Key Concepts

Lesson 1-9

Scientific Notation

Objective Introduce students to the differences between scientific notation and standard form, and teach them to compute with large numbers.

Note to the Teacher *Scientific notation is a useful way of expressing very large numbers. Teaching it also affords an excellent opportunity to reinforce the base ten and decimal expansions, as well as the properties of exponents.*

Large Numbers

Point out that many numbers encountered in science and other fields may be very large. Here are two examples.

- The sun is approximately 93,000,000 miles from Earth.
- There are approximately 6,000,000,000 people living on Earth today.

When we write each of these numbers, we have to write many zeros. Not only is this cumbersome, but it is difficult to get an idea of just how large the numbers are, and it is also difficult to compare two numbers when they are written in this way.

Scientific Notation

Remind students that the place values in a number are based on powers of ten. The place value in which a digit is written indicates the particular power of ten to use in the whole-number expansion for a number. For example,

$5{,}000 = 5 \times 1{,}000 = 5 \times 10^3$,
$600{,}000 = 6 \times 100{,}000 = 6 \times 10^5$, and
$2{,}000{,}000{,}000{,}000 = 2 \times 1{,}000{,}000{,}000{,}000 = 2 \times 10^{12}$.

Stress that students can determine the exponent to be used when writing the power of ten by counting the number of zeros in numbers like those above. But what about numbers that have more than one nonzero digit, like 546,000,000? Emphasize that scientific notation provides a way for writing such numbers in a condensed form.

Key Idea	Every nonzero number can be written in the general form $\left(\begin{array}{c}\text{number greater than or}\\ \text{equal to 1 but less than 10}\end{array}\right) \times$ (power of 10). The power of ten is written using an exponent. This way of writing a number is called **scientific notation**.

Remind students that the decimal in a whole number, although not shown, is just to the right of the ones digit. Point out that to write a large number in scientific notation, the first step is to move the decimal point to the *left* until it is just to the right of the first digit of the number, counting the number of places as you move it. This decimal value is then written as the first part of the general form shown above. The next step is to write the number of places the decimal point was moved as the exponent in the power of ten that is the second part of the general form shown above.

Example 1 **Write 546,000,000 in scientific notation.**

Solution **Step 1** Move the decimal point, counting the number of places moved.

$$546{,}000{,}000. \rightarrow 5.46$$

8 places

Step 2 Use the decimal and the number of places from Step 1 to write the given number in scientific notation.

$$5.46 \times 10^8$$

So, in scientific notation, the number 546,000,000 is written as 5.46×10^8.

Example 2 **Write the distance from Earth to the sun, which is 93,000,000 miles, in scientific notation.**

Solution The decimal point must be moved 7 places to the left so it is between the digit 9 and the digit 3.

$$93{,}000{,}000. \rightarrow 9.3$$

7 places

So, the distance 93,000,000 miles is written in scientific notation as 9.3×10^7 miles.

Exercises

Write each number in scientific notation.

1. 140,000
1.4×10^5

2. 23,400
2.34×10^4

3. 1,052,000
1.052×10^6

4. 23,510,000,000
2.351×10^{10}

5. 10,040,000
1.004×10^7

6. 249,000,000,000,000
2.49×10^{14}

From Scientific Notation Back to Standard Form

It is also very easy to convert from scientific notation to base-ten notation (often called **standard form**). Your students should quickly grasp the fact that the process is reversed, that is, the decimal point is simply moved to the *right* the number of places indicated by the exponent in the power of ten, inserting zeros as necessary.

Example 3 **The number 2.3×10^5 is written in scientific notation. Express the number in standard form.**

Solution The power of ten has an exponent of 5, so the decimal point in 2.3 must be moved 5 places to the right. After moving the decimal point 1 place to the right, four zeros will need to be added to the right of the digit 3 in order to move the remaining 4 places.

Written in standard form, the number is 230,000.

Example 4 **Express the number 8.057×10^8 in standard form.**

Solution The power of ten has an exponent of 8, so the decimal point in 8.057 must be moved 8 places to the right. After moving the decimal point 3 places to the right, five zeros will need to be added to the right of the digit 7 in order to move the remaining 5 places.

In standard form, the number is 805,700,000.