

Scientific Notation (See Appendix in Textbook)

- In this course, we will often be writing numbers in **scientific notation**, a way of expressing numbers that are too large or small to be conveniently written in decimal form.
- Numbers such as 87,000,000 and 0.000056 are written more compactly in scientific notation as:

8.7×10^7 and 5.6×10^{-5} , respectively

- Although scientific notation is most often used for very large and small numbers (well below 1), all numbers can be written in scientific notation.

Scientific Notation

Numbers written in **scientific notation** have two parts:

Decimal part and Exponential part

To write 24000 in the correct scientific notation,

- the decimal part (coefficient) is 2.4.
- the exponential part is 10^4 .
- multiply the two parts together to get

$$2.4 \times 10^4$$

Writing Numbers in Scientific Notation

To write a number in scientific notation,

- move the decimal point to give a number 1-9.
- show the spaces moved as a power of 10.
- * If the decimal point moves left, the power of ten is **positive**.
- * If the decimal point moves right, the power of ten is **negative**.

Examples:

$$\begin{array}{ccc} & \text{coeff.} & \text{power} \\ & & \text{of ten} \\ 52\,000. & = 5.2 \times 10^4 \\ \leftarrow & & \\ 4 \text{ spaces left} & & \end{array}$$

$$\begin{array}{ccc} & \text{coeff.} & \text{power} \\ & & \text{of ten} \\ 0.00178 & = 1.78 \times 10^{-3} \\ \rightarrow & & \\ 3 \text{ spaces right} & & \end{array}$$

Some Positive Powers of 10

A positive exponent (n) means 1 multiplied by 10 n times.

TABLE 1.2 Some Powers of 10

Standard Number	Multiples of 10	Scientific Notation	
10 000	$10 \times 10 \times 10 \times 10$	1×10^4	Some positive powers of 10
1000	$10 \times 10 \times 10$	1×10^3	
100	10×10	1×10^2	
10	10	1×10^1	
1	0	1×10^0	

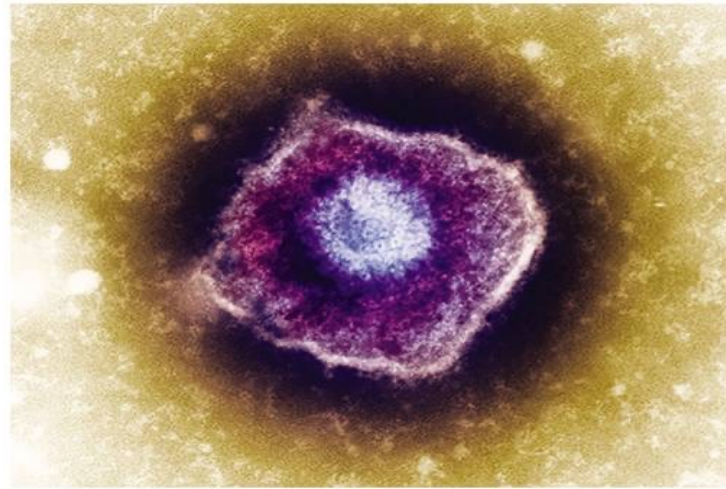
Some Negative Powers of 10

A negative exponent $(-n)$ means 1 divided by 10 n times.

TABLE 1.2 Some Powers of 10

0.1	$\frac{1}{10}$	1×10^{-1}	Some negative powers of 10
0.01	$\frac{1}{10} \times \frac{1}{10} = \frac{1}{100}$	1×10^{-2}	
0.001	$\frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} = \frac{1}{1000}$	1×10^{-3}	
0.0001	$\frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} = \frac{1}{10\,000}$	1×10^{-4}	

Measurements in Scientific Notation



Diameter of chickenpox virus = 0.000 000 3 m
= 3×10^{-7} m

Some Measurements Written as Standard Numbers and in Scientific Notation

TABLE 1.3 Some Measurements Written as Standard Numbers and in Scientific Notation

Measured Quantity	Standard Number	Scientific Notation
Volume of gasoline used in the United States each year	550 000 000 000 L	5.5×10^{11} L
Diameter of Earth	12 800 000 m	1.28×10^7 m
Average volume of blood pumped in 1 day	8500 L	8.5×10^3 L
Time for light to travel from the Sun to Earth	500 s	5×10^2 s
Mass of a typical human	68 kg	6.8×10^1 kg
Mass of stirrup bone in ear	0.003 g	3×10^{-3} g
Diameter of a chickenpox (<i>Varicella zoster</i>) virus	0.000 000 3 m	3×10^{-7} m
Mass of bacterium (mycoplasma)	0.000 000 000 000 000 000 1 kg	1×10^{-19} kg

Scientific Notation and Calculators

Numbers in scientific notation can typically be entered into a calculator using the EXP or EE key.

Number to Enter	Procedure	Calculator Display
4×10^6	4 EE or EXP 6	4 06 or 4^{06} or 4E06
2.5×10^{-4}	2.5 EE or EXP +/- 4	2.5-04 or 2.5^{-04} or 2.5E-04

The calculator display shows a number between 1 and 10 followed by a space or E and the power of 10.

Calculator Display	Expressed in Scientific Notation
7.52 04 or 7.52^{04} or 7.52E04	7.52×10^4
5.8-02 or 5.8^{-02} or 5.8E-02	5.8×10^{-2}

Guide to Writing a Number in Scientific Notation

STEP 1

Move the decimal point to obtain a coefficient that is at least 1 but less than 10.

STEP 2

Express the number of places moved as a power of 10.

STEP 3

Write the product of the coefficient multiplied by the power of 10.

Reminders

- If a number is 10 or larger, the power of 10 is positive.
- If a number less than 1, the power of 10 is negative
- **Only one digit is to the left of the decimal point.**

Learning Check

Write each of the following in correct scientific notation:

A. 64 000

B. 0.000 021

Solution to A.

Write each of the following in correct scientific notation:

A. 64 000

STEP 1 Move the decimal point to obtain a coefficient that is at least 1 but less than 10.

6.4

STEP 2 Express the number of places moved as a power of 10.

10^4

STEP 3 Write the product of the coefficient multiplied by the power of 10.

6.4×10^4

Solution to B.

Write each of the following in correct scientific notation:

B. 0.000 021

STEP 1 Move the decimal point to obtain a coefficient that is at least 1 but less than 10.

2.1

STEP 2 Express the number of places moved as a power of 10.

10^{-5}

STEP 3 Write the product of the coefficient multiplied by the power of 10.

2.1×10^{-5}