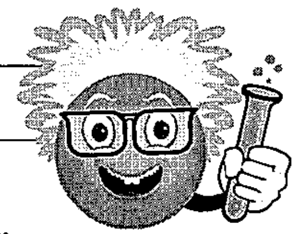
5.3 Scientific Notation

Use a scientific calculator to compute the following: 5,000,000 × 6,000,000 = 3×10^{13}

Very large and very small numbers often occur in the sciences. For such numbers, we use scientific notation simply because it's easier to work with AND most calculators cannot display enough digits to give the answer in decimal form!



The form for scientific notation is: $a \times 10^n$ where $1 \le a < 10$ and n is an integer.

Example 1: Determine whether or not each number is written in scientific notation. Circle the numbers written in scientific notation.

1.3×10^2 $\quad 2 \times 10^{-3}$ $\quad 0.4 \times 10^2$ $\quad 21 \times 10^{-3}$ $\quad 53.2 \times 10^6$ $\quad 5.99 \times 10^{-46}$

Observe the following:

$2.14 \times 10^{-1} = 2.14 \times \frac{1}{10} = 0.214$

$2.14 \times 10^{-2} = 2.14 \times \frac{1}{100} = 0.0214$

$2.14 \times 10^{-3} = 2.14 \times \frac{1}{1000} = 0.00214$

$2.14 \times 10^{1} = 2.14 \times 10 = 21.4$

$2.14 \times 10^{2} = 2.14 \times 100 = 214$

$2.14 \times 10^{3} = 2.14 \times 1000 = 2{,}140$

Do you notice a pattern??

How to write a number <u>in decimal notation (without exponents)</u>:

For numbers greater than 10, the exponent n is **positive** and equal to the number of places the decimal point in the number a **moves to the right.**

scientific notation ⟶ *decimal notation (without exponents)*

$3.45 \times 10^4 = 3.4500. = 34{,}500$

For numbers less than 1, the exponent n is **negative** and equal to the number of places the decimal point in the number a **moves to the left.**

scientific notation ⟶ *decimal notation (without exponents)*

$3.45 \times 10^{-4} = .0003.45 = .000345$

Example 2: Write in decimal notation:

1. 7.4×10^8 740000000
2. 3.54×10^{-6} .00000354
3. 2.5×10^{-2} .025
4. 2×10^2 200
5. 1.333×10^4 13330
6. 8×10^{-1} .8

How to write a number in <u>scientific notation</u>:

First write a (where $1 \le a < 10$) by placing the decimal after the first nonzero digit.

For numbers greater than 10, the exponent n on the base 10 should be **positive** and equal to the number of places the decimal point in a would need to **move to the right** to yield the number without exponents.

decimal notation (without exponents) ⟶ *scientific notation*

$$34{,}500 = 3_{\odot}\underbrace{4\,5\,0\,0}.= 3.45 \times 10^4$$

For numbers less than 1, the exponent n on the base 10 should be **negative** and equal to the number of places the decimal point in a would need to **move to the left** to yield the number without exponents.

decimal notation (without exponents) ⟶ *scientific notation*

$$0.000345 = .\underbrace{0\,0\,0\,3}_{\odot}45 = 3.45 \times 10^{-4}$$

Example 3: Write each number in scientific notation:

1. 0.00035 3.5×10^{-4}
2. 358 3.58×10^{2}
3. 0.0000056 5.6×10^{-6}
4. 280,000 2.8×10^{5}
5. 0.125 1.25×10^{-1}
6. 43,000,000 4.3×10^{7}

Example 4: Perform the indicated operations. Write each answer (a) in scientific notation and (b) without exponents.

1. $(4 \times 10^7)(3 \times 10^{-3})$ $= 12 \times 10^4$

$= \boxed{1.2 \times 10^5}$

2. $\frac{3\times10^9}{6\times10^5}$ $= .5 \times 10^4$

$= \boxed{5 \times 10^3}$