Exponents and Polynomials

9

SECTION 9.5

Scientific Notation

Objectives

A Write numbers in scientific notation.

B Convert numbers written in scientific notation to standard form.

Scientific Notation

There are many disciplines that deal with very large numbers and others that deal with very small numbers.

For example, in astronomy, distances commonly are given in light-years.

A light-year is the distance that light will travel in one year. It is approximately

5,880,000,000,000 miles

Scientific Notation

It can be difficult to perform calculations with numbers in this form because of the number of zeros present.

Scientific notation provides a way of writing very large, or very small, numbers in a more manageable form.

A Scientific Notation

Scientific Notation

Here is the formal definition of Scientific Notation:

Definition

A number is in **scientific notation** when it is written as the product of a number between 1 and 10 and an integer power of 10. A number written in scientific notation has the form

$$n \times 10^r$$

where $1 \leq n < 10$ and r = an integer.

Example 2

The speed of light is 186,000 miles per second. Write 186,000 in scientific notation.

Solution:

To write this number in scientific notation, we rewrite it as the product of a number between 1 and 10 and a power of 10.

To do so, we move the decimal point 5 places to the left so that it appears between the 1 and the 8, giving us 1.86.

Example 2 – *Solution*

cont'd

Then we multiply this number by 10^5. The number that results has the same value as our original number but is written in scientific notation.

Here is our result:

$$\text{Standard form} \longrightarrow 186{,}000 = 1.86 \times 10^5 \longleftarrow \text{Scientific notation}$$

Both numbers have exactly the same value. The number on the left is written in *standard form*, while the number on the right is written in scientific notation.

B Converting to Standard Form

Converting to Standard Form

Lets now practice taking a number written in scientific notation and converting it to a number in standard form.

Example 4

If your pulse rate is 60 beats per minute, then your heart will beat 8.64×10^4 times each day. Write 8.64×10^4 in standard form.

Solution:

Because 10^4 is 10,000, we can think of this as simply a multiplication problem. That is,

$$8.64 \times 10^4 = 8.64 \times 10{,}000 = 86{,}400$$

Looking over our result, we can think of the exponent 4 as indicating the number of places we need to move the decimal point to write our number in standard form.

Example 4 – *Solution*

cont'd

Because our exponent is positive 4, we move the decimal point from its original position, between the 8 and the 6, four places to the right.

If we need to add any zeros on the right we do so. The result is the standard form of our number, 86,400.

Converting to Standard Form

Next, we turn our attention to writing small numbers in scientific notation. To do so, we use the concept of negative exponents.

For example, the number 0.00075, when written in scientific notation, is equivalent to 7.5×10^{-4}.

Here's why:

$$7.5 \times 10^{-4} = 7.5 \times \frac{1}{10^4} = 7.5 \times \frac{1}{10{,}000} = \frac{7.5}{10{,}000} = 0.00075$$

Converting to Standard Form

The following table lists some numbers both in scientific notation and in standard form.

Standard Form		Scientific Notation
376,000	=	3.76×10^{5}
49,500	=	4.95×10^{4}
3,200	=	3.2×10^{3}
591	=	5.91×10^{2}
46	=	4.6×10^{1}
8	=	8×10^{0}
0.47	=	4.7×10^{-1}
0.093	=	9.3×10^{-2}
0.00688	=	6.88×10^{-3}
0.0002	=	2×10^{-4}
0.000098	=	9.8×10^{-5}

Example 5

Each pair of numbers in the table below is equal.

Standard Form		Scientific Notation
376,000	=	3.76×10^{5}
49,500	=	4.95×10^{4}
3,200	=	3.2×10^{3}
591	=	5.91×10^{2}
46	=	4.6×10^{1}
8	=	8×10^{0}
0.47	=	4.7×10^{-1}
0.093	=	9.3×10^{-2}
0.00688	=	6.88×10^{-3}
0.0002	=	2×10^{-4}
0.000098	=	9.8×10^{-5}

Converting to Standard Form

In general, when the exponent is positive, we are working with a large number.

On the other hand, when the exponent is negative, we are working with a small number. (By small number, we mean a number that is less than 1, but larger than 0.)

Converting to Standard Form

We end this section with a diagram that shows two numbers, one large and one small, that are converted to scientific notation.