Units And Measurments

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)

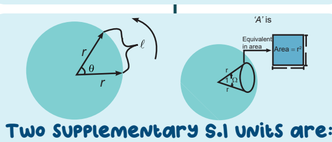
Numerical Value → 45 kg ← Unit

TYPES

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

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



Two supplementary S.I units are:-

(1) Radian(plane angle)
. Q= $\frac{\text{arc}}{\text{radius}}$

(2) Steradian (Solid angle).
$\Omega = \frac{\text{arc}}{(\text{radius})^2}$

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: meter, Newton, Joule, Seconds etc.

MKS (M, kg, S)

CGS (M, gm, S)

FPS (Ft, pound, S)

S.I Units

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

Dimensional Analysis

Dimension formula is the expression for the unit of a physical quantity in terms of the fundamental quantities

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

Primary or fundamental Dimensional Formula

There are seven fundamental dimensional formulas:
(1) Mass = (M), (2) Length = (L), (3) Time = (T), (4) Temperature = (K) or (Q), (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) example: (1) (Speed) = (MoL1T-1).
(2) (Acceleration) = (MoL1T2)

Conversion of Units From are System to another

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

N1 = Numerical Part of one System
N2 = Numerical Part of another System

KNOW YOUR LCROS (SIGNIFICANT FIGURES)

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

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

SOME OTHER UNITS

(1) Mass:- 1 quintal = 100 kg, 1 ton = 1000 kg
(2) Length:- 1 light year = 9.46 × 1015 m
1 au = 1.496 × 1011 m
(3) Temperature: 0o C = 273 K 1o F = 255.928 K

PRINCIPLE OF HOMOGENITY

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

ORDER OF MAGNITUDE

It is defined as the power of 10 which is closest to its magnitude

N = N × 10x: x = order of magnitude.

coefficient, exponent

6.022×10^{23}

base

All non - zero digits are significant
4.125 - 4 Sf:
123 - 3 Sf

Leading zeroes i.e. are never significant placed to the left of the number
0.0403 - 3 Sf:
0.04030 - 4 Sf

10.9 - 3 Sf:
400.001 - 4 Sf
All zero lie in between the non - zero digits are significant

Order of magnitude is not considered
38.3 × 104 - 3 Sf:
38.30 × 10-9 - 4 Sf

Constants and pure numbers have infinite significant figures:

RULE 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

ACCURACY

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

PRECCISION

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

ERRORS

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

TYPES OF ERROR

Absolute Error, = true value – measured value

Mean absolute errors

$$\Delta\alpha_{mean} = \frac{|\Delta\alpha_1| + |\Delta\alpha_2| + \ldots\ldots\ldots\ldots + |\Delta\alpha_n|}{n}$$

Relative error

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

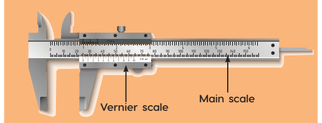
Percentage error.

is difference the measured value and the true value as a percentage of true value
Percentage error

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

VERNIER CALLIPERS

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



Total reading = Main Scale Reading +(Vernier Coincidence × least Count)

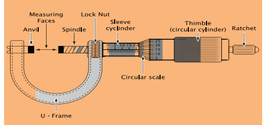
Zero error = N × L.C: N = No. of coinciding division: L.C = Least count of an instrunment.

Pitch =

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

L.C. =

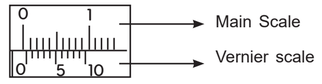
$$\frac{\text{Pitch}}{\text{total no. of divisions}}$$



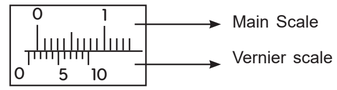
Zero error = N × L.C
N = No. of circular Scale division that coincides with the reference line

L.C = Least Count

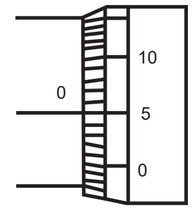
POSITIVE ZERO ERROR



NEGATIVE ZERO ERROR

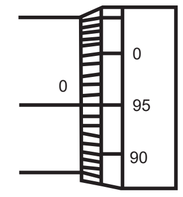


POSITIVE ZERO ERROR



Positive Zero Error

NEGAITIVE ZERO ERROR



Negative Zero Error