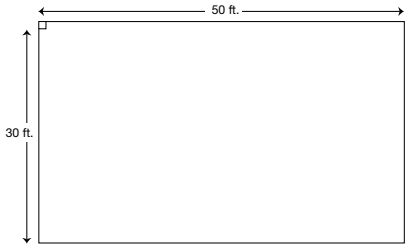
Exponents and Large Numbers

Reckoning

Reckoning is counting or calculating. In the story Sand Reckoning, a girl named Ellen learns about calculating and counting with large numbers. First, she and her father estimate the number of leaves she will have to rake in her yard.

1. The rectangle below is a sketch of Ellen's yard. What is the area of the yard?
2. If Ellen's father estimates that each square foot has 100 leaves, how many leaves does Ellen have to rake?

□ 1 square foot



3. **A.** There are 20 houses on Ellen's block. If each house has about the same number of leaves, how many leaves are on Ellen's block?
   B. There about 300 blocks in Ellen's town. Estimate the number of leaves in the town.

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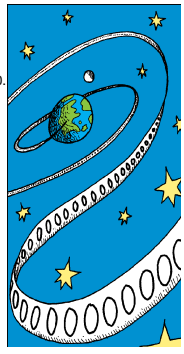
Exponents

Discuss

In the story Sand Reckoning, Archimedes estimated that the number of grains of sand it would take to fill the universe was the number 10^{63}.

10^{63} means we multiply 10 by itself 63 times.
"Who thought of that?" asked Ellen.

10^2 means $10 \times 10 = 100$.
10^3 means $10 \times 10 \times 10 = 1000$.
10^6 means $10 \times 10 \times 10 \times 10 \times 10 \times 10 = 1{,}000{,}000$.



When we write 10^6, the number 10 is called the **base.** The number 6 is the **exponent** or **power.** We say "ten to the sixth power" or just "ten to the sixth." We call 10^6 the sixth power of 10.

Other numbers can be written using exponents.

For example,
2^3 means $2 \times 2 \times 2 = 8$
5^2 means $5 \times 5 = 25$
3^4 means $3 \times 3 \times 3 \times 3 = 81$
7^1 means 7

When we write 2^3, the 2 is the base and 3 is the power or exponent.

4. **A.** Name the base and the exponent in 5^2.
   B. Name the base and the power in 3^4.
5. Find n.
   A. $4^3 = n$ **B.** $2^5 = n$ **C.** $6^1 = n$
6. Write the following using exponents. Then find the value of n.
   Example:
   $5 \times 5 \times 5 \times 5 = n$
   $5^4 = 625$
   A. $4 \times 4 \times 4 = n$ **B.** $2 \times 2 \times 2 \times 2 \times 2 \times 2 = n$ **C.** $8 \times 8 \times 8 = n$

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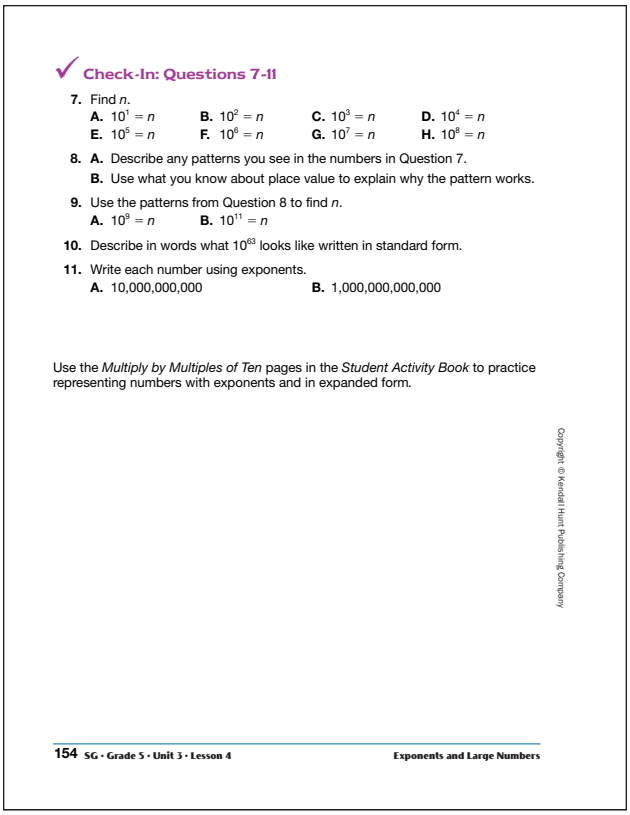
Exponents and Large Numbers (SG pp. 144, 153–154) Questions 1–11

1.* 30 ft. × 50 ft. = 1500 sq. ft. in the yard
2.* 1500 sq ft × 100 leaves per sq. ft. = 150,000 leaves
3. **A.*** 20 yards × 150,000 leaves per yard = 3,000,000 leaves or about 3 million leaves
   B.* 300 blocks × 3,000,000 leaves per block = 900,000,000 leaves or about 9 hundred million in town
4. **A.*** base: 5; exponent: 2
   B.* base: 3; power: 4
5. **A.*** 64
   B. 32
   C. 6
6. **A.** $4^3 = 64$
   B. $2^6 = 64$
   C. $8^3 = 512$

* Answers and/or discussion are included in the lesson.

