

## Scientific Notation

Any number can be written as a multiplication of a number between  $-10$  and  $10$  and a power of ten. When a number is written in this form we say that it is *written in scientific notation*. This approach is useful for writing very large and very small numbers in a manner that is easy to understand.

For example, try comparing the large numbers: 381 000 000 000 and 98 200 000 000. Which one is larger? When the same numbers are written in scientific notation it is easier to see which one is larger by comparing the indices of  $3.81 \times 10^{11}$  and  $9.82 \times 10^{10}$ .

The same applies to small numbers: 0.000 000 000 034 and 0.000 000 000 85, which in scientific notation becomes  $3.4 \times 10^{-11}$  and  $8.5 \times 10^{-10}$ .

For example:

$3.2 \times 10^3$ ,  $4.69 \times 10^{15}$  and  $9.567 \times 10^{-6}$  are all positive numbers written in scientific notation.

$-8.2 \times 10^3$ ,  $-6.72 \times 10^{15}$  and  $-3.201 \times 10^{-23}$  are all negative numbers written in scientific notation.

This time the number at the front is between  $-1$  and  $10$ .

Writing numbers in scientific notation involves two steps:

- Moving the decimal point so that it is placed after the first non-zero digit from the left; and
- Multiplying by a power of ten which will return decimal point to its original position.

### Example 1:

Converting 365 000 to scientific notation.

Step 1	3.650 000	Move the decimal point so that it is after the first non-zero digit.
Step 2	$3.650\ 00 \times 10^5$	To maintain the initial value of the number, we must multiply by $10^5$ . That is, move the decimal point 5 places to the right. Our index is positive because we need to make the number larger to get back to the original number.

Therefore,  $365\ 000 = 3.65 \times 10^5$  is expressed in scientific notation. Note that we have left off the zeros that came after the last number after the decimal point.

### Example 2:

Express 0.003 05 in scientific notation.

Step 1	003.05	Place the decimal point after the first non-zero number (in this case after the 3).
Step 2	$3.05 \times 10^{-3}$	To maintain the initial value of the number, we must multiply by $10^{-3}$ (which is the same as dividing by $10^3$ ). That is, move the decimal point 3 places to the left. Our index is negative because we need to make the number smaller to get back to the original number.

Therefore, expressing this in scientific notation form gives:  $0.003\ 05 = 3.05 \times 10^{-3}$ .

**Example 3:**

Convert  $3.65 \times 10^5$  to ordinary form.

365 000

Notice the 5 in  $10^5$  moved the decimal point five places to the left (since the 5 is a positive number).

**Now try some yourself:** (Answers at the bottom of the page)

Convert the following numbers to scientific notation:

- a) 0.01      b) -0.01      c) -912      d) 2 450 113      e) 0.000 051 263

Convert the following numbers to ordinary form:

- f)  $2.531 \times 10^{-2}$       g)  $-1.91 \times 10^{12}$       h)  $-3.762\,531 \times 10^3$       i)  $7.015 \times 10^{-6}$

**Scientific notation and the calculator**

Most scientific calculators have the ability to display and calculate with numbers in scientific notation. Unfortunately, they don't all do it the same way. Some (usually older) calculators will use the EXP key to enter numbers, while others (newer) will use the  $\times 10^x$  to do this. Also the way that scientific numbers are displayed will vary from calculator to calculator. Please consult your calculator manual for more details.

Try entering some of the above scientific numbers into your calculator. Once the numbers have been entered into the calculator they can be used in calculations the same as any other number.

**Example:**

To calculate  $6.3 \times 10^3 \div 1.23 \times 10^{-1}$ , use the following keystrokes:

$\boxed{6} \boxed{.} \boxed{3} \boxed{\times 10^x} \boxed{3} \boxed{\div} \boxed{1} \boxed{.} \boxed{2} \boxed{3} \boxed{\times 10^x} \boxed{(-)} \boxed{1} \boxed{=}$ , the answer is 51219.5122 (Use the EXP key if you do not have the  $\times 10^x$  key.)

**ONLINE RESOURCE LINKS**

<http://www.usq.edu.au/resources/a3thepoweofnumbers.pdf>

Answers:

- a)  $1 \times 10^2$       b)  $-1 \times 10^2$       c)  $-9.12 \times 10^2$       d)  $2.450\,113 \times 10^6$       e)  $5.126\,3 \times 10^{-5}$   
 f) 0.025 31      g) -1910 000 000 000      h) -3762.531      i) 0.000 007 015