57. $(t \div 7) - 4 = 4$　　　　**58.** $(c \div 5) - 13 = 11$　　　　**59.** $(y \div 3) + 15 = 36$

C　**60.** $3n + 10 > 40$　　　　**61.** $5b - 12 \le 42$　　　　**62.** $6m - 17 \ge 49$

　　63. $4d + 21 \ge 53$　　　　**64.** $(y \div 14) - 32 \le 38$　　　　**65.** $(x \div 8) + 15 < 19$

Self-Test A

Simplify the numerical expression.

1. 4.3×6　　　　**2.** $4.15 + 1.6$　　　　**3.** $8.16 - 5.7$　　　　**4.** $68.4 \div 9$　　　　**[1-1]**

Evaluate the expression when $k = 4$ and $m = 6$.

5. $184 \div k$　　　　**6.** $8 + m + 1$　　　　**7.** $7km$

Simplify the expression.

8. $8 + 3 \times 14$　　　　**9.** $48 \div (6 \times 2 - 4)$　　　　**10.** $\dfrac{7 + (9 \times 3) - 2}{(5 \times 4) - (2 \times 2)}$　　　　**[1-2]**

Evaluate the expression when $s = 12$ and $t = 18$.

11. $\dfrac{s}{4} + 6$　　　　**12.** $(t + 2) \div 5$　　　　**13.** $2s - t$

Find the solution or solutions for the given replacement set.

14. $72 - m = 43$; $\{19, 29, 31\}$　　　　**15.** $6r = 48$; $\{6, 7, 8\}$　　　　**[1-3]**

16. $t \div 12 = 11$; $\{23, 24, 25\}$　　　　**17.** $4d + 16 = 28$; $\{3, 4, 5\}$

Replace __?__ with =, >, or < to make a true statement.

18. 430 __?__ 403　　　　**19.** $52 \div 17$ __?__ 19　　　　**20.** 225 __?__ 9×25　　　　**[1-4]**

Find the solutions of the inequality. The replacement set for x is the set of whole numbers.

21. $x < 5$　　　　**22.** $x \ge 85$　　　　**23.** $19 \le x \le 27$

Use inverse operations to solve.

24. $g - 32 = 12$　　　　**25.** $7d < 112$　　　　**26.** $5a + 4 = 49$　　　　**[1-5]**

Self-Test answers and Extra Practice are at the back of the book.

15. Gregory ordered the following items from the Huntington Gardens catalog: a watering can for $15.80, a trowel for $4.49, and 6 packages of seeds for $.75 each. He must add $2.50 for shipping charges. He has 2 coupons, each allowing him to deduct $2.00 from his order. How much will Gregory pay for the order?

C 16. Joy and David Kramer had $30 to spend on dinner, a movie, and parking. Dinner cost $15.50 and parking cost $4. The Kramers had $2 left after paying for everything. What was the cost of one movie ticket?

17. The museum charges $4.50 per person for a 2 h tour with fewer than 20 people. If 20 or more people take the tour, the charge is $3.75 per person. Of the 23 people in today's tour, 17 had paid $4.50 in advance. How much money will the museum return as a refund?

Self-Test B

Write a variable expression for the word phrase.

1. Twelve divided by a number y [1-6]

2. Five less than a number x

3. The difference when twenty-one is subtracted from the product of nine and a number g

Write an equation or inequality for the word sentence.

4. Fifteen is the sum of nine and twice a number x.   [1-7]

5. Twenty-five times the sum of a number b and 7 is greater than eleven divided by four.

6. When the product of four and a number is subtracted from twenty-four, the result is less than or equal to twelve.

Solve, using the five-step plan.

7. Laura bought a hammer for $12.95, 5 lb of nails for $5.20, and 8 sheets of plywood for $12 each. What was her total bill?   [1-8]

8. Between the hours of 6 A.M. and 9 P.M., 8 buses that were filled to capacity left the terminal. Since the capacity of each bus is the same and 392 tickets were sold, how many passengers were on each bus?

Self-Test answers and Extra Practice are at the back of the book.

2-1 Exponents

When two or more numbers are multiplied, these numbers are called **factors** of the product. For example,

$$\underbrace{5 \times 8}_{\text{factors}} = 40 \quad \text{and} \quad \underbrace{3 \times 7}_{\text{factors}} = 21.$$

When one factor is used a number of times, we may use an *exponent* to simplify the notation, as shown in the following example.

$$125 = \underbrace{5 \times 5 \times 5}_{\text{equal factors}} = 5^3$$

The expression 5^3 is read *5 cubed,* or *5 to the third power,* where 5 is the **base** and 3 is the **exponent.**

Since 125 is the product of three factors of 5, we say that 125 is *the third power of 5.* Examples of other bases and exponents are listed below.

$15 = 15^1$ *15 to the first power*

$36 = 6 \times 6 = 6^2$ *6 squared,* or *6 to the second power*

$64 = 4 \times 4 \times 4 = 4^3$ *4 cubed,* or *4 to the third power*

$16 = 2 \times 2 \times 2 \times 2 = 2^4$ *2 to the fourth power*

EXAMPLE 1   Express 81 as a power of 3.

