Scientific Notation

Unit: Mathematics

MA Curriculum Frameworks (2016): SP5

AP® Physics 2 Learning Objectives: SP 2.2

Mastery Objective(s): (Students will be able to…)

- Correctly use numbers in scientific notation in mathematical problems.

Success Criteria:

- Numbers are converted correctly to and from scientific notation.
- Numbers in scientific notation are correctly entered into a calculator.
- Math problems that include numbers in scientific notation are set up and solved correctly.

Language Objectives:

- Explain how numbers are represented in scientific notation, and what each part of the number represents.

Tier 2 Vocabulary: N/A

Notes:

This section is intended to be a brief review. You learned to use the scientific notation in elementary or middle school. ***You are expected to be able to fluently perform calculations that involve numbers in scientific notation, and to express the answer correctly in scientific notation when appropriate.***

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 6.63×10^{-34}.

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

$$5.6 \times 10^3 = 5.6 \times 1\,000 = 5\,600$$

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

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, which means 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, which means 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.

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

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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 notes**:*

- *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.*
- *Regardless of how you enter numbers in scientific notation into your calculator, always place parentheses around the denominator of fractions.*

$$\frac{2.75\times10^{3}}{5.00\times10^{-2}} \text{ becomes } \frac{2.75\times10^{3}}{(5.00\times10^{-2})}$$

- *You need to **write** answers using correct scientific notation. For example, if your calculator displays the number* 1.52E12*, you need to write* 1.52×10^{12} *(plus the appropriate unit, of course) in order to receive credit.*

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Homework Problems

Convert each of the following between scientific and algebraic notation.

1. $2.65 \times 10^{9} =$

2. $387\,000\,000 =$

3. $1.06 \times 10^{-7} =$

4. $0.000\,000\,065 =$

Solve each of the following on a calculator that can do scientific notation.

5. $(2.8\times10^{6})(1.4\times10^{-2}) =$

   Answer: 3.9×10^{4}

6. $\dfrac{3.75\times10^{8}}{1.25\times10^{4}} =$

   Answer: 3.00×10^{4}

7. $\dfrac{1.2\times10^{-3}}{5.0\times10^{-1}} =$

   Answer: 2.4×10^{-3}

Use this space for summary and/or additional notes: