

## PME1.6: 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 (this will be a multiple of 3).

The power of 10 is:

- **positive** if the decimal point is moved to the **left**
- **negative** if the decimal point is moved to the **right**.

### Example 1

Write 1635 000 000 in Engineering Notation.

$$\underline{1635} \underline{000} \underline{000} = 1.635 \times 10^9$$

*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.*

### Example 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.*

### Example 3 Write 0.000 0045 in Engineering Notation.

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

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  $-6$ .

**Example 4** Write  $5.75 \times 10^4$  in Engineering Notation.

$$5.75 \times 10^4 = 57\text{500} = 57.5 \times 10^3$$

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  $10 \times 10^3$  then multiply 5.75 by 10. The number is between 1 and 1000 and the power of 10 is 3.

**Example 5** Write  $3.175 \times 10^{-1}$  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  $-3$ .

**Example 6** . Write  $57.5 \times 10^2$  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 1** 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)  $5.6 \times 10^{-2}$         (j)  $54.8 \times 10^8$

## 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	$\mu$	$10^{-6}$	micrometre ( $\mu\text{m}$ )
nano	n	$10^{-9}$	nanosecond (ns)
pico	p	$10^{-12}$	picofarad (pf)

*Example 7* Write the following in S.I Units using a preferred prefix:

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

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

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

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

*Example 8* Write  $9.625 \times 10^{-5} \text{ A}$  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  $10^{-6}$  with the corresponding prefix.*  $9.625 \times 10^{-5} \text{ A} = 96.25 \mu\text{A}$

**Exercise 2** 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			

**Exercise 3**

Write the following in engineering notation, using the correct preferred prefix.

- (a) 0.002s      (b) 0.075km      (c) 0.05mA  
 (d) 0.0033 $\mu$ F      (e) 4500mm      (f) 0.25kV

**Answers**

**Exercise 1**

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

**Exercise 2**

Quantity	Engineering Notation	S.I Unit with prefix	Scientific Notation
450m	450 m	450 m No Prefix	$4.5 \times 10^2$ m
63 200W	$63.2 \times 10^3$ W	63.2 kW	$6.32 \times 10^4$ W
0.000007F	$7 \times 10^{-6}$ F	7 $\mu$ F	$7 \times 10^{-6}$ F
37 808 000m	$37.808 \times 10^6$ m	37.808 Mm	$3.7808 \times 10^7$ m
.000 000 083m	$83 \times 10^{-9}$ m	83 nm	$8.3 \times 10^{-8}$ m
0.800s	$800 \times 10^{-3}$ s	800 ms	$8.00 \times 10^{-1}$ s

**Exercise 3**

- (a) 2ms    (b) 75m    (c) 50 $\mu$ A    (d) 3.3nF    (e) 4.5m    (f) 250V