Units and Measurement

Physical Quantity :- The quantities which can be measured by an instrument and which describes the law of physical world.

Physical Quantity = numerical value × Unit

$$\boxed{PQ = n \times u}$$

Types of Physical Quantities:—

1. Fundamental Physical Quantity

- Quantity which ~~two~~ do not depend on any other PQ.
- There are seven base units.

	~~Uni~~ PQ	Unit	Symbol
1.	Length	metre	m
2.	Mass	Kilogram	Kg
3.	Time	second	s
4.	Temperature	Kelvin	K
5.	Electric Current	Ampere	A
6.	Luminous Intensity	Candela	cd
7.	No. of substance	Mole	mol

2. Derived Physical Quantity

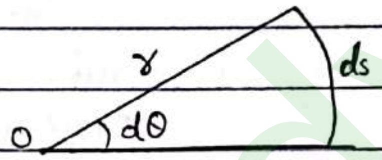
- These quantities are made up of fundamental physical quantity.

e.g. Volume = $m \times m \times m = m^3$

3. Supplementary Physical Quantity

(i) Plane Angle $d\theta$ as the ratio of length of arc ds to the radius r

$$\boxed{d\theta = \frac{ds}{r}} = \frac{\text{arc}}{\text{radius}}$$

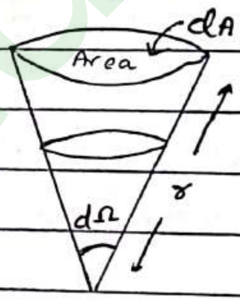


Unit ⇒ Radian (rad)

(ii) Solid angle $d\Omega$ as the ratio of the intercepted area dA of the spherical surface.

- 3D angle.

$$\boxed{d\Omega = \frac{dA}{r^2}} = \frac{\text{Surface area}}{r^2}$$



Unit ⇒ Steridian (sd) or (Sr)

★ Supplementary angles do not have any dimension but have unit.

Dimensions of Physical Quantities

Dimension: The dimensions of a physical quantity are the powers (or exponents) to which the base quantities are raised to represent that quantity.

e.g. Volume = m^3 = $[L^3]$, here dimension of L is 3.

Dimensions are denoted by square brackets [ ].

1. Length [L]
2. Mass [M]
3. Time [T]
4. Temperature [K]
5. Electric Current [A]
6. Luminous intensity [cd]
7. Amount of Substance [mol]

- In mechanics, all physical quantities can be written in terms of dimensions [L], [M] and [T].

Example :-

1. Force = $m \times a$ = $Kg \times \frac{m}{s^2}$ = $\frac{[M] \times [L]}{[T]^2}$ = $[M^1 L^1 T^{-2}]$
2. Work = $F \times s$ = $[MLT^{-2}] \times [L]$ = $[ML^2T^{-2}]$
3. Energy = $[ML^2T^{-2}]$
4. Power = Work / Time = ML^2T^{-2}/T = $[ML^2T^{-3}]$
5. Trigonometric Ratios = $[L]/[L]$ = $[M^0L^0T^0]$

⇒ Trigonometric ratios, angles, numbers are dimensionless.

(Appendix A9 Page no. 218)

Dimensional Formulae and Dimensional Equations

$\Downarrow$ Expression which shows how & which of the base quantities & represent the dimensions of PQ.

$\Downarrow$ Equation obtained by equating a physical quantity with its dimensional formula.

⇒ Principle of Homogenety of Dimension

- The dimension of each term of an equation must be same.
- We can add or subtract similar physical Quantities

\# A dimensionally correct equation need not be actually an exact eqn. but a dimensionally wrong or inconsistent eqn must be wrong.

