

Chapter-01

: Units and Measurement:

Physical quantities:-

Quantities that can be measured by us is called physical quantities.

Example:- Mass, time, length, temperature, speed etc.

Types of physical quantities.

- (i) Fundamental quantities
- (ii) Derived quantities
- (iii) Supplementary quantities

(i) Fundamental quantities:- Quantities that are independent from any other quantities are called physical quantities.

There are only 7 in numbers.

Ex:- length, Mass, time, temperature, electric current, luminous intensity, Quantity of matter.

(ii) Derived Quantities:- Quantities that are dependent on fundamental quantities are called Derived quantities.

Qr Speed = $\frac{\text{Distance}}{\text{time}}$

Area = $l \times b$

Force = $m \times a$

(iii) Supplementary: There are only two supplementary quantities.

(1) Plane angle.

(2) Solid angle.

(1) Plane angle: Angle subtended by arc at the centre of circle is called Plane angle. it is denoted by θ .

Angle = Arc

radius

S.I. unit = radian.

One radian: Angle subtended by an arc of a circle having r at its centre is called one radian.

Angle = Arc

radius

$360^\circ = 2\pi \text{ rad}$

$$\frac{360^\circ}{2} = \frac{2\pi \text{ radians}}{2}$$

$$180^\circ = \pi^c$$

Degree to radian

$$(1) \quad 90^\circ = \frac{90 \times \pi}{180} = \left(\frac{\pi}{2}\right)^c$$

$$(2) \quad 30^\circ = \frac{30 \times \pi}{180} = \left(\frac{\pi}{6}\right)^c$$

$$(3) \quad 60^\circ = \frac{60 \times \pi}{180} = \left(\frac{\pi}{3}\right)^c$$

$$120^\circ = \frac{120 \times \pi}{180} = \left(\frac{2\pi}{3}\right)^c$$

$$150^\circ = \frac{150 \times \pi}{180} = \left(\frac{5\pi}{6}\right)^c$$

#

Radian to degree me badalna - π π

$$(1) \left(\frac{\pi}{3} \right)^c = \frac{180}{3} = 60^\circ$$

$$\pi = 3.14$$

$$(2) \left(\frac{\pi}{2} \right)^c = \frac{180}{2} = 90^\circ$$

$$(3) \left(\frac{\pi}{6} \right)^c = \frac{180}{6} = 30^\circ = \frac{\pi \times 180}{180} = 30^\circ (1)$$

$$(4) \left(\frac{\pi}{4} \right)^c = \frac{180}{4} = 45^\circ = \frac{\pi \times 180}{180} = 45^\circ (1)$$

$$(5) \left(\frac{2\pi}{3} \right)^c = \frac{2 \times 180}{3} = 120^\circ = \frac{\pi \times 180}{180} = 120^\circ (1)$$

$$(6) \left(\frac{3\pi}{2} \right)^c = \frac{3 \times 180}{2} = 270^\circ$$

$$(7) \left(\frac{5\pi}{6} \right)^c = \frac{5 \times 180}{6} = 150^\circ$$

Units:-

They are some standard values with the help of them we measure physical quantities.

To measure physical quantities we set some standard value for each quantity that standard are known as units.

* There are four unit systems.

1. (M.K.S) (Metric system) - metre, kilogram, seconds

2. (C.G.S) (centimetre, gram, second)

3. (F.P.S) (foot, pounds, seconds)
(British system)

4. S.I System -

International system of units. It have 7 fundamental units and this is the extended form of this system.

(F)

length	metre	m (m)
Mass	kilogram	kg
time	seconds	s
temperature	Kelvin	K
current	Ampere	A
luminous intensity	Candela	cd
Quantity of matter	mole	mol

1) Area = $l \times b = m^2$

2) Volume = $l \times b \times h = m \times m \times m = m^3$

3) Speed (velocity) = $\frac{\text{Distance}}{\text{time}} = \frac{m}{s} = ms^{-1}$

4) Acceleration = $\frac{\text{velocity}}{\text{time}} = \frac{m/s}{s} = ms^{-2}$

5) Force = mass $\times$ a = $kg \times \frac{m}{s^2} = kg \times m/s^2 = \text{Newton}$

6) Work = force $\times$ displacement
 = Newton $\times$ m
 = N $\times$ m = Joule

(7) Pressure = $\frac{\text{force}}{\text{Area}} = \frac{N}{m^2} = \text{Pascal}$

8) Density = $\frac{\text{mass}}{\text{volume}} = \frac{\text{kg}}{\text{m}^3}$

9) Momentum = mass $\times$ velocity
 $= \text{kg} \times \text{m/s}$
 $= \text{kg} \times \text{m} \cdot \text{s}^{-1}$

Dimensions:

This is the symbolic representation of fundamental quantities which gives the relation between fundamental and derived units.

