# Scientific Notation

Scientific notation for a number is an expression of the form $N \times 10^m$, where $N$ is in decimal notation, $1 \le N < 10$ (i.e. with only one digit before the decimal and all of the others after the decimal), and $m$ is an integer.

## I. Converting to Scientific Notation:

When starting with decimal notation (the way we normally write numbers), if you must move the decimal to the left to put the number in scientific notation, then the exponent will be positive.

If you must move the decimal to the right to put the number in scientific notation, then the exponent will be negative.

Examples: Convert to scientific notation.

1. pg. 61 # 2 in Intermediate Algebra by Bittinger

$$2{,}600{,}000{,}000{,}000 = \boxed{2.6 \times 10^{12}}$$

We had to move the decimal 12 spaces to the left to get it to rest after the first digit. Thus, the power on the 10 is positive 12.

2. pg. 61 # 4 in Intermediate Algebra by Bittinger

$$572{,}000{,}000{,}000{,}000{,}000 = \boxed{5.72 \times 10^{17}}$$

We had to move the decimal 17 places to the left. Thus, the power on the 10 is positive 17.

3. pg. 61 # 12 in Intermediate Algebra by Bittinger

$$0.00000000802 = \boxed{8.02 \times 10^{-9}}$$

We had to move the decimal 9 spaces to the right to get it to rest after the first nonzero digit. Thus, the power on the 10 is –9.

## II. Converting to Decimal Notation:

When starting with scientific notation, if you must move the decimal to the left to put the number in decimal notation, then the exponent will be negative.

If you must move the decimal to the right to put the number in decimal notation, then the exponent will be positive.

Examples: Convert to decimal notation.

1. pg. 61 # 18 in Intermediate Algebra by Bittinger

$$9.24 \times 10^{7} = \boxed{92{,}400{,}000}$$

The exponent on the 10 is positive 7. Thus, we must move the decimal 7 places to the right.

**2.** pg. 61 # 22 in Intermediate Algebra by Bittinger

$$1.01 \times 10^{12} = \boxed{1{,}010{,}000{,}000{,}000}$$

The exponent on the 10 is positive 12. Thus, we move the decimal 12 places to the right.

**3.** pg. 61 # 24 in Intermediate Algebra by Bittinger

$$3.007 \times 10^{-9} = \boxed{0.000000003007}$$

The exponent on the 10 was –9. Thus, we moved the decimal 9 places to the left.

## III. Significant Digits and Rounding

"In the world of science, it is important to know just how accurate a measurement is. For example, the measurement 5.12 cm is more precise than the measurement 5.1 cm. We say that the measurement 5.12 cm has three significant digits whereas 5.1 cm has only two significant digits. . . . When two or more measurements are added, subtracted, multiplied, or divided, the result is only as accurate as the *least* precise measurement used in the computation. Thus, scientists have agreed on the following conventions." (pg. 61 # 24 in Intermediate Algebra by Bittinger)

**A.** The sum or difference of two numbers should be rounded off so that it has the same number of significant digits to the right of the decimal as the number in the measurement with the fewest significant digits to the right of the decimal.

Example:

$$187.5 \text{ cm} + 29.67 \text{ cm} = 217.17 \text{ cm}$$

The first number has 1 significant digit after the decimal. The second number has 2 significant digits after the decimal. Thus, our answer should be rounded so that it has only 1 significant digit after the decimal. i.e. 217.2 cm

**B.** The product or quotient of two numbers should be rounded off so that it contains the same number of significant digits as the measurement with the fewest significant digits.

Example:

$$3.65 \text{ cm} \times 134.679 \text{ cm} = 491.57835 \text{ cm}$$

The first measurement has 3 significant digits in all. The second measurement has 6 significant digits in all. Thus, our answer should be rounded so that it has only 3 significant digits in all.
i.e. 492 cm

## IV. Scientific Notation in Problem Solving

Examples: Solve.

1. pg. 62 # 56 in Intermediate Algebra by Bittinger

Astronomy. The diameter of the Milky Way galaxy is approximately $5.88 \times 10^{17}$ miles. How many light years is it from one end of the galaxy to the other?
(1 light year = $5.88 \times 10^{12}$ mi)

**U** The distance across our galaxy is $5.88 \times 10^{17}$ mi.
1 light year = $5.88 \times 10^{12}$ mi

**P** We want to find how many light years it is across our galaxy, so we divide.
$5.88 \times 10^{17}$ mi $\div 5.88 \times 10^{12}$ mi

**S** $5.88 \times 10^{17}$ mi $\div 5.88 \times 10^{12}$ mi/year = **100,000 light years**

or in scientific notation $1.00 \times 10^{5}$ light years

**Check** Is the answer reasonable? Use what we learned with exponents. 5.88 divided by itself would be 1. $10^{17}$ divided by $10^{12}$ would be $10^{17-12} = 10^{5}$. Thus, our answer is reasonable.

**State** It is $1.00 \times 10^{5}$ light years from one end of our galaxy to the other.