Ques Find dimesions of a and b in $v = a + bt$ where ($v \to$ velocity and $t \to$ time)

Soln

$$v = a + bt$$

dimension of v = dimension of a

$$L/T = \text{d. of } a$$

$$\Rightarrow \boxed{\text{d. of } a = [M^0 L T^{-1}]}$$

$$\text{d. of } bt = \text{d. of } v$$

$$\text{d. of } bt = [M^0 L T^{-1}]$$

$$\Rightarrow \boxed{\text{d. of } b = [M^0 L T^{-2}]}$$

Ques Find the dimension of $\frac{a}{b}$ ~~and b~~ in $P = \frac{a+t^2}{bx}$, where (P = Pressure, t = time, x = displacement)

Soln

$$P = \frac{a+t^2}{bx}$$

d. of a = d. of t^2 (Principle of homogenity of dimension)

$$\boxed{\text{d. of } a = [T^2]}$$

$$\text{d. of } P = \text{d. of} \left(\frac{a+t^2}{bx}\right)$$

(Pressure = $\frac{\text{Force}}{\text{Area}}$)

$$\frac{MLT^{-2}}{L^2} = \frac{T^2+T^2}{b[L]}$$

$$\frac{M\cancel{L}T^{-2}}{\cancel{L^2}} \times [\cancel{L}] = \frac{T^2}{b}$$

$$MT^{-2} = \frac{T^2}{b}$$

$$\Rightarrow b = \frac{T^2}{MT^{-2}}$$

$$\Rightarrow \boxed{b = M^{-1}T^4}$$

$$\frac{a}{b} = \frac{T^2}{M^{-1}T^4}$$

$$\Rightarrow \boxed{\frac{a}{b} = M^1T^{-2}}$$

Ques Find the dimension of α in $P = P_0 e^{\alpha t^2}$ (t = time).

Soln Power is a pure number. So, d. αt^2 = dimensionless

$$\alpha T^2 = [M^0L^0T^0]$$

$$\boxed{\alpha = [M^0L^0T^{-2}]}$$

Ques find dimension of β in $P = \frac{\alpha}{\beta} e^{-\alpha z/K\theta}$, where p = pressure, z = distance, θ = temperature and K = Boltzmann Constant ($Kg m^2/s^2 K$).

Soln

$$P = \frac{\alpha}{\beta} e^{-\alpha z/K\theta}$$

$\Rightarrow$ Power is dimensionless

$$\alpha z/K\theta = [M^0 L^0 T^0]$$

$$\frac{\alpha \times \cancel{K}}{ML^2T^{-2}\cancel{\theta^{-1}} \times \theta} = [M^0 L^0 T^0]$$

$$\frac{\alpha}{MLT^{-2}} = [M^0 L^0 T^0]$$

$$\alpha = [M^0L^0T^0] \times [MLT^{-2}]$$

$$\boxed{\alpha = MLT^{-2}}$$

$$P = \frac{\alpha}{\beta}$$

$$\beta = \frac{\alpha}{P}$$

$$\beta = \frac{\cancel{MLT^{-2}}}{\frac{\cancel{MLT^{-2}}}{L^2}}$$

$$\boxed{\beta = L^2}$$

Ques $y = A \sin(\omega t - Kx)$, find dimension of A, ω & K where y = displacement, x = Distance, t = time.

Soln

$$y = A \sin(\underbrace{\omega t - Kx}_{\text{Angle (dimensionless)}})$$

d. of $\omega t = M^0L^0T^0$

$$\boxed{d.\ of\ \omega = M^0L^0T^{-1}}$$

d. of $Kx = M^0L^0T^0$

$$\boxed{d.\ of\ K = M^0L^{-1}T^0}$$

d. of y = d. of A

$$\boxed{d.\ of\ A = [L]}$$

Applications of Dimensional Analysis

1. For checking the correctness of an equation.

2. For checking derivations, accuracy and homogenity of various mathematical expressions.

Que Check correctness of eq^n

① $s = ut + \frac{1}{2}at^2$

$[M^0L^1T^0] = \frac{L}{\cancel{T}} \times \cancel{T} + \frac{L}{\cancel{T^2}} \times \cancel{T^2}$

$\Rightarrow L + L = L$

$[M^0L^1T^0] = [M^0L^1T^0]$

② $T = 2\pi\sqrt{\frac{l}{g}}$

$T = \sqrt{\frac{\cancel{L}}{\frac{\cancel{L}}{T^2}}}$

$T = T$

L.H.S = R.H.S

Que Convert 1 N to dyne by dimensional analysis.

