# SCIENTIFIC NOTATION

Name Key

Scientists very often deal with very small and very large numbers, which can lead to a lot of confusion when counting zeros! We have learned to express these numbers as powers of 10.

Scientific notation takes the form of $M \times 10^n$ where $1 \leq M < 10$ and "n" represents the number of decimal places to be moved. Positive n indicates the standard form is larger than zero whereas negative n would indicate a number smaller than zero.

**Example 1:** Convert 1,500,000 to scientific notation.
We move the decimal point so that there is only one digit to its left, a total of 6 places.

$1{,}500{,}000 = 1.5 \times 10^6$

**Example 2:** Convert 0.000025 to scientific notation.
For this, we move the decimal point 5 places to the right.

$0.000025 = 2.5 \times 10^{-5}$

(Note that when a number starts out less than one, the exponent is always negative.)

Convert the following to scientific notation.

1. $0.005 = 5 \times 10^{-3}$
2. $5{,}050 = 5.05 \times 10^{3}$
3. $0.0008 = 8 \times 10^{-4}$
4. $1{,}000 = 1 \times 10^{3}$
5. $1{,}000{,}000 = 1 \times 10^{6}$
6. $0.25 = 2.5 \times 10^{-1}$
7. $0.025 = 2.5 \times 10^{-2}$
8. $0.0025 = 2.5 \times 10^{-3}$
9. $500 = 5 \times 10^{2}$
10. $5{,}000 = 5 \times 10^{3}$

Convert the following to standard notation.

1. $1.5 \times 10^3 =$ 1,500
2. $1.5 \times 10^{-3} =$ 0.0015
3. $3.75 \times 10^{-2} =$ 0.0375
4. $3.75 \times 10^{2} =$ 375
5. $2.2 \times 10^{5} =$ 220,000
6. $3.35 \times 10^{-1} =$ 0.335
7. $1.2 \times 10^{-4} =$ 0.00012
8. $1 \times 10^{4} =$ 10,000
9. $1 \times 10^{-1} =$ 0.1
10. $4 \times 10^{0} =$ 4 ($* 10^0 = 1$ !)

# Scientific Notation

Key

A. Do the worksheet on scientific notation on the back of this sheet.

B. Read Section 2.2 (Tro) and do these problems for practice: #3, 27-35 (odd).

C. Scientific Notation is usually written in a certain form. For instance, in this number

$$6.022 \times 10^{23} \text{ molecules}$$

the 6.022 is called a coefficient (or "decimal", as Tro says). This coefficient is usually between 1 and 10. Sometimes, the coefficient is not between 1 and 10.

$450 \times 10^{-9}$ nm ← I meant to put $450 \times 10^{-9}$ m

not nm

(Since 1 nm = $10^{-9}$ m)

In the number above, 450 is not between 1 and 10. To put it into the "standard" scientific notation, the decimal is moved from 450. to 4.50 (or 4.5) to make the number between 1 and 10. This is in effect dividing 450 by 100 (to get 4.5). However, we cannot simply write $4.5 \times 10^{-9}$ nm (this is not the same as the number above—write it out in "decimal" form and check for yourself). To compensate for the ***division*** by 100, you must ***multiply*** the exponent part ($10^{-9}$) by 100. 100 is 2 powers of 10 (it is $10 \times 10$). Therefore, you can add 2 powers of 10 to negative 9 powers of ten ($10^{(-9+2)}=10^{-7}$). Therefore,

$450 \times 10^{-9}$ ~~n~~m = $4.5 \times 10^{-7}$ ~~n~~m

(both are in scientific notation, but the latter is in "standard" scientific notation).

1. Express the two numbers below in decimal form. Verify that they are the same.

$450 \times 10^{-9}$ 0.00000045

$4.5 \times 10^{-7}$ 0.00000045

Same!

2. Practice converting these to "standard" scientific notation:

$39 \times 10^{-1}$ 3.9 (or $3.9 \times 10^{0}$)

$3859 \times 10^{7}$ $3.859 \times 10^{10}$

$0.01 \times 10^{2}$ $1 \times 10^{0}$ (or 1)

$423 \times 10^{1}$ $4.23 \times 10^{3}$

$0.000078 \times 10^{-9}$ $7.8 \times 10^{-14}$

$53.498 \times 10^{-34}$ $5.3498 \times 10^{-33}$

$10000000 \times 10^{-100}$ $1 \times 10^{-93}$