



Scientific Notation

Scientific Notation is the system of notation developed using exponents to express very large and very small numbers in a way that does not require using many zeros and commas, which can be confusing and lead to errors.

- **Scientific Notation** is written in the form of: $a \times 10^n$ where $1 \leq a < 10$. In other words, scientific notation is written as a number from 1 through 9 multiplied by 10 raised to the appropriate exponent.

- **Changing large numbers to scientific notation:**

The distance from the earth to the sun is 93,000,000 miles.

$$93,000,000 = 9.3 \times 10,000,000 = \mathbf{9.3 \times 10^7}$$

1. Move the decimal point of the original number to the left until you get a natural number to the left of the decimal point. (9.3)
2. Count the number of places you have moved the decimal (7 places) and multiply the number 10 raised to that exponent. (10^7)
Hint: Since you moved the decimal point to the left the exponent will be positive. This happens when you convert a large number to scientific notation.

- **Changing small numbers to scientific notation:**

A red blood cell may be 0.000004 inch.

$$0.000004 = 4.0 \times 0.000001 = \mathbf{4.0 \times 10^{-6}}$$

1. Move the decimal point of the original number to the right until you get a natural number to the left of the decimal point. (4.0)
2. Count the number of places you have moved the decimal (6 places) and multiply the number 10 raised to that exponent. (10^{-6})
Hint: Since you moved the decimal point to the right the exponent will be negative. This happens when you convert a small number to scientific notation.

- **Changing a number from scientific notation to decimal notation:**

1. $3.6 \times 10^9 = \mathbf{3,600,000,000}$. Move the decimal point to the right the same number of places as the exponent adding zeros as necessary. The positive exponent indicates a large number.
2. $1.35 \times 10^{-5} = \mathbf{0.0000135}$ Move the decimal point to the left the same number of places as the exponent adding zeros as necessary. The negative exponent indicates a small number.



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Multiplication and Division of Scientific Notation:

- Multiply $(4.3 \times 10^6)(2 \times 10^3) = 8.6 \times 10^9 = \mathbf{8,600,000,000}$
 1. Multiply the numbers. $(4.3 \times 2) = 8.6$
 2. Multiply the powers of 10 by adding the exponents.
 $(10^6 \times 10^3) = (10^{6+3}) = 10^9$
 3. Change from scientific notation to decimal notation.
 $8.6 \times 10^9 = 8,600,000,000$

- Divide $\frac{0.0000093}{0.003} = \frac{9.3 \times 10^{-6}}{3 \times 10^{-3}} = \frac{9.3}{3} \times \frac{10^{-6}}{10^{-3}} = 3.1 \times 10^{-3} = \mathbf{0.0031}$
 1. Change to scientific notation. $\frac{9.3 \times 10^{-6}}{3 \times 10^{-3}}$
 2. Divide the numbers. $\frac{9.3}{3} = 3.1$
 3. Divide the powers of 10 by adding the exponents. *Hint: Remember the negative exponent rule: $\frac{1}{10^{-3}} = 10^3$ The negative exponent in the denominator becomes positive in the numerator.*

 $\text{Therefore, } \frac{10^{-6}}{10^{-3}} = (10^{-6+3}) = 10^{-3}$
 4. Change from scientific notation to decimal notation.
 $3.1 \times 10^{-3} = 0.0031$