Writing Numbers in Scientific Notation

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WHAT'S COVERED

In this lesson, you will learn how to write numbers in scientific notation as numbers in standard form and vice versa. Specifically, this lesson will cover:

1. Writing Numbers in Scientific Notation

One application of exponent properties comes from **scientific notation**. Scientific notation is used to represent really large or really small numbers. An example of really large numbers would be the distance that light travels in a year measured in miles. An example of really small numbers would be the mass of a single hydrogen atom in grams. Doing basic operations such as multiplication and division with these numbers would normally be very cumbersome. However, our exponent properties make this process much simpler.

First, we will take a look at what scientific notation is. Scientific notation has two parts: a number between one and ten (it can be equal to one, but not ten), and a power of ten (10 raised to an exponent power).

Scientific Notation: $a \times 10^b$ where $1 \leqslant a < 10$

The exponent, b, is very important to how we convert between scientific notation and normal numbers, or standard notation. The exponent tells us how many times we will multiply by a factor of 10. Multiplying by 10 in effect moves the decimal point one place. So the exponent will tell us how many times the exponent moves between scientific notation and standard notation. To decide which direction to move the decimal (left or right) we simply need to remember that positive exponents mean in standard notation we have a big number (bigger than ten) and negative exponents mean in standard notation we have a small number (less than one). Keeping this in mind, we can easily make conversions between standard notation and scientific notation.

↱ EXAMPLE

Convert $14{,}200$ to scientific notation	Put decimal after first nonzero number
1.42	Count how many times you have to move the decimal to obtain the original number
1.4200	Exponent is how many times decimal moved, 4
$\times 10^4$	Positive exponent, standard notation is big

1.42×10^4 Our Solution

↱ EXAMPLE

Convert 0.0042 to scientific notation — Put decimal after first nonzero number

4.2 — Count how many times you have to move the decimal to obtain the original number

$\overleftarrow{.004}.2$ — Exponent is how many times decimal moved, 3

$\times 10^{-3}$ — Negative exponent, standard notation is small

4.2×10^{-3} Our Solution

Let's look at a few more examples.

Standard Notation	Scientific Notation
110300	1.103×10^5
0.00340	3.4×10^{-3}

TRY IT

Consider the number $24{,}500$.

Convert this number to scientific notation. +

$24{,}500$ — The number.

2.45 — Put decimal after first nonzero number.

$\times 10^4$ — Exponent is how many times decimal moved, 4. It is also a positive exponent because, in standard notation, the number is big.

2.45×10^4 — Combine both parts.

BIG IDEA

When converting into scientific notation, if we move the decimal to the left, this increases the exponent. If we move the decimal to the right, this decreases the exponent.

HINT

Recall that the decimal number in scientific notation must be at least 1, but no greater than 10. This means that 0.4×10^4 and 11.2×10^{-2} are not in proper scientific notation. To correct these types of expressions, the decimal needs to shift either to the right or to the left, to fit our rules for what the decimal number can be:

- $0.4 \times 10^4 \rightarrow 4.0 \times 10^3$: 0.4 needs to be written as 4.0, and the exponent needs to change from 4 to 3 (decreasing due to a shift to the right).

- $11.2 \times 10^{-2} \rightarrow 1.12 \times 10^{-1}$: 11.2 needs to be written as 1.12, and the exponent needs to change from -2 to -1 (increasing due to a shift to the left).

TERM TO KNOW

Scientific Notation

A way to express numbers as the product of a decimal number and a power of 10.

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2. Converting from Scientific Notation to Standard Notation

We can use similar thinking to convert from a number written in scientific notation into standard notation. For these types of conversions, remember that a positive exponent means a large number, and a negative exponent means a small number.

EXAMPLE

Convert 3.21×10^{5} to standard notation	Positive exponent means standard notation big number. Move decimal to the right 5 places
$3.21000\rightarrow$	Simplify solution with any commas
321,000	Our Solution

EXAMPLE

Convert 7.4×10^{-3} to standard notation	Negative exponent means standard notation is a small number. Move decimal to the left 3 places
$\leftarrow.007.4$	Simplify solution
0.0074	Our Solution

TRY IT

Consider the number 1.15×10^{-4}.

Convert this number to standard notation. +

1.15×10^{-4}	The number.
$\leftarrow.0001.15$	Negative exponent means standard notation is a small number. Move decimal left 4 places.
0.000115	Place the decimal in the final spot.

DID YOU KNOW

Archimedes (287 BC - 212 BC), the Greek mathematician, developed a system for representing large

numbers using a system very similar to scientific notation. He used his system to calculate the number of grains of sand it would take to fill the universe. His conclusion was 1063 grains of sand because he figured the universe to have a diameter of 1014 stadia or about 2 light years.

SUMMARY

It is important to remember that when you're **writing numbers in scientific notation**, you can only have one non-zero digit to the left of the decimal, but you can have any number of digits to the right. Also keep in mind when you're writing in scientific notation, moving the decimal to the left is going to increase your exponent and moving the decimal to the right is going to decrease your exponent. When you're writing in standard form, a positive exponent indicates moving the decimal to the right and a negative exponent indicates moving the decimal to the left.

TERMS TO KNOW

Scientific Notation
A way to express numbers as the product of a decimal number and a power of 10.