7.3 Scientific Notation

Objective To introduce scientific notation.

1 Teaching the Lesson

Key Concepts and Skills
- Explore the place value of numbers written as powers of 10.
  [Number and Numeration Goal 1]
- Translate numbers from scientific notation to standard and number-and-word notation.
  [Number and Numeration Goal 1]
- Use number patterns to solve problems involving exponents.
  [Patterns, Functions, and Algebra Goal 1]

Key Activities
Students use powers of 10 to write numbers in expanded notation. They solve multiplication expressions containing exponents and translate numbers written in scientific notation into standard and number-and-word notation. Students practice writing and comparing numbers written in scientific notation by playing Scientific Notation Toss.

Ongoing Assessment: Recognizing Student Achievement
Use journal page 217.
[Number and Numeration Goal 1]

Key Vocabulary
expanded notation • scientific notation

Materials
Math Journal 2, pp. 214–217
Student Reference Book, p. 329
Study Link 7-2
Class Data Pad • slate • per partnership:
2 six-sided dice

2 Ongoing Learning & Practice

Math Boxes 7-3
Math Journal 2, p. 218
Students practice and maintain skills through Math Box problems.

Study Link 7-3
Math Masters, p. 194
Students practice and maintain skills through Study Link activities.

3 Differentiation Options

READINESS
Using Place Value to Rename Numbers
Math Masters, p. 195
Students rename numbers using place value and number-and-word notation.

EXTRA PRACTICE
Writing Numbers in Expanded Notation
Math Masters, p. 196
Students write whole numbers in expanded notation as addition and multiplication expressions.

ELL SUPPORT
Comparing Notations for Numbers
Differentiation Handbook, p. 149
Students compare and contrast the terms standard notation and exponential notation.

Advance Preparation

552 Unit 7 Exponents and Negative Numbers
Getting Started

Math Message Follow-Up

(Math Journal 2, p. 214)

Ask students to share their solutions for Problems 1–10. Ask a volunteer to write 236 on the Class Data Pad using expanded notation. 236 = 200 + 30 + 6 Show the use of powers of 10 to write numbers in expanded notation. Write 236 = (2 * 10^2) + (3 * 10^1) + (6 * 10^0) on the Class Data Pad. Ask another volunteer to evaluate the expressions in parentheses. 236 = (2 * 10 * 10) + (3 * 10) + (6 * 1) = (2 * 100) + (3 * 10) + (6 * 1) = 200 + 30 + 6

Ask students what observations or connections they notice between the number sentences. Point out that the expanded notation expressions contain powers of 10 written in standard notation, as products of 10s, and in exponential notation.

As a class, read the introduction to scientific notation on the journal page. Problems 6–14 are given in scientific notation.

Do Problems 11–14 as a class. Ask volunteers to rename the power of 10 as a product of 10s. Then carry out the multiplication.

Example: 5 * 10^3 = 5 * (10 * 10 * 10) = 5 * 1,000 = 5,000

Translating Scientific Notation

(Math Journal 2, pp. 215 and 216)

Science Link Ask a student to select an event from journal page 215 and read, in scientific notation, how many years ago the event took place. Demonstrate how to use the place-value chart on page 216 to write the number in standard notation.

Whole-Class Activity

Scientific Notation

Complete the following pattern.

1. 1,000 = 10^3
2. 10 * 10 * 10 = 10^3
3. 10 * 10 * 10 * 10 = 10^4
4. 10^4 = 10,000
5. 10 * 10 * 10 * 10 * 10 = 10^5
6. 10^5 = 100,000
7. 10 * 10 * 10 * 10 * 10 * 10 = 10^6
8. 10^6 = 1,000,000
9. 10 * 10 * 10 * 10 * 10 * 10 * 10 = 10^7
10. 10^7 = 10,000,000

When you write a number as the product of a number and a power of 10, you are using scientific notation. Scientific notation is a useful way to write large or small numbers. Many calculators display numbers in scientific notation.

Example: In scientific notation, 4,800 is written as 4.8 * 10^3.

To write six in scientific notation, it is equal as six times ten to the third power.

Write each of the following in standard notation and number-and-word notation.

1. 5 * 10^4 = 50,000
2. 7 * 10^2 = 700
3. 2 * 10^3 = 20,000
4. 6 * 10^5 = 600,000

Math Journal 2, p. 214

Lesson 7-3 553
Write 2,784 in expanded notation as the sum of multiplication expressions using powers of 10.

Write 6,125 in expanded notation as the sum of multiplication expressions.

Write 6,125 in expanded notation as the sum of multiplication expressions using powers of 10.

Each digit in a number has a value depending on its place in the numeral. Numbers written in expanded notation are written as addition expressions.

Write 4,768 in expanded notation as the sum of multiplication expressions using powers of 10.

Write 8,945 in expanded notation as the sum of multiplication expressions.

Write 987 in expanded notation as an addition expression.

According to the geological record, about how long did dinosaurs roam on Earth?

According to the estimates by scientists, about how many years passed since the appearance of the first fish and the appearance of forests and swamps?

Expect students to reference ideas from the Math Message chart, 4

Ask partners to complete the journal page. Circulate and assist.

