A. 2^{2x} B. 2^{2+x} C. 2^{x^2} D. 4^x

Exercises

- | | | | | |
|---------------|---------------|------------------------|-----------------------------|---------------------------------|
| 1. 2^{10} | 12. w^{84} | 25. $-216t^6$ | 36. $\frac{49}{x^{14}}$ | 44. $\frac{a^3b^{12}}{c^3}$ |
| 2. 3^{12} | 13. $81y^4$ | 26. $100b^{12}$ | 37. $\frac{x^8}{256}$ | 45. $\frac{4x^4y^{12}}{25}$ |
| 3. 5^6 | 14. $32t^5$ | 27. $512k^{12}$ | 38. $\frac{y^{10}}{9}$ | 46. $\frac{81x^{12}y^{12}}{16}$ |
| 4. 6^{72} | 15. $343y^3$ | 28. $343x^{15}$ | 39. $\frac{m^{12}}{n^6}$ | 47. $\frac{64m^6n^{15}}{27}$ |
| 5. y^{45} | 16. $4096x^4$ | 29. $4x^{16}y^6$ | 40. $\frac{a^{24}}{b^{12}}$ | 48. $\frac{125p^{12}q^9}{8}$ |
| 6. x^{15} | 17. $25m^2$ | 30. $27m^3n^{12}$ | 41. $\frac{1728}{125}$ | 49. x^{30} |
| 7. m^{32} | 18. $1024y^5$ | 31. $-8x^6y^{12}$ | 42. $\frac{6400}{9}$ | 50. y^{36} |
| 8. n^{60} | 19. $2401x^4$ | 32. $9m^8n^4$ | 43. $\frac{x^3y^6}{z^3}$ | 51. $\frac{-x^3}{27y^3}$ |
| 9. a^{30} | 20. $1728a^3$ | 33. $256x^8y^{12}z^4$ | | |
| 10. y^{49} | 21. $4m^4$ | 34. $8m^{15}n^{12}p^9$ | | |
| 11. p^{100} | 22. $16n^6$ | 35. $\frac{27}{a^6}$ | | |

Challenge

Simplify.

70. $x^{2a}x^4$

72. $x^{a+4}x^3$

74. $(a^{n+1}b^{m+2})^3$

76. $(c^3d)^a(cd^7)^a$

71. $x^{3a}x^{2b}$

73. x^5x^{2a-4}

75. $(x^a y^{a-3})^3$

77. $x^2(x^{a+2}y^3)$

Solve for a .

78. $x^{a+4} = x^4x^8$

80. $x^{2a} = \frac{x^{12}}{x^9}$

79. $x^{a-3} = x^5x^3$

81. $x^{3a} = x^4x^6$

Mixed Review

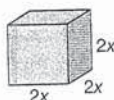
Simplify. 82. $6c + (-9m) - 5c + m$ 83. $21 - 8x - 9 - (-7x)$

Give the reciprocal. 84. $\frac{x}{y}$ 85. $\frac{5c}{8}$ 86. $\frac{-5}{2a}$ 87. $\frac{m}{2}$ 88. $\frac{7}{t}$

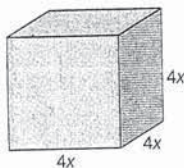
Solve. 89. $m + 4 = -3m$ 90. $4x + 2x = 9x - 6$

Connections: Geometry

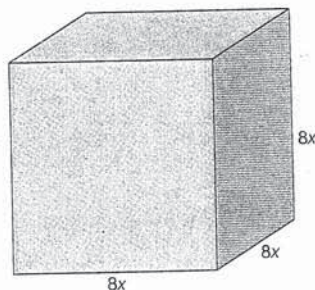
1. Find the volume of a cube with sides of length $2x$.



2. Suppose the cube has sides of length $4x$. What would its volume be?



3. Suppose the cube has sides of length $8x$. What would its volume be?



4. How do the volumes of each of the cubes above change as the dimension doubles?

52. $\frac{16c^4}{y^4}$

53. $\frac{x^6y^3}{z^3}$

54. $\frac{m^3}{n^{12}p^3}$

55. $\frac{9a^4b^8}{16c^6}$

56. $\frac{8m^{15}n^{15}}{p^{12}}$

57. $54n^7$

58. $24x^6$

59. $19a^2$

60. 0

61. $8z^8$

62. $39c^2d^4$

63. $6z^7 - 25z^6$

64. $2a^6b^4$

65. $18c^9$

66. $16x^{11}y^{15}$

67. $-432a^{12}b^{14}$

68. Yes. We know

$(a^m)^n = a^{mn}$.

By the commutative

property $mn = nm$,

so $a^{mn} = a^{nm}$. Since

$a^{nm} = (a^n)^m$,
 $(a^m)^n = (a^n)^m$.

69. B

70. x^{2a+4}

71. x^{3a+2b}

72. x^{a+7}

73. x^{2a+1}

74. $a^{3n+3}b^{3m+6}$

75. $x^{3a}y^{3a-9}$

76. $c^{4a}d^{8a}$

77. $x^{a+4}y^3$

78. $a = 8$

79. $a = 11$

80. $a = \frac{3}{2}$

81. $a = \frac{10}{3}$

Mixed Review

82. $c - 8m$

83. $12 - x$

84. $\frac{y}{x}$

85. $\frac{8}{5c}$

86. $-\frac{2a}{5}$

87. $\frac{2}{m}$

88. $\frac{t}{7}$

89. $m = -1$

90. $x = 2$

Connections: Geometry

1. $(2x)^3$ or $8x^3$

2. $(4x)^3$ or $64x^3$

3. $(8x)^3$ or $512x^3$

4. As the dimension doult increases 8 times.

2 Dividing Monomials

Objective: Divide monomials.

can also divide monomials using the properties of rational numbers and properties of exponents.

EXAMPLES Divide.

$$\frac{x^5}{x^2} = x^{5-2} = x^3$$

$$\frac{4x^2}{5x^7} = \frac{4}{5} \cdot x^{2-7} = \frac{4}{5}x^{-5} = \frac{4}{5x^5}$$

$$\frac{8x^5y^{12}}{-2x^3y^{10}} = \frac{8}{-2} \cdot x^{5-3}y^{12-10} = -4x^2y^2$$

Try This Divide.

$$\frac{x^8}{x^5} \quad \text{j. } \frac{12m^5}{8m^8} \quad \text{k. } \frac{-5x^3y^4}{-5x^2y} \quad \text{l. } \frac{-32x^{15}y^7}{8x^{14}y^6}$$

5-3 Exercises

Multiply.

- | | | |
|--------------------------|----------------------------|---------------------------|
| 1. $(6x^2)(7)$ | 2. $(5y^3)(-2)$ | 3. $(-x^3)(-x)$ |
| 4. $(-y^4)(y^2)$ | 5. $(-x^5)(x^3)$ | 6. $(-m^6)(-m^2)$ |
| 7. $(3a^4)(2a^2)$ | 8. $(5x^3)(4x^5)$ | 9. $(7t^5)(4t^3)$ |
| 10. $(-3b^3)(5b^5)$ | 11. $(3g^4)(-6g^3)$ | 12. $(h^5)(-7h^3)$ |
| 13. $(-6x^3)(x^8)$ | 14. $(-8m^7)(-4m^3)$ | 15. $(-5n^4)(-5n^4)$ |
| 16. $(-x^7)(5x^{12})$ | 17. $(x^3y^4)(x^4y^2)$ | 18. $(2m^3n^2)(-3m^6n^5)$ |
| 19. $(4a^4b^8)(2a^4b^2)$ | 20. $(-2x^3y)(-6x^9y^8)$ | 21. $(y^5)(2y)(3y^2)$ |
| 22. $(3x^4)(x^4)(5x^2)$ | 23. $(-4m^2)(5m^4)(-2m^3)$ | 24. $(9b^2)(2b^5)(-3b^7)$ |

Divide.

- | | | | |
|--------------------------|---------------------------|----------------------------|-------------------------|
| 25. $\frac{x^6}{x^2}$ | 26. $\frac{a^7}{a}$ | 27. $\frac{4x^5}{2x^2}$ | 28. $\frac{-6a^3}{6a}$ |
| 29. $\frac{12m^4}{4m^4}$ | 30. $\frac{-4x^6}{-2x^6}$ | 31. $\frac{5a^3}{a^7}$ | 32. $\frac{15y^8}{3}$ |
| 33. $\frac{-h^5}{2h^4}$ | 34. $\frac{k^3}{3k^8}$ | 35. $\frac{2x^{10}}{8x^5}$ | 36. $\frac{3m^5}{6m^7}$ |

5-3 Multiplying and Dividing Monomials 215

Try This

- i. x^3
j. $\frac{3}{2m^3}$
k. xy^3
l. $-4xy$

Exercises

1. $42x^2$
2. $-10y^3$
3. x^4
4. $-y^6$
5. $-x^8$

6. m^8

7. $6a^6$

8. $20x^8$

9. $28t^8$

10. $-15b^8$

11. $-18g^7$

12. $-7h^8$

13. $-6x^{11}$

14. $32m^{10}$

15. $25n^8$

16. $-5x^{19}$

17. x^7y^6

18. $-6m^9n^7$

19. $8a^8b^{10}$

20. $12x^{12}y^9$

21. $6y^8$

22. $15x^{10}$

23. $40m^9$

24. $-54b^{14}$

25. x^4

26. a^6

27. $2x^3$

28. $-a^2$

29. 3

30. 2

31. $\frac{5}{a^4}$

32. $5y^8$

33. $-\frac{1}{2}h$

34. $\frac{1}{3k^5}$

35. $\frac{1}{4}x^5$

36. $\frac{1}{2m^2}$

2 Dividing Monomials

You may want to illustrate the algebraic concept with an arithmetic example. For instance,

$$\frac{4^3}{4^2} = \frac{4 \cdot 4 \cdot 4}{4 \cdot 4} = \frac{64}{16} = 4$$

or

$$\frac{4^3}{4^2} = 4^{3-2} = 4^1 = 4$$

Key Question

■ Is the quotient of two monomials always a monomial?

No, the quotient may not have whole-number exponents. For example $x \div y = \frac{x}{y}$ or xy^{-1} . This is not a monomial.

Chalkboard Examples

Divide.

1. $\frac{y^7}{y^4}$

$$y^{7-4} = y^3$$

2. $\frac{6a^9}{8a^4}$

$$\frac{6}{8}(a^{9-4}) = \frac{3}{4}a^5$$

3. $\frac{9a^3b^5}{3a^2b^3}$

$$\frac{9}{3}a^{3-2}b^{5-3} = 3ab^2$$

3. PRACTICE/ASSESS

LESSON QUIZ

Multiply.

1. $(4x)(-5)$

$$-20x$$

2. $(-3a^5)(4a^7)$

$$-12a^{12}$$

3. $(x^3)(-6x^2)(4x^5)$

$$-24x^{10}$$

Divide.

4. $\frac{y^9}{y^2}$

$$y^7$$

5. $\frac{4x^7}{2x^3}$

$$2x^4$$

Assignment Guide

To provide flexible scheduling, this lesson can be split into parts.

▼ Core 1–24, 49–60

Extension 70, 71, 74–77

▼ Core 25–48, 61–68

Extension 69, 72, 73

Use Mixed Review to maintain skills.

37. $\frac{16x^2}{-4x^2}$ 38. $\frac{-25a^7}{-25}$ 39. $\frac{45x^3}{15x^2}$ 40. $\frac{6m^6}{2m^2}$
 41. $\frac{10x^5y^4}{2x^3y}$ 42. $\frac{-12m^7n^8}{4m^2n^5}$ 43. $\frac{24a^6b^9}{-6a^6b^3}$ 44. $\frac{48x^6y^7}{12xy^5}$
 45. $\frac{-12p^{8r-3}}{4p^{6r-4}}$ 46. $\frac{2x^{12}y^5}{3x^4y^2}$ 47. $\frac{5a^{11}b^7}{-7a^5b^9}$ 48. $\frac{6x^{13}y^4}{24x^5y^7}$

B

Simplify.

49. $x^3(x^4)^2$ 50. $p(p^4)^3$ 51. $(a^3)^2(a^4)^3$
 52. $(m^2)^4(m^3)^2$ 53. $(2x^2)(3x^3)^2$ 54. $(3y^4)(5y^4)^2$
 55. $(3x^4)^2(2x^5)^2$ 56. $(4y)^3(-2y^2)^2$ 57. $(2x^2y)(3x^4y^5)^2$
 58. $(-3mn^4)(4mn^2)$ 59. $(ab^2)^3(a^3b^4)^2$ 60. $(m^3n)^2(mn^5)^3$
 61. $\frac{(-2x^2)^2}{x^3}$ 62. $\frac{(3a^3)^2}{18a^2}$ 63. $\frac{(4y^3)^2}{(4y^2)^2}$ 64. $\frac{(-5m)^4}{(-25m^2)^2}$
 65. $\frac{a^4b^5}{3a^2b^6}$ 66. $\frac{2x^6y^4}{8x^4y^7}$ 67. $\frac{-2m^3}{-4m^4n^6}$ 68. $\frac{-4ab^3}{-8a^2b^4}$

69. **Critical Thinking** When a monomial is multiplied or divided by a certain monomial, you get the same result. What must be true of the certain monomial?

Challenge

Simplify.

70. $(5x^{-2})(2x^{-4})$ 71. $(8m^{-3})(-4m^4)(m^{-4})$
 72. $\frac{25b^{16}}{5b^{-12}}$ 73. $\frac{12m^{-10}}{-4m^5}$
 74. $(3a^{-2}b^4)(-4a^6b^{-7})$ 75. $(5x^6y^7)(3x^{-6}y^{-7})$
 76. $(5x^{-4}y^{-6}z^5)(-4x^5y^5z^{-3})(-4x^2yz^{-1})$ 77. $(qrs)(-qrs^3)(-5q^{-3}r^4s^{-5})$

Mixed Review

Each problem below involves the sum or difference of monomials. Simplify each expression by collecting like terms.

