



Scientific Notation

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Scientific notation offers a means of writing very large or very small numbers (which are frequently encountered in science) easily.

Examples: The mass of a proton $m_p = 0.000\ 000\ 000\ 000\ 000\ 000\ 000\ 000\ 001673$ kg.
Which equals 1.673×10^{-27} kg in scientific notation.

The radius of the Earth $r_e = 6,380,000$ m which is 6.38×10^6 m in scientific notation.

Notice that the exponent indicates the number of factors of 10 to multiply by if positive or divide by if negative.

A number that is written in scientific notation means that it is written as a product of a decimal number greater than or equal to 1 but less than 10 times $10^{(\text{exponent})}$.

To Write a Number in Scientific Notation:

Examples: a) $478,000 = 4.73000 \times (10 \cdot 10 \cdot 10 \cdot 10 \cdot 10)$

$$= 4.73 \times 10^5$$

b) $0.00032 = 00003.2 \times \left(\frac{1}{10} \cdot \frac{1}{10} \cdot \frac{1}{10} \cdot \frac{1}{10} \right)$

$$= 3.2 \times 10^{-4}$$

To Go from Scientific Notation to Standard (Decimal) Notation:

Example: a) $3.75 \times 10^4 = 3.7500 \times (10 \cdot 10 \cdot 10 \cdot 10 \cdot 10)$

$$= 37,500$$

b) $2.03 \times 10^{-3} = 0002.03 \times \left(\frac{1}{10} \cdot \frac{1}{10} \cdot \frac{1}{10} \right)$

$$= 0.00203$$

Exercises:

I. Express each number using scientific notation.

Example: a) 680,000 b) 0.000043 c) 0.00245

Solution: a) 6.8×10^5 b) 4.3×10^{-5} c) 2.45×10^{-3}

- 1) 285 2) 3476 3) 21 4) 68,742
5) 8,372,000 6) 481,000 7) 0.024 8) 0.0063
9) 0.421 10) 0.000523 11) 0.000004 12) 0.0006

II. Express each number using standard form.

Example: a) 1.01×10^3 b) 6.3×10^{-4} c) 4.317×10^{-2}

Solution: a) 1010 b) 0.00063 c) 0.04317

- 13) 2.4×10^2 14) 4.8×10^3 15) 6.87×10^5 16) 8.31×10^4
17) 5.0×10^{-3} 18) 8.0×10^{-1} 19) 2.02×10^{-2} 20) 4.31×10^{-3}
21) 12.27×10^3 22) 14.38×10^4 23) 23.5×10^{-4} 24) 621.0×10^{-2}

Example: a) $\frac{1}{4 \times 10^3}$ b) $\frac{1}{5 \times 10^{-1}}$

Solution: a) $\frac{1}{4 \times 10^3} = \frac{1}{4} \times \frac{1}{10^3} = .025 \times 10^{-3}$ b) $\frac{1}{5 \times 10^{-1}} = \frac{1}{5} \times \frac{1}{10^{-1}} = 0.2 \times 10^{-1}$
= 0.00025 = 2

- 25) $\frac{1}{2 \times 10^3}$ 26) $\frac{1}{5 \times 10^{-3}}$ 27) $\frac{5}{8 \times 10^{-2}}$

$$\begin{aligned}
 \text{c) } \frac{0.00025}{500,000} &= \frac{2.5 \times 10^{-4}}{5 \times 10^5} && \text{write in SN} \\
 &= \frac{0.5 \times 10^{-4}}{10^5} && \frac{2.5}{5} = 0.5 \\
 &= 0.5 \times 10^{-9} && \frac{10^{-4}}{10^5} = 10^{-9} \\
 &= 5 \times 10^{-1} \times 10^{-9} && 0.5 = 5 \times 10^{-1} \\
 &= 5 \times 10^{-10} && 10^{-1} \times 10^{-9} = 10^{-10} \\
 &= 0.0000000005 && \text{final answer}
 \end{aligned}$$

$$\begin{aligned}
 \text{d) } \frac{(800,000)(60,000)}{6,000,000} &= \frac{(8 \times 10^5)(6 \times 10^4)}{6 \times 10^6} \\
 &= \frac{(8 \times 6)(10^5 \times 10^4)}{6 \times 10^6} \\
 &= \frac{48 \times 10^9}{6 \times 10^6} \\
 &= 8 \times 10^3 \\
 &= 8,000
 \end{aligned}$$

