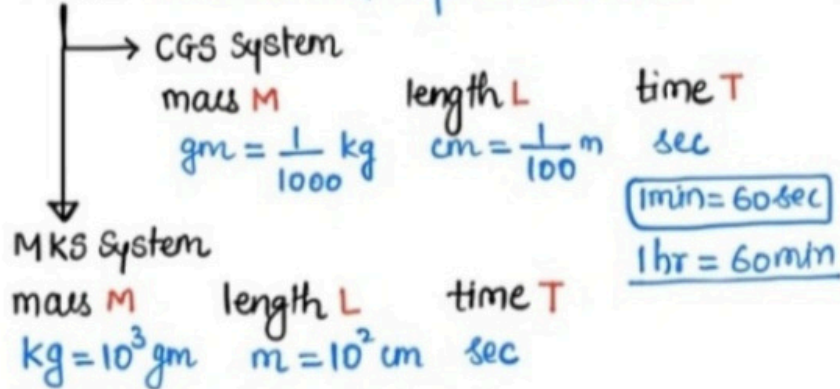


# Unit & Measurement



1. Units:- standard of representation.



2. Physical Quantity

PQ = numerical value \* unit

$$Q = n u = const$$

on changing u, n changes but Q = const.

3. Dimension :- Power of M, L and T needed to represent any physical quantity

- velocity  $\longrightarrow [v] = [M^0 L T^{-1}]$
- acceleration  $\longrightarrow [a] = [M^0 L T^{-2}]$
- force  $\longrightarrow [F] = [M L T^{-2}]$
- Pressure/stress  $\longrightarrow [P] = [M L^{-1} T^{-2}]$
- Work/Energy/Torque  $\longrightarrow [W] = [M L^2 T^{-2}]$
- Power  $\longrightarrow [P] = [M L^2 T^{-3}]$
- Angular momentum  $\longrightarrow [L] = [M L^2 T^{-1}]$
- Impulse  $\longrightarrow [J] = [M L T^{-1}]$
- Plank's constant  $\longrightarrow [h] = [M L^2 T^{-1}]$
- Gravitational constant  $\longrightarrow [G] = [M^{-1} L^3 T^{-2}]$

NOTE :-

Dimensions of any physical quantity does not depends on formula to be used for dimension.

$$[V] = [M^0 L^3 T^0]$$

$$V = \frac{4}{3} \pi r^3 \quad V = l b h$$

$$\# f = m \cdot a \rightarrow \text{Non FQ}$$

$$\downarrow$$

$$FQ$$

$$= m \cdot \frac{v}{t} \rightarrow \text{non FQ}$$

$$= m \cdot \frac{L}{t \cdot t} \quad [F] = [M L T^{-2}]$$

4. Rule 1 for Dimension:-

pressure -  $\pi = \dots$   
 $\downarrow$   
 must be a kind of pressure

5. Rule 2 for Dimension:-

$$\boxed{\text{Dimension of LHS} = \text{Dimension of RHS}}$$

$\rightarrow$  Principle of Homogeneity

$\rightarrow$  A given equation can be dimensionally correct, but not mathematically.

$\rightarrow$  A given is mathematically correct, it will be dimensionally correct too, with some exceptions.

6.  $\theta \rightarrow$  Dimensionless, but has unit (radian).

$\rightarrow \sin \theta$  } Dimensionless.  
 $\cos \theta$  }  
 etc }  $\sin(\dots)$

$\rightarrow \log(\dots)$  } Dimensionless  
 $e(\dots)$  }



7.  $\theta = n_1 u_1 = \text{constant}$

$$n_1 u_1 = n_2 u_2$$

$n_2 = n_1 \frac{u_1}{u_2}$  } different standard of representation.

8. Absolute error = True value - Measured value

In case true value is not given, than mean value is used as true value.

# more no of observation, less will be the error.

Arithmetic mean of all values.

$$a_m = \frac{a_1 + a_2 + a_3 + \dots}{n}$$

9. Mean Absolute error :-

$$\Delta a_m = \frac{\Delta a_1 + \Delta a_2 + \Delta a_3 + \dots}{n}$$

10. Relative error =  $\frac{\Delta a}{a}$  or  $\frac{\Delta a_m}{a_m}$

11. Percentage error = Relative error \* 100.

12. Propagation of error in addition/subtraction and multiplication/division

$X = x \pm \Delta x$   
↓  
absolute error in x

and  $Y = y \pm \Delta y$   
↓  
absolute error in y

$Z = X + Y$   
or  
 $Z = X - Y$

$Z = X \cdot Y$   
or  
 $Z = \frac{X}{Y}$

$$\Delta Z = \pm (\Delta X + \Delta Y)$$

$$Z = Z \pm \Delta Z$$

$$\frac{\Delta Z}{Z} = \pm \left( \frac{\Delta X}{X} + \frac{\Delta Y}{Y} \right)$$

