Scientific Notation

- ***Scientific Notation*** or ***Standard Form*** is a way of writing numbers in a compact form.

- A number written in ***Scientific Notation*** is written in the form:

  $\mathbf{a} \times 10^{\mathbf{b}}$

  Where : **a** is a number from 1 to less than 10
  b is an integer

  Examples :
  - 3.24×10^{5}
  - 1.435×10^{-7}
  - 3.29×10^{6}
  - 7.3×10^{-2}

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 :

Examples #1 : Express 5630 in Scientific Notation

$$5630 = 5630.0 = 5.6300 \times 10^{3}$$

Note : Because the decimal point was moved to the left, the power of 10 is positive.

Examples #2 : Express 0.000628 in Scientific Notation

$$0.000628 = 6.28 \times 10^{-4}$$

Note : Because the decimal point was moved to the right, the power of 10 is negative.

Reasons for using Scientific Notation

1. **Very large and very small numbers can be expressed in a simple, compact form.**

   For example :

   The mass of the moon is:
   73,600,000,000,000,000,000,000 kg. = 7.36×10^{22} kg.

   The charge on one electron is:
   0.00000000000000000001602 C = 1.602×10^{-19} C

   - **The relative size of the number is more easily seen.**
   - **Errors are less likely when writing the number.**

2. **Calculations can be simplified by using index laws.**

   For example:

   $$840000 \times 1080000000 = 8.4 \times 10^5 \times 1.08 \times 10^9$$
   $$= 8.4 \times 1.08 \times 10^{5+9}$$
   $$= 9.072 \times 10^{14}$$

Breakout Exercise #1

Write the following numbers in Scientific Notation :

a) 3700

b) 0.00046

c) 60.2

d) 4500000

e) 0.000000784

Breakout Exercise #2

Write the following numbers in decimal form :

a) 7.24×10^{2}

b) 4.3×10^{-4}

c) 3.459×10^{2}

d) 5.96×10^{-5}

e) 2.43×10^{3}

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 × $10^{\mathbf{b}}$

  Where : **a** is a number from 1 to less than 1000

  b is an integer multiple of three

  Examples :

  - 71.24×10^{3}
  - 4.32×10^{-6}
  - 320.49×10^{9}
  - 123.452×10^{-12}

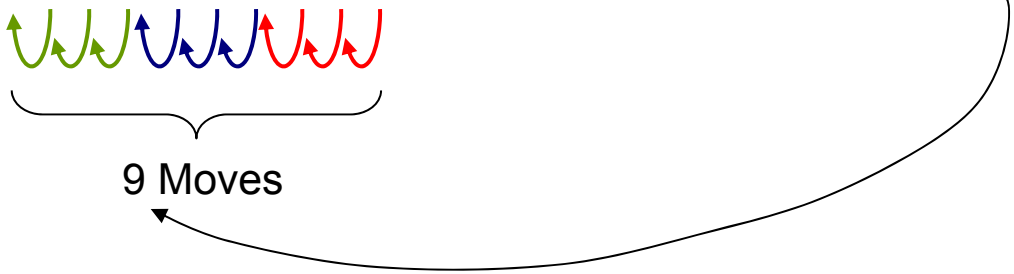
To write a number in Engineering Notation:

- 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 :

Examples #1 : Express 16346000000 in Engineering Notation

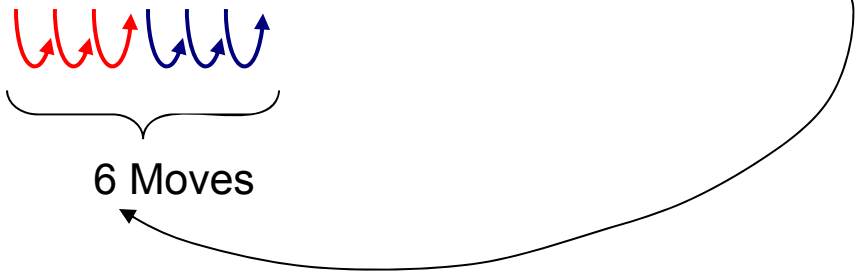
$$16346000000 = 16346000000.0 = 16.346 \times 10^{9}$$



Note : Because the decimal point was moved to the left, the power of 10 is positive.

Examples #2 : Express 0.0003486 in Engineering Notation

$$0.0003486 = 0.0003486 = 348.6 \times 10^{-6}$$



Note : Because the decimal point was moved to the right, the power of 10 is negative.

Breakout Exercise #3

Write the following numbers in Engineering Notation :

a) 82700

b) 0.0005723

c) 27450000

d) 3.459×10^{4}

e) 2.843×10^{-7}

SI Prefixes

- **SI prefixes** are a short hand way of writing Engineering Notation for SI numbers.

- The **International System of Units** (abbreviated **SI** from the French *Système International d'Unités*) is the modern form of the metric system. It is the world's most widely used system of units for science and engineering.

Most Commonly Used SI Prefixes

Prefix	Symbol	Value	Example	Comments
giga	G	10^{9}	24.3×10^{9} Hz = 24.3 GHz	Hz = Frequency
mega	M	10^{6}	6.8×10^{6} Ω = 6.8 MΩ	Ω = Ohms (Resistors)
kilo	k	10^{3}	2.56×10^{3} V = 2.56 kV	V = Volts
milli	m	10^{-3}	14.3×10^{-3} A = 14.3 mA	A = Amps (Current)
micro	μ	10^{-6}	324.6×10^{-6} h = 324.6 μH	H = Henry (Inductors)
nano	n	10^{-9}	14.23×10^{-9} s = 14.23 ns	s = seconds
pico	p	10^{-12}	47×10^{-12} F = 47 pF	F = Farads (Capacitors)

Breakout Exercise #4

Write the following numbers using SI Prefix Notation :

a) 2.75×10^{3} Hz

b) 62.4×10^{-6} A

c) 680×10^{-12} F

d) 4.7×10^{6} Ω

e) 3.25×10^{-9} s