Solution $81 = 3 \times 3 \times 3 \times 3$

$$= 3^4$$

EXAMPLE 2   Simplify the expression $2^3 \times 5^2$.

Solution $2^3 = 2 \times 2 \times 2 = 8$ $5^2 = 5 \times 5 = 25$

$$2^3 \times 5^2 = 8 \times 25 = 200$$

Can we give an expression such as 7^0 a meaning? When the powers of any base are listed in order, we may recognize a pattern. Study the example at the top of the next page.

$$7^4 = 7 \times 7 \times 7 \times 7 = 2401$$
$$7^3 = 7 \times 7 \times 7 = 343$$
$$7^2 = 7 \times 7 = 49$$
$$7^1 = 7$$

Notice that in increasing order each power of 7 is seven times the preceding power. Conversely, in decreasing order, each power of 7 is the quotient of the preceding power divided by a factor of 7. That is, $7^3 = 7^4 \div 7$, $7^2 = 7^3 \div 7$, and so on. This decreasing pattern suggests that 7^0 (read *7 to the zero power*) is $7^1 \div 7$. Study the example below to verify that the expression $7^0 = 1$.

$$7^0 = 7^1 \div 7 = 7 \div 7 = 1$$

In general,

Definition

For every number a ($a \neq 0$), $a^0 = 1$.

If an expression contains powers of the same base, the expression may be written as a single power of that base. For example, $13^2 \times 13^3$ can be written as a single power of 13.

$$13^2 \times 13^3 = (13 \times 13) \times (13 \times 13 \times 13)$$
$$= 13 \times 13 \times 13 \times 13 \times 13$$
$$= 13^5$$

Notice that the exponent in the product is the sum of the exponents in the factors, that is, $2 + 3 = 5$.

In general,

Rule

For every number a ($a \neq 0$) and all whole numbers m and n,

$$a^m \times a^n = a^{m+n}$$

Notice that the bases must be the same.

EXAMPLE 3 Write $15^3 \times 15^4$ as a single power of 15.

Solution $15^3 \times 15^4 = 15^{3+4} = 15^7$

EXAMPLE 4 Evaluate the expression if $n = 3$.

a. n^2 **b.** $4n^2$ **c.** $(4n)^2$ **d.** $n^2 \times n^2$

Solution Replace n with 3 in each expression and simplify.

a. $n^2 = 3^2 = 3 \times 3 = 9$

b. $4n^2 = 4(3^2) = 4 \times 9 = 36$

c. $(4n)^2 = (4 \times 3)^2 = 12^2 = 12 \times 12 = 144$

d. $n^2 \times n^2 = n^{2+2} = n^4 = 3^4 = 3 \times 3 \times 3 \times 3 = 81$

Notice in parts (b) and (c) of Example 4 how grouping symbols change the values of expressions that have the same numbers.

COMMUNICATION IN MATHEMATICS: *Study Helps*

Look back at this lesson. Notice that the information in the blue boxes on page 41 summarizes important ideas from the lesson. The first box gives a definition and the second box states a rule. Both are applied in the examples. Throughout the book, boxes are used to help you identify important definitions, rules, properties, facts, and formulas. Use them as reminders when you do the exercises and when you review the lesson.

Class Exercises

Read each expression.

1. 4^5 **2.** 9^1 **3.** 15^2 **4.** 3^7 **5.** 10^3 **6.** 2^8

Write using exponents.

7. 9 to the third power **8.** 15 cubed **9.** 4 squared

10. 6 to the fifth power **11.** 216 is the third power of 6.

Express the number as a power of 3.

12. 9 **13.** 27 **14.** 3 **15.** 243 **16.** 1

Simplify the expression.

17. 8^2 **18.** 2^3 **19.** 1^{11} **20.** 18^0 **21.** 83^1

Select the most reasonable estimated answer.

B **25.** $89.6 + 13.5$ **a.** 90   **b.** 100   **c.** 70

     26. $35 + 12 + 26 + 11$ **a.** 70   **b.** 110   **c.** 90

     27. $65.43 - 8.92$ **a.** 56   **b.** 60   **c.** 90

     28. $2196 - 924$ **a.** 1300   **b.** 1000   **c.** 3100

     29. 6.82×4.7 **a.** 24   **b.** 35   **c.** 28

     30. $54 \div 2.5$ **a.** 30   **b.** 20   **c.** 18

     31. $36\overline{)283}$ **a.** 10   **b.** 3   **c.** 7

     32. $4.7 \times 1.8 + 3.7$ **a.** 7   **b.** 14   **c.** 32

Self-Test A

Simplify the expression.

1. 2^4 **2.** 8^3 **3.** 9^1 **4.** $5^2 \times 5^3$ **5.** $a^6 \times a^5$ [2-1]

Replace __?__ with > or < to make a true statement.