Dimensional formula - $M^x L^y T^z$

(1) Mass [M]

(2) Length [L]

(3) Time [T]

(4) Temperature [K] or [K]

(5) Current [A]

$$1) \text{ Area} = l \times b = m \times m = m^2 = [M^0 L^2 T^0] = [L^2]$$

$$2) \text{ Volume} = l \times b \times h = m \times m \times m = m^3 = [M^0 L^3 T^0] = [L^3]$$

$$3) \text{ Speed} = \frac{\text{distance}}{\text{time}} = \frac{m}{s} = m s^{-1} = [M^0 L T^{-1}] = [L T^{-1}]$$

$$4) \text{ acceleration} = \frac{\text{velocity}}{\text{time}} = \frac{m/s}{s} = m/s^2 = m s^{-2} = [M^0 L T^{-2}]$$

$$5) \text{ Force} = \text{mass} \times \text{acceleration} = kg \times m/s^2 = \text{Newton} = [M L T^{-2}]$$

$$6) \text{ Work} = \text{force} \times \text{displacement} \\ = \text{Newton} \times m \\ = N \times m = \text{Joule} = [M L^2 T^{-2}] = [L^2]$$

$$(7) \text{ Pressure} = \frac{\text{force}}{\text{Area}} = \frac{N}{m^2} = \text{Pascal} = [M L^{-1} T^{-2}] = [L^{-1}]$$

$$(8) \text{ Density} = \frac{\text{Mass}}{\text{volume}} = \frac{kg}{m^3} = [M L^{-3} T^0] = [M L^{-3}]$$

$$(9) \text{ Momentum} = \text{Mass} \times \text{velocity} \\ = kg \times m/s \\ = \frac{kg \times m}{s} = [M L T^{-1}]$$

Application of dimensional formula:-

- 1) To convert one unit system to another unit system.
- 2) To check any physical eqⁿ.
- 3) To derive the formula of any physical quantity.
- 4) To determine the unit of any physical quantity.

2) Solid Angle -

Angle formed by a surface at a / the centre of a sphere is called solid angle.

It is denoted by Ω (radian)

$$\text{Solid Angle} = \frac{\text{Surface Area}}{\text{Radius}^2}$$

$$\text{S.I unit} = \text{Steradian}$$

To find unit of any physical quantity
ex:- find the unit of work done.

$$\text{Dim(work)} = [M^1 L^2 T^{-2}]$$

$$\text{Unit} = \text{kg m}^2 \text{s}^{-2}$$

$$\text{Unit} = \text{kg} \times \text{m}^2 \text{s}^{-2}$$

Q find the unit of a physical quantity whose dimensions are $[M^{-1} L^2 T^{-3}]$

$$\text{kg}^{-1} \text{m}^2 \text{s}^{-3}$$

$$\text{kg}^{-1} \text{m}^2 \text{s}^{-3}$$

2) To Convert a unit from one system to another system.

$$n_2 = n_1 \left(\frac{M_1}{M_2} \right)^x \left(\frac{L_1}{L_2} \right)^y \left(\frac{T_1}{T_2} \right)^z$$

$n_2 =$ find करने वाली वेल्थ

$n_1 = 10$ वेल्थ Given hai

$x, y, z =$ dimensional formula me M, L, T की Power

M, L, T = वो unit जो Given हो

$M_2 L_2 T_2 \Rightarrow$ वो unit जो find करनी है

Density of water is 1 g/cm^3 then find its value in S.I. system

$$1 \text{ g/cm}^3 = 10^{-3} \text{ kg/m}^3 = 10^{-3} \text{ kg m}^{-3}$$

Dimensions of Density = $[M L^{-3} T^0]$

$$x=1, y=-3, z=0$$

$$n_2 = 1 \left(\frac{1 \text{ g}}{1 \text{ kg}} \right) \left(\frac{1 \text{ cm}}{1 \text{ m}} \right)^{-3} \left(\frac{1 \text{ s}}{1 \text{ s}} \right)^0$$

$$n_2 = \left(\frac{1 \text{ g}}{1000 \text{ g}} \right) \left(\frac{1 \text{ cm}}{100 \text{ cm}} \right)^{-3}$$

$$n_2 = \left(\frac{1}{1000} \right) \left(\frac{1}{100} \right)^{-3} \quad \therefore n_2 = 10^6$$

$$n_2 = \left(\frac{1}{1000} \right) \left(\frac{100}{1} \right)^3$$

$$n_2 = \frac{1}{1000} \times 100 \times 100 \times 100$$

$$n_2 = 1000$$

$$= 10^3 \text{ kg/m}^3$$

Q. The speed of sound is 332 m/s find its value in km/h.

$$332 \text{ m/s} = 1195.2 \text{ km/h}$$

$$n_2 = n_1 \left(\frac{M_1}{M_2} \right)^x \left(\frac{L_1}{L_2} \right)^y \left(\frac{T_1}{T_2} \right)^z$$

$$n_2 = 332 \left(\frac{L_1}{L_2} \right)^y \left(\frac{T_1}{T_2} \right)^z$$

$$n_2 = 332 \left(\frac{1 \text{ m}}{1 \text{ km}} \right) \left(\frac{1 \text{ s}}{1 \text{ hr}} \right)^{-1}$$

Dimension of Speed = $(L T^{-1})$

$$x = 0, y = 1, z = -1$$

$$332 \left(\frac{1 \text{ m}}{1000 \text{ m}} \right) \left(\frac{1.9 \text{ h}}{60 \times 60 \text{ s}} \right)^{-1}$$

$$332 \left(\frac{1}{1000} \right) \times \frac{60 \times 60 \text{ m s}^{-1}}{1} = 0$$

$$= 332 \times 36 = 11952 = 11952 \text{ km/h}$$

$$10 \left(\frac{1}{10} \right) \left(\frac{1}{10} \right) \left(\frac{1}{10} \right) = 0$$

Que - Acceleration due to gravity on earth is 32 ft s^{-2} .
Find its value in ms^{-2} .