Sol^n

1 N	x dyne
$kg\,m/s^2$	$g.cm/s^2$
$n_1 = 1$	$n_2 = ?$

$u_1 \begin{bmatrix} M_1 = kg \\ L_1 = m \\ T^1 = s \end{bmatrix}$ $\quad \begin{bmatrix} M_2 = g \\ L_2 = cm \\ T_2 = s \end{bmatrix} u_2$

$n_1 u_1 = n_2 u_2$

$M_1L_1T_1^{-2} \times 1 = M_2L_2T_2^{-2} \times \cancel{u_2}\, n_2$

$\frac{M_1L_1T_1^{-2}}{M_2L_2T_2^{-2}} = n_2$

$PQ = n \times u$

$\boxed{n_1u_1 = n_2u_2}$

e.g. $1m = 100m$

$n_2 = \frac{1\,kg \times 1m \times \cancel{1s^2}}{1g \times 1cm \times \cancel{s^2}}$

$= \frac{10^3 g \times 10^2 \cancel{cm}}{1g \times 1\cancel{cm}}$

$\boxed{n_2 = 10^5}$

$1\,N = 10^5$ dyne.

Ques Centripetal force 'F' acting on a particle of mass 'm' moving in a circle of radius 'r' with velocity 'v' depends upon m, v and r. Find expression for F.

Soln

$$F \propto m^x$$
$$F \propto v^y$$
$$F \propto r^z$$
$$F = K m^x v^y r^z$$

$$[MLT^{-2}] = M^x [LT^{-1}]^y L^z$$
$$[MLT^{-2}] = M^x L^{y+z} T^{-y}$$

$M^1 = M^x$, $\boxed{x=1}$ | $L^1 = L^{y+z}$, $\boxed{z=-1}$ | $T^{-y} = T^{-2}$, $\boxed{y=2}$

$$F = K m^1 v^2 r^{-1}$$
$$\boxed{F = \frac{K m v^2}{r}}$$

Limitations of Dimensional Analysis

1. It cannot find the value of proportionality constant.
2. Cannot be applied in expressions involving trigonometric ratios and exponential terms.
3. Cannot be applied in expressions involving proportionality constant which has dimension.
4. Cannot be applied in expression involving two or more terms seperated by (+) or (−).

Significant Figures

- It gives information of the number of digits in a measured value to which we are confident of.

More significant fig. → More accurate measurement

Rules for Calculating Significant Figures

1. All non-zero digits are significant.
   e.g. 284, 954, 1.926.

2. Trapped zeros (zeroes b/w two Non-zero digits) are significant.
   e.g 4.009, 2.04, 400.7, 300.002.

3. Initial zeroes / Leading zeroes are never significant.
   e.g. 0.002388 → 3 s.f.
   0.008 → 1 s.f.

4. Ending zeros (terminal or trailing) are significant if they appear after decimal
   e.g. 2.00 → 3 s.f.
   200 → 1 s.f.
   3.500 → 4 s.f.

5. While changing units, no. of significant figures remain same (unchanged).

   e.g. 1.5 m → 150 cm (2 s.f.)
   2.0 Km → 2.0×10^3 m (2 s.f.)

6. Order of magnitude is never significant.

e.g. $2.1 \times 10^3 \rightarrow 2$ s.f.
$4.009 \times 10^4 \rightarrow 4$ s.f.
$2.010 \times 10^6 \rightarrow 4$ s.f.

