1. UNITS AND MEASUREMENTS

UNITS

1) Unit is defined as the reference standard used for measurements.
2) Measurements consists of a numerical value along with a relevant unit.
3) Example: metre, newton, joule, second etc.

- **MKS (m, kg, s)**
- **CGS (m, gm, s)**
- **FPS (ft, lb, s)**

50 m
Numerical Value → 50
Unit → m

ORDER OF MAGNITUDE

It is defined as the
$N = n \times 10^x$
x = order of magnitude.

coefficient → 6.022 x 10^{23} ← exponent
base

S.I UNITS

- The system of units accepted internationally.
- S.I unit of time is 'sec' is the example of S.I system.

PHYSICAL QUANTITY

- Quantities which can be measured by an instrument and used to describe Laws of physics are physical quantities
- Physical quantity = Numerical value (N) × Unit (U)

Fundamental Quantities in S.I System

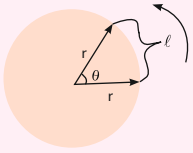
Fundamental quantities do not depend upon other quantities:

1) Length
2) Mass
3) Time
4) Temperature
5) Amount of Substance
6) Electric current
7) Luminous Intensity

Two supplementary S.I units are

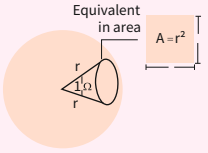
1) Radian(plane angle)

$$\theta = \frac{\text{arc length}}{\text{radius}}$$



2) Steradian (solid angle)

$$\Omega = \frac{\text{area}}{(\text{radius})^2}$$



Derived Physical Quantities

- Derived quantities are formed by combining more than one fundamental physical quantities.
- Area, Volume, velocity and acceleration are some Derived quantities.

SIGNIFICANT FIGURE

The number of digits in the measured values about the correctness are known as significant figures.

All non – zero digits are significant
4.125 - 4 sf;
123 - 3 sf

Leading zeroes placed to the left of the number are never significant figures.
0.0403 - 3 sf;
0.04030 - 4 sf

All zero lie in between the non–zero digits are significant figure.
10.9 - 3 sf;
400.001 - 6 sf

Order of magnitude is not considered
38.3×10^4 - 3 sf;
38.30×10^{-9} - 4 sf

Constants or pure numbers have infinite significant figures;
$4 \rightarrow \infty$, sf
$\pi \rightarrow \infty$, sf

Trailing zero digits are significant only when they appear after decimal
4.00 - 3 sf;
0.043010 - 5 sf

RULES OF ROUNDING OFF

Rules of Rounding off the uncertain digits (up to 3 Significant Figures)

If **digit > 5** then, preceding digit +1

If **digit <5** then, preceding digit remain same

If insignificant **digit = 5**
a) Preceding digit remain same when rounded off digit is even.
b) Preceding digit +1 when rounded off digit is odd.

ERRORS

The uncertainty in measurement is called errors.
Error = true value – measured value

ACCURACY

- Accuracy is degree of closeness of measured value to the true value.
- Shows that how closely the results agree with the standard value.

Types of Error

1) **Absolute Error** = Δa
= true value – measured value

2) **Mean absolute errors**

$$\Delta a_{mean} = \frac{|\Delta a_1|\,|\Delta a_2|\,|\Delta a_3|\,\ldots\ldots\ldots\ldots\,|\Delta a_n|}{n}$$

3) **Relative error/ Fractional error**

$$\frac{\Delta a_{mean}}{a_{mean}}$$

4) **Percentage error**

$$\frac{\Delta \alpha_{mean}}{\alpha_{mean}} \times 100$$

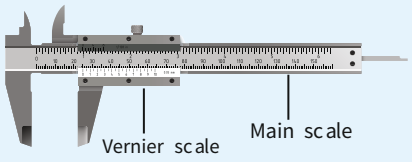
PRECISION

Precision is the range of variation of true value during several observation.

VERNIER CALLIPERS

Least Count (L.C) = 1 MSD – 1 VSD;
MSD = main scale division;
VSD = Vernier scale division

Total reading = MSD + (Vernier Coincidence × least Count)
Zero error = N × L.C;
N = no. of coinciding division; L.C = Least count of Vernier callipers



PRINCIPLE OF HOMOGENITY

Principle of homogeneity states that the dimension of each term on both sides of dimensional equation should be same.

DIMENSIONAL ANALYSIS

Dimensional formula is expressed in terms of power of M, L and T.

Primary or Fundamental Dimensional Formula

There are seven fundamental dimensional formulae:
1) Mass = [M]
2) Length = [L]
3) Time = [T]
4) Temperature = [K] or[θ]
5) Electric Current = [I]
6) Luminous intensity = [cd]
7) Amount of matter = [mol]

Secondary or Derived Dimensional Formula

i) Other than Fundamental formula all other are derived dimensional Formula
ii) ex: 1) [speed] = $[M^0L^1T^{-1}]$
2) [Acceleration] = $[M^0L^1T^{-2}]$

SCREW GAUGE

$$\textbf{Pitch} = \frac{\text{displacement of screw}}{\text{no. of rotations}}$$

$$\textbf{L.C} = \frac{\text{Pitch}}{\text{total no. of divisions}}$$

Zero error = N × L.C
N = no. of circular scale division that coincides with the reference line
L.C = Least Count of screw gauge.

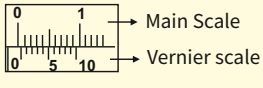
Conversion of Units From one system to another

$$N_2 = N_1\left[\frac{M_1}{M_2}\right]^a\left[\frac{L_1}{L_2}\right]^b\left[\frac{T_1}{T_2}\right]^c$$

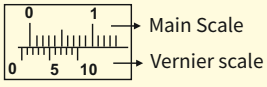
N_1 = numerical part of one system
N_2 = numerical part of another system

Vernier Callipers

Positive Zero Error

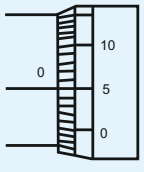


Negative zero error



Screw Gauge

Positive Zero Error



Negative zero error