Given that $1 \text{ ft} = 0.3048 \text{ m}$.

Given,

$$n_1 = 32 \text{ ft s}^{-2}$$

Dimensional formula $[L T^{-2}]$

$$\Rightarrow n_2 = n_1 \left(\frac{M_1}{M_2} \right) \left(\frac{L_1}{L_2} \right) \left(\frac{T_1}{T_2} \right)$$

$$\Rightarrow n_2 = 32 \left(\frac{1 \text{ ft}}{0.3048 \text{ m}} \right) \left(\frac{1 \text{ s}}{1 \text{ s}} \right)^{-2}$$

$$\Rightarrow n_2 = 32 \text{ ft s}^{-2} \times 0.3048 \text{ m}$$

$$\Rightarrow n_2 = 32 \text{ s}^{-2} \times 0.3048 \text{ m}$$

$$n_2 = 9.7536 \text{ ms}^{-2}$$

Q1 The value of g is 9.8 m s^{-2} . Calculate its value in $(\text{km min})^{-2}$.

Given.

$$g = 9.8 \text{ m s}^{-2}$$

Dimensional formula = $[L T^{-2}]$

$$n_2 = n_1 \left(\frac{M_1}{M_2} \right) \left(\frac{L_1}{L_2} \right) \left(\frac{T_1}{T_2} \right)^x$$

$$n_2 = 9.8 \left(\frac{1 \text{ m}}{1 \text{ km}} \right) \left(\frac{1 \text{ s}}{1 \text{ min}} \right)^2$$

$$n_2 = 9.8 \left(\frac{1 \text{ m}}{1000 \text{ m}} \right) \left(\frac{1 \text{ s}}{60 \text{ s}} \right)^2$$

$$n_2 = 9.8 \times \frac{1}{1000} \times \frac{1}{60 \times 60}$$

$$n_2 = \left(\frac{9.8 \times 1}{1000} \right) \left(\frac{1}{60 \times 60} \right)$$

$$n_2 = \left(\frac{353.8}{1000000} \right)$$

$$n_2 = 353.8 \text{ km min}^{-2}$$

$$n_2 = 353.8 \text{ km min}^{-2}$$

$$n_2 = 353.8 \text{ km min}^{-2}$$

Ques-10 By dimensional method, obtain the value of 1 Joule in work in energy.

Given

$$n_1 = 1 \text{ Joule}$$

$$n_2 = ?$$

Dimensional formula = $[M L^2 T^{-2}]$

$$n_2 = n_1 \left(\frac{M_1}{M_2} \right) \left(\frac{L_1}{L_2} \right)^2 \left(\frac{T_1}{T_2} \right)^{-2} \quad n = 1$$

$$n_2 = 1 \left(\frac{1 \text{ kg}}{1 \text{ g}} \right) \left(\frac{1 \text{ m}}{1 \text{ cm}} \right)^2 \left(\frac{1 \text{ s}}{1 \text{ s}} \right)^{-2} = 1$$

$$n_2 = 1 \left(\frac{1000 \text{ kg}}{1000 \text{ g}} \right) \left(\frac{1 \text{ m}}{100 \text{ cm}} \right)^2 = 1$$

$$n_2 = 1 \left(\frac{1000 \text{ g}}{1 \text{ g}} \right) \left(\frac{1 \text{ m}}{100 \text{ cm}} \right)^2 = 1$$

$$n_2 = 1000 \times \frac{1}{100} \times \frac{1}{100}$$

11. The velocity of sound at 0°C in air is 332 m s^{-1} . Find its value in CGS system Dimensional.

Given.

$$n_1 = 332 \text{ m s}^{-1}$$

Dimensional formula = $[L T^{-1}]$

$$n_2 = n_1 \left(\frac{M_1}{M_2} \right)^x \left(\frac{L_1}{L_2} \right)^y \left(\frac{T_1}{T_2} \right)^z$$

$$n_2 = 332 \left(\frac{1000 \text{ cm}}{1 \text{ m}} \right)^x \left(\frac{1 \text{ s}}{1000 \text{ s}} \right)^y = 1$$

$$n_2 = 332 \left(\frac{1000}{1} \right) \left(\frac{1}{1000} \right)^y = 1$$

$$n_2 = 332 \left(\frac{1000}{1} \right) \left(\frac{1}{1000} \right)^y = 1$$

$$\frac{1}{1000} \times \frac{1}{1000} \times 1000 = 1$$

Ques Speed of sound in air is 332 m/s find its value in km/h

$$332 \text{ m/s} = \dots\dots\dots \text{km/h}$$

$$\frac{332 \text{ m}}{\text{s}}$$

$$\left[\begin{array}{l} \because 1 \text{ km} = 1000 \text{ m} \\ 1 \text{ km} = \frac{1000 \text{ m}}{1000} \end{array} \right]$$

$$332 \left(\frac{1}{1000} \right) \text{ km}$$

$$\left(\frac{1}{3600} \right) \text{ h}$$

$$\left[\begin{array}{l} 1 \text{ h} = 3600 \text{ s} \\ 1 = \frac{3600 \text{ s}}{3600} \end{array} \right]$$

$$\frac{332 \times 360}{10} \text{ km/h}$$

$$11952 = 11952 \text{ km/h}$$

A force of 1 dyne is equal to how many newtons.