7. **A.*** 10
   B. 100
   C. 1000
   D. 10,000
   E. 100,000
   F. 1,000,000
   G. 10,000,000
   H. 100,000,000
8. **A.*** Each power of ten can be written as 1 followed by the same number of zeros as the exponent.
   B.* The pattern works because the places in a number in the base-ten system stand for ten times the place to the right. So each time you add a zero, it adds another place to the number.
9. **A.** 1,000,000,000
   B. 100,000,000,000
10. 1 followed by 63 zeros
11. **A.** 10^{10}
    B. 10^{12}



✓ Check-In: Questions 7–11

7. Find *n*.
   A. $10^1 = n$ **B.** $10^2 = n$ **C.** $10^3 = n$ **D.** $10^4 = n$
   E. $10^5 = n$ **F.** $10^6 = n$ **G.** $10^7 = n$ **H.** $10^8 = n$
8. **A.** Describe any patterns you see in the numbers in Question 7.
   B. Use what you know about place value to explain why the pattern works.
9. Use the patterns from Question 8 to find *n*.
   A. $10^9 = n$ **B.** $10^{11} = n$
10. Describe in words what 10^{63} looks like written in standard form.
11. Write each number using exponents.
    A. 10,000,000,000 **B.** 1,000,000,000,000

Use the *Multiply by Multiples of Ten* pages in the *Student Activity Book* to practice representing numbers with exponents and in expanded form.

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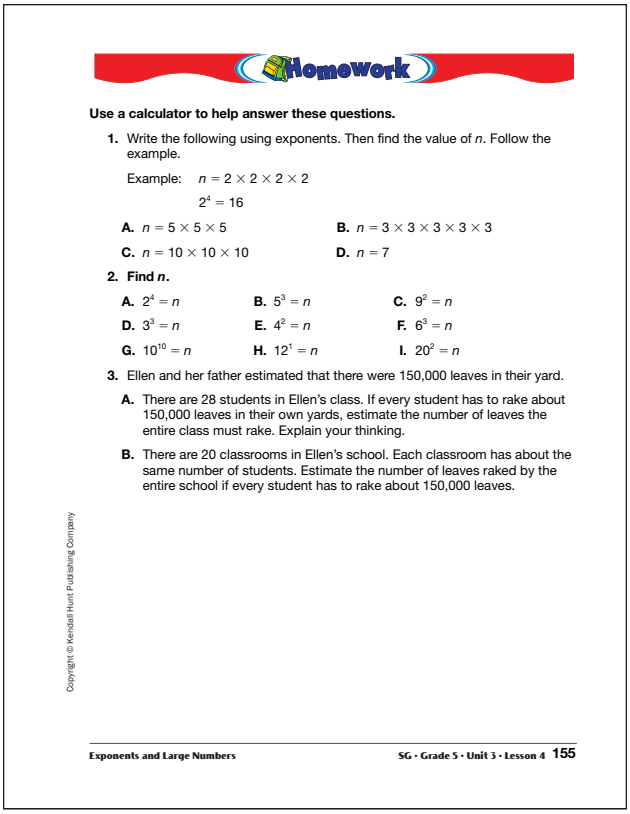
Homework (SG p. 155)
Questions 1–3

1. **A.** $5^3 = 125$
   B. $3^5 = 243$
   C. $10^3 = 1000$
   D. $7 = 7^1$
2. **A.** 16
   B. 125
   C. 81
   D. 27
   E. 16
   F. 216
   G. 10,000,000,000
   H. 12
   I. 400
3. **A.** Estimates will vary. One reasonable estimate is 150,000 leaves × 30 students or 4,500,000 leaves.
   B. Estimates will vary. One reasonable estimate is 4,500,000 leaves × 20 classrooms = 90,000,000 leaves.



Homework

Use a calculator to help answer these questions.

1. Write the following using exponents. Then find the value of *n*. Follow the example.
   Example: $n = 2 \times 2 \times 2 \times 2$
   $2^4 = 16$
   A. $n = 5 \times 5 \times 5$ **B.** $n = 3 \times 3 \times 3 \times 3 \times 3$
   C. $n = 10 \times 10 \times 10$ **D.** $n = 7$
2. **Find *n*.**
   A. $2^4 = n$ **B.** $5^3 = n$ **C.** $9^2 = n$
   D. $3^3 = n$ **E.** $4^2 = n$ **F.** $6^3 = n$
   G. $10^{10} = n$ **H.** $12^1 = n$ **I.** $20^2 = n$
3. Ellen and her father estimated that there were 150,000 leaves in their yard.
   A. There are 28 students in Ellen's class. If every student has to rake about 150,000 leaves in their own yards, estimate the number of leaves the entire class must rake. Explain your thinking.
   B. There are 20 classrooms in Ellen's school. Each classroom has about the same number of students. Estimate the number of leaves raked by the entire school if every student has to rake about 150,000 leaves.

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