

Scientific Notation, Engineering Notation

Scientific Notation

“Scientific Notation” or “Standard Form” is a way of writing numbers in a compact form.

A number written in Scientific Notation is expressed as a number from 1 to less than 10 multiplied by a power of 10.

To write a number in Scientific Notation:

- shift the decimal point so that there is **one** digit (which cannot be zero), **before** the decimal point.
- multiply by a power of 10, equal to the number of places the decimal point has been moved.

The power of 10 is **positive** if the decimal point is moved to the **left** and **negative** if the decimal point is moved to the **right**.

Examples

1. Write 5630 in Scientific Notation.

$$\underline{5630} = 5.63 \times 1000 = 5.63 \times 10^3 \quad (\text{remember } 1000 = 10^3)$$

Move the decimal point three places to the left. The number becomes 5.63. The power of 10 is then positive 3.

2. Write 0.00725 in Scientific Notation.

$$\underline{0.00725} = 7.25 \times 0.001 = 7.25 \times 10^{-3} \quad (\text{remember } 0.001 = 10^{-3})$$

Move the decimal point three places to the right. The number becomes 7.25. The power of 10 is then -3.

Always check your answer. If the magnitude of the number is less than one, then the power of 10 is negative. If the magnitude is greater than or equal to 10 then the power of 10 is positive.

**Engineering
Notation**

“Engineering Notation” is similar to scientific notation. In engineering notation the powers of ten are multiples of 3.

A number written in Engineering Notation is written in the form:

$$a = b \times 10^n$$

- **b is a number from 1 to less than 1000**
- **n is a multiple of three**

To write a number in engineering notation:

- shift the decimal point in “groups” of three places to give a number between 1 and 1000
- multiply by a power of 10 equal to the number of places the decimal point has been moved.

The power of 10 is **positive** if the decimal point is moved to the **left** and **negative** if the decimal point is moved to the **right**.

Examples

1. Write 1635 000 000 in engineering notation.

$$1635\ 000\ 000 = 1.635 \times 10^9$$

Move the decimal point three groups of three places (9 places) to the left. The number is now between 1 and 1000 and the power of 10 is 9.

2. Write 0.4 in engineering notation.

$$0.4 = 400 \times 10^{-3}$$

Move the decimal point one group of three places (3 places) to right. In this case we have to add zeros for the last two places. The number is now between 1 and 1000. The power of 10 is -3.

3. Write 0.000 0045 in engineering notation.

$$0.000\ 0045 = 4.5 \times 10^{-6}$$

Move the decimal point two groups of three places (6 places) to the right. The number is now between 1 and 1000 and the power of 10 is -6.

4. Write 5.75×10^4 in engineering notation.

$$5.75 \times 10^4 = 57500 = 57.5 \times 10^3$$

Write as a decimal number then move the decimal point 3 places to the left. The number is now between 1 and 1000 and the power of 10 is 3.

Or

$$5.75 \times 10^4 = 5.75 \times 10 \times 10^3 = 57.5 \times 10^3$$

Write 10^4 as 10×10^3 then multiply 5.75 by 10. The number is between 1 and 1000 and the power of 10 is 3.

5. Write 3.175×10^{-1} in engineering notation.

$$3.175 \times 10^{-1} = 3.175 \times 10^2 \times 10^{-3} = 317.5 \times 10^{-3}$$

Write 10^{-1} as $10^2 \times 10^{-3}$ then multiply 3.175 by 100. The number is between 1 and 1000 and the power of 10 is -3 .

6. Write 57.5×10^2 in engineering notation.

$$57.5 \times 10^2 = 57.5 \times 10^{-1} \times 10^3 = 5.75 \times 10^3$$

Write 10^2 as $10^{-1} \times 10^3$ then divide 57.5 by 10. The number is between 1 and 1000 and the power of 10 is 3.

Exercise 3

Write the following numbers in Engineering notation.

(a) 53800

(b) 145 000 000

(c) 0.761

(d) 0.000534

(e) 0.0028

(f) 9620

(g) 0.34820

(h) 0.6

(i) 5.6×10^{-2}

(j) 54.8×10^8

Engineering Notation and S.I. Units.

Engineering Notation is used to express physical quantities in terms of the basic S.I. units and a preferred prefix. The preferred prefixes all have powers that are a multiple of three.

Prefix	Symbol	Value	Example
giga	G	10^9	gigahertz (GHz)
mega	M	10^6	megavolt (MV)
kilo	k	10^3	kilometre (km)
milli	m	10^{-3}	milligram (mg)
micro	μ	10^{-6}	micrometre (mm)
nano	n	10^{-9}	nanosecond (ns)
pico	p	10^{-12}	picofarad (pf)

Examples

1. Write the following in S.I Units using a preferred prefix:

(a) 6000m $6000\text{m} = 6 \times 10^3 \text{ m} = 6 \text{ km}$

(b) 0.005V $0.005\text{V} = 5 \times 10^{-3}\text{V} = 5\text{mV}$

(c) 0.000 3s $0.000 \text{ 3s} = 300 \times 10^{-6} \text{ s} = 300 \mu\text{s}$

In each case the number is written in engineering notation then the power of ten is replaced by the corresponding prefix.

2. Write 9.625×10^{-5} A using a preferred prefix and the basic S.I Unit.

Write the number in engineering notation.

$$\begin{aligned} 9.625 \times 10^{-5} \text{ A} &= 9.625 \times 10 \times 10^{-6} \text{ A} \\ &= 96.25 \times 10^{-6} \text{ A} \end{aligned}$$

Replace 10^{-6} by the corresponding prefix.

$$9.625 \times 10^{-5} \text{ A} = 96.25 \mu\text{A}$$

Exercise 4 Complete the following table.

Quantity	Engineering Notation	S.I Unit with prefix	Scientific Notation
450m			
63 200W			
0.000007F			
37 808 000m			
0.000 000 083m			
0.800s			

Answers

3. (a) 53.8×10^3 (b) 145×10^6 (c) 761×10^{-3} (d) 534×10^{-6} (e) 2.8×10^{-3} (f) 9.620×10^3
(g) 348.20×10^{-3} (h) 600×10^{-3} (i) 56×10^{-3} (j) 5.48×10^9

4.

Quantity	Engineering Notation	S.I Unit with prefix	Scientific Notation
450m	450 m	450 m	4.5×10^2 m
63 200W	63.2×10^3 W	63.2 kW	6.32×10^4 W
0.000007F	7×10^{-6} F	7 μ F	7×10^{-6} F
37 808 000m	37.808×10^6 m	37.808 Mm	3.7808×10^7 m
0.000 000 083m	83×10^{-9} m	83 nm	8.3×10^{-8} m
0.800s	800×10^{-3} s	800 ms	8.00×10^{-1} s