$$1 \text{ dyne} = 10^{-5} \text{ Newton}$$

$$[\text{Dim (force)}] = [MLT^{-2}]$$

$$CGS = g \times m \times s^{-2} = \left(\frac{g \times cm}{s^2} \right) = \text{dyne}$$

$$SI = kg \times m \times s^{-1} = \frac{kg \times m}{s^2} = \text{Newton}$$

$$1 \frac{g \times cm}{s^2} = 1 \times \frac{1}{1000} kg \times \frac{1}{100} m \quad \left[\because 1000g = 1kg \right]$$

$$= 1 \times \frac{1}{1000} \times \frac{1}{100} \left(\frac{kg \times m}{s^2} \right)$$

$$= \frac{1}{10^5} \text{ Newton}$$

$$= 10^{-5} \text{ Newton}$$

The young's modulus of iron is 2×10^{12} dyne cm^{-2} , find its value in Nm^{-2}

$$2 \times 10^{12} \frac{\text{dyne}}{\text{cm}^2} = \frac{(\text{N})}{(\text{m}^2)}$$

$$2 \times 10^{12} \left(\frac{\text{g} \times \text{cm}}{\text{s}^2} \right) \frac{1}{\text{cm}^2}$$

$$2 \times 10^{12} \left(\frac{\text{g}}{\text{cm} \times \text{s}^2} \right) \quad (i)$$

$$2 \times 10^{12} \frac{1}{1000} \text{ kg} \quad \frac{1}{100} \text{ ms}^2 \quad (ii)$$

$$2 \times 10^{12} \times \frac{1}{10} \left(\frac{\text{kg}}{\text{m} \cdot \text{s}^2} \right) \quad [T] = \text{time} = T$$

$$2 \times 10^{11} \text{ N/m}^2 \quad [T] = \text{time} = T$$

$$[T] = \frac{[L]}{[L] \cdot [T]} = \frac{[L]}{[L] \cdot [T]}$$

Principle of Homogeneity

According to principle of homogeneity, two quantities of same dimensions can only be added or subtracted together.

$$A + B + C + D \quad \text{Dim}(A) \quad \text{Dim}(B) \quad \text{Dim}(C) \quad \text{Dim}(D) \quad \text{Dim}(F)$$

(i) Let the time period of simple pendulum be given by the following two expression.

(i) $T = 2\pi \sqrt{\frac{L}{g}}$

$T = \text{Time} = [T]$

$L = \text{length} = [L]$

$g = \text{acceleration} = [L T^{-2}]$

LHS =

$\text{Dim } [T]$

$[T]$

RHS

$\text{Dim} \left(2\pi \sqrt{\frac{L}{g}} \right)$

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

$[T^2]$

$P_{00} + P_{11} = P_{00}$ mit der Zeit. Zeit nicht mehr P_{00}

LHS $\neq$ RHS. also nicht möglich!

ii) $T = 2\pi \left(\sqrt{\frac{l}{g}} \right)$ $P_{00} + P_{11} = P_{00}$

LHS $[T]$ (Zeit) = s

$[l]$ (Länge) = m

Dim (T)

$[T] = 1/s$

RHS $[2\pi \sqrt{\frac{l}{g}}] =$

Dim $(2\pi \sqrt{\frac{l}{g}})$ $[T] = (1/s)$ m/s

$= \sqrt{\frac{[l]}{[g]}}$ $[T] = (1/s)$ m/s

$= \sqrt{\frac{[l]}{[g]}}$ $[T] =$

$= \sqrt{T} = [T]$ (Zeit) ist eine Zeit.

Es ist korrekt.

$T = (2\pi \sqrt{\frac{l}{g}})$ (Zeit) und (Länge) (Länge)

1. a) für (Länge) (Zeit)

Ex-9 - Show that the relation $v^2 = u^2 + 2gs$ is dimensionally correct.

$$v^2 = u^2 + 2gs$$

$u, v = \text{velocity} [LT^{-1}]$

$g = \text{acceleration} [LT^{-2}]$

$s = \text{distance} [L]$

$$\text{Dim}(v^2) = [LT^{-1}]^2$$

$$= [L^2 T^{-2}]$$

$$\text{Dim}(u^2) = [LT^{-1}]^2$$

$$= [L^2 T^{-2}]$$

$$\text{Dim}(2gs) = [LT^{-2}] [L]$$

$$= [L^2 T^{-2}]$$

Hence eqn is correct.

