

Scientific Notation

Astronomers deal with quantities that range from the truly microscopic to the mind-boggling enormous. As a result, the numbers that represent these quantities can be very cumbersome to write out in their entirety. For example, it is inconvenient to write out the age of the universe as 15,000,000,000 years or the distance to the Sun as: 149,600,000,000 meters. Therefore, scientists use a system called *scientific notation* to write these numbers. This method involves using powers of ten:

$$\begin{aligned}10^0 &= 1 \\10^1 &= 10 \\10^2 &= 10 \times 10 = 100 \\10^3 &= 10 \times 10 \times 10 = 1,000 \\10^4 &= 10 \times 10 \times 10 \times 10 = 10,000 \\10^5 &= 10 \times 10 \times 10 \times 10 \times 10 = 100,000 \quad \text{and so on.}\end{aligned}$$

The number of zeros indicate both the power (or exponent) to which the ten is raised and the number of times ten is multiplied by itself. However, there is one trick to remember. If the exponent is negative then it means to divide by 10.

The following are the rules for writing a number in scientific notation:

- 1.) The general form of a number that is written in scientific notation is: $A \times 10^B$ where A is a real number between 1 and 10, and B is an integer. Thus, for example, these are not in scientific notation: 34×10^5 , $4.8 \times 10^{0.5}$.
- 2.) If the number is between 1 and 10, so that it would be multiplied by $10^0 (=1)$, then it is not necessary to write the power of ten. For example, the number: 4.56 is already in scientific notation. You may, however, write: 4.56×10^0 if you wish.
- 3.) If the number is a power of ten, then it is not necessary to write that is multiplied by 1. For example, the number: 100 can be written as either: 10^2 or: 1×10^2 . Note that the latter form should be used when entering a number into a calculator.

Converting to Scientific Notation

In order to convert a number from normal notation to scientific notation, perform the following steps:

- 1.) Place the decimal point after the first non-zero digit.
- 2.) Count the number of places the decimal point has moved. This number will become your exponent. If the decimal has moved to the left, then this number will be positive. If it has moved to the right, then it will be negative.

Example 1: To write: 3040 in scientific notation, we must move the decimal point 3 places to the left. Therefore, it becomes: 3.04×10^3 (*you may drop any trailing zeros*).

Example 2: To write 0.0012 in scientific notation, we must move the decimal point 3 places to the right. Therefore, it becomes: 1.2×10^{-3} .

Converting from Scientific Notation

In order to convert a number from scientific notation to normal notation, move the decimal point the number of places indicated by the exponent. If the exponent is positive, then move the point to the right. If the exponent is negative, then move the decimal point to the left.

Example 3: To write: 4.01×10^2 in normal notation, move the decimal point two places to the right making it: 401.

Example 4: To write: 5.7×10^{-3} in normal notation, we move the decimal point three places to the left making it: 0.0057. (*Note that we had to add some zeros into the number as place-holders.*)