# 0.1: Manipulating Numbers in Scientific Notation

**Learning Objectives**

- Students will be able to perform basic math with numbers in scientific notation.
- Students will be able to use a scientific calculator effectively.

The ability to work with and understand scientific notation is one of the most important skills for science, whether it's astronomy, chemistry, or biology.

When thinking about astronomy and cosmology, it is easier to deal with large quantities, such as distances and masses, by using scientific notation. But you should also be thinking about what these numbers signify. Knowing that each power of ten increases the amount by ten times, and becoming familiar with the prefixes of the "series of 3's" can help you grasp how large of a number you're dealing with. The series of 3's is rather simple: $10^0$ is one, $10^3$ is a thousand, $10^6$ is a million, $10^9$ is billion, and $10^{12}$ is a trillion. Every third power changes the base name of the quantity. Adding one to each power gives you the "tens," so $10^1$ is ten, $10^4$ is ten-thousand, $10^7$ is ten-million, etc. Add two each power, and you have the "hundreds," so $10^2$ is a hundred, $10^5$ is a hundred-thousand, $10^8$ is a hundred-million, and so on.

Sometimes, we need to do more complex manipulations and calculations with numbers in scientific notation. For example, if you want to multiply two numbers using scientific notation, you multiply the coefficients and add the exponents, as in the following examples:

$$10^2 \times 10^5 = 10^{2+5} = 10^7$$

$$(2 \times 10^2) \times (3 \times 10^5) = (2 \times 3) \times 10^{2+5} = 6 \times 10^7$$

$$(4 \times 10^2) \times (5 \times 10^{-5}) = (4 \times 5) \times 10^{2-5} = 20 \times 10^{-3} = 2 \times 10^{-2}$$

If you want to divide two numbers using scientific notation, you divide the coefficients and subtract the exponents, as in the following examples:

$$\frac{10^2}{10^6} = 10^{2-6} = 10^{-4}$$

$$\frac{4 \times 10^2}{2 \times 10^6} = \left(\frac{4}{2}\right) \times 10^{2-6} = 2 \times 10^{-4}$$

Taking the inverse of a number with an exponent changes the sign of the exponent. For example:

$$\frac{1}{10^3} = 10^{-3}$$

When raising a number with an exponent to a higher power, you multiply the exponents. For example:

$$(10^2)^3 = 10^6$$

$$(4 \times 10^2)^3 = 4^3 \times 10^6 = 64 \times 10^6 = 6.4 \times 10^7$$

**MANIPULATING NUMBERS IN SCIENTIFIC NOTATION**