78. $3x + 2y + 4x$ 79. $7x + 3y^2 + y^2$ 80. $8pt + 4t + 2pt + t$ 1-5
 81. $5m - 7m$ 82. $m - 3n - 2n$ 83. $14a + b - 5a - 3b$ 2-7
 Write each as a decimal. 84. 15% 85. 0.04% 86. 125% 3-10

Solve. 87. $8x + 4 - 6x < -10$ 88. $6x \leq -36$ 89. $3 - 6x < 9$ 4-4

90. There were 407 books in the school library. The ninth grade returned 23 books and checked out 17; the tenth grade returned 15 books and checked out 29; the twelfth grade checked out 26 books and returned 30. How many books were left in the library? 2-1, 2-4

Exercises

37. -4
 38. a^7
 39. $3x$
 40. $3m^4$
 41. $6x^2y^3$
 42. $-3m^5n^3$
 43. $-4b^6$
 44. $4x^5y^2$
 45. $\frac{-3p^2}{r}$
 46. $\frac{2x^5y^3}{3}$
 47. $\frac{-5a^4}{7b^2}$

48. $\frac{x^8}{4y^3}$ 59. a^9b^{14}
 49. x^{11} 60. m^8n^{17}
 50. p^{13} 61. $4x$
 51. a^{18} 62. $\frac{a^4}{2}$
 52. m^{14} 63. y^2
 53. $18x^8$ 64. 1
 54. $75y^{12}$ 65. $\frac{a^2}{3b}$
 55. $36x^{18}$ 66. $\frac{x^2}{4y^3}$
 56. $256y^7$ 67. $\frac{1}{2mn^6}$
 57. $6x^6y^6$ 68. $\frac{1}{2ab}$
 58. $-12m^2n^6$

69. It must be equal to one.
 70. $\frac{10}{x^6}$
 71. $\frac{-32}{m^3}$
 72. $5b^{28}$
 73. $-\frac{3}{m^{15}}$
 74. $-\frac{12a^4}{b^3}$
 75. 15
 76. $80x^3z$
 77. $\frac{5r^6}{qs}$

Mixed Review

78. $7x + 2y$
 79. $4y^2 + 7x$
 80. $10pt + 5t$
 81. $-2m$
 82. $m - 5n$
 83. $9a - 2b$
 84. 0.15
 85. 0.0004
 86. 1.25
 87. $x < -7$
 88. $x \leq -6$
 89. $x > -1$
 90. 403

Calculating with Scientific Notation

Some calculators allow you to enter numbers in scientific notation. Using a scientific calculator, follow the example below. The **EXP** key tells the calculator that you are entering a power of ten. If the exponent is negative, enter the negative sign after you enter the exponent.

Problem in standard notation

$$(42,000,000)(250,000,000) = 10,500,000,000,000,000$$

Problem using scientific notation

$$(4.2 \times 10^7)(2.5 \times 10^8) = (4.2)(2.5) \times (10^7)(10^8) \\ = 10.5 \times 10^{15} = 1.05 \times 10^{16}$$

Using a calculator

$$4.2 \text{ EXP } 7 \times 2.5 \text{ EXP } 8 = 1.05 \text{ E } 16$$

Notice that the calculator display shows only the 16 rather than 10^{16} .

5-4 Exercises

A

Write using standard notation.

- | | | |
|---------------------------|----------------------------|---------------------------|
| 1. 5.543×10^3 | 2. 3.29×10^2 | 3. 2.35×10^{-3} |
| 4. 1.743×10^{-4} | 5. 5.7×10^4 | 6. 4.89×10^5 |
| 7. 3.4×10^{-5} | 8. 4×10^3 | 9. 6×10^{-4} |
| 10. 1.206×10^2 | 11. 3.007×10^{-3} | 12. 8.04×10^{-5} |

Write using scientific notation.

- | | | | |
|---------------|----------------|---------------|-----------------|
| 13. 425 | 14. 0.478 | 15. 12,400 | 16. 32,060 |
| 17. 0.045 | 18. 0.00003 | 19. 125,000 | 20. 12 |
| 21. 5,200,000 | 22. 12,400,000 | 23. 0.0000056 | 24. 0.000000032 |

Multiply or divide. Express your answer in scientific notation.

- | | | |
|---|---|---|
| 25. $(7 \times 10^4)(2 \times 10^2)$ | 26. $(2.2 \times 10^{-3})(3.0 \times 10^5)$ | |
| 27. $(4.0 \times 10^7)(8.0 \times 10^3)$ | 28. $(6.1 \times 10^9)(2.5 \times 10^{-4})$ | |
| 29. $(2.5 \times 10^{-3})(4.0 \times 10^{-8})$ | 30. $(5.4 \times 10^{-6})(5.1 \times 10^{-8})$ | |
| 31. $\frac{(6.0 \times 10^7)}{(3.0 \times 10^2)}$ | 32. $\frac{(9.0 \times 10^8)}{(3.0 \times 10^2)}$ | 33. $\frac{(8.4 \times 10^6)}{(2.0 \times 10^8)}$ |
| 34. $\frac{(6.9 \times 10^4)}{(3.0 \times 10^8)}$ | 35. $\frac{(1.5 \times 10^{-2})}{(3 \times 10^{-4})}$ | 36. $\frac{(2.7 \times 10^{12})}{(9.0 \times 10^{12})}$ |



Look for worked-out examples at the Prentice Hall Web site.
www.phschool.com

Problems involving large numbers also be done on calculators that have exponential notation. Write the numbers in scientific notation, perform the calculations on a calculator, and use the laws of exponents to determine the magnitude of the result.

3. PRACTICE/ASSESS

LESSON QUIZ

Write using standard notation.

1. 6.420×10^2

642

2. 1.357×10^5

135,700

Write using scientific notation.

3. 987654321

9.87654321×10^8

Multiply or divide. Express the result in scientific notation.

4. $(4.4 \times 10^{-5})(7.0 \times 10^{-5})$

3.08×10^{-9}

5. $\frac{8.1 \times 10^{-6}}{1.8 \times 10^9}$

4.5×10^{-15}

Assignment Guide

▼ Core 1–44, 46, 47

Extension 45, 48–51

Use Mixed Review to maintain skills.

Exercises

- 5543
- 329
- 0.00235
- 0.0001743
- 57,000
- 489,000
- 0.000034
- 4000
- 0.0006
- 120.6
- 0.003007
- 0.0000804
- 4.25×10^2

- 4.78×10^{-1}
- 1.24×10^4
- 3.206×10^4
- 4.5×10^{-2}
- 3×10^{-5}
- 1.25×10^5
- 1.2×10
- 5.2×10^6
- 1.24×10^7
- 5.6×10^{-6}
- 3.2×10^{-8}
- 1.4×10^7
- 6.6×10^2
- 3.2×10^{11}

- 1.525×10^6
- 1.0×10^{-10}
- 2.754×10^{-13}
- 2.0×10^5
- 3.0×10^6
- 4.2×10^{-2}
- 2.3×10^{-4}
- 5.0×10^1
- 3.0×10^{-1}



Practice Multiple Choice

Choose the best answer.

1. Simplify.

$$(5x^3y^4z)^3$$

- A $15x^9y^4z$
- B $15x^9y^4z^3$
- C $125x^6y^7z^4$
- D $125x^9y^{12}z^3$

2. Simplify.

$$\left(\frac{-10m^3n^2}{2rt^2}\right)^2$$

- F $\frac{25m^6n^2}{r^2t^4}$
- G $\frac{-50m^5n}{r^2t^4}$
- H $\frac{-5m^5n^3}{r^3t^4}$
- J $\frac{-8m^5n^3}{r^3t^4}$

1. D; Algebra 2.0
2. F; Algebra 2.0

220 Chapter 5 Exponents and Polynomials

Exercises

37. $4.08 \times 10^4 = 40,800$
 38. $5.915 \times 10^{10} = 59,150,000,000$
 39. $8.32 \times 10^{-8} = 0.0000000832$
 40. $4.075 \times 10^{-9} = 0.000000004075$
 Since all data are approximations, answers to Exercises 41–47 will be approximate. Students' answers may vary if they use a calculator.
 41. $1.5 \times 10^8 \text{ km} = 150,000,000 \text{ km}$
 42. $6.3072 \times 10^{10} \text{ s} = 63,072,000,000 \text{ s}$
 43. Answers may vary.
 44. $3.913 \times 10^{-2} \text{ g} = 0.03913 \text{ g}$

45. C

46. $5.8657 \times 10^{12} \text{ mi}$
 $= 5,865,700,000,000 \text{ mi}$
 47. $1.5 \times 10^4 = 15,000 \text{ s}$
 48. $1.24 \times 10^{-3} = 0.00124$
 49. 8×10^2
 50. 3×10^{-2}
 51. 2.5×10^{-1}

Mixed Review

52. $3(7 - 5t)$
 53. $3(3a + 2)$
 54. $15(2 + k)$

B

Divide. Express the result using scientific and standard notation.

37. $\frac{(3.4 \times 10^6)(6 \times 10^3)}{(5 \times 10^5)}$ 38. $\frac{(4.55 \times 10^3)(2.6 \times 10^5)}{(2 \times 10^{-2})}$
 39. $\frac{(5.2 \times 10^{-4})(4 \times 10^5)}{(2.5 \times 10^9)}$ 40. $\frac{(5 \times 10^{-3})(3.26 \times 10^{-4})}{(4 \times 10^2)}$

41. Light traveling from the sun at about $3.0 \times 10^5 \text{ km}$ per second takes about 5.0×10^2 seconds to reach Earth. Approximately what is the distance, expressed in scientific notation, from the sun to Earth?
 42. **Estimation** Approximately how many seconds are there in 2000 years? Assume 365 days per year.
 43. **Estimation** About how many seconds have you been alive?
 44. A certain molecule has a mass of $3.01 \times 10^{-23} \text{ g}$. There are 1.3×10^{21} of these molecules in a drop. What is the approximate mass of these molecules?
 45. **TEST PREP** Compare the quantities in Column A and Column B.
- | | |
|------------------------------------|---------------------------------|
| <u>Column A</u> | <u>Column B</u> |
| three times (3.6×10^{-3}) | half of (2.16×10^{-2}) |
- A. The quantity in Column A is greater.
 B. The quantity in Column B is greater.
 C. The quantities are equal.
 D. The relationship cannot be determined from the information given.
46. Light travels 1.86×10^5 miles in 1 second. How far does light travel in one year (light year)?
 47. Neptune is approximately 2,790,000,000 mi from the sun. About how many seconds does it take light from the sun to reach Neptune?
 48. **Critical Thinking** Use the digits 1, 2, 3, and 4 and one negative sign to write a number in scientific notation that is close to 0.001.

Challenge

Solve for y.

49. $(8 \times 10^4)y = 6.4 \times 10^7$ 50. $(3.1 \times 10^5)y = 9.3 \times 10^3$
 51. Simplify $\frac{(3.6 \times 10^6)(4 \times 10^{-3})}{(4.8 \times 10^{-2})(1.2 \times 10^6)}$

Mixed Review

- Factor. 52. $21 - 15t$ 53. $9a + 6$ 54. $30 + 15k$
 55. $12m - 4n$ 56. $3a^2 + 6a + 9$ 2-7, 1-5
 Simplify. 57. $5x + (2x - 6)$ 58. $(11y + 9) - 6y$
 59. $4a - (3a + 15)$ 60. $(4x - 7) - (3x - 7)$ 2-8

PRACTICE/ASSESS

CONCEPT QUIZ

Determine whether each of the following is a polynomial.

$x^2 - y^2 + xy^2$ Yes

$a^2 - \frac{a^2}{5} + b^2$ Yes

Identify the terms. Give the coefficient of each term.

$5x^2y^3 - 4y^2 - 3$

The term $5x^2y^3$ has coefficient 5.

The term $-4y^2$ has coefficient -4 .

The term -3 has coefficient -3 .

Collect like terms.

$3 - 5x^4 + 7 + 8x^4 + x$

$10 + x + 3x^4$

$4a^3b^6 + 2ab + 3a^3b^6 + 5ab$

$7a^3b^6 + 7ab$

Identify the degree of each term and the degree of the polynomial.

$3x^5 + 4x^3 + 1$

$3x^5$ is of degree 5.

$4x^3$ is of degree 3.

1 is of degree 0.

The degree of the polynomial is 5.

Assignment Guide

To provide flexible scheduling, this lesson can be split into parts.

▼ Core 1–24

Extension 54, 55

▼ Core 25–39 odd, 49–53

Extension 41

▼ Core 26–40 even, 42–47,

Extension 48, 56

Use Mixed Review to maintain skills.



Extra Help On the Web

Look for worked-out examples at the Prentice Hall Web site.

www.phschool.com

Try This Identify the degree of each term. Give the degree of the polynomial.

j. $-6x^4 + 8x^2 - 2x + 9$

k. $9x^6y^5 - 7x^4y^3 + 3x^3y^4 + 17x$

5-5 Exercises

A

Tell whether each expression is a polynomial. If it is a polynomial, identify it as a monomial, binomial, or trinomial.

1. $\frac{1}{x}$

3. $7 + 6x^2$

5. $-4m^5 + \frac{6}{m} - 1$

7. $-12ab^7 - 12$

9. -43

11. $-h^2 - 3h + 8$

13. $\frac{r^2}{7}$

2. $5x^3 - 6x - 3$

4. $15p^2qr^5$

6. $a^2 + ab + b^3$

8. $4 + y$

10. $y^3 - 3y^2 - 5$

12. $5x^5y^3 + 5x^3y^2 + 6$

14. $\frac{7}{r^2}$

Identify the terms. Give the coefficient of each term.

15. $-4m^9 + 6m - 1$

17. $2x^2y + 5xy^2 - 6y^4$

19. $8p^3 + 2pq - 4$

21. $-3n^6 + 3n - 3$

23. $x^8y^6 - 2x^6y^6 + 8x^4y^7 - 4xy^8$

24. $12m^{12} - 8m^{11}n^{10} + 5m^5n^{11} - m^4n^{12} + n^{14}$

Collect like terms.

