Scientific Notation

Unit: Mathematics

NGSS Standards: N/A

MA Curriculum Frameworks (2006): N/A

AP Physics 1 Learning Objectives: N/A

Skills:

- Be able to convert numbers to and from scientific notation.
- Be able to enter numbers in scientific notation correctly on your calculator.

Language Objectives:

- Accurately describe and apply the concepts described in this section using appropriate academic language.

Notes:

Scientific notation is a way of writing a very large or very small number in compact form. The value is always written as a number between 1 and 10 multiplied by a power of ten.

For example, the number 1 000 would be written as 1×10^{3}. The number 0.000 075 would be written as 7.5×10^{-5}. The number 602 000 000 000 000 000 000 000 would be written as 6.02×10^{23}. The number 0.000 000 000 000 000 000 000 000 000 000 000 663 would be written as 6.6×10^{-34}.

(Note: in science, large numbers are typeset with a space after every three digits, both before and after the decimal point. To avoid confusion, commas are not used because in some countries, the comma is used as a decimal point.)

Scientific notation is really just math with exponents, as shown by the following examples:

$$5.6 \times 10^{3} = 5.6 \times 1000 = 5600$$

$$2.17 \times 10^{-2} = 2.17 \times \frac{1}{10^{2}} = 2.17 \times \frac{1}{100} = \frac{2.17}{100} = 0.0217$$

Use this space for summary and/or additional notes.

Notice that if 10 is raised to a positive exponent means you're multiplying by a power of 10. This makes the number larger, and the decimal point moves to the right. If 10 is raised to a negative exponent, you're actually dividing by a power of 10. This makes the number smaller, and the decimal point moves to the left.

Significant figures are easy to use with scientific notation: all of the digits before the "×" sign are significant. The power of ten after the "×" sign represents the (insignificant) zeroes, which would be the rounded-off portion of the number. In fact, the mathematical term for the part of the number before the "×" sign is the *significand*.

Math with Scientific Notation

Because scientific notation is just a way of rewriting a number as a mathematical expression, all of the rules about how exponents work apply to scientific notation.

Adding & Subtracting: adjust one or both numbers so that the power of ten is the same, then add or subtract the significands.

$$\left(3.50\times10^{-6}\right)+\left(2.7\times10^{-7}\right)=\left(3.50\times10^{-6}\right)+\left(0.27\times10^{-6}\right)$$
$$=(3.50+0.27)\times10^{-6}=3.77\times10^{-6}$$

Multiplying & dividing: multiply or divide the significands. If multiplying, add the exponents. If dividing, subtract the exponents.

$$\frac{6.2\times10^{8}}{3.1\times10^{10}}=\frac{6.2}{3.1}\times10^{8-10}=2.0\times10^{-2}$$

Exponents: raise the significand to the exponent. Multiply the exponent of the power of ten by the exponent to which the number is raised.

$$\left(3.00\times10^{8}\right)^{2}=\left(3.00\right)^{2}\times\left(10^{8}\right)^{2}=9.00\times10^{(8\times2)}=9.00\times10^{16}$$

Use this space for summary and/or additional notes.

Using Scientific Notation on Your Calculator

Scientific calculators are designed to work with numbers in scientific notation. It's possible to can enter the number as a math problem (always use parentheses if you do this!) but math operations can introduce mistakes that are hard to catch.

Scientific calculators all have some kind of scientific notation button. The purpose of this button is to enter numbers directly into scientific notation and make sure the calculator stores them as a single number instead of a math equation. (This prevents you from making PEMDAS errors when working with numbers in scientific notation on your calculator.) On most Texas Instruments calculators, such as the TI-30 or TI-83, you would do the following:

What you type	What the calculator shows	What you would write
6.6 [EE] −34	6.6E−34	6.6×10^{-34}
1.52 [EE] 12	1.52E12	1.52×10^{12}
−4.81 [EE] −7	−4.81E−7	-4.81×10^{-7}

On some calculators, the scientific notation button is labeled [EXP] or [$\times 10^x$] instead of [EE].

***Important note**: many high school students are afraid of the [EE] button because it is unfamiliar. If you are afraid of your [EE] button, you need to get over it and start using it anyway. However, if you insist on clinging to your phobia, you need to at least use parentheses around all numbers in scientific notation, in order to minimize the likelihood of PEMDAS errors in your calculations.*

Use this space for summary and/or additional notes.

Homework Problems

Convert the following between scientific notation and algebraic notation.

1. 2.65×10^{9} = _____
2. 1.06×10^{-7} = _____
3. $387\,000\,000$ = _____
4. $0.000\,000\,065$ = _____

Solve the following expressions. Be sure to include the correct units.

5. $(\frac{1}{2})(2.5\,\text{kg})(10.\,\frac{\text{m}}{\text{s}})^2$ = _____
6. $\dfrac{3.75\times10^{8}\ \text{m}}{1.25\times10^{4}\ \text{s}}$ = _____
7. $\dfrac{1.2\times10^{-3}\ \text{N}}{5.0\times10^{-7}\ \text{C}}$ = _____

Use this space for summary and/or additional notes.