Exercises:

Use scientific notation (SN) to perform each of the following calculations.

$$31) (3,000,000)(0.00002)$$

$$35) \frac{(150,000)(60,000)}{(9,000)(0.01)}$$

$$32) (4,000,000)(100,000)(0.0002)$$

$$36) \frac{0.00064}{3,200,000}$$

$$33) \frac{80,000,000}{40,000}$$

$$37) \frac{40,000}{0.0008}$$

$$34) \frac{(2,000,000)(0.004)(100,000)}{80,000}$$

II. Scientific notation can simplify the addition and subtraction of some very large or very small numbers.

Example: a) $(2.75 \times 10^{-5}) + (3.5 \times 10^{-4})$

Solution: First, write the problem so that both expressions in parentheses contain the same power of 10, in this case 10^5 .

$$(2.75 \times 10^{-5}) = (0.275 \times 10^{-4})$$

The problem becomes

$$(0.275 \times 10^{-4}) + (3.5 \times 10^{-4})$$

Using the distributive property

$$(0.275 + 3.5) \times 10^{-4}$$

$$= 3.775 \times 10^{-4} \text{ or } 0.000377$$

b) $(3.65 \times 10^6) - (1.05 \times 10^5)$

Solution: Both expressions must contain the same power of 10, in this case 10^6 . In general, the highest exponent for 10 that appears in the problem can be used for the common exponent.

$$1.05 \times 10^5 \text{ may be written as } 0.105 \times 10^6$$

The problem becomes

$$(3.65 \times 10^6) - (0.105 \times 10^6) = (3.65 - 0.105) \times 10^6$$

$$= 3.545 \times 10^6 \text{ or } 3,545,000$$

Exercises:

Find the sum or difference of the following.

38) $(1.67 \times 10^6) + (2.52 \times 10^5)$

40) $(2.65 \times 10^{-5}) - (1.35 \times 10^{-4})$

39) $(3.15 \times 10^{-4}) + (1.5 \times 10^{-6})$

41) $(4.52 \times 10^6) - (2.35 \times 10^4)$

Answer Key

- | | | | | | |
|-----|-----------------------|-----|------------------------|-----|--|
| 1) | 2.85×10^2 | 11) | 4×10^{-6} | 21) | 12,270 |
| 2) | 3.476×10^3 | 12) | 6×10^{-4} | 22) | 143,800 |
| 3) | 2.1×10 | 13) | 240 | 23) | 0.00355 |
| 4) | 6.8742×10^4 | 14) | 4800 | 24) | 6.210 |
| 5) | 8.372×10^6 | 15) | 687,000 | 25) | $0.5 \times 10^{-3} = 0.0005$ |
| 6) | 4.81×10^5 | 16) | 83,100 | 26) | $0.2 \times 10^3 = 200$ |
| 7) | 2.4×10^{-2} | 17) | 0.0050 | 27) | $0.625 \times 10^2 = 62.5$ |
| 8) | 6.3×10^{-3} | 18) | 0.80 | 28) | $\frac{10^{-2}}{10^2} = 10^{-4} = 0.0001$ |
| 9) | 4.21×10^{-1} | 19) | 0.0202 | 29) | $\frac{24 \times 10}{3 \times 10^{-7}} = 8 \times 10^8 = 800,000,000$ |
| 10) | 5.23×10^{-2} | 20) | 0.00431 | 30) | $\frac{(4 \times 10^{-6})(3 \times 10^2)}{2 \times 10^4} = \frac{12 \times 10^{-4}}{2 \times 10^4}$ $= 6 \times 10^{-8} = 0.00000006$ |
| 31) | 60 | 37) | 50,000,000 | | |
| 32) | 8×10^7 | 38) | 1.92×10^6 | | |
| 33) | 2000 | 39) | 3.17×10^{-4} | | |
| 34) | 10,000 | 40) | -1.09×10^{-4} | | |
| 35) | 100,000,000 | 41) | 4.50×10^6 | | |
| 36) | 200 | | | | |