25. $2x - 5x$

27. $2x^2 + 8x^2$

29. $x^3 - 5x - 2x^3$

31. $6x^4 - 3x^4 + 7$

33. $5x^3 - 3 - 2x^3$

35. $3a^4 - 2a + 2a + a^4$

37. $4xy^2 + 2x^2y - xy^2 + 3x^2y$

39. $2ab^2 + 3ab - 5a^2b + 4ab^2$

26. $x - 9x$

28. $3x^2 - 4x^2$

30. $5x^3 + 6x^3 + 4$

32. $6x^4 - 2x^4 + 5$

34. $-3x^4 - 6x^4 + 5$

36. $2x^2 - 6x + 3x + 4x^2$

38. $-7m^2n^2 + 2mn - 2m^2n^2 - 4mn$

40. $6x^2 + 5xy^2 + 2x^2 - 3xy^2$

41. **Error Analysis** A student simplified $7x^3 - x^3$ and got 7 as a result. Write an explanation of the student's error using the words *coefficient* and *like terms*.

Try This

j. 4, 2, 1, 0; 4

k. 11, 7, 7, 1; 11

Exercises

1. No

2. Yes; trinomial

3. Yes; binomial

4. Yes; monomial

5. No

6. Yes; trinomial

7. Yes; binomial

8. Yes; binomial

9. Yes; monomial

0. Yes; trinomial

11. Yes; trinomial

12. Yes; trinomial

13. Yes; monomial

14. No

15. Terms: $-4m^9, 6m, -1$

Coefficients: $-4, 6, -1$

16. Terms: $a^5, 4a^3, -3a^2, a$

Coefficients: $1, 4, -3, 1$

17. Terms: $2x^2y, 5xy^2, -6y^4$

Coefficients: $2, 5, -6$

18. Terms: $m^4n^3, -3m^3n^2, 6m^2n^4$

Coefficients: $1, -3, 6$

19. Terms: $8p^3, 2pq, -4$

Coefficients: $8, 2, -4$

20. Terms: $a^4b^6, -2a^6b^4$

Coefficients: $1, -2$

21. Terms: $-3n^6, 3n, -3$

Coefficients: $-3, 3, -3$

22. Terms: $x^6, -2x^5, 3x^2, -2x, -4$

Coefficients: $1, -2, 3, -2, -4$

23. Terms:

$x^8y^6, -2x^6y^6, 8x^4y^7, -4xy^8$

Coefficients: $1, -2, 8, -4$

24. Terms:

$12m^{12}, -8m^{11}n^{10}, 5m^5n^{11},$

$-m^4n^{12}, n^{14}$

Coefficients: $12, -8, 5, -1, 1$

25. $-3x$

26. $-8x$

27. $10x^2$

28. $-x^2$

29. $-x^3 - 5x$

30. $11x^3 + 4$

31. $3x^4 + 7$

32. $4x^4 + 5$

33. $3x^3 - 3$

34. $-9x^4 + 5$

35. $4a^4$

36. $6x^2 - 3x$

Identify the degree of each term and the degree of the polynomial.

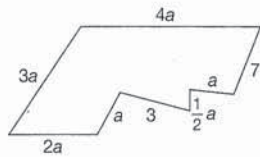
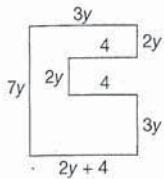
42. $2x - 4$ 43. $3x^2 - 5x + 3$
 44. $-7x^3 + 6x^2 + 3x + 7$ 45. $x^2 - 3x + x^6 - 9x^4$
 46. $-7x^3y^3 + 6x^2y^2 + 3xy + 7$ 47. $-5x^4y^5 + 6x^3y^6 - 3x^2y^2$

48. **Mathematical Reasoning** Is the sum of the degrees of the terms of a binomial *sometimes, always, or never* equal to the degree of the binomial? Justify your answer.

B
Collect like terms.

49. $\frac{1}{4}x^5 - 5 + \frac{1}{2}x^5 - 2x$ 50. $\frac{1}{3}x^3 + 2x - \frac{1}{6}x^3 + 4$
 51. $\frac{1}{2}a^4 - 4a^2 + \frac{2}{3}a^4 - 3$ 52. $\frac{2}{5}r^5 - \frac{1}{2}r^3 + \frac{7}{2}r^3$

53. Write a polynomial for the perimeter of these figures. Simplify the polynomial by collecting like terms.



54. **Critical Thinking** Tell why the following algebraic expressions are not polynomials.

- $\frac{1}{x}$ $7 + \frac{5}{y}$ $x^2 - 5x + \sqrt{x}$ $(y^2 + 3) \div y$

Challenge

55. The sum of a number and 2 is multiplied by the number, and then 3 is subtracted from the result. Express the final result as a polynomial.
 56. The polynomial in x has degree 3. The coefficient of x^2 is 3 less than the coefficient of x^3 . The coefficient of x is 3 times the coefficient of x^2 . The remaining coefficient is 2 more than the coefficient of x^3 . The sum of the coefficients is -4 . Find the polynomial.

Mixed Review

- Simplify. 57. $c^2 \cdot c^5 \cdot c^3$ 58. $(3m^2)^3$ 59. $(x^3y^2)(x^4y^9)$
 60. $(-2ab)^3$ 61. $(3c^{-2})^2$ 62. $(3c)^{-2}$ 5-1, 5-2
 Evaluate for $y = -\frac{1}{2}$. 63. $y(y + \frac{2}{3})$ 64. y^4 65. $1 - \frac{3}{4}y$ 1-1, 2-5
 Solve. 66. $-6x \leq 12$ 67. $2 + 9a \geq 29$ 68. $9 - 6c = 3c + 54$ 3-5, 4-3, 4-4

37. $3xy^2 + 5x^2y$
 38. $-9m^2n^2 - 2mn$
 39. $6ab^2 - 3ab - 5a^2b$
 40. $8x^2 + 2xy^2$
 41. The student should have subtracted the coefficients of the like terms.
 $7x^3 - x^3 = 7x^3 - 1x^3 = (7 - 1)x^3 = 6x^3$
 42. 1, 0; 1
 43. 2, 1, 0; 2
 44. 3, 2, 1, 0; 3
 45. 2, 1, 6, 4; 6
 46. 6, 4, 2, 0; 6

47. 9, 9, 4; 9
 48. Sometimes. For example, the degree of $4x + 1$ equals the sum of the degrees of the terms. The degree of $x^2 + x$ is less than the sum of the degrees of the terms.
 49. $\frac{3}{4}x^5 - 2x - 5$
 50. $\frac{1}{6}x^3 + 2x + 4$
 51. $\frac{7}{6}a^4 - 4a^2 - 3$
 52. $3r^3 + \frac{2}{5}r^5$
 53. $19y + 12$ $11\frac{1}{2}a + 10$

54. $\frac{1}{x}$ not a monomial;
 $\frac{5}{y}$ not a monomial;
 \sqrt{x} not a monomial;
 $\frac{y^2 + 3}{y} = y + \frac{3}{y}$, $\frac{3}{y}$ not a monomial.
 55. $n(n + 2) - 3 = n^2 + 2n - 3$
 56. $x^3 - 2x^2 - 6x + 3$ is the polynomial.

Mixed Review

57. c^{10}
 58. $27m^6$

59. x^7y^{11}
 60. $-8a^3b^3$
 61. $9c^{-4}$ or $\frac{9}{c^4}$
 62. $\frac{1}{9c^2}$
 63. $-\frac{1}{12}$
 64. $\frac{1}{16}$
 65. $\frac{11}{8}$
 66. $x \geq -2$
 67. $a \geq 3$
 68. -5

5-6 Exercises



**Extra Help
On the Web**

Look for worked-out examples at the Prentice Hall Web site.

www.phschool.com

A

Arrange each polynomial in descending order.

1. $x^5 + x + 6x^3 + 1 + 2x^2$
2. $3 + 2x^2 - 5x^6 - 2x^3 + 3x$
3. $5x^3 + 15x^9 + x - x^2 + 7x^8$
4. $9x - 5 + 6x^3 - 5x^4 + x^5$
5. $8y^3 - 7y^2 + 9y^6 - 5y^8 - y^7$
6. $p^8 - 4 + p + p^2 - 7p^4$

Collect like terms and then arrange in descending order for the variable m .

7. $3m^4 - 5m^6 - 2m^4 + 6m^6$
8. $-1 + 5m^3 - 3 - 7m^3 + m^4 + 5$
9. $-2m + 4m^3 - 7m + 9m^3 + 8$
10. $-6m^2 + m - 5m + 7m^2 + 1$
11. $3mp + 3mp + 3mp + m^2 - 4m^2$
12. $-2m - 2mp - 2m - m^3p^4 - 5m^3p^4$
13. $-m + \frac{3}{4} + 15m^4 - m - \frac{1}{2} - 3m^4$
14. $2m - \frac{5}{6} + 4m^3 + m + \frac{1}{3} - 2m$

Evaluate each polynomial for the given value.

15. $x^3 - 27$ for $x = 5$
16. $x^5 + x$ for $x = -2$
17. $x^4 - x$ for $x = 3$
18. $5x^4 - 7x + 2$ for $x = -2$
19. $2x^3 - 5x^2 + x - 3$ for $x = 3$
20. $2x - 5 + 4x^3 + x + x^2 - 2x$ for $x = -4$
21. $-4x^3 + 2x^2 + x - 3$ for $x = 5$
22. $x^5 - x^4 + x^3 - x^2 + x - 1$ for $x = -1$

Evaluate each polynomial for $x = 4$.

23. $-5x + 2$
24. $-3x + 1$
25. $2x^2 - 5x + 7$
26. $3x^2 + x - 7$
27. $x^3 - 5x^2 + x$
28. $7 - x + 3x^2$

Evaluate each polynomial for $a = -1$ and $b = 2$.

29. $3a + 5ab$
30. $6 - 2ab$
31. $a^2 - 2a + b$
32. $5a - 6 + a^2b$
33. $-3a^3 + 7a^2 - 3b - 2$
34. $-2a^3 - 5a^2 + 4a + 3b$

The daily number of automobile accidents involving drivers of age x ($x > 15$) is approximated by the polynomial $0.4x^2 - 40x + 1039$.

35. Evaluate the polynomial for $x = 18$ to find the number of daily accidents involving 18-year-old drivers.
36. Evaluate the polynomial for $x = 20$ to find the number of daily accidents involving 20-year-old drivers.

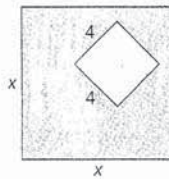
5-6 More on Polynomials 229

Exercises

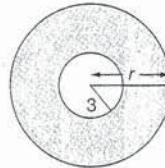
1. $x^5 + 6x^3 + 2x^2 + x + 1$
2. $-5x^6 - 2x^3 + 2x^2 + 3x + 3$
3. $15x^9 + 7x^8 + 5x^3 - x^2 + x$
4. $x^5 - 5x^4 + 6x^3 + 9x - 5$
5. $-5y^8 - y^7 + 9y^6 + 8y^3 - 7y^2$
6. $p^8 - 7p^4 + p^2 + p - 4$
7. $m^6 + m^4$
8. $m^4 - 2m^3 + 1$
9. $13m^3 - 9m + 8$
10. $m^2 - 4m + 1$
11. $-3m^2 + 9mp$
12. $-6m^3p^4 - 2mp - 4m$
13. $12m^4 - 2m + \frac{1}{4}$
14. $4m^3 + m - \frac{1}{2}$
15. 98
16. -34
17. 78
18. 96
19. 9
20. -249
21. -448
22. -6
23. -18
24. -11
25. 19
26. 45
27. -12
28. 51
29. -13
30. 10
31. 5
32. -9
33. 2
34. -1
35. 448.6 or 449 accidents
36. 399 accidents

B

37. A 4-ft by 4-ft sandbox is placed on a square lawn whose side is x ft long. Express the area left over as a polynomial.



38. Express the shaded area in the figure below as a polynomial.



39. **Critical Thinking** The trinomial $ax^2 + 3x + 7$ is equal to 15 when x is 1, and the trinomial is equal to 33 when x is 2. What is the value of a ?

Challenge

Evaluate each expression for the given value.

40. $(-5x^3 + 3x^2 + 6)(7x - 12)$ for $x = 3$
41. $(2x^3 + 3x^2 - 4x + 8)(x^4 - x^2 + 5x)$ for $x = -2$
42. $(4x^5 - 4x^3 + 5x^2 - 4x + 6)(-3x^3 + 6x^2 - x + 8)$ for $x = -1$
43. For a polynomial of degree 2 of the form $ax^2 + bx + c$ where a , b , and c are coefficients, the extreme (highest or lowest) value of the polynomial is the value of x when $2ax = -b$. Find the age with the lowest daily accidents for the polynomial $0.4x^2 - 40x + 1039$, as given for Exercises 35 and 36.



Self-Test On the Web

Check your progress. Look for a self-test at the Prentice Hall Web site.
www.phschool.com

Mixed Review

- Simplify. 44. $\frac{x^2y^4}{xy}$ 45. $\left(\frac{x^3}{2}\right)^3$ 46. $\frac{4a^9}{a^7}$ 47. $\frac{21c^3}{7a^3}$ 5-2
Write in standard notation. 48. 1.603×10^4 49. 7.662×10^{-3} 5-4
Write an equation and solve.
50. The sum of two consecutive integers is 67. Find the integers. 10-9

Exercises

37. $x^2 - 16$
38. $\pi r^2 - 9\pi$
39. $a = 5$
40. -918
41. 24
42. 270
43. $a = 0.4$, $b = -40$
 $2ax = -b$
 $2(0.4)x = -(-40)$
 $0.8x = 40$
 $x = 50$

The age with the lowest daily accidents is age 50.

Mixed Review

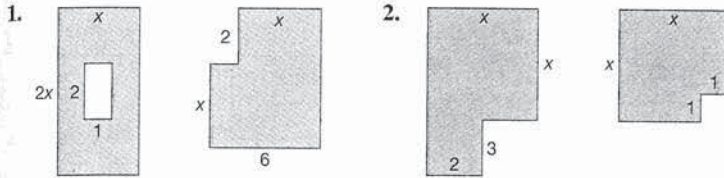
44. xy^3
45. $\frac{x^9}{8}$
46. $4a^2$
47. $\frac{3c^3}{a^3}$
48. 16,030
49. 0.007662
50. $n + (n + 1) = 67$; 33, 34

Try This Add using columns.

