Scientific Notation

Scientific notation is a form of "short hand" for writing long numbers. In various fields of science, very large and very small numbers are the norm. For instance, the mass of the sun is

1,988,920,000,000,000,000,000,000,000,000 kilograms

and the mass of an electron is

0.000000000000000000000000000000910938 kilograms

There are shorthand ways of writing these numbers. Using scientific notation, the mass of the sun is $1.98892 * 10^{30}$ kilograms and the mass of an electron is $9.10938 * 10^{-31}$ kilograms.

Not that $1 = 10^0$; $10 = 10^1$; $100 = 10^2$; $1,000 = 10^3$; $10,000 = 10^4$ and so on.

$$3,208 = 3.208 \text{ thousand} = 3.208 * 10^3$$

Likewise $0.1 = 1/10 = 10^{-1}$; $0.01 = 1/100 = 10^{-2}$; $0.001 = 1/1,000 = 10^{-3}$; $0.0001 = 1/10,000 = 10^{-4}$ and so on.

$$0.00045 = 4.5 * .00001 = 4.5 * 1/10,000 = 4.5 * 1/10^{-4} = 4.5 * 10^{-4}$$

Even scientific calculators cannot deal with long strings of zeros such as those shown above. Still, they can easily deal with scientific numbers (and follow all the next rules accurately).

There are rules for working with exponents that are imbedded in scientific calculators:

$$a * 10^b \text{ multiplied by } c * 10^d = ac * 10^{b+c}$$

For example, $4 * 10^3$ multiplied by $6 * 10^4 = 24 * 10^7 = 2.4 \text{ x } 10^8$

$$a * 10^b \text{ divided by } c * 10^d = a/c * 10^{b-c}$$

For example, $4 * 10^3$ divided by $8 * 10^4 = 0.5 * 10^{-1} = 0.05 * 10^0 = 0.05$

Note how moving the decimal point in a number to the left in a leading number requires one to increase the exponent on 10 by 1; moving a decimal point in a leading number to the right requires one to decrease the exponent on 10 by 1. For example (and noting $10^{-1} * 10^1 = 10^0 = 1$)

$23 * 10^6 = 23 * 10^{-1} * 10^1 * 10^6 = 2.3 * 10^7$ and $0.5 * 10^3 = 0.5 * 10^1 * 10^{-1} * 10^3 = 5 * 10^2$

The rule for addition and subtraction is the same for both. That is, in order to add or subtract two numbers written with scientific notation, the exponents must first be the same. For instance,

$$250 + 1,400 = 1,650$$

$$2.5 * 10^2 + 1.4 * 10^3 = 2.5 * \mathbf{10^2} + 14 * \mathbf{10^2} = 16.5 * 10^2 = 1.65 * 10^3$$