Scientific Notation

- In science we often need to work with very large and very small numbers

- Scientific notation makes working with and comparing these values much easier

- A scientific number consists of two parts, a real number and 10 to an integer power:
  e.g. $2.55 * 10^6$

- The proper form for the real component is one non-zero digit followed by a decimal, and then the other digits.

Remember that:

$10^0 = 1$
$10^1 = 10$
$10^2 = 10 * 10 = 100$
$10^3 = 10 * 10 * 10 = 1000$
…

so:

$2.15 * 10^2 = 2.15 * 100 = 215$

$2.15 * 10^5 = 2.15 * 100000 = 215000$

Also, since $X^{-1} = 1/X$:

$10^{-1} = 1/10 = 0.1$
$10^{-2} = 1/(10 * 10) = 1/100 = 0.01$
$10^{-3} = 1/(10 * 10 *10) = 1/1000 = 0.001$
$10^{-4} = 1/(10 * 10 * 10 * 10) = 0.0001$
...
and:

$5.45 * 10^{-1} = 5.45 * 0.1 = 0.545$

$5.45 * 10^{-4} = 5.45 * 0.0001 = 0.000545$

When multiplying exponential values, add the exponents:

$10^x * 10^y = 10^{(x + y)}$

$10^3 * 10^2 = 10^{(3 + 2)} = 10^5$

And for multiplied values with real and exponential parts:

$(2.5 * 10^2) * (3.0 * 10^4) = (2.5 * 3.0) * (10^2 * 10^4)$

$$= 7.5 * 10^6$$

When dividing exponents, remember that:
$1/10^x = 10^{-x}$

$10^3/10^4 = 10^3 * 10^{-4} = 10^{-1}$
$10^3/10^{-4} = 10^3 * 10^4 = 10^7$

$4.66 * 10^2/(2.00 * 10^4) = 4.66/2.00 * 10^2/10^4$
$$= 2.33 * 10^{-2}$$

When using a calculator for numbers in this format, be sure to use parenthesis around the entire divisor so that you will obtain the correct answer.

For addition/subtraction of exponential values, the exponents must be identical before adding/subtracting the real components:

$10^3 + 10^4 = 1 * 10^3 + 10 * 10^3$
$\qquad = 11 * 10^3$
$\qquad = 1.1 * 10 * 10^3$
$\qquad = 1.1 * 10^4$

$1.11 * 10^5 + 1.11 * 10^4 = 1.11 * 10 * 10^4 + 1.11 * 10^4$
$\qquad\qquad\qquad = 11.1 * 10^4 + 1.11 * 10^4$
$\qquad\qquad\qquad = 12.21 * 10^4$
$\qquad\qquad\qquad = 1.221 * 10 * 10^4$
$\qquad\qquad\qquad = 1.221 * 10^5$

Scientific notation may be abbreviated using exponential shorthand:

For a value such as $5.43 * 10^5$,
'* 10' is replaced by 'E', so:
$5.43 * 10^5 = 5.43E5$

Scientific calculators have a button for entering values in this format (usually 'E', 'EE', or 'Exp').

This makes data entry easier by saving on keystrokes, and also reduces the chance of common calculator errors, as shown on the next slide.

Suppose we want to divide 4.22 * 104 by 2.11 * 10-4.

This would be entered into a calculator as:
(4.22 * 10^4) / (2.11 * 10^-4) = 2.00 * 10^8

but if you forget the parenthesis:
4.22 * 10^4 / 2.11 * 10^-4 = 2.00 * 10^0 = 2.00
so the answer is off by 100 million.

A simpler way to input the calculation is:
4.22E4 / 2.11E-4 = 2.00E8