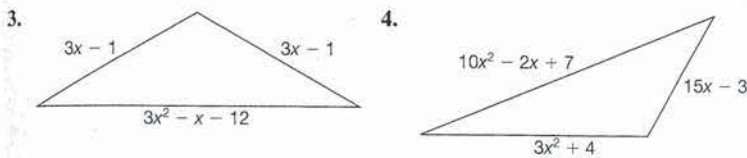
g. $(-2m^3 - 5m^2 - 2m - 4) + (m^4 - 6m^2 + 7m - 10)$
 h. $(-3x^4y^3 - 5xy + 2) + (x^4y^3 + x^2 + 2xy + 5)$

5-7 Exercises

A
Express the sum of the areas of the two figures as a simplified polynomial.



Express the perimeter of each triangle as a simplified polynomial.



Add.

5. $3x + 2$ and $-4x + 3$
6. $5x^2 + 6x + 1$ and $-7x + 2$
7. $-4x^4 + 6x^2 - 3x - 5$ and $6x^3 + 5x + 9$
8. $5x^3 + 6x^2 - 3x + 1$ and $5x^4 - 6x^3 + 2x - 5$
9. $(7x^3 + 6x^2 + 4x + 1) + (-7x^3 + 6x^2 - 4x + 5)$
10. $(3x^4 - 5x^2 - 6x + 5) + (-4x^3 + 6x^2 + 7x - 1)$
11. $5x^4 - 6x^3 - 7x^2 + x - 1$ and $4x^3 - 6x + 1$
12. $8x^5 - 6x^3 + 6x + 5$ and $-4x^4 + 3x^3 - 7x$
13. $9x^8 - 7x^4 + 2x^2 + 5$ and $8x^7 + 4x^4 - 2x$
14. $4x^5 - 6x^3 - 9x + 1$ and $6x^3 + 9x^2 + 9x$
15. $(-3cd^4 + 6d^2 + 2cd - 1) + (-3d^2 + 2cd + 1)$

Add using columns.

16. $(4m^4 - 3m^3 + 6m^2 + 5m - 4) + (6m^3 - 8m^2 - 3m + 1)$
17. $(5a^4 - 2a^3 + 4a^2 + 5a) + (5a^3 - 5a^2 + 2)$



Extra Help On the Web

Look for worked-out examples at the Prentice Hall Web site.
www.phschool.com

3. PRACTICE/ASSES

LESSON QUIZ

1. $4y + 7$ and $-6y - 2$
 $-2y + 5$
2. $-4x^3 + 2x^2 + 5x - 6$ and $7x^3 + 5x + 4$
 $3x^3 + 2x^2 + 10x - 2$
3. Add by writing like terms
 $7x^4 - 3x^2 + 2x - 8$ and $2x^4 + 4x^3 + 5x^2 - 6x + 9$
 $9x^4 + 4x^3 + 2x^2 - 4x + 1$

Assignment Guide

To provide flexible scheduling, this lesson can be split into parts:
 ▼ Core 1–15, 25, 26
 Extension 27, 28, 31–33
 ▼ Core 16–24
 Extension 29, 30

Use Mixed Review to maintain skills.

Try This

g. $m^4 - 2m^3 - 11m^2 + 5m - 14$
 h. $-2x^4y^3 + x^2 - 3xy + 7$

Exercises

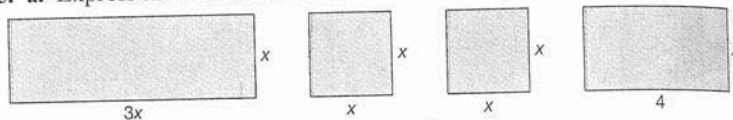
1. $2x^2 + 8x - 2$
2. $2x^2 + 5$
3. $3x^2 + 5x - 14$
4. $13x^2 + 13x + 8$
5. $-x + 5$
6. $5x^2 - x + 3$
7. $-4x^4 + 6x^3 + 6x^2 + 2x + 4$
8. $5x^4 - x^3 + 6x^2 - x - 4$
9. $12x^2 + 6$
10. $3x^4 - 4x^3 + x^2 + x + 4$
11. $5x^4 - 2x^3 - 7x^2 - 5x$
12. $8x^5 - 4x^4 - 3x^3 - x + 5$
13. $9x^8 + 8x^7 - 3x^4 + 2x^2 - 2x + 5$
14. $4x^5 + 9x^2 + 1$
15. $-3cd^4 + 3d^2 + 4cd$
16. $4m^4 + 3m^3 - 2m^2 + 2m - 3$
17. $5a^4 + 3a^3 - a^2 + 5a + 2$

Add using columns.

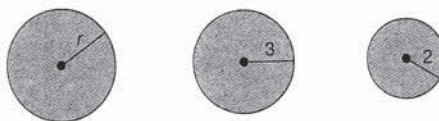
18. $(5t^2 - 2t + 3) + (-3t^4 + 3t^2 + 5t - 3)$
19. $(7y^5 - 6y^4 + 3y^3 - 1) + (6y^4 - 4y^3 + 6y^2 + 5)$
20. $(-x^3y^2 + 6x^2 + 3x + 5) + (x^4 + 2x^3y^2 - 3x^2 + 2)$
21. $(-2h^3 + 3h^2k + 5hk + 3) + (-5h^2k - 2hk + 1)$
22. $(-3x^4y^3 + 6x^3y^3 - 6x^2 + 5xy^5 + 1) + (5x^5 - 3x^3y^3 - 5xy^5)$
23. $(4x^2y - 5xy + 7) + (8x^2y + 7xy^2 + 3xy - 2)$
24. $(4x^3y^4 + 7x^4y^3 - 4x^5 - 6x^4) + (-6x^3y^4 - 3x^4y^3 + 2x^4 - x^3)$

B

25. a. Express the sum of the areas of these rectangles as a polynomial.



- b. Find the sum of the areas when $x = 3$.
 - c. Find the sum of the areas when $x = 8$.
26. a. Express the sum of the areas of these circles as a polynomial (area = πr^2).



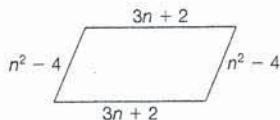
- b. Find the sum of the areas when $r = 5$.
 - c. Find the sum of the areas when $r = 11.3$.
27. **Multi-Step Problem** Use the steps below to solve the following problem. Three brothers have ages that are consecutive multiples of five. The sum of their ages two years ago was 69. Find their ages now.
- a. Let the youngest brother's age be n . Write an expression for the age of each of the other brothers.
 - b. Use your answer to part (a) to write an expression for the age of each of the brothers two years ago.
 - c. Use your answer to part (b) to write an expression for the sum of the brothers' ages two years ago. Simplify the expression.
 - d. For what value of n will the expression in part (c) equal 69?
 - e. Use the value of n you found in part (d) to find the age of each of the brothers now.
 - f. Check: First check that each age you found in part (e) is a multiple of five. Then find the ages of the brothers two years ago. Check that the sum is 69.

Exercises

18. $-3t^4 + 8t^2 + 3t$
19. $7y^5 - y^3 + 6y^2 + 4$
20. $x^4 + x^3y^2 + 3x^2 + 3x + 7$
21. $-2h^3 - 2h^2k + 3hk + 4$
22. $5x^5 - 3x^4y^3 + 3x^3y^3 - 6x^2 + 1$
23. $12x^2y + 7xy^2 - 2xy + 5$
24. $-2x^3y^4 + 4x^4y^3 - 4x^5 - 4x^4 - x^3$
25. a. $3x^2 + x^2 + x^2 + 4x = 5x^2 + 4x$
 b. 57
 c. 352

26. a. $\pi r^2 + 9\pi + 4\pi = \pi r^2 + 13\pi$
 b. 38π
 c. 140.69π
27. a. $n + 5, n + 10$
 b. $n - 2, n + 3, n + 8$
 c. $3n + 9$
 d. 20
 e. 20, 25, 30
 f. $\frac{20}{5} = 4, \frac{25}{5} = 5, \frac{30}{5} = 6;$
 18, 23, 28;
 18 + 23 + 28 = 69

28. a. Use the lengths of the sides of the parallelogram to explain why the value of n must be greater than 2.
 b. Express the perimeter as a simplified polynomial.
 c. Why must the perimeter be greater than 16?



29. **Critical Thinking** Compare and contrast the column method for adding whole numbers and the column method for adding polynomials.

Challenge

30. The sum of two polynomials is $2x^2 + x + 8$. One polynomial is $x^2 + 3$. What is the other?
 31. Addition of real numbers is commutative. That is, $a + b = b + a$ where a and b are real numbers. Show that addition of binomials such as $(ax + b)$ and $(cx + d)$ is commutative.
 32. Show that addition of trinomials such as $(ax^2 + bx + c)$ and $(dx^2 + ex + f)$ is commutative.
 33. Show that addition of polynomials is commutative. Use $a_n x^n + a_{n-1} x^{n-1} + \dots + a_1 x + a_0$ and $b_n x^n + b_{n-1} x^{n-1} + \dots + b_1 x + b_0$

Mixed Review

Name the properties that guarantee that these statements are true.

34. $a(b + c) = ab + ac$ 35. $x + (-x) = 0$ 36. $y \cdot 1 = y$
 37. $nm = mn$ 38. $a + 0 = a$ 39. $4 + 1 = 1 + 4$ 2-10
 Simplify. 40. $(2r^3)^5$ 41. $(3a^5)(6a^2)$ 42. $x^0 \cdot x^1$ 43. $(2m^2n)(6n)$ 3-1, 5-2, 5-3
 Factor. 44. $5ac + 12a$ 45. $xyz + 5y - 9yz$ 46. $a^2 + a + ab$ 2-7

HISTORICAL NOTE

In 2000 B.C., the Babylonians used algebraic methods in solving problems. However, they used no mathematical symbols other than primitive numerals. This lack of symbolism in algebra continued until almost 1500 A.D.

The plus, +, and minus, -, signs first appeared in 1489 A.D. and were regularly used by 1544 A.D. The equal sign, =, was first used in 1557 by Robert Recorde in England. The raised dot, ·, and juxtaposition were first used for multiplication about 1600, and the symbol × about 1620. The division symbol, ÷, appeared in 1659.

Writing Math

The ellipsis points "... " indicate that a pattern continues.

Exercises

28. a. The length of a side must be greater than 0.
 $n^2 - 4 > 0$ when $n > 2$ and when $n < -2$. But n cannot be less than -2 because then $3n + 2$ would be negative.
 b. $2n^2 + 6n - 4$
 c. When $n = 2$,
 $2n^2 + 6n - 4 = 16$. When $n > 2$, $2n^2 + 6n - 4 > 16$.
 29. Answers may vary. Some differences are that

coefficients of polynomials cannot be carried and that adding polynomials can involve adding negative coefficients.

30. $x^2 + x + 5$
 31. $(ax + b) + (cx + d)$
 $= (a + c)x + (b + d)$
 $(cx + d) + (ax + b)$
 $= (c + a)x + (d + b)$
 $= (a + c)x + (b + d)$
 Addition of binomials is commutative.
 32. See 31 above.
 33. See 31 above.

Mixed Review

34. Distributive property of mult. over addition
 35. Additive inverse
 36. Multiplicative identity
 37. Commutative property of multiplication
 38. Additive identity
 39. Commutative property of addition
 40. $32t^{15}$
 41. $18a^7$
 42. x
 43. $12m^2n^2$

44. $a(5c + 12)$
 45. $y(xz + 5 - 9z)$
 46. $a(a + 1 + b)$

PRACTICE/ASSESS

N QUIZ

Find the additive inverse of the polynomial $5x^4 - 2x^3 + x^2 - 6$.
 $x^4 + 2x^3 - x^2 + 6$

Subtract.

$$7x^3 - 6x^2 + 3x$$

$$5x^3 - 3x^2 - 5x + 4$$

$$-6x^2 + 3x - 5x^3 + 3x^2$$

$$5x - 4 = 2x^3 - 3x^2 + 8x - 4$$

Subtract using columns.

$$4x^4 + 5x^2 + 3x + 5$$

$$-6x^4 + 2x^3 - 3x^2 + 7$$

$$-2x^3 + 8x^2 + 3x - 2$$

Assignment Guide

Core 1–37

Extension 38–44

• Mixed Review to maintain skills.



Extra Help On the Web

Look for worked-out examples at the Prentice Hall Web site.

www.phschool.com

5-8 Exercises

A

Find the additive inverse of each polynomial.

1. $-5x$

2. $x^2 - 3x$

3. $-x^2 + 10x - 2$

4. $-4x^3 - x^2 - x$

5. $12x^4y - 3x^3 + 3$

6. $4x^3 - 6x^2y^2 - 8xy + 1$

Subtract

7. $(5x^2 + 6) - (3x^2 - 8)$

8. $(7a^3 - 2a^2 + 6) - (7a^2 + 2a - 4)$

9. $(6x^5 - 3x^4 + x + 1) - (8x^5 + 3x^4 - 1)$

10. $(\frac{1}{2}x^2 - \frac{3}{2}x + 2) - (\frac{3}{2}x^2 + \frac{1}{2}x - 2)$

11. $(6b^2 + 2b) - (-3b^2 - 7b + 8)$

12. $7x^3 - (-3x^2 - 2x + 1)$

13. $(5m^3 - 3m - 6) - (-2m^3 + 5)$

14. $(-4n^4 + n^3 + 2n^2) - (n^4 - 3n^3 - n^2 + 4)$

15. $(6y^3 - 4y - 7) - (-3y^4 - 2y^3 + y - 4)$

16. $(7t^4 + 4t) - (6t^5 - 3t^4 + 2t^2 + 3t - 1)$

17. $(8v^4u + 6v^2 - 5) - (2v^4u - 3v^2 + 2)$

18. $(-3m^3n^2 + 2m^2 - mn - 4) - (-5m^3n^2 - 4m^2 + 3mn + 2)$

19. $(8mn^5 + n^4 - 3mn^3 + 2n^2) - (-mn^5 - mn^4 - n^2 - 1)$

20. $(3x^4y + 2x^3y - x^2 - 7) - (-2x^6 - 3x^4y + 2x^3y - x^2 - 7)$

Subtract.

