# Scientific Notation

**Examples:**

speed of light

$\approx 300,000,000$ m/sec

$3 \times 10^8$

radius of a proton

$\approx 0.000000000088$ mm

$8.8 \times 10^{-12}$

**Why are we interested in scientific notation?**

It's a way for us to write really big or small numbers more quickly.

**What do we want to be able to do with scientific notation?**

- Take numbers in standard notation and write them in scientific notation
- Take numbers in scientific notation and write them in standard notation

# Powers of 10:

## Patterns when taking powers of 10

n = positive integer

$10^n$ = a one followed by n-many zeros
(the 1 is in the $10^n$-ths place)

⋮

$10^4 = 10{,}000$ ←

$10^3 = 1000$

$10^2 = 100$

$10^1 = 10$

$10^0 = 1$

$10^{-1} = \frac{1}{10^1} = \frac{1}{10} = 0.1$ (one-tenths)

$10^{-2} = \frac{1}{10^2} = \frac{1}{100} = 0.01$ (one-hundredths)

$10^{-3} = \frac{1}{10^3} = \frac{1}{1000} = 0.001$ (one-thousandths) ←

⋮

$10^{-n}$ = a one with (n-1)-many zeros between the one and the decimal place
(the 1 is in the $\frac{1}{10^n}$-ths place)

Any number (really big numbers or really small numbers in particular) can be written as a product of some number between 1 and 10 and a power of ten.

Examples:

Speed of light $300,000,000$ m/sec (8 places)

$3 \times 100,000,000 = \boxed{3 \times 10^{8}}$ m/sec

(3: number between 1 & 10; $10^{8}$: power of ten)

radius of a proton $0.000000000000088$ mm (12 places)

$\boxed{8.8 \times 10^{-12}\ \text{mm}}$

$8.8 \times 0.000000000001$

Patterns with scientific notation:

- Exponent tells us how many places the decimal place will move when we go from scientific to standard notation or vice versa.
- Multiply by ten to a positive exponent gives us a "big" number
  negative exponent → "small" decimal

## Scientific Notation definition:

$a \times 10^n$ $n$ is an integer

$1 \leq a < 10$

Examples:

radius of a proton: $8.8 \times 10^{-12}$ m

$88 \times 10^{-13}$ = or $0.88 \times 10^{-11}$

too big — NOT scientific notation — too small

Make sure that a has one and only one number to the left of the decimal point

# Examples:

1) Write in scientific notation:

$0.0000004.07$

7 places

a small decimal ⇒ negative exponent

$4.07 \times 10^{-7}$

✓ bigger than 1, less than 10

2) $2.3 \times 10^{7}$ Write in standard notation.

decimal should move 7 spaces

positive ⇒ will get a "big" number

$2.3000000.$

23,000,000

3) Write in scientific notation:

$3.605000,000.$ → "big" number ⇒ positive exponent

$3.605 \times 10^{9}$

4) Write in standard notation:

$6.97 \times 10^{-8}$ move the decimal point 8 places

exponent is negative ⇒ "small" decimal

0.00000006 97

0.000000097