If, van der Waals equation $(P + \frac{a}{v^2})(v - b) = RT$

Find the Dimension of a, b .

$$(P + \frac{a}{v^2}) (v - b) = RT$$

$$\text{Dim } (P) = \text{dim } \left(\frac{a}{v^2} \right)$$

$$[M L^{-1} T^{-2}] = \frac{\text{dim } (a) [L^3 T^{-2} M]}{[L^3 T^{-2} M]} = \text{dim } (a) = b$$

$$M L^{-1} T^{-2} = \text{dim } (a)$$

$$L^6 \cdot M L^{-1} T^{-2} = \text{dim } (a) [L^5 T^{-2}] = V$$

$$\text{dim } (a) = [M L^5 T^{-2}]$$

$$\text{dim } (b) = \text{dim } (v)$$

$$= [L^3]$$

$$[L^3] = b$$

$$[L^3] = b$$

$$[L^3] = b$$

$$[L^3] = b$$

$$[L^3] = b$$

2. Test the validity of the formula $v = \sqrt{\frac{P}{d}}$

dimensionally, where P is pressure, d the density of medium and v the velocity of sound.

$$v = \text{velocity} = [LT^{-1}]$$

$$P = \text{Pressure} = [ML^{-1}T^{-2}] \text{ mib} = [^6T^{-2}IM]$$

$$d = \text{Density} = [ML^{-3}] [^8]$$

$$v = \sqrt{\frac{P}{d}}$$

$$[^6] \text{ mib} = ^6T^{-2}IM$$

LHS =

$$v = [LT^{-1}] [^6] \text{ mib} = ^6T^{-1}IM$$

$$RHS = \sqrt{\frac{P}{d}}$$

$$[^6T^{-2}IM] = [^6] \text{ mib}$$

$$[^6] \text{ mib} = [^6] \text{ mib}$$

$$= \sqrt{\frac{ML^{-1}T^{-2}}{ML^{-3}}}$$

$$[^8] =$$

$$= \sqrt{L^2T^{-2}}$$

$$= (L^2T^{-2})^{\frac{1}{2}}$$

$$= [LT^{-1}]$$

$$LHS = RHS$$

3. Test the validity of formula $T = 2\pi \sqrt{\frac{l}{g}}$ dimensionally where the symbols have their usual meanings.

$T = \text{Time} = [T]$

$l = \text{length} = [L]$

$g = \text{Acceleration} = [LT^{-2}]$

$T = 2\pi \sqrt{\frac{l}{g}}$

Taking L.H.S.

$T = [T]$

R.H.S. =

$2\pi \sqrt{\frac{l}{g}}$

$\sqrt{\frac{L}{LT^{-2}}}$

$\sqrt{T^2}$

$[T]$

L.H.S. = R.H.S.

$[1] =$

4) Test the validity of the equation $S = \frac{1}{2} g t^2$ by the dimensional analysis;
Where S is the distance travelled by the freely falling body, g the acceleration due to gravity and t is the time.

$$S = \frac{1}{2} g t^2$$

[L] = distance
[L T⁻²] = acceleration = g
[T] = time = t

S = Distance = [L]

g = acceleration = [L T⁻²]

t = time = [T]

Taking LHS.

$$S = S = [L]$$

RHS $\rightarrow$

$$\frac{1}{2} g t^2 = \frac{L T^{-2}}{(T)^2}$$

$$= \frac{L T^{-2}}{T^2}$$

$$= L T^{-2} \cdot T^2$$

$$= L T^{-2+2} = L T^0$$

$$= [L]$$

5] Test the validity of the equation $S = ut + at^2$ dimensionally, where u is the initial velocity, a is acceleration, t is time and S the distance travelled.

$$S = ut + at^2$$

$$S = \text{Distance} [L]$$

$$u = \text{initial velocity} [LT^{-1}]$$

$$t = \text{time} [T]$$

$$a = \text{acceleration} [LT^{-2}]$$

Taking LHS

$$S = [L]$$

$$[L] = [L]$$

$$\text{RHS} = \text{First term, } ut$$

$$\begin{aligned} & ut \\ & (LT^{-1}) \cdot T \\ & = [L] \end{aligned}$$

Second term

$$at^2$$

$$[LT^{-2}] \times [T^2]$$

$$= [L]$$

6 Check the correctness of equation $v = u + at$ by Dimensional method

$$v = u + at$$

$$v = \text{final velocity} = [LT^{-1}]$$

$$u = \text{initial velocity} = [LT^{-1}]$$

$$a = \text{acceleration} = [LT^{-2}]$$

$$t = \text{time} = [T]$$

$$\text{Taking L.H.S. } v = [LT^{-1}]$$

$$v = [LT^{-1}]$$

$$= [LT^{-1}]$$

$$\text{R.H.S.} = \text{first term} []$$

$$\Rightarrow u = [LT^{-1}]$$

$$\text{Second term } []$$

$$= at$$

$$= [LT^{-2}] \times [T]$$

$$= [LT^{-1}]$$

$$\text{L.H.S.} = \text{R.H.S.}$$

$$[] =$$

7 If the equation $\frac{1}{2}mv^2 = mgh$ dimensionally correct? If here m is mass of the object, v is velocity, g is acceleration due to gravity, and h is height.

$$\frac{1}{2}mv^2 = mgh$$

$$m = \text{mass} = [M]$$

$$v = \text{velocity} = [LT^{-1}]$$

$$g = \text{acceleration} = [LT^{-2}]$$

$$h = \text{height} = [L]$$

Taking L.H.S.