21. $\frac{x^2 + 5x + 6}{x^2 + 2x}$

22. $\frac{x^3}{x^3 + x^2} + 1$

23. $\frac{c^4}{c^4 - 4c^3} - 3c^2 + c + 1$

24. $\frac{3x^2 - 6x + 1}{6x^2 + 8x - 3}$

Subtract using columns.

25. $(5x^4 + 6x^3 - 9x^2) - (-6x^4 - 6x^3 + 8x)$

26. $(5x^4 + 6x^2 - 3x + 6) - (6x^3 + 7x^2 - 8x - 9)$

27. $(3m^4 + 6m^2 + 8m - 1) - (4m^5 - 6m^4 - 8m - 7)$

28. $(6x^5 + 3x^2 - 7x + 2) - (10x^5 + 6x^3 - 5x^2 - 2x + 4)$

29. $(x^5y^2 - x^3y^2 + xy - 1) - (x^5y^2 - x^4y^2 - x^3y^2 - x^2y + xy - 1)$

30. $(x^5 + x^4y^2 - x^3 + x^2y - xy + 2) - (x^5 + x^4y^2 + x^3 - x^2y - xy + 2)$

Exercises

- $5x$
- $-x^2 + 3x$
- $x^2 - 10x + 2$
- $4x^3 + x^2 + x$
- $-12x^4y + 3x^3 - 3$
- $-4x^3 + 6x^2y^2 + 8xy - 1$
- $2x^2 + 14$
- $7a^3 - 9a^2 - 2a + 10$
- $-2x^5 - 6x^4 + x + 2$
- $-x^2 - 2x + 4$
- $9b^2 + 9b - 8$
- $7x^3 + 3x^2 + 2x - 1$

- $7m^3 - 3m - 11$
- $-5n^4 + 4n^3 + 3n^2 - 4$
- $3y^4 + 8y^3 - 5y - 3$
- $-6t^5 + 10t^4 - 2t^2 + t + 1$
- $6v^4u + 9v^2 - 7$
- $2m^3n^2 + 6m^2 - 4mn - 6$
- $9mn^5 + n^4 + mn^4 - 3mn^3 + 3n^2 + 1$
- $2x^6 + 6x^4y$
- $3x + 6$
- $-x^2 + 1$
- $4c^3 - 3c^2 + c + 1$
- $-3x^2 - 14x + 4$

- $11x^4 + 12x^3 - 9x^2 - 8x$
- $5x^4 - 6x^3 - x^2 + 5x + 15$
- $-4m^5 + 9m^4 + 6m^2 + 16m + 6$
- $-4x^5 - 6x^3 + 8x^2 - 5x - 2$
- $x^4y^2 + x^2y$
- $-2x^3 + 2x^2y$



Practice Multiple Choice

Choose the best answer.

1. Simplify. Arrange the terms of your answer in descending order.

$$(-2m + 7m^3 - 6) + (9m^2 - 7 + 4m)$$

- A $-13 + 2m + 9m^2 - 7m^3$
 B $-13 + 2m + 15m^3$
 C $7m^3 + 9m^2 + 2m - 13$
 D $-7 - 5m + 16m^2 + 4m^3$

2. Which statement is true about this expression?

- $4x^2 - 5x + 3$
 F This trinomial has numerical coefficients 4, -5, and 3.
 G This binomial has numerical coefficients 4, -5, and 3.
 H This polynomial is written in ascending order.
 J The degree of this polynomial is 0.

1. C; Algebra 10.0
2. F; Algebra 10.0

Mixed Review

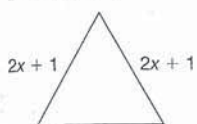
45. 1.594×10^3
 46. 7.72×10^{-1}
 47. 9.361×10^4
 48. Terms: $5x^3, 3x^2, -2x, 1$
 Coefficients: 5, 3, -2, 1
 49. Terms: $5n^4m, 7n^2m^2, -2m, 3$
 Coefficients: 5, 7, -2, 3
 50. $2 < a$
 51. 3

simplify.

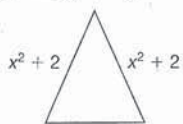
- $(y + 4) + (y - 5) - (y + 8)$
- $(7y^2 - 5y + 6) - (3y^2 + 8y - 12) + (8y^2 - 10y + 3)$
- $(4a^2 - 3a) + (7a^2 - 9a - 13) - (6a - 9)$
- $(3x^2 - 4x + 6) - (-2x^2 + 4) + (-5x - 3)$
- $(-8y^2 - 4) - (3y + 6) - (2y^2 - y)$
- $(5x^3 - 4x^2 + 6) - (2x^3 + x^2 - x) + (x^3 - x)$
- $(-xy^4 - 7y^3 + xy^2) + (-2xy^4 + 5y - 2) - (-6y^3 + xy^2)$
- Critical Thinking** The difference of two polynomials is $2x^2 + x + 4$. One polynomial is $3x^2 + x$. What is the other polynomial?

Express the measure of the third side of each triangle as a simplified polynomial. P is the perimeter.

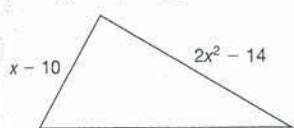
9. $P = 6x + 3$



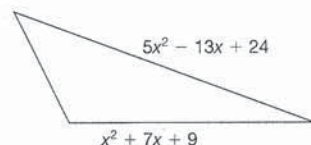
40. $P = 3x^2 - 6$



11. $P = 4x^2 - x - 16$



42. $P = 11x^2 + 10$



Challenge

- Does replacing each occurrence of x with its additive inverse in the polynomial $5x^3 - 3x^2 + 2x$ result in the additive inverse of the polynomial? Explain.
- What is the additive identity for addition of polynomials? Show that subtraction of binomials is not commutative. Is it associative? Justify your answer.

Mixed Review

Write using scientific notation. 45. 1594 46. 0.772 47. 93,610 5-4

Identify the terms. Give the coefficient of each term.

48. $5x^3 + 3x^2 - 2x + 1$ 49. $5n^4m + 7n^2m^2 - 2m + 3$ 5-5

Solve. 50. $16 - 3a < 5a$ 51. $21 + 4h = 11h$ 3-5, 4-4

Exercises

- $y - 9$
- $12y^2 - 23y + 21$
- $11a^2 - 18a - 4$
- $5x^2 - 9x - 1$
- $-10y^2 - 2y - 10$
- $4x^3 - 5x^2 + 6$
- $-3xy^4 - y^3 + 5y - 2$
- $x^2 - 4$ or $5x^2 + 2x + 4$
- $2x + 1$
- $x^2 - 10$
- $2x^2 - 2x + 8$
- $5x^2 + 6x - 23$

- No, $-3(-x)^2 = -3x^2$
- a. A zero polynomial, or 0
 b. $(ax + by) - (cx + dy)$
 $= ax + by - cx - dy$
 $= x(a - c) + y(b - d)$
 $(cx + dy) - (ax + by)$
 $= cx + dy - ax - by$
 $= x(c - a) + y(d - b)$
 Since the coefficients $a, b, c,$ and d are rational numbers, and subtraction of rational numbers is not commutative, $(c - a) \neq (a - c)$ and $(d - b) \neq$

- $(d - b)$; thus, $(ax + by) - (cx + dy) \neq (cx + dy) - (ax + by)$, and subtraction of binomials is not commutative.
 c. No, subtraction of binomials is not associative. Again the coefficients are rational numbers, and subtraction of rational numbers is not associative.

PRACTICE/ASSESS

WARM-UP QUIZ

Multiply and collect like terms.

$$\begin{aligned} & 5x^2(3x + 2) \\ & 15x^3 + 10x^2 \\ & (x + 7)(x + 2) \\ & x^2 + 2x + 7x + 14 \\ & = x^2 + 9x + 14 \\ & (3x^2 + 4)(5x^3 + 1) \\ & 15x^5 + 3x^2 + 20x^3 + 4 \\ & = 15x^5 + 20x^3 + 3x^2 + 4 \end{aligned}$$

Assignment Guide

To provide flexible scheduling, this lesson can be split into parts.

- ▼ Core 1–20
Extension 59, 60, 65, 67
- ▼ Core 21–54
Extension 55–58, 61–64, 66, 68–76

Use Mixed Review to maintain skills.



Extra Help On the Web

Look for worked-out examples at the Prentice Hall Web site.
www.phschool.com

We can also use columns to multiply. We multiply each term on the top row by each term on the bottom. Then we add.

EXAMPLE 8

Multiply $4x - 3$ and $x - 2$.

$$\begin{array}{r} 4x - 3 \\ \times \quad x - 2 \\ \hline 4x^2 - 3x \\ \quad -8x + 6 \\ \hline 4x^2 - 11x + 6 \end{array}$$

Multiplying the top row by x
Multiplying the top row by -2
Adding

Try This Multiply.

- | | |
|----------------------------|---|
| n. $(5x + 3)(x - 4)$ | o. $(2y^2 - 3)(3y - 5)$ |
| p. $(3a + b)(2a - b)$ | q. $(6m^2 + n)(3m - n^2)$ |
| r. $(4pq - p^2)(pq + p^2)$ | s. $(\frac{1}{2}r^2s + s)(\frac{1}{2}r^2s - s)$ |

5-9 Exercises

A

Multiply.

- | | |
|----------------------------------|---------------------------------------|
| 1. $3x(-x + 5)$ | 2. $2y(4y - 6)$ |
| 3. $4x^2(3x + 6)$ | 4. $5a^2(-2a + 1)$ |
| 5. $-6m^2(m^2 + x)$ | 6. $-4x^2(x^2 - x)$ |
| 7. $3x^3(x^3 + 5)$ | 8. $-5m(-3m^5 - 4m^2)$ |
| 9. $3y^2(6y^4 + 8y^3)$ | 10. $4y^4(y^3 - 6y^2)$ |
| 11. $2x(3x^2 + 4x - 3)$ | 12. $-6x(-5x^3 - x^2 + 4)$ |
| 13. $-5a^2(-3a^2 - 6a + 7)$ | 14. $4b^2(-6b^4 + 3b^2 - 4)$ |
| 15. $4y^6(-2y^3 - 2y^2 + y - 5)$ | 16. $-2x^5(x^4 + 2x^3 - x^2 - x + 3)$ |
| 17. $-7h^4(k^6 - k^4 - k^3 + k)$ | 18. $x^3(-y^7 + y^4 - y^3 + y^2 - y)$ |
| 19. $2a(-5a^8b + a^2 - 12ab)$ | 20. $10x(-y^5 - xy^3 + 12x)$ |

Multiply.

- | | |
|------------------------|-------------------------|
| 21. $(x + 1)(x^2 + 3)$ | 22. $(x^2 - 3)(x - 1)$ |
| 23. $(x^3 + 2)(x + 1)$ | 24. $(x^4 + 2)(x + 12)$ |
| 25. $(a + 2)(a - 3)$ | 26. $(x + 2)(x + 2)$ |
| 27. $(3x + 2)(3x + 3)$ | 28. $(4x + 1)(2x + 2)$ |

Exercises

- $-3x^2 + 15x$
- $8y^2 - 12y$
- $12x^3 + 24x^2$
- $-10a^3 + 5a^2$
- $-6m^4 - 6m^2x$
- $-4x^4 + 4x^3$
- $3x^6 + 15x^3$
- $15m^6 + 20m^3$
- $18y^6 + 24y^5$
- $4y^7 - 24y^6$
- $6x^3 + 8x^2 - 6x$
- $30x^4 + 6x^3 - 24x$

- $15a^4 + 30a^3 - 35a^2$
- $-24b^6 + 12b^4 - 16b^2$
- $-8y^9 - 8y^8 + 4y^7 - 20y^6$
- $-2x^9 - 4x^8 + 2x^7 + 2x^6 - 6x^5$
- $-7h^4k^6 + 7h^4k^4 + 7h^4k^3 - 7h^4k$
- $-x^3y^7 + x^3y^4 - x^3y^3 + x^3y^2 - x^3y$
- $-10a^9b + 2a^3 - 24a^2b$
- $-10xy^5 - 10x^2y^3 + 120x^2$
- $x^3 + x^2 + 3x + 3$
- $x^3 - x^2 - 3x + 3$

- $x^4 + x^3 + 2x + 2$
- $x^5 + 12x^4 + 2x + 24$
- $a^2 - a - 6$
- $x^2 + 4x + 4$
- $9x^2 + 15x + 6$
- $8x^2 + 10x + 2$

Try This

- $5x^2 - 17x - 12$
- $6y^3 - 10y^2 - 9y + 15$
- $6a^2 - ab - b^2$
- $18m^3 - 6m^2n^2 + 3mn - n^3$
- $4p^2q^2 + 3p^3q - p^4$
- $\frac{1}{4}r^4s^2 - s^2$

Multiply.