7. Pure number or constant have infinite significant fig.
e.g.
Perimeter of square $= \underbrace{4}_{\text{inf. s.f.}}a$

Rounding off the Uncertain Digits

1. Preceding digit is raised by 1, if insignificant digit is more than 5.
e.g $3.76 \rightarrow 3.8$
$3.78 \rightarrow 3.8$

2. Preceding digit left unchanged if the latter is less than 5.
e.g. $3.72 \rightarrow 3.7$

3. If the insignificant figure is 5, then if the preceding digit is even the insignificant figure is simply dropped and if it is odd, the preceding digit is raised by 1.

e.g. $2.74\underline{5} \longrightarrow 2.74$
$2.73\underline{5} \longrightarrow 2.74$

Calculations in Significant Figures

⇒ Addition and Subtraction

The result of addition & subtraction after rounding off have same number of decimal places as present in the value with least decimal place.

e.g.

$$\begin{array}{r} 436.32 \\ 227.2 \\ +\ 0.301 \\ \hline 663.821 \end{array}$$

← least decimal place is 1, So the final answer is 663.8

⇒ Multiplication and ~~Subs~~ Division

The result is rounded off to same number of significant figure as present in the value with least s.f.

e.g. $\frac{4.237}{2.51} = \underline{\underline{1.69}}$ (Least s.f. 3)

$2.42 \times 2.1 = 5.082 = \underline{\underline{5.0}}$

Error Analysis

There is always some difference between the measured value and the true value of a quantity, which is known as error.

⇒ Absolute Error

The magnitude of the difference between the individual measurement and the true value of the quantity is called absolute error.

- Denoted by $|\Delta a|$, always positive.

Let the quantity is measured 'n' times. The measurements are $a_1, a_2, a_3, ---- a_n$

$$\boxed{\underset{(a_m \text{ or } a)}{\text{True Value/Mean Value}} = \frac{a_1 + a_2 + a_3 + \cdots + a_n}{n}}$$

Absolute Error $\Delta a_1 = a_n - a_1$

$\Delta a_2 = a_n - a_2$

$$\boxed{\underset{(\Delta a)}{\text{Mean Absolute Error}} = \frac{|\Delta a_1| + |\Delta a_2| + |\Delta a_3| + \cdots + |\Delta a_n|}{n}}$$

⇒ Relative Error / Fractional error

It is the ratio of the mean absolute error Δa_{mean} to the mean value a_{mean} of the quantity measured.

$$\boxed{\text{Relative error} = \frac{\Delta a \text{ (Mean Absolute error)}}{a \text{ (Mean Value)}}}$$

⇒ Percentage Error

When relative error is expressed in percent, it is called the percentage error (δa).

$$\boxed{\text{Percentage error } (\delta a) = \frac{\Delta a_{mean}}{a_{mean}} \times 100}$$

Error of a sum or a difference

- Errors are always added in case of addition and subtraction.

$x = A + B$

$\Delta x = \Delta A + \Delta B$

$\Rightarrow \boxed{x \pm \Delta x}$ → Result

$x = A - B$

$\Delta x = \Delta A + \Delta B$

Result,

$\Rightarrow \boxed{x \pm \Delta x}$

Error of a product or a quotient

- When two quantities are multiplied or divided, the relative error in the result is the sum of the relative errors in the multiplies

$$x = ab \text{ or } \frac{a}{b}$$

$$\boxed{\frac{\Delta x}{x} = \frac{\Delta a}{a} + \frac{\Delta b}{b}}$$

Error in case of a measured quantity raised to a power.

- The relative error in a physical quantity raised to the power K is the K times the relative error in the individual quantity.

$$x = \frac{a^p b^q}{c^r}$$

$$\boxed{\frac{\Delta x}{x} = \frac{p\Delta a}{a} + \frac{q\Delta b}{b} + \frac{r\Delta c}{c}}$$

[Fractional Error]

Percentage error → Relative error × 100

$$\frac{\Delta x}{x} \times 100 = p\left(\frac{\Delta a}{a} \times 100\right) + q\left(\frac{\Delta b}{b} \times 100\right) + r\left(\frac{\Delta c}{c} \times 100\right)$$

$$\boxed{\% \text{ error of } x = p(\% \text{ error of } a) + q(\% \text{ error of } b) + r(\% \text{ error of } c)}$$

Ques [NEET 2023] In an expression the % error occured in the measurement of a physical quantity A, B, C and D are 1%, 2%, 3% and 4% respectively. Then the max. % error in the measurement X, where $X = \frac{A^2 B^{1/2}}{C^{1/3} D^3}$, will be?