$$\begin{aligned}\frac{1}{2}mv^2 &= [M] [LT^{-1}]^2 \\ &= [ML^2T^{-2}]\end{aligned}$$

Taking R.H.S.:

$$\begin{aligned}mgh &= [M] [LT^{-2}] [L] \\ &= [ML^2T^{-2}]\end{aligned}$$

$$\text{L.H.S.} = \text{R.H.S.}$$

dimensional where k is force constant, n frequency and m is the mass.

$$n = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$$

$$n = \text{frequency } [T^{-1}]$$

$$k = \frac{1}{404 \text{ cm}} \quad [M \cdot T^{-1}] = 2 [M \cdot T^{-2}] \text{ or}$$

$$m = \text{mass} \quad [M] = \text{kg} \quad W = \text{N}$$

Taking LHS

T-1

$$\text{RHS} = \frac{1}{2\pi} \int_{\Gamma} \frac{K}{M} [1] - \text{even } 1$$

$$= \sqrt{\frac{MKT^2}{M}} \quad \sqrt{\frac{MT^2}{M}}$$

$$\frac{1}{2} \sqrt{1 - \frac{1}{2}} \left[4 \sqrt{1 - \frac{1}{2}} \right] \sqrt{1 - \frac{1}{2}}$$

1. 4-TRIM =

T-1

НЗ = 2Н

Q1) Test the validity of the formula $v = \frac{1}{2\pi} \sqrt{\frac{T}{m}}$

Dimensionally, where v = frequency, L = length, T = tension and m = mass per unit length.

$$v = \frac{1}{2\pi} \sqrt{\frac{T}{m}}$$

$$\begin{aligned} v &= \text{frequency} = [T^{-1}] \\ L &= \text{length} = [L] \\ T &= \text{force} = [M L T^{-2}] \\ m &= \text{mass per unit length} = [M L^{-1}] \end{aligned}$$

Taking LHS

$$v = [T^{-1}]$$

Taking RHS

$$\frac{1}{2\pi} \sqrt{\frac{T}{m}} = \frac{1}{2\pi} \sqrt{\frac{[M L T^{-2}]}{[M L^{-1}]}} = [T^{-1}]$$

$$= [T^{-1}]$$

$$\begin{aligned} 1 &= \mu p - \quad \quad \quad 1 = \mu + \mu \\ &= \frac{1}{2} \times K \times T^{-1} \quad \quad \quad 1 = \mu + \mu \\ &= \frac{1}{2} \times K \times T^{-1} \quad \quad \quad 1 = 1 + \mu \\ &= [T^{-1}] \end{aligned}$$

$$\text{LHS} = \text{RHS} \quad \quad \quad 1 = \mu$$

4. To establish the relation between different physical quantities:-

Q The time period T of a simple pendulum depends upon the effective length l and acceleration due to gravity g . Using the dimensional eqn. Obtain the relationship between them.

T = time period $[T] = [T]$ 6H9 point

l = length $[L] = [L]$ 6H9 point

g = acceleration $[LT^{-2}]$ 6H9 point

$$T \propto l^x g^y \quad \text{--- (1)}$$

By dimensional formula $[T] = V$

$$[T] = [L]^x [LT^{-2}]^y \quad \text{6H9 point}$$

$$[M^0 L^0 T^1] = [L]^x [L]^y [T]^{-2y}$$

$$[M^0 L^0 T^1] = [L]^{x+y} [T]^{-2y}$$

$$x + y = 0 \quad -2y = 1$$

$$\frac{x-1}{2} = 0 \quad y = -\frac{1}{2}$$

$$[T] =$$

$$x = \frac{1}{2}$$

$$6H9 = 6H9$$

Put the values in eqn. (1)

$$T \propto \frac{l}{g^{1/2}}$$

$$T \propto \sqrt{\frac{l}{g}}$$

$$T = k \sqrt{\frac{l}{g}}$$

$$T = k \sqrt{\frac{l}{g}}$$

$$T = k \sqrt{\frac{l}{g}}$$

$$T = k \sqrt{\frac{l}{g}}$$

When the value of g is not constant, the value of T will change.

$$T = k \sqrt{\frac{l}{g}}$$

$$T = k \sqrt{\frac{l}{g}}$$

This method is used to find the value of g at different places. The value of g is not constant.

The value of g is not constant. It is different at different places.

Limitations of Dimensional analysis:-

1) We can't find the value of any constant by the dimensional analysis.

ex:- $L \propto \sqrt{\frac{L}{g}}$

$$L = K \sqrt{\frac{L}{g}}$$

actual formula $L = 2\pi \sqrt{\frac{L}{g}}$

$$L \propto T$$

$$L \propto T$$

$$L \propto T$$

2) We can not derive such formulas in which constant has dimension by dimensional analysis.

$$T = 2\pi \sqrt{\frac{L}{g}}$$

$$F = \frac{Gm_1m_2}{r^2}$$

3) This method cannot be used to establish the formula containing the sum and difference of two or more than two quantities.

4) If a formula contains two or more than two quantities of the same dimensions. It is not possible to differentiate them.

5) It is not possible to analyze the formula which contains the trigonometric terms like $\sin \theta$, $\cos \theta$ etc.

