Lesson 4: Scientific Notation

In the last section you learned how to use sig digs in your calculations.

- What do you do if you multiply numbers like 537 x 269 = 144 453... you are supposed to only have three sig digs, but your answer sure has more than three sig digs! *We need a way to show the correct number of sig digs.*
- What if you have a large number like **4 503 443 661** km (the distance from Neptune to the sun), or a small number like **0.000 000 000 100** m (the diameter of an atom) and you don't want to be bothered with writing out all those zeros? *We need a way to show really big and really small numbers.*

Note: Numbers written this "normal" way are called standard notation.

To get around these problems, we use **Scientific Notation** (sometimes called Exponential Notation).

- This system makes use of powers of 10, raising 10 to whatever value you need.
- You can get either really big numbers by using positive powers like $10^5 = 100\ 000$
- You can also show really small numbers by using negative powers like $10^{-5} = 0.00001$

Example 1:

$10^5 = 10 \times 10 \times 10 \times 10 \times 10 = 100\ 000$

$$10^{-5} = \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} = 0.00001$$

Don't worry about spending half a minute using your calculator to figure out what 10^5 equals. When you do this stuff correctly on your calculator it will all be taken care of, no need to change it to standard notation.

Converting Standard Numbers into Scientific Notation

When you use scientific notation, follow these rules. We'll try them out on the numbers from the start of the lesson ...

1. Move the decimal over so that only one non-zero number is to the left of the decimal.

   4 503 443 661 => **4.503 443 661**
   0.000 000 000 100 => **000 000 000 1.00**

2. Count how many spaces over you moved the decimal. If you moved it to the left it's positive, if you moved it to the right it's negative.

   4.503 443 661 => moved **9** spaces left (**+9**)
   000 000 000 1.00 => moved **10** spaces right (**-10**)

3. Get rid of any numbers that are not sig digs. This depends on the numbers you used in your calculation.

   4.500 000 000 000 => **4.5**
   Let's assume that I only actually trust the first couple of sig digs.

Warning!
When you use sci not, you might be writing a number down with more or less sig digs than it actually has. Be very careful to pay attention to the number of sig digs you are really dealing with.

000 000 000 1.00 => **1.00**
I'll keep this last two zeroes, giving it three sig digs. Since it was written in the original number for such a small number, they're probably significant.

4. Write down the number, multiplied by 10 to the power of however many spaces you found in step 2.
   4 503 443 661 = **4.5×10^9**

   0.000 000 000 100 = **1.00×10^{-10}**

If you ever need to change a number in scientific notation back to standard notation, do the reverse of the above.

Scientific Notation on Your Calculator

Most calculators now have a key on them for doing scientific notation. Look for one of the following...

EXP (most Casio calculators)
EE (TI 83, 84, and Nspire calculators. You have to use the 2nd function key to use it on the older 83's and 84's)

> Warning!
> Do **NOT** use the "hat" symbol on your calculator to enter scientific notation (eg. 4.5 x 10^5). Your calculator will treat this as two separate numbers, and you will get some calculations wrong because of it (it screws up the proper order of operations). Do not make excuses like "I'll use brackets," since you'll only screw up later.

On your calculator, type in the question as it's written.

- Remember, the calculator doesn't care about sig digs... it's up to you to round off the answer.
- Most of the time you'll be dealing with multiplying and dividing Scientific Notation, which makes it easier to figure out the sig digs.
- **Use the rules we covered for sig digs, but don't look at the 10 to whatever power part... it does not count for sig digs.**
  - So a number like **4.5×10^9** has only two sig digs. Only the numbers to the left of the "x" are counted for sig digs.
- If you have to type in a negative number, use the (-) button on the calculator, not the subtraction button.

Example 2: **Determine** the answer to the following question.

$4.587 \times 10^4 \div 1.2 \times 10^{-3} = \mathbf{3.8 \times 10^7}$

If you're using a TI graphing calculator, you'll notice that it shows scientific notation with an "E" (for exponent). **Example 2** would look like this on your display...

> Warnings!
> Now is a good time to also check your "float" setting on your calculator. It should just be float, with no numbers.
>
> When doing follow up calculations, always use UNROUNDED numbers, even if you had to round them off for a previous answer.

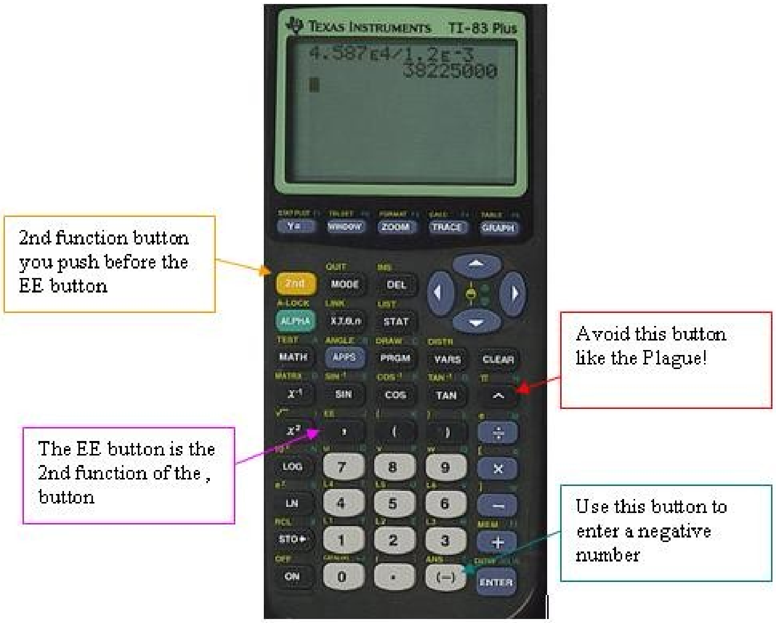

Illustration 1: TI:83 Calculator

To make typing scientific notation easier for me on this site, I will be using a style similar to the way a TI graphing calculator would show the numbers. For example, I'll be typing **3.8e7** instead of **3.8 x 10^7** .

Video Killed the Radio Star!

It's really easy to mix up typing a set of numbers on your calculator using scientific notation. Click on one of these links to watch how to do it on the model of calculator you have:

- Casio Calcultor
- TI 83 , TI 84 , or an older Nspire with the 84 Faceplate
- TI Nspire CX

Casio Calculator

TI 83 and TI 84

TI Nspire CX