Very large and very small numbers are most conveniently expressed with **powers of ten**.
A *power* (or *exponent*) tells how many times a number is repeated as a factor. For example:

10^2 (ten repeated as a factor 2 times) = 10 x 10 = 100

10^5 (ten repeated as a factor 5 times) = 10 x 10 x 10 x 10 x 10 = 100,000

By definition, any number to the zero power = 1, so $10^0 = 1$. Any number with a *negative* exponent indicates the *reciprocal* of the same number with a positive exponent. Combining all this into a table, we we have:

10^6 = 1,000,000	10^{-1} = 1/10 = 0.1
10^5 = 100,000	10^{-2} = 1/100 = 0.01
10^4 = 10,000	10^{-3} = 0.001
10^3 = 1,000	10^{-4} = 0.0001
10^2 = 100	10^{-5} = 0.00001
10^1 = 10	10^{-6} = 0.000001
10^0 = 1	10^{-7} = 0.0000001

Numbers which are not integer powers of 10 may be written as a product of two numbers, one of which **is** a power of 10. The other number is customarily written with just *one* digit to the left of the decimal point:

$$5400 = 5.4 \times 1,000 = 5.4 \times 10^3$$
$$627 = 6.27 \times 100 = 6.27 \times 10^2$$
$$0.00059 = 5.9 \times 0.0001 = 5.9 \times 10^{-4}$$
$$0.000000783 = 7.83 \times 0.0000001 = 7.83 \times 10^{-7}$$

The purpose of scientific notation is *simplicity*. In the first two examples above, it would be more “scientific” to leave the number in conventional (decimal) notation because it takes less ink to write it that way than in power-of-ten notation. In the last example the number is much easier to read when written with a power of ten.

MULTIPLICATION: You can easily verify that 100 x 1000 = 100,000.
If you write that statement with powers of ten, an interesting fact becomes apparent: $10^2 \times 10^3 = 10^5$
We see that whenever powers of 10 are multiplied, the exponents are simply *added*. For example:

$$10^3 \times 10^4 = 10^7 \qquad 10^{-2} \times 10^{-6} = 10^{-8}$$
$$10^{-3} \times 10^5 = 10^2 \qquad 10^{-6} \times 10^2 = 10^{-4}$$

The associativetive property of multiplication is helpful when you need to multiply numbers in scientific notation: (A x B) x (C x D) = (A x C) x (B x D)

For example, $(4.0 \times 10^7) \times (2.0 \times 10^3) = (4 \times 2) \times (10^7 \times 10^3) = 8.0 \times 10^{10}$

Similarly, $(3.0 \times 10^2) \times (2.3 \times 10^5) = (3.0 \times 2.3) \times (10^2 \times 10^5) = 6.9 \times 10^7$

Division works in similar fashion, but the exponents are *subtracted* instead of added:

$$(4.0 \times 10^8) \div (2.0 \times 10^6) = (4.0 / 2.0) \times (10^8 / 10^6) = 2.0 \times 10^2$$
$$(15.5 \times 10^4) \div (2.2 \times 10^{-9}) = (15.5 / 2.2) \times (10^4 / 10^{-9}) = 7.0 \times 10^{13}$$

When **adding** or **subtracting** numbers in scientific notation it is necessary to adjust them so that they have equal exponents. (You can’t add or subtract quantities with different units, and powers of ten are just like units.) **Remember:** if you make an exponent bigger then you must compensate by making the other part of the number *smaller*. For example:

$$2.3 \times 10^4 + 4.5 \times 10^7 = 0.0023 \times 10^7 + 4.5 \times 10^7 = 4.5023 \times 10^7$$
$$456 + 3.2 \times 10^3 = 0.456 \times 10^3 + 3.2 \times 10^3 = 3.656 \times 10^3$$
$$5.8 \times 10^{-5} + 4.1 \times 10^{-3} = 0.058 \times 10^{-3} + 4.1 \times 10^{-3} = 4.158 \times 10^{-3}$$
$$4.8 \times 10^5 - 2.4 \times 10^3 = 4.8 \times 10^5 - 0.024 \times 10^5 = 4.776 \times 10^5$$