6) By this method we can't know whether the quantity is scalar or a vector.

$$[L^{-1}T] = \text{dimension} = n$$

$$[L] = \text{dimension} = l$$

$$[L^{-1}TM] = \text{dimension} = T$$

$$[L^{-1}M] = \text{dimension} = M$$

$$(1) \sim M^a T^b l^c, \text{ } \forall n$$

$$M^a T^b l^c, \text{ } \forall T^0 l^0 M$$

$$[L^{-1}M]^a [L^{-1}TM]^b [L]^c = T^0 l^0 M$$

$$[L^{-1}M]^a [L^{-1}T]^b [L]^c =$$

$$[L^{-1}M]^a [L^{-1}T]^b [L]^c = T^0 l^0 M$$

$$\sim (\text{dimension}) \sim$$

$$1 = \mu^2 - \epsilon^2$$

$$\frac{1}{c} = \mu$$

$$\boxed{\frac{1}{c} = \mu}$$

$$0 = \gamma - \mu + \gamma$$

$$0 = \left[\frac{1}{c} \right] - \frac{1}{c} + \gamma$$

$$\boxed{\gamma = \frac{1}{c}}$$

$$0 = \gamma + \mu - \epsilon$$

$$0 = \gamma + \frac{1}{c} - \epsilon$$

$$\boxed{\epsilon = \gamma + \frac{1}{c}}$$

Que-11 The time period T of a simple pendulum depends upon l

Que-12 Frequency n of transverse vibrations in a stretched string depends on the length l and acceleration tension T in string and mass per unit length m of the string. Obtain the expression for n dimensionally.

$$n = \text{frequency} = [T^{-1}]$$

$$l = \text{length} = [L]$$

$$T = \text{Tension} = [MT^{-2}]$$

$$M = \text{Mass per unit length} = [ML^{-1}]$$

$$n \propto l^x T^y M^z \quad \text{--- (1)}$$

$$M^0 L^0 T^{-1} \propto l^x T^y M^z$$

$$M^0 L^0 T^{-1} = [L]^x [MT^{-2}]^y [ML^{-1}]^z$$

$$= [L]^x [M^y L^y T^{-2y}] [M^z L^{-z}]$$

$$M^0 L^0 T^{-1} = [M^{y+z} L^{x+y-z} T^{-2y}]$$

~ Comparing ~

$$\Rightarrow y + z = 0$$

$$\Rightarrow \frac{1}{y} + z = 0$$

$$\Rightarrow \frac{1}{z} = -1$$

$$x + y - z = 0$$

$$\Rightarrow x + 1 - (-1) = 0$$

$$\Rightarrow \boxed{x = -1}$$

$$\Rightarrow -2y = -1$$

$$\Rightarrow y = \frac{-1}{-2}$$

$$\Rightarrow \boxed{y = \frac{1}{2}}$$

Putting value in eq (1) :

$$n \propto J^{\frac{1}{2}} T^{\frac{1}{2}} M^{\frac{1}{2}}$$

$$1 = n \propto J^{\frac{1}{2}} T^{\frac{1}{2}} M^{\frac{1}{2}}$$

$$1 = n \propto J^{\frac{1}{2}} T^{\frac{1}{2}} M^{\frac{1}{2}}$$

$$1 = n \propto J^{\frac{1}{2}} T^{\frac{1}{2}} M^{\frac{1}{2}}$$

Que-13 The Speed v of sound in air depends elasticity E and density d of air. Establish the formula of v for v dimensionally.

$$v = \text{velocity} = [L T^{-1}]$$

$$E = \text{Elasticity} = [M L^{-1} T^{-2}]$$

$$d = \text{Density} = [M L^{-3}]$$

$$v \propto E^x d^y$$

$$v \propto [M L^{-1} T^{-2}]^x [M L^{-3}]^y$$

$$M^0 L T^{-1} \propto [M^x L^{-x} T^{-2x}] [M^y L^{-3y}]$$

$$M^0 L T^{-1} = [M^{x+y} L^{-x-3y} T^{-2x}]$$

$$M^0 L T^{-1} = [M^{2+4} L^{-3y-2} T^{-2x}] \text{ (units of velocity)}$$

Comparing

$$x + y = 0 \quad -3y = -2x - 2 \quad -2x = -1$$

$$\frac{1}{2} + \left(-\frac{1}{2}\right) = 0 \quad -3y - \left(\frac{1}{2} + \frac{1}{2}\right) = -1 \quad \therefore x = \frac{1}{2}$$

$$-6y - 1 = -2 \quad x = \frac{1}{2}$$

$$y = \frac{1}{6}$$

$$y = \frac{1}{6}$$

Putting the value in (1) $V = \sqrt{\frac{K}{d}}$

$$V \propto \sqrt{\frac{K}{d}}$$

$$V \propto \sqrt{\frac{K}{d}}$$

$$V = \sqrt{\frac{K}{d}}$$

$$V = \sqrt{\frac{K}{d}}$$

$$V = \sqrt{\frac{K}{d}}$$

$$\left[S = \frac{F}{l} = \frac{MKT^{-1}}{L} \right]$$

Que. If time period T due to surface tension of a drop depends on its density d , radius r and surface tension S . Obtain expression for the time period dimensionally.