Solⁿ

$$x = \frac{A^2 B^{1/2}}{C^{1/3} D^3}$$

$$\frac{\Delta x}{x} \times 100 = 2\left[\frac{\Delta A}{A} \times 100\right] + \frac{1}{2}\left(\frac{\Delta B}{B} \times 100\right) + \frac{1}{3}\left(\frac{\Delta C}{C} \times 100\right) + 3\left(\frac{\Delta D}{D} \times 100\right)$$

$$\text{Max. \% error} = 2(\text{\% error of } A) + \tfrac{1}{2}(\text{\% error of } B) + \tfrac{1}{3}(\text{\% error of } C) + 3(\text{\% error of } D)$$

$$= 2 \times 1 + \frac{1}{\cancel{2}} \times \cancel{2} + \frac{1}{\cancel{3}} \times \cancel{3} + 4 \times 3$$

$$= 2 + 1 + 1 + 12$$

$$\boxed{\text{Max. \% error} = 16\%}$$

Ques (Main 2018) The density of a material in the shape of a cube is determined by measuring three sides of the cube and its mass. If the relative error in measuring the mass and length are respectively 1.5% and 1%, the max. error in determining the density is?

Solⁿ

$$\text{Relative \% error of } m \left(\frac{\Delta m}{m} \times 100\right) = 1.5\%$$

$$\text{density} = \frac{\text{mass}}{\text{Vol.}} = \frac{m}{l^3}$$

$$\text{Relative \% error of } l \left(\frac{\Delta l}{l} \times 100\right) = 1\%$$

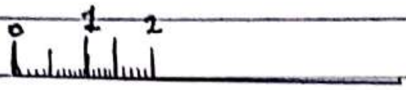
$$\text{Max. \% error in density} \left(\frac{\Delta d}{d} \times 100\right) = \frac{\Delta m}{m} \times 100 + 3\left(\frac{\Delta l}{l} \times 100\right)$$

$$= 1.5 + 3$$

$$= 4.5\%$$

Vernier Callipers

To measure length of an object. we use normal scale in which is marked in cm.



1 cm = 10 division

$LC = \frac{1}{10} = 0.1$ cm

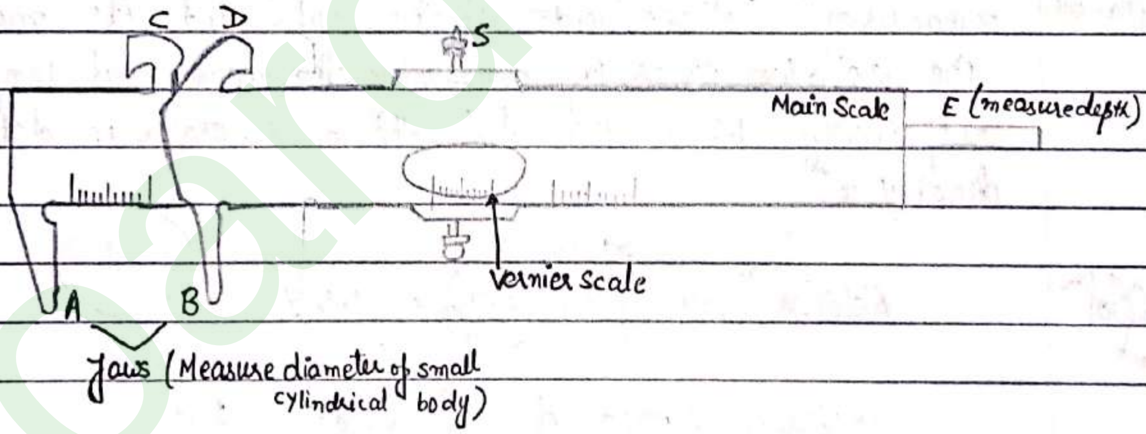
Least Count - Smallest measurement which can be made by an instrument