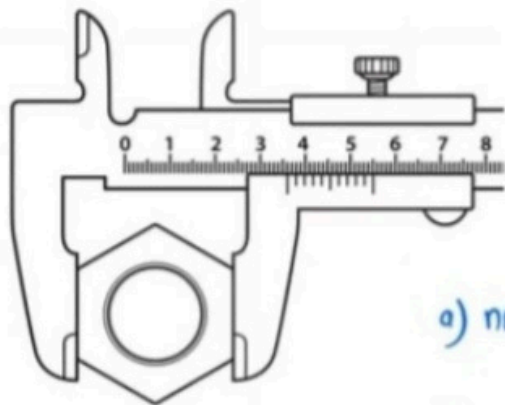
$$\Delta Z = \pm \left( \frac{\Delta X}{X} + \frac{\Delta Y}{Y} \right) \cdot Z$$

13. If any PQ is represented as

$$x = \frac{p^a q^b}{r^c s^d} : \frac{\Delta x}{x} = \pm \left( a \frac{\Delta p}{p} + b \frac{\Delta q}{q} + c \frac{\Delta r}{r} + d \frac{\Delta s}{s} \right)$$

if zero of ms and zero of vs does not coincide, when jaws are touched without object.

14. Vernier Caliper:-



MSR = 3.6 cm

VSR = 2 (0.1 cm).

Least count.

Total Reading = MSR + VSR - Zero error

↓  
Main scale Reading  
↓  
mark on main scale just before zero of VS.

↓  
Vernier scale Reading  
↓  
Coinciding VS Division with any MS Mark.

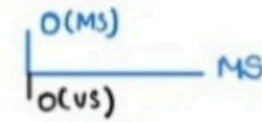
x (least count)

$$LC = 1MSD - 1VSD$$

$$LC = x \left( 1 - \frac{m}{n} \right)$$

m MSD coincides with n VSD

a) no. zero error:-

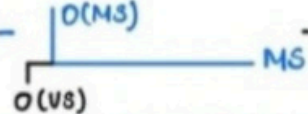


b) +ve zero error:-



+ve zero error = C.V.S.D x L.C.

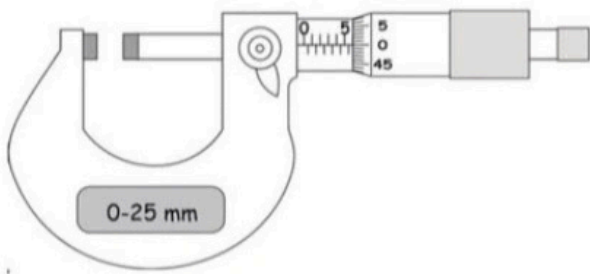
c) -ve zero error:-



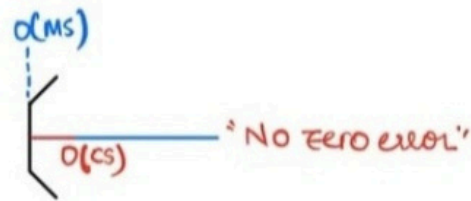
-ve zero error = (total VSD - CVSD) x L.C.  
= (10 - 7) x ...

CVSD = 7; TVSD = 10

15. Screw Gauge :-



MSR = 5.5  
 VSR =  $0 \times \frac{0.5 \rightarrow P}{50 \rightarrow \text{No of CSD}}$



total reading = MSR + CSR - Zero error → when zero of main scale coincide with thumb & zero of CS coincides with reference line of MS simultaneously, no zero error.

Main scale Reading  
 ↓  
 "last visible digit of" MS just before circle of circular scale

circular scale Reading  
 ↓  
 "coinciding circular" scale division with reference line of MS

\* least count

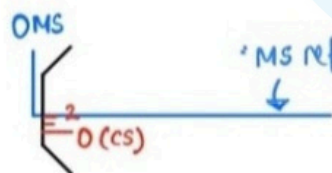
L.C. =  $\frac{\text{pitch}}{\text{no of CSD}}$

pitch → distance moved by thumb on main scale in one complete rotation.

\* Generally →  $P = 1 \text{MSD}$

$\frac{5 \text{mm}}{5} \rightarrow 1 \text{rot}$   
 $\frac{10}{10} \rightarrow 1 \text{rot}$   
 Pitch =  $\frac{5}{10} = 0.5 \text{mm}$

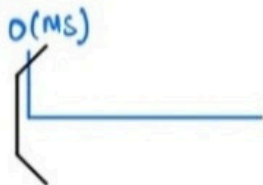
# +ve zero error :-



0 of MS is visible

+ve zero error  
 =  $C \times \text{CSD} \times \text{L.C.}$   
 =  $(2) \times \frac{1 \text{mm}}{50} \rightarrow 1 \text{MSD}$

# -ve zero error :-



0 of MS is not visible

-ve zero error

=  $(\text{total no of CSD} - C \times \text{CSD}) \times \text{L.C.}$   
 =  $(50 - 47) \times \frac{1 \text{mm}}{50} \rightarrow \text{pitch} \rightarrow 1 \text{MSD}$

# Follow?

