8-2 Scientific Notation

Converting powers of ten to decimals and fractions

$10^{-3} = 1 \div 10^3 = \frac{1}{10^3} = \frac{1}{1000} = .001$

$10^{4} = 1 \times 10^4 = 10 \cdot 10 \cdot 10 \cdot 10 = 10000$

$10^{-5} * 10^{3} = 10^{-2} = \frac{1}{10^2} = \frac{1}{100} = .01$

$10^{-4} \div 10^{6} = 10^{-10} = \frac{1}{10^{10}} = \frac{1}{10{,}000{,}000{,}000} = .0000000001$

$10^{9} * 10^{-5} = 10^4 = 10000$

$10^{-3} \div 10^{2} = 10^{-5} = \frac{1}{10^5} = .00001$

Converting decimals and fractions to powers of ten

1 / 1,000 = 10^{-3}

1,000,000 = 10^{6}

1,000 * 10,000 = 10^{7}

10,000 ÷ 100,000 = 10^{-1}

$10^{4} \div 10^{5}$

1/1000 * 10/10000 = 10^{-6}

$10^{-3} \cdot 10^{-3}$

100/1000000 ÷ 1000/10000 = 10^{-3}

$10^{-4} \div 10^{-1}$

8-2 Scientific Notation

Scientific Notation:
Scientists had a need for a shorter method to express very large and very small numbers. The method they developed is called **scientific notation**. Scientific Notation is built on powers of the base number 10. It was developed before calculators could handle really large and really small numbers.

In scientific notation, every number is written as a product of two factors, the "base", which is always a power of 10 and the "coefficient", which is always a decimal between 1-10.

To write a number in scientific notation:
- To find the coefficient, put the decimal after the first digit and drop all unnecessary zeroes.
- The base is always 10
- To find the exponent of 10, count the number of places from the decimal to the end of the number.
- If in counting the number of places to the end of the number you count to the left then the exponent is negative.
- If in counting the number of places to the end of the number you count to the right then the exponent is positive.

The number 123,000,000,000 in scientific notation is written:

$$1.23 \times 10^{11}$$

- *Move the decimal after the 1. Drop all zeroes after the 3.*
- *1.23, the coefficient, is between 1-10*
- *The base is always 10*

- *In 1. 23,000,000,000 there are 11 places from the decimal to the end of the number*
- *In counting from the decimal to the end of the number you counted to the right, so the exponent is positive (+11)*

More samples: $3{,}460 = 3.46 * 10^{3}$ $6.11 \times 10^{5} = 611{,}000$

The number .00000436 in scientific notation is written:

$$4.36 \times 10^{-6}$$

- *Move the decimal after the 4. Drop all zeroes before the 4.*
- *4.36 is a number between 1-10*
- *The base is 10*

- *In .000004. 36 there are 6 places from the decimal to the end of the number*
- *In counting from the decimal to the end of the number, you counted to the left, so the exponent is negative (- 6).*

More samples: $5.43 * 10^{-8} = .0000000543$

$.00023 = 2.3 * 10^{-4}$

How the Graphing Calculator Handles Scientific Notation

The graphing calculator uses "E" to indicate scientific notation:

1.23E+11 = 1.23 x 10^{11}

.000000000056 = 5.6 E-11

You try:

Write each number in scientific notation:

56,900,000 = 5.69×10^{7} = 56,900,000

.00985 = 9.85×10^{-3}

123,000,000,000 = 1.23×10^{11}

.00000008756 = 8.756×10^{-8}

52 x 10^{4} = 520000 = 5.2×10^{5}

5.2×10^{1}

.04 x 10^{-5} = 4×10^{-7}

Convert each number from scientific notation to standard form:

3.2 x 10^{12} = 3200000000000

2 x 10^{-11} = .00000000002

1.6749 x 10^{23} = 167490000000 . . .

3.7 x 10^{-15} =

Rules for Multiplication in Scientific Notation:

1) Multiply the coefficients
2) Add the exponents (base 10 remains)

Example 1: $(3 \times 10^4)(2 \times 10^5) = \mathbf{6 \times 10^9}$

What happens if the coefficient is more than 10 when using scientific notation?

Example 2: $(5 \times 10^3)(6 \times 10^3) = 30 \times 10^6$

While the value is correct it is not correctly written in scientific notation, since the coefficient is not between 1 and 10. We then must move the decimal point over to the left until the coefficient is between 1 and 10. For each place we move the decimal over the exponent will be raised 1 power of ten.

$30 \times 10^6 = 3.0 \times 10^7$

Example 3: $(2.2 \times 10^4)(7.1 \times 10^5) = 15.62 \times 10^9$

$15.62 \times 10^9 = 1.562 \times 10^{10}$

Example 4: $(7 \times 10^4)(5 \times 10^6)(3 \times 10^2) = 105. \times 10^{12}$
$105. \times 10^{12} = 1.05 \times 10^{14}$

Now Try these:

$(2 \times 10^3)(4 \times 10^4) =$ 8×10^7

$(6 \times 10^5)(7 \times 10^6) =$ $42 \times 10^{11} = 4.2 \cdot 10^{12}$

$(5.5 \times 10^7)(4.2 \times 10^4) =$ $23.1 \times 10^{11} = 2.31 \cdot 10^{12}$

$(3 \times 10^{-3})(3 \times 10^{-3}) =$ $2.31 \cdot 10^1$ $9 \cdot 10^{-6}$

$(2 \times 10^{-3})(3 \times 10^8) =$

$(5 \times 10^7)(8 \times 10^{-6})(4.2 \times 10^4) =$

8-2 Scientific Notation

Rules for Division in Scientific Notation:

1) Divide the coefficients

2) Subtract the exponents (base 10 remains)

Example 1: $\frac{(6 \times 10^{6})}{(2 \times 10^{3})} = \mathbf{3 \times 10^{3}}$

Example 2: $\frac{(2 \times 10^{7})}{(8 \times 10^{3})} = 0.25 \times 10^{4}$

$0.25 \times 10^{4} = 2.5 \times 10^{3}$

Now Try these:

$(9 \times 10^{-6}) / (3 \times 10^{-3}) =$

$(2 \times 10^{3}) / (4 \times 10^{-8}) =$

$(3 \times 10^{7}) / (8 \times 10^{4}) =$

$(9 \times 10^{8}) / (2 \times 10^{6}) =$

$(4 \times 10^{6}) / (2 \times 10^{4}) =$

$(3 \times 10^{-6}) / (2 \times 10^{-4}) =$

$(7 \times 10^{-5}) / (2 \times 10^{10}) =$

$(1.5 \times 10^{-7}) / (3.0 \times 10^{4}) =$

$(3 \times 10^{7}) / (8 \times 10^{-6}) =$