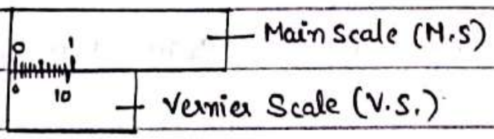
⇒ But it cannot give precision upto second decimal place.

In 1631, Pierre Vernier deviced Vernier Callipes.

⇓

can give accurate measurement upto second decimal place.





$\boxed{LC = 1 MSD - 1 VSD}$

Generally, each division on V.S is smaller than each division of M.S.

Let 'n' VSD are equal to 'm' MSD

$$n \text{ V.S.D} = m \text{ M.S.D}$$

$$\boxed{1 \text{ V.S.D} = \frac{m}{n} \text{ M.S.D}}$$

$$LC = 1 \text{ MSD} - 1 \text{ VSD}$$
$$= 1 \text{ MSD} - \frac{m}{n} \text{ MSD}$$

$$\boxed{L.C. = \text{MSD}\left(1 - \frac{m}{n}\right)}$$

m → no. of MSD which is equal to
n → no. of VSD

- In ordinary vernier Calliper:—

$$10 \text{ VSD} = 9 \text{ MSD} \qquad \text{M.S.D} = \frac{1 \text{ cm}}{10} = 0.1 \text{ cm}$$

$$LC = \text{MSD}\left[1 - \frac{m}{n}\right]$$
$$= 0.1\left(1 - \frac{9}{10}\right)$$
$$= \frac{0.1}{10}$$

$$\boxed{L.C. = 0.01 \text{ cm}}$$

Ques (JEE 2010) In a vernier calliper, the M.S. is marked in mm & 20 vernier scale division are equal to 16 M.S.D. Calculate L.C.

Sol^n

$$LC = \text{MSD}\left[1 - \frac{m}{n}\right]$$
$$= 1 \text{ mm}\left[1 - \frac{16}{20}\right]$$
$$\Rightarrow 1 \text{ mm} \times \frac{1}{5} = \underline{0.2 \text{ mm}}$$

Ques (JEE 2003) 'N' divisions of M.S. are equal to 'N+1' division of Vernier Scale. If each division on M.S measure 'a' units. find L.C.

Sol^n

$$1 \text{ M.S.D} = a$$

$$LC = 1 \text{ M.S.D}\left(1 - \frac{m}{n}\right)$$

$$= a\left[1 - \frac{N}{N+1}\right]$$

$$= a\left[\frac{\cancel{N}+1-\cancel{N}}{N+1}\right]$$

$$\underline{L.C. = \frac{a}{N+1}}$$

Reading of Vernier Callipers

$$\boxed{\text{Total Reading} = MSR + \underset{(L.C. \times \text{ coinciding division of V.S.})}{VSR}}$$

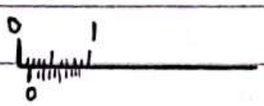
⇒ Applicable only when VSD < MSD and there is no zero error.

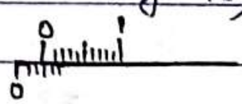
Zero Error

When zero of V.S & zero of M.S. do not coincide, then the instrument is said to have a zero error.

+ve zero error (When zero of VS is on right of MS)

−ve zero error (zero of VS is on left of MS)





$$\boxed{\text{Correct Reading} = \underset{(MSR + VSR)}{\text{Total Reading}} - \text{Zero error}}$$

+ve zero error = L.C. × coin. div. of V.S.

