

**University of Guelph
Numeracy Project**

About Scientific Notation



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About Scientific Notation

What is SCIENTIFIC NOTATION?

- A method developed to express extremely large or small numbers.

Introduction

- In dealing with numbers, sometimes they may become extremely large or small.

For instance, light travels at an exceptionally fast speed of approximately 308,000,000 m/s; meanwhile, the distance between two hydrogen atoms in a hydrogen molecule is estimated to be 0.000,000,000,074 m.

It is obvious that writing these types of numbers is troublesome and inconvenient, and that they are mind-boggling to read. For this particular reason, a method has been developed to express such large or small numbers.

- Did you know that scientific notation can also be called standard form or exponential notation?
- When expressing a number in scientific notation, it is written in the form:

$A \times 10^n$ (this is read as A times 10 to the power of n)
mantissa exponent

Based on convention, the mantissa A is a number between 1 and 10, and the exponent n is a positive or negative integer.

- Note: 10^0 is 1. By definition, any number raised to the power of 0 is 1.

- A number expressed in scientific notation is based on powers of 10.

→ If n is a positive integer, then the mantissa of the scientific notation is multiplied by n factor(s) of 10.

10	10	10^1
100	10 x 10	10^2
1,000	10 x 10 x 10	10^3
10,000	10 x 10 x 10 x 10	10^4
100,000	10 x 10 x 10 x 10 x 10	10^5

→ If n is a negative integer, then the mantissa of the scientific notation is divided by n factor(s) of 10.

0.1	1/10	10^{-1}
0.01	1/(10 x 10)	10^{-2}
0.001	1/(10 x 10 x 10)	10^{-3}
0.0001	1/(10 x 10 x 10 x 10)	10^{-4}
0.00001	1/(10 x 10 x 10 x 10 x 10)	10^{-5}

- As mentioned earlier, the conventional method to express a number in scientific notation is in the form $A \times 10^n$.

But have you ever noticed the use of e or E as part of the scientific notation?

$$1.4 e^5 \quad \text{or} \quad 1.4 E^5$$

In such cases, note that e or E is used to replace the 'x 10' part in the scientific notation.

Conversion between Numbers and Scientific Notations

Conversion of a number into scientific notation

- Any number can be converted into scientific notation by following the steps:
 1. Shift the decimal point to acquire a number between 1 and 10 -- refer to this number as A .
 2. If the decimal point is shifted to the left, multiply A by 10^n , where n equals the number of place holders shifted.
 3. If the decimal point is shifted to the right, multiply A by 10^{-n} , where n equals the number of place holders shifted.

Conversion of scientific notation into a number

- Transforming a number expressed in scientific notation back to its decimal form requires a reversed process:
 1. Examine the value of the exponent n .
 - a) If the exponent n is positive, shift the decimal point to the right by the number of place holders equal to the value of n .
 - b) If the exponent n is negative, shift the decimal point to the left by the number of place holders equal to the value of n .

Algebraic Operations Involving Scientific Notation

Addition and Subtraction

- For adding or subtracting two numbers expressed in scientific notation, follow the steps:
 1. Convert the one of the two scientific notations such that both of its exponents are raised to the same power of 10.
 2. Add or subtract the two mantissas of the scientific notations.
 3. If necessary, convert the answer into the conventional form of scientific notation (i.e., shift the decimal point in the mantissa such that A is between 1 and 10, and change the value of the exponent accordingly).

Multiplication and Division

- For multiplying and dividing two numbers expressed in scientific notation, follow the steps:
 1. Multiply or divide the two powers of 10 of the scientific notations.
 - a. For multiplication, add the two exponents of the powers of 10.
 - b. For division, subtract the two exponents of the powers of 10.
 2. Multiply or divide the two mantissas of the scientific notations.
 3. If necessary, convert the answer into the conventional form of scientific notation (i.e., shift the decimal point in the mantissa such that A is between 1 and 10, and change the value of the exponent accordingly).

Scientific Notation and Calculators

- The importance of knowing how to use your calculator properly cannot be stressed enough. Many students believe that they know their calculators inside out, but often get surprised when their calculators spit out answers that are incorrect due to faulty input of numbers and functions.

In this section, the topic of discussion will focus on inputting scientific notations into a calculator.

- There are many different models of calculators in use, and for that reason, this discussion may or may *not* be applicable to ALL calculators.

Please refer to your calculator's manual for specific directions.

By reading over the following section, you may be able to use the directions provided to help you figure out how they are applicable to your own calculator.

- Most calculators have a built-in function allowing the calculators to recognize that subsequent numbers entered are the exponents of scientific notations. The key may look like **EE** or **EXP** (depending on the model of the calculator, you may need to press the second-function key in order to access it). By pressing this key, it informs the calculator that the next numbers you enter are the exponential values of the scientific notation.

Notice that the calculator does not display the “ x 10 ” part of the scientific notation.

Glossary

Integer:

a set of positive and negative natural numbers such as -2, -1, 0, 1, 2.

Scientific Notation:

a method developed to express extremely large or small numbers.

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