0.0: Scientific Notation

Learning Objective

- Students will be able to express numbers in scientific notation.

In astronomy, we are often working with extreme numbers—large or small. The best way to express such numbers is to use scientific notation (sometimes called exponential notation or powers of 10). Scientific notation makes computation much easier, and scientists use it because it allows them to be precise.

For example, we know that the distance between Earth and the Sun is 93 million miles. If we write 93 million out as a number, it is:

$$93,000,000$$

In scientific notation, this rather large number is written as:

$$9.3 \times 10^7$$

Here is how it works: the first number, called the coefficient, is always a number greater than or equal to 1 but less than 10 (in our example, it is 9.3). The second number is always a multiple of 10. It can be written in exponential form (in our example, it is 10^7). Sometimes, it is written as “E” or “e"—as on a scientific calculator—but it still means the same thing. So, the example from above would appear as:

$$9.3\text{E}7$$

and would be read as “nine point three times ten to the seventh.” In this book we will favor "E" over "e," but both are in common use.

The exponent is how many powers of 10. In this case, the exponent would be 7. This means there are seven powers of 10, i.e.,

$$\begin{aligned} 10^7 &= 10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10 \\ &= 1\text{E}7 \\ &= 1.0 \times 10^7. \end{aligned}$$

To determine the exponent for a large number, count the number of digits to the left of decimal place, except for the last digit on the left.

For small numbers, we use negative exponents. For example, the size of an atom is about 0.0000000001 meters. In scientific notation, this rather small number is written as:

$$1.0 \times 10^{-10} \text{ or } 1.0\text{E}{-}10$$

To determine the exponent for a small number, count the number of digits to the right of the decimal place (in this case, 10).

Since we will be doing calculations using scientific notation, this site has a built-in scientific calculator. For information on how to use the site’s scientific calculator, see the calculator instructions. You may also choose to use your own handheld or computerized calculator. Whichever calculator you use, make sure you know how to use it properly. For example, you should always use the exponent key (E or EE on many calculators) and not the 10^ key, which can give you an error if used improperly. Finally, some calculators or computers will express positive exponents with a “+” sign instead or no sign, e.g., 1E5 is the same as 1E+5.

SCIENTIFIC NOTATION

In this activity, you will practice converting between regular decimal notation, scientific notation, and scientific notation with the “E” convention (as on your scientific calculator). Fill in the blanks in the chart.

Worked Examples

Some examples are shown in the chart below; the numbers in the three columns on a single row are equal. In other words, 1,000,000 is equal to 10^6 is equal to 1E6.

DECIMAL NOTATION	SCIENTIFIC NOTATION	EXPONENTIAL NOTATION

https://phys.libretexts.org/@go/page/47900

DECIMAL NOTATION	SCIENTIFIC NOTATION	EXPONENTIAL NOTATION
1000000	10^{6}	1E6
0.000001	10^{-6}	1E−6
378	3.78×10^{2}	3.78E2
0.0378	3.78×10^{-2}	3.78E−2

Questions

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