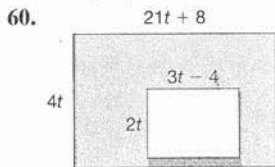
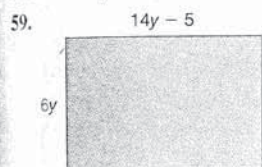
29. $(5x - 6)(x + 2)$
 31. $(3x - 1)(3x + 1)$
 33. $(4x - 2y)(x - y)$
 35. $(x - \frac{1}{4})(x + \frac{1}{4})$
 37. $(x - 0.1)(x + 0.1)$
 39. $(2x^2 + 6)(x + 1)$
 41. $(-2x + 1)(x - 6)$
 43. $(x + 7y)(x + 7y)$
 45. $(3x^5 + 2)(2x^2 + 6)$
 47. $(8x^3 + 1)(x^3 + 8)$
 49. $(4x^2 + 3)(x - 3)$
 51. $(4x^4 + x^2)(x^2 + x)$
 53. $(ab + 3b^2)(ab - 3b^2)$
 30. $(x - 8)(x + 8)$
 32. $(2x + 3)(2x + 3)$
 34. $(2x - y)(3x + y)$
 36. $(x + \frac{3}{4})(x + \frac{3}{4})$
 38. $(3x^2 + 1)(x + 1)$
 40. $(2b^2 + 3)(2b - 1)$
 42. $(3x + 4)(2x - 4)$
 44. $(2x + 5y)(2x + 5y)$
 46. $(1 - 2x)(1 + 3x^2)$
 48. $(4 - 2x)(5 - 2x^2)$
 50. $(7x - 2)(2x - 7)$
 52. $(5x^6 + 3x^3)(2x^6 + 2x^3)$
 54. $(m^2n - 5n)(m^2n + 5n)$

B

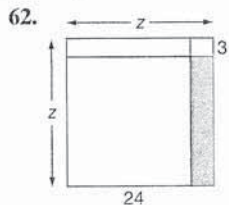
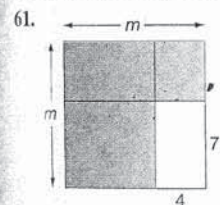
Multiply.

55. $(a + b)^2$ 56. $(a - b)^2$ 57. $(2x + 3)^2$ 58. $(5y + 6)^2$

Find an expression for the area of the shaded regions.



Find an expression for the area of the shaded portion of each square.



63. **Critical Thinking** The product of two binomials is $2x^2 + 5x + 2$. One of the binomials is $(x + 2)$. What is the other binomial?

Exercises

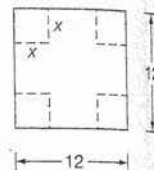
29. $5x^2 + 4x - 12$
 30. $x^2 - 64$
 31. $9x^2 - 1$
 32. $4x^2 + 12x + 9$
 33. $4x^2 - 6xy + 2y^2$
 34. $6x^2 - xy - y^2$
 35. $x^2 - \frac{1}{16}$
 36. $x^2 + \frac{3}{2}x + \frac{9}{16}$
 37. $x^2 - 0.01$
 38. $3x^3 + 3x^2 + x + 1$
 39. $2x^3 + 2x^2 + 6x + 6$
 40. $4b^3 - 2b^2 + 6b - 3$
 41. $-2x^2 + 13x - 6$
 42. $6x^2 - 4x - 16$
 43. $x^2 + 14xy + 49y^2$
 44. $4x^2 + 20xy + 25y^2$
 45. $6x^7 + 18x^5 + 4x^2 + 12$
 46. $1 - 2x + 3x^2 - 6x^3$
 47. $8x^6 + 65x^3 + 8$
 48. $20 - 10x - 8x^2 + 4x^3$
 49. $4x^3 - 12x^2 + 3x - 9$
 50. $14x^2 - 53x + 14$
 51. $4x^6 + 4x^5 + x^4 + x^3$
 52. $10x^{12} + 16x^9 + 6x^6$
 53. $a^2b^2 - 9b^4$
 54. $m^4n^2 - 25n^2$
 55. $a^2 + 2ab + b^2$
 56. $a^2 - 2ab + b^2$
 57. $4x^2 + 12x + 9$
 58. $25y^2 + 60y + 36$
 59. $84y^2 - 30y$
 60. $78t^2 + 40t$
 61. $m^2 - 28$
 62. $z^2 - 24(z - 3) - (24 \cdot 3)$
 $- 3(z - 24) = z^2 - 27z + 72$
 63. $2x + 1$

Error Analysis Study each of the products below. Which are correct and which are incorrect? For those that are incorrect, give the correct answer and state what error was made.

64. $(x^2 + 3y^3)(2x^2 - y) = 2x^2 - x^2y + 6x^2y^3 - 3y^3$
 65. $(4m^3)(2m^2 - 2m + 1) = 8m^5 - 8m^4 + 4m^3$
 66. $(ab + 2b^2)(ab - 2b^2) = a^2b^2 + 4b$
 67. $-2x^2(x^3 + 3x^2 - 3x + 2) = -2x^6 - 6x^4 + 6x^2 - 4x^2$
 68. **Critical Thinking** A student claimed that the product of two binomials always results in a polynomial with at least three terms. Provide a counterexample to show that the student's claim is incorrect.

Challenge

69. A box with a square bottom is to be made from a 12-inch square piece of cardboard. Squares with side x are cut out of the corners, and the sides are folded up. Express the volume and the surface area of the outside of the box as polynomials.



Compute.

70. a. $(x + 3)(x + 6) + (x + 3)(x + 6)$
 b. $(x + 4)(x + 5) - (x + 4)(x + 5)$
 71. a. $(x - 2)(x - 7) + (x - 2)(x - 7)$
 b. $(x - 6)(x - 2) - (x - 6)(x - 2)$
 72. a. $(x + 5)(x - 3) + (x + 5)(x - 3)$
 b. $(x + 9)(x - 4) - (x + 9)(x - 4)$
 73. a. $(x + 7)(x - 8) + (x - 7)(x + 8)$
 b. $(x + 2)(x - 5) - (x - 2)(x + 5)$
 74. If a and b are positive, how many terms are there in $(x - a)(x - b) + (x - a)(x - b)$?
 75. If a and b are positive, how many terms are there in $(x + a)(x - b) + (x - a)(x + b)$?
 76. If a and b are positive, how many terms are there in $(x + a)(x - b) - (x + a)(x - b)$?

Mixed Review

- Write as an algebraic expression. 77. half of the sum of a number and 3
 78. 9 more than the product of a number and 6 79. 3 times the difference of 7 and a number 80. the sum of two consecutive integers $1-6$
 Solve. 81. $15r = 3(r + 28)$ 82. $25 = 4(m - 3) - 3$
 83. $13k = 19k + 12$ 84. $12x = 16(x - 2) + 48$ $3-5$

are two errors. $x^2(2x^2) = 2x^4$
 $3(-y) = -3y^4$. The correct
 is $2x^4 - x^2y + 6x^2y^3 - 3y^4$.
 answer is correct.
 it term is incorrect. The correct
 is $a^2b^2 - 4b^4$.
 st term should be $-2x^5$. The
 term should be $6x^3$. The correct
 is $-2x^5 - 6x^4 + 6x^3 - 4x^2$.
 $(x + 2) = x^2 - 4$

69. Formulas are in Appendix.
 $V = lwh$
 $V = (12 - 2x)(12 - 2x)x$
 $= (4x^2 - 48x + 144)x$
 $= 4x^3 - 48x^2 + 144x$
 $S = \text{area of sides} + \text{area of base}$
 $= 4x(12 - 2x) + (12 - 2x)^2$
 $= -4x^2 + 144$
 70. a. $2x^2 + 18x + 36$
 b. 0
 71. a. $2x^2 - 18x + 28$
 b. 0

72. a. $2x^2 + 4x - 30$
 b. 0
 73. a. $2x^2 - 112$
 b. $-6x$
 74. 3
 75. 2
 76. 1

Mixed Review

77. $\frac{n+3}{2}$
 78. $6n + 9$
 79. $3(7 - n)$
 80. $n + (n + 1)$
 81. 7
 82. 10
 83. -2
 84. -4

5-10 Exercises



**Extra Help
On the Web**

Look for worked-out examples at the Prentice Hall Web site.
www.phschool.com

3. PRACTICE/ASSESS

LESSON QUIZ

Multiply.

- $(x + 9)(x - 9)$
 $x^2 - 81$
- $(2x - y)(2x + y)$
 $4x^2 - y^2$
- $(x + 7)^2$
 $x^2 + 14x + 49$
- $(x - 8)^2$
 $x^2 - 16x + 64$

Assignment Guide

To provide flexible scheduling, this lesson can be split into parts.

- ▼ Core 1–20
Extension 43, 44
- ▼ Core 21–42
Extension 45–52

Use Mixed Review to maintain sk

- A**
Multiply.
- $(x + 4)(x - 4)$
 - $(a + 1)(a - 1)$
 - $(d - 6)(d + 6)$
 - $(y - 5)(y + 5)$
 - $(6 - m)(6 + m)$
 - $(8 + m)(8 - m)$
 - $(2x + 1)(2x - 1)$
 - $(3y - 1)(3y + 1)$
 - $(4a - 7)(4a + 7)$
 - $(5b - 2)(5b + 2)$
 - $(4x^2 - 3)(4x^2 + 3)$
 - $(2x^2 + 3)(2x^2 - 3)$
 - $(3x^4 + 2)(3x^4 - 2)$
 - $(6t^5 - 5)(6t^5 + 5)$
 - $(x^6 - x^2)(x^6 + x^2)$
 - $(3a - 4b)(3a + 4b)$
 - $(7c - 2d)(7c + 2d)$
 - $(-3m + 2n)(-3m - 2n)$
 - $(-6t + s)(-6t - s)$
 - $(x^2 + y^2)(x^2 - y^2)$

- Multiply.
- $(x + 2)^2$
 - $(a + 3)^2$
 - $(t - 3)^2$
 - $(r - 2)^2$
 - $(2x - 1)^2$
 - $(3c - 1)^2$
 - $(4a - 3b)^2$
 - $(7a - 2b)^2$
 - $(4s + 5t)^2$
 - $(x - \frac{1}{2})^2$
 - $(x - \frac{1}{4})^2$
 - $(a + \frac{2}{3})^2$
 - $(2x + 7)(2x + 7)$
 - $(4x + 3)(4x + 3)$
 - $(3x - 2y)(3x + 2y)$
 - $(7x - 5y)(7x + 5y)$
 - $(5x^2 - 1)(5x^2 - 1)$
 - $(12 - 3x^2)(12 + 3x^2)$
 - $(2x - \frac{1}{5})(2x - \frac{1}{5})$
 - $(3x + \frac{3}{4})(3x - \frac{3}{4})$
 - $(2x^3 - 0.3)(2x^3 + 0.3)$
 - $(t^2 - 0.2)(t^2 + 0.2)$

- B**
43. a. Find the area of the 4 small rectangles.



- b. What is the sum of the areas?
c. Find the area of the blue rectangle.
Compare your result with your answer to part b.

5-10 Multiplying Binomials: Special Products 247

Exercises

- $x^2 - 16$
- $a^2 - 1$
- $d^2 - 36$
- $y^2 - 25$
- $36 - m^2$
- $64 - m^2$
- $4x^2 - 1$
- $9y^2 - 1$
- $16a^2 - 49$
- $25b^2 - 4$
- $16x^4 - 9$
- $4x^4 - 9$
- $9x^8 - 4$
- $36t^{10} - 25$
- $x^{12} - x^4$
- $9a^2 - 16b^2$
- $49c^2 - 4d^2$
- $9m^2 - 4n^2$
- $36t^2 - s^2$
- $x^4 - y^4$
- $x^2 + 4x + 4$
- $a^2 + 6a + 9$
- $t^2 - 6t + 9$
- $r^2 - 4r + 4$
- $4x^2 - 4x + 1$
- $9c^2 - 6c + 1$
- $16a^2 - 24ab + 9b^2$
- $49a^2 - 28ab + 4b^2$
- $16s^2 + 40st + 25t^2$
- $x^2 - x + \frac{1}{4}$
- $x^2 - \frac{1}{2}x + \frac{1}{16}$
- $a^2 + \frac{4}{3}a + \frac{4}{9}$
- $4x^2 + 28x + 49$
- $16x^2 + 24x + 9$
- $9x^2 - 4y^2$
- $49x^2 - 25y^2$
- $25x^4 - 10x^2 + 1$
- $144 - 9x^4$
- $4x^2 - \frac{4}{5}x + \frac{1}{25}$
- $9x^2 - \frac{9}{16}$
- $4x^6 - 0.09$
- $t^4 - 0.04$
- a. ac, ad, bc, bd
b. $ac + ad + bc + bd$
c. $ac + ad + bc + bd$, equal

5-10 Multiplying Binomials: Special Products

44. Consider the rectangle at the right. The area of the shaded region is $(a + b)(a - b)$.



- Find the area of the large rectangle.
 - Find the area of the two small unshaded rectangles.
 - Find the difference of the areas in part a and part b.
 - Find the area of the shaded region and compare this result with part c.
45. **Critical Thinking** Find three consecutive integers, the sum of whose squares is 65 more than three times the square of the smallest.
46. **Mathematical Reasoning** If $m = k^2 + 10k + 25$ and k is an integer, which of the following statements about m must always be true?
- m is odd.
 - m is even.
 - m is divisible by 5.
 - m is not divisible by 5.
 - m is the square of an integer.
47. **TEST PREP** If $a^2 - 2ab + b^2 = 0$, then a must equal
- 0
 - 1
 - 1
 - b
 - $-b$
48. **Mathematical Reasoning** Is the expression $x^2 - 6x + 9$ sometimes, always, or never negative? Justify your answer.

Challenge

- What is the relationship between $x - y$ and $y - x$?
 - Find $(x - y)^2$ and $(y - x)^2$.
 - Explain your results.
50. Find $(10x + 5)^2$. Use your result to show how to mentally square any two-digit number ending in 5.
51. The product of the sum and difference of two expressions is $25a^2 - 49$. What are the two expressions?
52. The height of a box is one more than its length, and the length is one more than its width.
- Find the volume of the box in terms of the width (w).
 - Find the volume in terms of the length (l).
 - Find the volume in terms of the height (h).

Mixed Review

- Simplify. 53. $(9x - 7) + (11x - 6)$ 54. $(4y^3 - 7y) - (2y^3 - 5y^2)$
55. $(3m^5)^3$ 56. $(a^3b^2c)(a^2b^4c^2)$ 57. $15(2y^2)(y^5)$ 5-2, 5-7, 5-8, 5-9
- Evaluate for $a = 3$. 58. $-9a^2 + 8$ 59. $2a^2 - 9a + 15$
60. $7 - 9a + a^2$ 61. $15a - 3a^2 - 7$ 62. $5a^2 - 9a - 18$ 1-1
63. 17 is 25% of what number? 64. What number is 8% of 750? 3-10

Exercises

- $a^2 + ab$
 - $ab + b^2$
 - $a^2 + ab - (b^2 + ab) = a^2 - b^2$
 - $a(a - b) + b(a - b) = a^2 - b^2$, equal
- 10, 11, 12
- E
- D
- Never; $x^2 - 6x + 9 = (x - 3)^2$ and the square of a real number is never negative.