6. 30.694 __?__ 27.35 **7.** 0.024 __?__ 0.017 **8.** 0.87 __?__ 1.22 [2-2]

Round to the place specified.

9. tens: 84.307 **10.** hundredths: 3.176 **11.** hundreds: 293.84 [2-3]

Self-Test answers and Extra Practice are at the back of the book.

███ **CALCULATOR INVESTIGATION:** *Simplifying Expressions*

Use a calculator to simplify the expressions.

1. $15^2 - 13^2$ and $(15 + 13)(15 - 13)$

2. $47^2 - 21^2$ and $(47 + 21)(47 - 21)$

3. $82^2 - 59^2$ and $(82 + 59)(82 - 59)$

4. $104^2 - 76^2$ and $(104 + 76)(104 - 76)$

Do you recognize a pattern?
Write two expressions that will result in the same pattern.

8. A photograph is enlarged so that its new dimensions are four times its original dimensions. If the new dimensions are 19.2 cm by 25.6 cm, what were the original dimensions?

9. Today the firm of Beckman and Beckman bought three types of stocks: 4780 shares of utility stocks, 1389 shares of commodity stocks, and 3542 shares of energy-related stocks. This is exactly three times the number of shares the firm bought yesterday. How many shares of stock did the firm buy in the past two days?

10. Yukio bought traveler's checks in the following denominations: five $50 checks, thirty $20 checks, five $10 checks, and twenty $5 checks. What is the total value of the checks bought?

11. Katelyn had 3 twenty-dollar bills to buy school clothes. She picked out a pair of jeans for $15.90, two pairs of socks at $2.35 each, and three blouses at $12.50 each. How much change did she receive?

12. A direct dial call from Boston to Australia costs $3.17 for the first minute and $1.19 for each additional minute. A station-to-station operator-assisted call costs $9.45 for the first 3 minutes and $1.19 for each additional minute. How much money would you save by dialing direct for a 5-minute call?

Self-Test B

Use the properties of addition and multiplication to simplify.

1. $12(15 - 8) + 6 \times 3$

2. $(31 \times 4) + (15 \times 4) - 91$ **[2–4]**

3. $7(56 \div 8) - 7(24 \div 6)$

4. $9(0.36 \times 4) + 55$

5. $[(128 \div 4) \div 8]9$

6. $(12 + 9)5 + (17 - 3)6$

Simplify the expression.

7. $(6a + 7)2 + 4a$

8. $(1.26 + 3.74)^2 \div 4$ **[2–5]**

9. $[(12 + 6) \div 6] + [(25 + 5) \div 3]$

10. $(7b + 3)5 + (11 + 4b)2$

Solve.

11. Jeremy and his roommate share the monthly utility bills evenly. For November the cost of electricity was $87.90, gas was $24.35, heating fuel was $215.80, and water was $36.43. How much did each person pay that month? **[2–6]**

Self-Test answers and Extra Practice are at the back of the book.

5. A parachutist jumped from an airplane flying at an altitude of 1100 m, dropped 200 m in the first 25 s, and then dropped 350 m in the next 35 s. What was the altitude of the parachutist 60 s after jumping?

6. In Summit City, 78 cm of snow fell on Sunday. The snow melted approximately 5.8 cm on Monday, approximately 7.5 cm on Tuesday, and approximately 12 cm on Wednesday. Approximately how much snow remained?

B **7.** Donna receives an allowance every 2 weeks that includes $20 for school lunches. During the past 4 weeks, she spent $7.50, $8.25, $5.25, and $8.75 on lunches. How much did Donna have left from the money allowed for lunches for the 4 weeks?

8. Eric Chung had $65.10 in his checking account on June 1. He wrote two checks in June, one for $42.99. Eric forgot to write down the amount of the other check. At the end of the month, he received a notice that his account was overdrawn by $22.11. What was the amount of Eric's second check?

Self-Test A

Replace __?__ with =, >, or < to make a true statement.

1. $^-4$ __?__ $^-5$　　**2.** 0 __?__ $^-3$　　**3.** $^-8$ __?__ 9　　**4.** $|^-7|$ __?__ 7　　**5.** $|0|$ __?__ 0　　**[3-1]**

Write the numbers in order from least to greatest.

6. $0, 5.4, ^-4.52, ^-0.25, ^-54$　　　　**7.** $^-3.79, 37, ^-7.3, ^-0.37, ^-0.09$　　**[3-2]**

Find the sum or difference.

8. $^-9.3 + 42.3$　　　　**9.** $17.8 + ^-17.8$　　　　**10.** $8.76 + ^-10.2$　　**[3-3]**

11. $8 - (-27)$　　　　**12.** $-5.1 - (-5.1)$　　　　**13.** $0 - 36$　　**[3-4]**

Evaluate the expression when $a = -6.4$ and $b = -5.2$.

14. $-b - a$　　　　**15.** $a - (-b)$　　　　**16.** $b - |a|$

Self-Test answers and Extra Practice are at the back of the book.