Math Journal 2, p. 216

Ongoing Assessment: Recognizing Student Achievement

Use journal page 217, Problems 1–5 to assess students’ understanding of place value and their ability to translate numbers written in standard notation to expanded notation. Students are making adequate progress if they have accurately converted the numbers to expanded notation. Some students may be able to write in expanded notation using powers of 10.

[Number and Numeration Goal 1]

Example: The first fish appeared about $4 \times 10^8$ years ago. To express this number of years in standard notation, find $10^8$ on the place-value chart and write 4 beneath it, followed by the appropriate number of zeros in the cells to the right. From the chart, $4 \times 10^8$ can easily be read as four hundred million.

Ask partners to complete Problems 1–8 on the chart. Circulate and assist.

The scientific notations for Problems 5 and 7 contain decimals. Discuss the meanings of decimals in scientific notation. For example, to convert $6.5 \times 10^7$ to standard notation, think of number-and-word notation. The 6 represents 6 ten millions, or 60 million. The 0.5 represents half of 1 ten million, or 5 million. So $6.5 \times 10^7 = 65$ million. Write the 6 in the $10^7$ column, the 5 in the $10^6$ column, and complete the row with 0s. This shows that $6.5 \times 10^7 = 65,000,000$.

List the following numbers on the Class Data Pad, and ask volunteers to rename the numbers using decimals.

- 15 hundred 1.5 thousand
- 35 thousand 3.5 ten thousand
- 230 million 2.3 hundred million

Ask students to explain how they would write these answers in scientific notation. Thousands is $10^3$, so 1.5 thousand = $1.5 \times 10^3$; ten thousands is $10^4$, so 3.5 ten thousand = $3.5 \times 10^4$; hundred thousands is $10^5$, so 2.3 hundred million = $2.3 \times 10^8$. Add students’ responses to the Class Data Pad.

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Ask partners to complete the journal page. Circulate and assist.
Playing Scientific-Notation Toss
(Student Reference Book, p. 329)

Have students read the directions on page 329 in the Student Reference Book. Ask a volunteer to demonstrate how the game is played.

2 Ongoing Learning & Practice

Math Boxes 7-3
(Math Journal 2, p. 218)

Mixed Practice Math Boxes in this lesson are paired with Math Boxes in Lesson 7-1. The skills in Problems 2 and 6 preview Unit 8 content.

Study Link 7-3
(Math Masters, p. 194)

Home Connection Students practice reading and interpreting numbers written in scientific notation. Then they write the numbers in number-and-word notation.

3 Differentiation Options

Using Place Value to Rename Numbers
(Math Masters, p. 195)

To explore the use of place value and number-and-word notation to rename numbers, have partners complete name-collection cards. Refer students to the place-value chart on Math Masters, page 195.

Pose the following questions:

- What is $\frac{1}{10}$ of 10? 1
- What is $\frac{1}{10}$ of 100? 10
- What is $\frac{1}{10}$ of 1,000? 100
- What is $\frac{1}{10}$ of 10,000? 1,000

Name Date Time

Interpreting Scientific Notation

Scientific notation is a way to represent very large or very small numbers. In scientific notation, a number is written as the product of two factors. One factor is a whole number or a decimal. The other factor is a power of 10.

Scientific notation:

$4 \times 10^2$

$6 \times 10^8$

$\frac{4}{10} \times 10^2$

$\frac{4}{10} \times 10^8$

$-4 \times 10^2$

$-4 \times 10^8$

$1 \times 10^2$

$1 \times 10^8$

Number-and-word notation:

4 hundred

6 billion

.4 ten

.6 billion

-4 ten

-4 billion

1 ten

1 billion

Complete the following statements:

a. The area of Maine is about $6 \times 10^5$ square miles. The area of the other 49 states is about $3 \times 10^8$ square miles.

b. There are about $6 \times 10^9$, or 6 billion, people in the world.

c. It is estimated that $6 \times 10^9$, or 6 billion, people speak English as their first or second language.

d. In Bangladesh, India, and Bangladesh, 2.6 billion people speak Bengali.

e. At least 1 person in each of 115 households, or $10 \times 10^6$, watches the most popular TV show.
 Explain that just as we think of the place-value of each column as 10 times that of the column to its right, we can also think of the place-value of each column as \( \frac{1}{10} \) of the column to its left.

We can use these relationships to rename numbers. In the example on the Math Masters page, we can think how many hundreds in 1,300? and rename it as 13 hundred. If we think how many thousands in 1,300, we can rename it as 1.3 thousand. Since 100 is \( \frac{1}{10} \) of 1,000, then 300 is \( \frac{3}{10} \) of 1,000.

Ask students to first write the numbers from the name-collection box tags in the place-value chart and then follow the pattern in the example to complete the name-collection boxes for these numbers.

Have students share their answers. Consider making posters to display the completed name-collection boxes.

**Writing Practice**

**Writing Numbers in Expanded Notation**

(Math Masters, p. 196)

Students practice writing whole numbers in expanded notation as addition expressions and multiplication expressions.

**Comparing Notations for Numbers**

(Differentiation Handbook, p. 149)

To provide language support for number notations, ask students to compare and contrast the terms standard notation and exponential notation. Have students use the Venn diagram found on Differentiation Handbook, page 149. See the Differentiation Handbook for more information.