

Writing Numbers in Scientific Notation



People have an average of 1×10^5 hairs on their scalp. Each hair is about 8×10^{-6} m wide.

Learning Goal Write a number in scientific notation.

Scientific Notation

Scientific notation is used to write very large or very small numbers, such as

- the width of a human hair, 0.000 008 m, which is also written as 8×10^{-6} m.
- the number of hairs on a human scalp, 100 000, which is also written as 1×10^5 hairs.



Scientific Notation


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


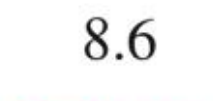

$$\begin{array}{ccc} 1.5 & \times & 10^2 \\ \text{Coefficient} & & \text{Power of 10} \end{array}$$

The coefficient is at least 1 but less than 10.

Writing Numbers in Scientific Notation

The coefficient is obtained by moving the decimal point to give a number that is at least 1 but less than 10.

| Standard Number | | Scientific Notation |
|---|---|---|
| 2400. | = | 2.4 × 10 ³ |
|  | |  Coefficient |
| ← 3 places | |  Power of 10 |

| Standard Number | | Scientific Notation |
|---|---|---|
| 0.00086 | = | 8.6 × 10 ⁻⁴ |
|  | |  Coefficient |
| 4 places → | |  Power of 10 |

Some Powers of 10

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 |
| 1 000 | $10 \times 10 \times 10$ | 1×10^3 | |
| 100 | 10×10 | 1×10^2 | |
| 10 | 10 | 1×10^1 | |
| 1 | 0 | 1×10^0 | |
| 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 | $\frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} = \frac{1}{1\,000}$ | 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} | |

Some Measurements 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 |

Comparing Numbers in Standard and Scientific Notation

Standard Format Scientific Notation

Diameter of the Earth:

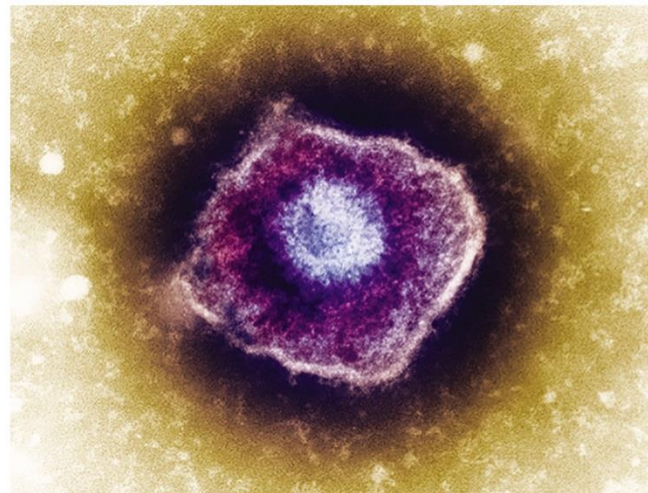
12 800 000 m 1.28×10^7 m

Mass of a human:

68 kg 6.8×10^1 kg

Diameter of a chickenpox virus:

0.000 000 3 cm 3×10^{-7} cm



A chickenpox virus.

Scientific Notation and Calculators

You can enter a number written in scientific notation on many calculators using the EE or EXP 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 |

Scientific Notation and Calculators

When a calculator display appears in scientific notation, it is shown as a number between 1 and 10, followed by a space and the power (exponent).

| 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} |

Scientific Notation and Calculators

On many scientific calculators, a number is converted to scientific notation, using the appropriate keys.

$$0.000\ 52 \left[\begin{array}{c} \text{2}^{\text{nd}} \text{ or } \text{3}^{\text{rd}} \\ \text{function key} \end{array} \right] \left[\text{SCI} \right] = \begin{array}{c} \boxed{5.2-04} \\ \text{Calculator display} \end{array} \text{ or } \boxed{5.2^{-04}} \text{ or } \boxed{5.2\text{E}-04} = 5.2 \times 10^{-4}$$

Learning Check

Write each of the following in correct scientific notation:

A. 64 000

B. 0.021

Solution

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

Write each of the following in correct scientific notation:

B. 0.021

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.

$$10^{-2}$$

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

$$2.1 \times 10^{-2}$$

Learning Check

Select the correct scientific notation for each.

A. 0.000 008

(1) 8×10^6

(2) 8×10^{-6}

(3) 0.8×10^{-5}

B. 72 000 000

(1) 7.2×10^7

(2) 72×10^6

(3) 7.2×10^{-7}

Solution

Select the correct scientific notation for each.

A. 0.000 008

(Move the decimal point 6 places to the right.)

(2) 8×10^{-6}

B. 72 000 000

(Move the decimal point 7 places to the left.)

(1) 7.2×10^7

Concept Map