49. a. Additive inverses

- Both $= x^2 - 2xy + y^2$
 - $a^2 = (-a)^2$ for any a
50. $100x^2 + 100x + 25 = 100(x^2 + x) + 25$
Add the first digit to its square, multiply by 100, add 25.
51. $(5a + 7)(5a - 7)$
52. a. $w(w + 1)(w + 2) = w^3 + 3w^2 + 2w$
- $l(l - 1)(l + 1) = l^3 - l$
 - $h(h - 1)(h - 2) = h^3 - 3h^2 + 2h$

Mixed Review

- $20x - 13$
- $2y^3 + 5y^2 - 7y$
- $27m^{15}$
- $a^5b^6c^3$
- $30y^7$
- 73
- 6
- 11
- 11
- 0
- 68
- 60

$$9 \quad \left(3x + \frac{1}{4}\right)^2 = 9x^2 + 2(3x)\frac{1}{4} + \frac{1}{16}$$

$$= 9x^2 + \frac{3}{2}x + \frac{1}{16}$$

Using rule 2 (the square of a binomial sum)

$$10 \quad (x^2 - 3x + 2)(2x - 4)$$

$$= 2x^3 - 6x^2 + 4x - 4x^2 + 12x - 8$$

$$= 2x^3 - 10x^2 + 16x - 8$$

Using rule 6 (the product of any two polynomials)

Try This Multiply.

8. $(x+5)(x+6)$
9. $(9x^2+1)^2$

h. $(x-4)(x+4)$

k. $(2x-5)(2x+8)$

i. $4x^2(-2x^3+5x^2+10)$

l. $(x^2-4x-3)(3x-2)$

5-11 Exercises

A
Multiply.

- $(x^2 + x + 1)(x - 1)$
- $(2x^2 + 6x + 1)(2x + 1)$
- $(3y^2 - 6y + 2)(y^2 - 3)$
- $(x^3 + x^2 - x)(x^3 + x^2)$
- $(a - b)(a^3 + a^2b + ab^2 + b^3)$
- $(x^2 + x + 1)(x^2 - x - 1)$
- $(2x^2 + 3x - 4)(2x^2 + x - 2)$
- $(2t^2 - t - 4)(3t^2 + 2t - 1)$
- $(2x^2 + x - 2)(-2x^2 + 4x - 5)$
- $(3x^2 - 8x + 1)(-2x^2 - 4x + 2)$
- $(x^5 - x^3 + x)(x^4 + x^2 - 1)$
- $(3x^6 + 3x^4 + 3x^2)(x^5 - x^3 + x)$
- $(b^3 + b^2 + b + 1)(b - 1)$
- $(x^3 + x^2 - x - 3)(xy - 3y)$
- $(n^2 - n + 2)(n + 2)$
- $(4x^2 - 2x - 1)(3x - 1)$
- $(y^2 + 6y + 1)(3y^2 - 3)$
- $(x^3 - x^2 + x)(x^3 - x^2)$
- $(c + d)(c^3 - c^2d + cd^2 - d^3)$
- $(x^2 - x + 1)(x^2 - x + 1)$
- $(2x^2 - x - 3)(2x^2 - 5x - 2)$
- $(3a^2 - 5a + 2)(2a^2 - 3a + 4)$
- $(x^3 + x^2 + x - 2)(x - 2)$
- $(x^3 - x^2 - x + 4)(xy + 4y)$

Multiply.

- $(x - 8)(x - 8)$
- $(x - 8)(x + 8)$
- $(x - 8)(x + 5)$
- $4x(x^2 + 6x - 3)$
- $\left(2x^2 - \frac{1}{2}\right)\left(2x^2 - \frac{1}{2}\right)$
- $(x + 7)(x + 7)$
- $(x + 7)(x - 7)$
- $(x + 7)(x - 4)$
- $8x(-x^2 - 4x + 3)$
- $(1 - x^2)(1 - x^2)$

Try This

- g. $x^2 + 11x + 30$
h. $x^2 - 16$
i. $-8x^5 + 20x^4 + 40x^2$
j. $81x^4 + 18x^2 + 1$
k. $4x^2 + 6x - 40$
l. $3x^3 - 14x^2 - x + 6$

Exercises

- $x^3 - 1$
- $n^3 + n^2 + 4$
- $4x^3 + 14x^2 + 8x + 1$
- $12x^3 - 10x^2 - x + 1$

- $3y^4 - 6y^3 - 7y^2 + 18y - 6$
- $3y^4 + 18y^3 - 18y - 3$
- $x^6 + 2x^5 - x^3$
- $x^6 - 2x^5 + 2x^4 - x^3$
- $a^4 - b^4$
- $c^4 - d^4$
- $x^4 - x^2 - 2x - 1$
- $x^4 - 2x^3 + 3x^2 - 2x + 1$
- $4x^4 + 8x^3 - 9x^2 - 10x + 8$
- $4x^4 - 12x^3 - 5x^2 + 17x + 6$
- $6t^4 + t^3 - 16t^2 - 7t + 4$
- $6a^4 - 19a^3 + 31a^2 - 26a + 8$
- $-4x^4 + 6x^3 - 2x^2 - 13x + 10$

- $-6x^4 + 4x^3 + 36x^2 - 20x + 2$
- $x^9 - x^5 + 2x^3 - x$
- $3x^{11} + 3x^7 + 3x^3$
- $b^4 - 1$
- $x^4 - x^3 - x^2 - 4x + 4$
- $x^4y - 2x^3y - 4x^2y + 9y$
- $x^4y + 3x^3y - 5x^2y + 16y$
- $x^2 - 16x + 64$
- $x^2 + 14x + 49$
- $x^2 - 64$
- $x^2 - 49$
- $x^2 - 3x - 40$
- $x^2 + 3x - 28$

- $4x^3 + 24x^2 - 12x$
- $-8x^3 - 32x^2 + 24x$
- $4x^4 - 2x^2 + \frac{1}{4}$
- $x^4 - 2x^2 + 1$



**Extra Help
On the Web**

Look for worked-out examples at the Prentice Hall Web site.

www.phschool.com

Exercises

5. $36a^6 - 1$
 6. $6b^4 - 3b^2 - 63$
 7. $-9x^2 + 4$
 8. $-25x^2 + 16$
 9. $36x^8 + 48x^4 + 16$
 10. $36x^8 - 96x^4 + 64$
 11. $-6x^5 - 48x^3 + 54x^2$
 12. $-5x^5 + 10x^3 - 20x^2$
 13. $12q^5 + 4q^3 - 2q^2 - 1$
 14. $35p^4 - 36p^2 - 32$
 15. $\frac{9}{16}x^2 + \frac{9}{4}x + 2$
 16. $\frac{3}{25}x^4 + 4x^2 - 63$
 17. $4x^3 + 13x^2 + 22x + 15$
 18. $3x^4 + 10x^3 + 13x^2 + 10x$
 19. $3x^5 - 14x^4 + 13x^3 - 20x^2$

Multiply.

35. $(6a^3 - 1)(6a^3 + 1)$
 37. $(2 - 3x)(2 + 3x)$
 39. $(6x^4 + 4)^2$
 41. $-6x^2(x^3 + 8x - 9)$
 43. $(6q^3 - 1)(2q^2 + 1)$
 45. $(\frac{3}{4}x + 1)(\frac{3}{4}x + 2)$
 47. $(x^2 + 2x + 3)(4x + 5)$
 49. $(x^3 - 4x^2)(3x^2 - 2x + 5)$
 36. $(2b^2 - 7)(3b^2 + 9)$
 38. $(4 + 5x)(4 - 5x)$
 40. $(8 - 6x^4)^2$
 42. $-5x^2(x^3 - 2x + 4)$
 44. $(7p^2 + 4)(5p^2 - 8)$
 46. $(\frac{1}{5}x^2 + 9)(\frac{3}{5}x^2 - 7)$
 48. $(x^2 + 2x)(3x^2 + 4x + 5)$
 50. $(x^3 - 4x^2 + 5)(3x^2 - 2x)$

B

51. Find $(x + y)^3$.
 52. Find $(x + y)^4$.
 53. **Critical Thinking** Study the pattern of your answers for Exercises 51 and 52. Without multiplying, find $(x + y)^5$.

Challenge

Multiply. Look for patterns.

54. a. $(x^2 + x + 1)(x - 1)$
 c. $(x^2 - x + 1)(x - 1)$
 e. $(-x^2 + x - 1)(x - 1)$
 g. $(x^3 + x^2 + x + 1)(x - 1)$
 i. $(x^3 - x^2 + x - 1)(x - 1)$
 k. $(-x^3 + x^2 - x + 1)(x - 1)$
 b. $(x^2 + x + 1)(x + 1)$
 d. $(x^2 - x + 1)(x + 1)$
 f. $(-x^2 + x - 1)(x + 1)$
 h. $(x^3 + x^2 + x + 1)(x + 1)$
 j. $(x^3 - x^2 + x - 1)(x + 1)$
 l. $(-x^3 + x^2 - x + 1)(x + 1)$

55. What polynomial times $(x - 1)$ equals $x^5 - 1$?
 56. What polynomial times $(x + 1)$ equals $x^5 + 1$?
 57. What polynomial times $(x - 1)$ equals $x^6 - 1$?
 58. Find $(x^2 + xy + y^2)^2$.
 59. Find a trinomial $ax^2 + bx + c$ and a binomial $dx + e$ so that when they are multiplied, the coefficient of the x term is 1.

Mixed Review

- Multiply. 60. $(x - 3)^2$ 61. $(x + 3)^3$ 62. $(x - 3)(x + 3)$ 5-10
 Give the additive inverse. 63. $7a$ 64. $-21n$ 65. $3y^2 - 9y + 1$ 2-3
 Write in standard notation. 66. 1.1×10^{-5} 67. 2.1×10^7 5-9
 Identify the degree of each term and the degree of the polynomial.
 68. $3n^2 - 4n + 11$ 69. $3x^3y^4 + 9x^2y - 24$ 70. $9a + 6$ 5-5
 71. On a scale drawing of a certain building, 1 in. represents 2.5 ft. The length of one wall in the drawing is 3.6 in. What is the actual length of that wall? 3-9

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50. $3x^5 - 14x^4 + 8x^3 + 15x^2 - 10x$
 51. $x^3 + 3x^2y + 3xy^2 + y^3$
 52. $x^4 + 4x^3y + 6x^2y^2 + 4xy^3 + y^4$
 53. $x^5 + 5x^4y + 10x^3y^2 + 10x^2y^3 + 5xy^4 + y^5$
 54. a. $x^3 - 1$
 b. $x^3 + 2x^2 + 2x + 1$
 c. $x^3 - 2x^2 + 2x - 1$
 d. $x^3 + 1$
 e. $-x^3 + 2x^2 - 2x + 1$
 f. $-x^3 - 1$

- g. $x^4 - 1$
 h. $x^4 + 2x^3 + 2x^2 + 2x + 1$
 i. $x^4 - 2x^3 + 2x^2 - 2x + 1$
 j. $x^4 - 1$
 k. $-x^4 + 2x^3 - 2x^2 + 2x - 1$
 l. $-x^4 + 1$
 55. $x^4 + x^3 + x^2 + x + 1$
 56. $x^4 - x^3 + x^2 - x + 1$
 57. $x^5 + x^4 + x^3 + x^2 + x + 1$
 58. $x^4 + 2x^3y + 3x^2y^2 + 2xy^3 + y^4$
 59. Answers may vary.
 Ex. $(x^2 - x + 2)(x + 1)$

Mixed Review

60. $x^2 - 6x + 9$
 61. $x^3 + 9x^2 + 27x + 27$
 62. $x^2 - 9$
 63. $-7a$
 64. $21n$
 65. $-3y^2 + 9y - 1$
 66. 0.000011
 67. 21,000,000
 68. 2, 1, 0; 2
 69. 7, 3, 0; 7
 70. 1, 0; 1
 71. 9 ft

5 Chapter Wrap Up

Key Terms

additive inverses (p. 236)
 ascending order (p. 226)
 binomial (p. 222)
 coefficient (p. 222)
 constant (p. 214)
 degree of a polynomial (p. 223)
 degree of a term (p. 223)
 descending order (p. 226)
 evaluating a polynomial (p. 227)
 exponential notation (p. 204)
 FOIL (p. 241)
 leading coefficient (p. 223)
 leading term (p. 223)
 monomial (p. 214)
 polynomial (p. 221)
 scientific notation (p. 217)
 standard notation (p. 217)
 trinomial (p. 222)

5-1

To multiply powers with like bases, such as $x^2 \cdot x^5$, you add the exponents to get x^7 . To divide powers with like bases, such as $\frac{x^6}{x^3}$, you subtract the exponents to get x^3 . To divide $\frac{x^3}{x^5}$, where the larger exponent is in the denominator, you subtract the exponents to get x^{-2} or $\frac{1}{x^2}$.

Simplify.

- | | | |
|---------------------|-----------------------|----------------------------|
| 1. $7^2 \cdot 7^4$ | 2. $y^3 \cdot y^5$ | 3. $x^7 \cdot x^3 \cdot x$ |
| 4. $(a^2b^4)(a^3b)$ | 5. $(x^4y^5)(x^4y^5)$ | 6. $(lm^7n^5)(l^2m^6n)$ |

Simplify.

- | | | |
|----------------------|----------------------|----------------------------|
| 7. $\frac{7^5}{7^3}$ | 8. $\frac{a^9}{a^4}$ | 9. $\frac{x^9y^7}{x^2y^3}$ |
|----------------------|----------------------|----------------------------|

Simplify. Express each power using positive exponents.