−ve zero error = −LC × coin. div. of V.S

Ques In a vernier callipers 10 VSD = 9 MSD and 1 cm on MS is divided into 10 parts while measuring the length of a line, the zero of V.S. is just ahead of 1.8 cm mark and 4th division of V.S. coincides with main scale division. The length of line is

Sol^n

$$10\,VSD = 9\,MSD$$

$$1\,MSD = 0.1\,cm$$

$$L.C = MSD\left(1 - \frac{m}{n}\right)$$

$$= 0.1\left(1 - \frac{9}{10}\right) = \underline{0.01\,cm}$$

Total Reading (Length) = V.S.R + M.SR

= L.C. × coin.div of V.S + MSR

= 0.01 × 4 + 1.8

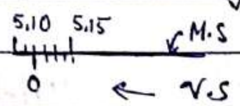
= 0.04 + 1.8

= $\underline{1.804\,cm}$

Ques (JEE Advance 2013) The diameter of a cylinder is measured using a V.C. with no zero error. It is found that the zero of V.C lies b/w 5.10 cm and 5.15 cm of MS. The V.C. have 50 division equivalent to 2.45 cm. The 24th division of V.S. exactly coincides with one of the MSD. The d of cylinder is ?

Sol^n

50 division (VSD) = 2.45 cm



1 division (VSD) = 0.049 cm

1 MSD = 0.05 cm

LC = 1 MSD − 1 VSD

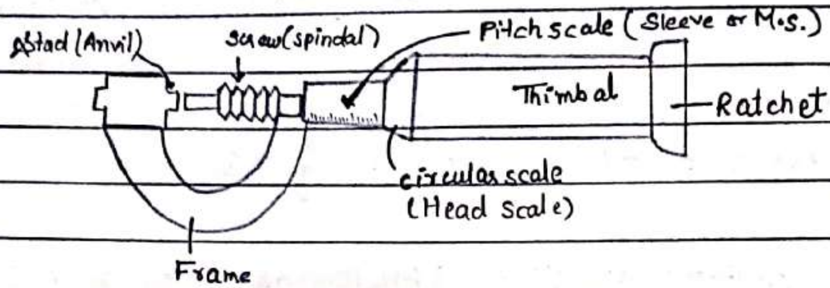
= 0.05 − 0.049 = $\underline{0.001\,cm}$

Total Reading (diameter) = MSR + L.C. × coin. div.

= 5.10 + 0.001 × 24

= $\underline{5.124\,cm}$

Screw Gauge



Pitch ⇒ The distance covered by screw in one complete rotation of the circular scale is called pitch.

- Distance b/w two consecutive thread.

$$\boxed{L.C = \frac{\text{Pitch}}{\text{No. of Circular Scale divisions}}}$$

Ques Two full turns of circular scale of a gauge cover a distance of 1mm on scale. Total no. of division on circular scale is 50. find LC.

Soln

$2 \text{ Pitch} = 1\,mm$

$LC = \frac{1/2\,mm}{50}$ $\quad 1 \text{ Pitch} = 1/2\,mm$

$= \underline{0.01\,mm}$

Ques (JEE Main 2019) The LC of MS of a screw gauge is 1mm. The min. no. of divisions on its circular scale required to measure $5\,\mu m$ diameter of a wire is?

$1\,\mu m = 10^{-6}\,m$

$1\,mm = 10^{-3}\,m$

Soln

Pitch = 1mm $\Rightarrow \frac{10^{-3}}{5 \times 10^{-6}}$

L.C. = $5\,\mu m$

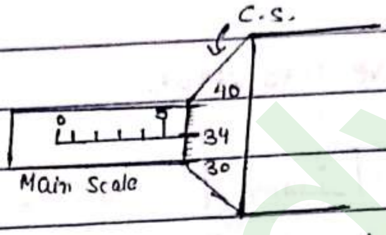
No. of CSD = $\frac{\text{Pitch}}{L.C.}$ $\Rightarrow \frac{10^{3}}{5} = \underline{\underline{200\,m}}$

