# 3.6 Scientific Notation

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Scientific notation is the way that scientists easily handle very large numbers or very small numbers.

**For example:**

Instead of writing 0.0000000056, we write $5.6 \times 10^{-9}$.

We can think of $5.6 \times 10^{-9}$ as the product of two numbers: 5.6 (the digit term) and $10^{-9}$ (the exponential term). More example are seen below.

| | |
|---|---|
| $10000 = 1 \times 10^{4}$ | $24327 = 2.4327 \times 10^{4}$ |
| $1000 = 1 \times 10^{3}$ | $7354 = 7.354 \times 10^{3}$ |
| $100 = 1 \times 10^{2}$ | $482 = 4.82 \times 10^{2}$ |
| $10 = 1 \times 10^{1}$ | $89 = 8.9 \times 10^{1}$ (not usually done) |
| $1 = 10^{0}$ | |
| $1/10 = 0.1 = 1 \times 10^{-1}$ | $0.32 = 3.2 \times 10^{-1}$ (not usually done) |
| $1/100 = 0.01 = 1 \times 10^{-2}$ | $0.053 = 5.3 \times 10^{-2}$ |
| $1/1000 = 0.001 = 1 \times 10^{-3}$ | $0.0078 = 7.8 \times 10^{-3}$ |
| $1/10000 = 0.0001 = 1 \times 10^{-4}$ | $0.00044 = 4.4 \times 10^{-4}$ |

As you can see, the exponent of 10 is the number of places the decimal point must be shifted to give the number in long form. A positive exponent shows that the decimal point is shifted that number of places to the right. A negative exponent shows that the decimal point is shifted that number of places to the left.In scientific notation, the digit term indicates the number of significant figures in the number. The exponential term only places the decimal point.

**For example:**

This number ($46600000 = 4.66 \times 10^{7}$) only has 3 significant figures. The zeros are not significant; they are only holding a place.

This number ($0.00053 = 5.3 \times 10^{-4}$)has 2 significant figures. The zeros are only place holders.

## Addition and Subtraction

All numbers are converted to the same power of 10, and the digit terms are added or subtracted.

**Example:** $(4.215 \times 10^{-2}) + (3.2 \times 10^{-4}) = (4.215 \times 10^{-2}) + (0.032 \times 10^{-2}) = 4.247 \times 10^{-2}$

**Example:** $(8.97 \times 10^{4}) - (2.62 \times 10^{3}) = (8.97 \times 10^{4}) - (0.262 \times 10^{4}) = 8.71 \times 10^{4}$

## Multiplication

The digit terms are multiplied in the normal way and the exponents are added. The end result is changed so that there is only one nonzero digit to the left of the decimal.

**Example:** $(3.4 \times 10^{6})(4.2 \times 10^{3}) = (3.4)(4.2) \times 10^{(6+3)} = 14.28 \times 10^{9} = 1.4 \times 10^{10}$ (to 2 significant figures)

**Example:** $(6.73 \times 10^{-5})(2.91 \times 10^{2}) = (6.73)(2.91) \times 10^{(-5+2)} = 19.58 \times 10^{-3} = 1.96 \times 10^{-2}$ (to 3 significant figures)

## Division:

The digit terms are divided in the normal way and the exponents are subtracted. The quotient is changed (if necessary) so that there is only one nonzero digit to the left of the decimal.

**Example:** $(6.4 \times 10^{6})/(8.9 \times 10^{2}) = (6.4)/(8.9) \times 10^{(6-2)} = 0.719 \times 10^{4} = 7.2 \times 10^{3}$ (to 2 significant figures)

**Example:** $(3.2 \times 10^{3})/(5.7 \times 10^{-2}) = (3.2)/(5.7) \times 10^{3-(-2)} = 0.561 \times 10^{5} = 5.6 \times 10^{4}$ (to 2 significant figures)

## Powers of Exponentials:

The digit term is raised to the indicated power and the exponent is multiplied by the number that indicates the power.

**Example:** $(2.4 \times 10^{4})^{3} = (2.4)^{3} \times 10^{(4x3)} = 13.824 \times 10^{12} = 1.4 \times 10^{13}$ (to 2 significant figures)

**Example:** $(6.53 \times 10^{-3})^{2} = (6.53)^{2} \times 10^{(-3)x2} = 42.64 \times 10^{-6} = 4.26 \times 10^{-5}$ (to 3 significant figures)