- | | | |
|--------------|--------------|-----------|
| 10. 7^{-3} | 11. y^{-2} | 12. a^0 |
|--------------|--------------|-----------|

5-2

To raise a power to a power, such as $(a^2)^3$, you multiply the exponents to get a^6 . To find the power of a product or quotient, everything inside the parentheses is raised to the power.

Simplify.

- | | | | |
|--------------------|--------------------|---------------------|------------------------------------|
| 13. $(5^3)^2$ | 14. $(3^4)^4$ | 15. $(x^6)^2$ | 16. $(a^3)^3$ |
| 17. $(3a)^2$ | 18. $(2b)^3$ | 19. $(2x^3)^3$ | 20. $(4p^2)^3$ |
| 21. $(3x^2yz^4)^2$ | 22. $(-2x^6y^2)^3$ | 23. $[(-n)^{15}]^2$ | 24. $\left(\frac{y^3}{3}\right)^4$ |

5-3

To multiply two **monomials**, multiply the numerical factors and the variable factors. Use the properties of exponents to multiply the variables: $(-3x^2y)(-5xy^5) = 15x^3y^6$. To divide two monomials, divide the numerical factors and the variable factors: $\frac{15x^3y^4}{-5xy^2} = -3x^2y^2$.

Multiply.

- | | | |
|-------------------------|--------------------------|-------------------------|
| 25. $(2a)(3a)$ | 26. $(-2x)(3x^2)$ | 27. $(5b^2c^3)(-4bc^3)$ |
| 28. $(5y^3)(-2y)(-y^4)$ | 29. $-(3wz^4)(-5w^2z^3)$ | 30. $(-4x^2y)(-8xy^3)$ |

Divide.

- | | | |
|-----------------------------------|------------------------------------|----------------------------------|
| 31. $\frac{a^6}{a^3}$ | 32. $\frac{15n^5}{-15n}$ | 33. $\frac{-15x^3y^6}{5xy^3}$ |
| 34. $\frac{-24m^{12}n^2}{-6m^5n}$ | 35. $\frac{18b^{14}c^6}{-3b^7c^2}$ | 36. $\frac{-28x^4y^8}{-7x^2y^6}$ |

- | | | |
|---------------------|-------------------------|-----------------|
| 1. 7^6 | 13. 5^6 | 25. $6a^2$ |
| 2. y^8 | 14. 3^{16} | 26. $-6x^3$ |
| 3. x^{11} | 15. x^{12} | 27. $-20b^3c^6$ |
| 4. a^5b^5 | 16. a^9 | 28. $10y^8$ |
| 5. x^8y^{10} | 17. $9a^2$ | 29. $15w^3z^7$ |
| 6. $l^3m^{13}n^6$ | 18. $8b^3$ | 30. $32x^3y^4$ |
| 7. 7^2 | 19. $8x^9$ | 31. a^3 |
| 8. a^5 | 20. $64p^6$ | 32. $-n^4$ |
| 9. x^7y^4 | 21. $9x^4y^2z^8$ | 33. $-3x^2y^3$ |
| 10. $\frac{1}{7^3}$ | 22. $-8x^{18}y^6$ | 34. $4m^7n$ |
| 11. $\frac{1}{y^2}$ | 23. n^{30} | 35. $-6b^7c^4$ |
| 12. 1 | 24. $\frac{y^{12}}{81}$ | 36. $4x^2y^2$ |



Internet Activity On the Web

Look for extension problems for this chapter at the Prentice Hall Web site. www.phschool.com

5-4

The numbers 3.215×10^4 and 4.17×10^{-3} are expressed using **scientific notation**, and the numbers 32,150 and 0.00417 are expressed using **standard notation**.

Write using standard notation.

37. 3.25×10^3

38. 5.7×10^{-3}

Write using scientific notation.

39. 2,426,000

40. 0.000045

5-5

In a **polynomial**, each monomial can be called a **term**. In the term $3a^2b^3$, 3 is called the **coefficient**, and factors are 3, a^2 , and b^3 . To collect like terms, add or subtract the coefficients of the like terms. To find the **degree of a term**, add the exponents of the variables in that term. The **degree of a polynomial** is the highest degree of its terms.

Collect like terms.

41. $5x^3 - x^3 + 4$

42. $-2x^4 + 16 + 2x^4 + 9 - 3x^5$

Identify the degree of each term and the degree of the polynomial.

43. $3x^3y^2 + 7x^2y - 5$

44. $4y^2 + 7y + 2$

5-6

To write a polynomial in **descending order** for the variable x , write the term with the greatest exponent for x first, the next greatest exponent for x second, and so on. A constant term will always be last. To evaluate a polynomial, replace the variable with the given number and calculate the result.

Arrange each polynomial in descending order for the variable x .

45. $3x^2 - 2x^4 + 5 + 7x^5 - 2x$

46. $3y - 4x^5 - 2x^3y^2 + 7x^2y^3$

47. $-x^5 + 14x^4 - 7x - 1 - 4x^4$

48. $6y + 3x^3 - 7xy^2 + 8x^4y^3$

Evaluate each polynomial for $x = 5$.

49. $7x - 10$

50. $x^2 - 3x + 6$

5-7

To add polynomials collect like terms and arrange in descending order.

Add.

51. $(5x^3 - 2x^2 + 3x) + (2x^3 + 6x^2 + x)$

52. $(3x^4 - x^3 + x - 4) + (3x^4 - 5x^3 + 3x^2 - 5)$

53. $(3x^5 - 4x^4 + x^3 - 3) + (3x^4 - 5x^3 + 3x^2)$

54. $(a^3 + 7a^2b - ab^2 - 2b^3) + (2a^3 - 3ab^2 + 2b^3)$

37. 3250

38. 0.0057

39. 2.426×10^6

40. 4.5×10^{-5}

41. $4x^3 + 4$

42. $-3x^5 + 25$

43. 5, 3, 0; 5

44. 2, 1, 0; 2

45. $7x^5 - 2x^4 + 3x^2 - 2x + 5$

46. $-4x^5 - 2x^3y^2 + 7x^2y^3 + 3y$

47. $-x^5 + 10x^4 - 7x - 1$

48. $8x^4y^3 + 3x^3 - 7xy^2 + 6y$

49. 25

50. 16

51. $7x^3 + 4x^2 + 4x$

52. $6x^4 - 6x^3 + 3x^2 + x - 9$

53. $3x^5 - x^4 - 4x^3 + 3x^2 - 3$

54. $3a^3 + 7a^2b - 4ab^2$

5-8

When you find the **additive inverse of a polynomial**, you change the sign of each term in the polynomial. You can subtract a polynomial by adding its additive inverse.

Subtract.

55. $(7y^3 + 8) - (3y^3 - 6)$ 56. $(5x^2 - 4x + 1) - (3x^2 + 7)$
57. $(3x^5 + 4x^4 + 2x^2 + 3) - (2x^5 - 4x^4 + 3x^3 + 4x^2 - 5)$

Use columns to subtract.

58. $(6y^2 - 5y + 3) - (8y^2 - 3y - 8)$
59. $(2x^5 - x^3 + x + 3) - (3x^5 - x^4 + 4x^3 + 2x^2 - x + 3)$

5-9

To multiply a polynomial by a monomial, multiply each term of the polynomial by the monomial. To multiply two binomials, use the **FOIL** method: multiply the **F**irst terms, the **O**utside terms, the **I**nside terms, and the **L**ast terms. Then collect like terms.

Multiply.

60. $3x(5x + 6)$ 61. $5x^3(3x^3 - 8x^2 + 10x + 2)$

Multiply and collect like terms.

62. $(x + 4)(x - 7)$ 63. $(a - 3)(a + 3)$
64. $(b^2 + 3)(b^2 + 2)$ 65. $(2x^2 + 5xy)(3x^2 - 3)$

5-10

Although FOIL can be used to multiply two binomials, the rules for the following special products can be used as shortcuts.

$$\begin{aligned}(A + B)(A - B) &= A^2 - B^2 \\(A + B)^2 &= A^2 + 2AB + B^2 \\(A - B)^2 &= A^2 - 2AB + B^2\end{aligned}$$

Multiply.

66. $(x - 3)(x + 3)$ 67. $(a - 8)(a + 8)$ 68. $(2y + 3)(2y - 3)$
69. $(3x^2 - 4)(3x^2 + 4)$ 70. $(-2y + 7x)(-2y - 7x)$
71. $(2 + 3y)(2 - 3y)$ 72. $(a + 4)^2$ 73. $(3x + 6)^2$

5-11

To multiply a trinomial by a binomial, multiply the trinomial by each term of the binomial. To multiply two polynomials, multiply each term of one polynomial by every term of the other. It may help you to use columns for long multiplications.

74. $(4x^2 - 5x + 1)(3x - 2)$ 75. $(2a^2 + 3a - 2)(a^2 - 4)$
76. $(2b^2 + 5b - 3)(2b^2 - 2b + 1)$ 77. $(x^4 - 2x + 3)(x^3 + x - 1)$

- | | |
|-------------------------------------|---|
| 55. $4y^3 + 14$ | 68. $4y^2 - 9$ |
| 56. $2x^2 - 4x - 6$ | 69. $9x^4 - 16$ |
| 57. $x^5 + 8x^4 - 3x^3 - 2x^2 + 8$ | 70. $4y^2 - 49x^2$ |
| 58. $-2y^2 - 2y + 11$ | 71. $4 - 9y^2$ |
| 59. $-x^5 + x^4 - 5x^3 - 2x^2 + 2x$ | 72. $a^2 + 8a + 16$ |
| 60. $15x^2 + 18x$ | 73. $9x^2 + 36x + 36$ |
| 61. $15x^6 - 40x^5 + 50x^4 + 10x^3$ | 74. $12x^3 - 23x^2 + 13x - 2$ |
| 62. $x^2 - 3x - 28$ | 75. $2a^4 + 3a^3 - 10a^2 - 12a + 8$ |
| 63. $a^2 - 9$ | 76. $4b^4 + 6b^3 - 14b^2 + 11b - 3$ |
| 64. $b^4 + 5b^2 + 6$ | 77. $x^7 + x^5 - 3x^4 + 3x^3 - 2x^2 + 5x - 3$ |
| 65. $6x^4 + 15x^3y - 6x^2 - 15xy$ | |
| 66. $x^2 - 9$ | |
| 67. $a^2 - 64$ | |

Simplify. Express using exponents.

1. $6^2 \cdot 6^3$ 2. $x^6 \cdot x^2$ 3. $a^8 \cdot a^3$
 4. $(r^2s^3)(rs^4)$ 5. $\frac{3^5}{3^2}$ 6. $\frac{a^4b^5}{ab^3}$

Simplify. Express using a positive exponent.

7. 6^{-2} 8. y^{-4} 9. 3^0

Simplify.

10. $(x^3)^2$ 11. $(-3y^2)^3$ 12. $\left(\frac{a^4}{3}\right)^3$

Multiply.

13. $(-2y^2)(4y)$ 14. $(6x^2)(-2x^3)(-2x^5)$ 15. $(-4n^3)(-4n^3)$

Divide.

16. $\frac{b^3}{b}$ 17. $\frac{7a^4}{a^4}$ 18. $\frac{4x^5}{12x^3}$

Write using standard notation.

19. 3.265×10^5 20. 2.07×10^{-3}

Write using scientific notation.

21. 246,000 22. 0.00385

Collect like terms.

23. $4a^2 - 6 + a^2$ 24. $y^2 - 3y - y + 2y^2$

Collect like terms, and then arrange them in descending order.

25. $3 - x^2 + 2x + 5x^2 - 6x$

Evaluate the polynomial for $x = -2$.

26. $x^2 - 5x - 1$

Add.

27. $(5x^4 + 7x^3 - 8) + (3x^4 - 5x^3 + 6x^2)$

Subtract.

28. $(12x^2 - 3x - 8) - (4x^2 + 5)$

Multiply.

29. $-3x^2(4x^2 - 3x - 5)$ 30. $(3b + 5)(b - 3)$
 31. $(6a^2 - 2)(a^2 - 1)$ 32. $(3p - 2)(3p + 2)$
 33. $(3x^2 + 4)(3x^2 - 4)$ 34. $(x - 9)^2$
 35. $(4x^7 + 3)(4x^7 - 3)$ 36. $(3x^2 - 2x)^2$
 37. $(2x + 1)(3x^2 - 5x - 3)$ 38. $(-2a^3 + 5a^2 - 3)(3a^2 + 1)$

Assessment Item Analysis

| Item | Lesson |
|--------|--------|
| 1-9 | 5-1 |
| 10-12 | 5-2 |
| 13-18 | 5-3 |
| 19-22 | 5-4 |
| 23, 24 | 5-5 |
| 25, 26 | 5-6 |
| 27 | 5-7 |
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1. 6^5 13. $-8y^3$ 26. 13
 2. x^8 14. $24x^{10}$ 27. $8x^4 + 2x^3 + 6x^2 - 8$
 3. a^{11} 15. $16n^6$ 28. $8x^2 - 3x - 13$
 4. $r^{3 \cdot 5 \cdot 7}$ 16. b^2 29. $-12x^4 + 9x^3 + 15x^2$
 5. 3^3 17. 7 30. $3b^2 - 4b - 15$
 6. a^3b^2 18. $\frac{x^2}{3}$ 31. $6a^4 - 8a^2 + 2$
 7. $\frac{1}{6^2}$ 19. 326,500 32. $9p^2 - 4$
 8. $\frac{1}{y^4}$ 20. 0.00207 33. $9x^4 - 16$
 9. 1 21. 2.46×10^5 34. $x^2 - 18x + 81$
 10. x^6 22. 3.85×10^{-3} 35. $16x^{14} - 9$
 11. $-27y^6$ 23. $5a^2 - 6$ 36. $9x^4 - 12x^3 + 4x^2$
 12. $\frac{a^{12}}{27}$ 24. $3y^2 - 4y$ 37. $6x^3 - 7x^2 - 11x - 3$
 25. $4x^2 - 4x + 3$ 38. $-6a^5 + 15a^4 - 2a^3 - 4a^2 - 3$