Finding Reading

$$\boxed{\text{Reading} = MSR + CSR}$$

CSR → L.C. × coin. div. on CS with base line

Ques Circular Scale has 100 division. Calculate diameter of the wire:



Sol^n

$$\text{Reading (Diameter)} = MSR + CSR$$
$$= MSR + L.C \times \text{coin. div.}$$
$$= 5 + 0.01 \times 34$$
$$= 5 + 0.34$$
$$= 5.34\ mm \text{ or } 0.534\ cm$$

$$LC = \frac{1}{100} = 0.01$$

Ques The thimble of a screw has 50 division and spindle advance 1mm when the screw is turned through two rotation. When the screw is used to measure the diameter of wire, the reading on the sleeve is found to be 0.5mm and reading on thimble is found 27 divisions. What is d of the wire in cm.

Sol^n

$$2 \text{ rotation} = 1mm$$
$$1 \text{ rotion} = \tfrac{1}{2} mm \text{ (Pitch)}$$

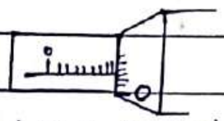
$$L.C = \frac{\text{Pitch}}{\text{No. of div. on CS}} = \frac{1/2}{50} = 0.01 mm$$

$$\text{Reading} = MSR + VSR$$
$$= MSR + L.C \times \text{Coin. of div. on V.S}$$
$$= 0.5 mm + 0.01 mm \times 27$$
$$= 0.5 mm + 0.27 mm$$
$$= 0.77 mm \text{ or } 0.077 cm$$

Zero Error & Correct Reading

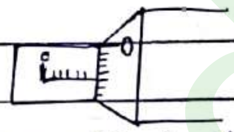
If zero of C.S. does not coincide with base line (at initial) then it is said that there is a zero error in screw gauge.

1. +ve zero error



zero of C.S is below the base line

2. -ve zero error



zero of CS is above base line.
⇒ Zero hides

$$\boxed{\text{Correct Reading} = \text{Reading} - \text{zero error}}$$

+ zero error = + LC × coin. div. of CS with base line
- ve zero error = − LC × coin. div. of CS with base line

Que The pitch and the no. of division, on the CS for a given screw gauge are 0.5 mm and 100, respectively. When the screw gauge is fully tightened without any object, the zero of its C.S. lies 3 division below, the main line. The reading of the MS and CS for a thin sheet are 5.5 mm and 48 respectively, thickness of sheet is ?

Solⁿ

Pitch = 0.5 mm
No. of div. = 100

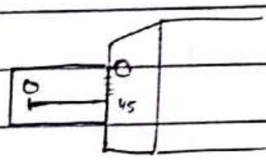
$$LC = \frac{0.5}{100} = 0.005\ mm$$

+ zero error = LC × ~~Ko~~ Coin. div
= 0.005 × 3
= + 0.015 mm

Reading = MSR + LC × coin. div
$= 5.5 + 0.05 \times 48$
$= 5.740\,mm$

Correct Reading = Reading − Zero error
$= 5.740 - 0.015$
$= \underline{5.725\,mm}$

Ques A screw gauge with a pitch of 0.5 mm and a C.S. with 50 divisions is used to measure thickness of a thin sheet of aluminium. Before starting the measurement, it is found that when two jaws of the screw gauge are brought in contact, the 45^{th} division coincides with M.S. line and that the zero of MS is barely visible. What is the thickness of the sheet, if the MS reading is 0.5 mm and the 25^{th} division coincides with MS line?



Sol^n Pitch = 0.5 mm
No. of div. = 50
$LC = \frac{0.5}{50} = 0.01\,mm$

−ve zero error = − LC × coin. div.
$= -(0.01) \times 5$
$= -0.05\,mm$

MSR = 0.5 mm

Reading = MSR + LC × coin. div.
$= 0.5 + 0.01 \times 25$
$= 0.75\,mm$

Correct Reading = Reading − zero error
$= 0.75 - (-0.05)$
$= 0.75 + 0.05$
$= \underline{0.80\,mm}$