T = Time period = $[T]$
 d = Density = $[ML^{-3}]$
 Surface Tension = $[MT^{-2}]$

Time period $[T] \propto d^x r^y S^z$ (1)

$[T] \propto [ML^{-3}]^x [L]^y [MT^{-2}]^z$

$[T] \propto [M^x L^{-3x}] [L^y] [M^z T^{-2z}]$

$[M^0 T^1] = [M^{x+z} L^{-3x+y} T^{-2z}]$

Comparing = $[M^0 T^1] = [M^{x+z} L^{-3x+y} T^{-2z}]$

$x + z = 0$ $-3x + y = 0$ $-2z = 1$

$x + -1 = 0$ $-3\left(\frac{1}{2}\right) - 1 = 0$ $z = -\frac{1}{2}$

$x = \frac{1}{2}$ $-3\left(\frac{1}{2}\right) + y = 0$ $y = \frac{3}{2}$

$-3\left(\frac{1}{2}\right) + y = 0$

$-3 + y = 0$

$y = 3$

Putting value in equation 7

$$T \propto d^2 \times S^2$$

$$T \propto d^2 \times S^2$$

$$T = k \sqrt{\frac{d^2 \times S^2}{S}}$$

$$(1) \sim 2k \times b \times [T] \text{ unit}$$

Que-15. The central force F acting on a particle revolving in a circular orbit depends on the mass m of the particle, radius r of the circle and speed v of the particle. Establish the formula for the force F dimensionally.

$$F = \text{Force} = [M L T^{-2}]$$

$$m = \text{mass} = [M]$$

$$r = \text{radius} = [L]$$

$$v = \text{Speed} = [L T^{-1}]$$

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

$$F \propto [M]^x [L]^y [L T^{-1}]^z$$

$$[M L T^{-2}] \propto [M]^x [L]^y [L T^{-1}]^z$$

$$0 = x + \left(\frac{1}{2}\right)z$$

$$0 = x + z$$

$$\frac{x}{z} = -1$$

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

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

Comparing

$$x = 1$$

$$y + z = 1$$

$$-2z = -2$$

$$x = 1$$

$$y + z = 1$$

$$z = 1$$

$$y = 1 - z$$

$$y = -1$$

Putting values in eqn (1)

$$F \propto m^x y^y v^z$$

$$F \propto m^1 y^{-1} v^2$$

$$F = \frac{kmv^2}{y}$$

It is a vector quantity and it is represented by a vector arrow pointing in the direction of motion.

It is a scalar quantity and it is represented by a scalar value.

Significant digits: - [P.T.M]

The number of digits known accurately in the measurement of a quantity is called the significant digits.

(Counting) of significant digits

- 1] All non-zero digits are significant.
- 2] All zeroes between two non-zero digits are significant digits.
- 3] Zeroes on right side of number are insignificant.
- 4] Zeroes after decimal on right side of number are significant.
- 5] Initial zeroes are insignificant.
- 6] Power of 10 is not counting as significant digits.
- 7] On changing the unit of a quantity no. of significant digits aren't change.
- 8] On changing the place of decimal no. of significant digits doesn't change.

90] Fixed number, constant, values are have zero significant digits like π (here), gravitational acceleration, acceleration, refractive index.

Example: —

- i) $0.007 \text{ m}^2 = 1$
- ii) $2.64 \times 10^{24} \text{ kg} = 3$
- iii) $0.2870 \text{ g cm}^{-3} = 4$
- iv) $6.820 \text{ J} = 4$
- v) $6.032 \text{ N/m}^2 = 4$
- vi) $0.0006032 \text{ m}^2 = 4$
- vii) $14.30 \text{ cm} = 4$
- viii) $0.00237 = 3$
- ix) $10.0340 = 6$
- x) $180.600 = 5$
- xi) $0.00230 = 3$

More the no. of significant digits in the measurement of a quantity more accurate is the measurement.

Rounding off

- 1.] $22.4327 = 22.43$
- 2.] $22.4372 = 22.44$
- 3.] $22.4852 = 22.43$
- 4.] $22.3352 = 22.34$
- 5.] $2.746 = 2.74$ $2.75 = 2.8$
- 6.] $5.325 = 5.32$ $5.33 = 5.3$

2] Addition and Subtraction - While adding or subtracting, it should be remembered that

- 1] All the quantities are in the same unit.
- 2] If the quantities are expressed in powers of ten, they all must be in the same powers of ten.

The result obtained on addition and subtraction of quantities must have the total number of significant digits after decimal same as the minimum number of significant digits after the decimal in the quantities added or subtracted.

example:-

$$\begin{array}{r} 25.6 \text{ cm} \\ 14.5 \text{ cm} \\ 32 \text{ cm} \\ 26.9 \text{ cm} \\ \hline 143.2 \text{ cm} \end{array}$$

Multiplication and division of two significant numbers:-

The product or quotient of two measured quantities will have the total number of significant digits same as the minimum number of significant digits in the given quantities.

$$\begin{array}{r} l = 1.024 \text{ m} \\ b = 5.13 \text{ cm} = 0.0513 \text{ m} \\ \hline \end{array}$$

$$\begin{aligned} \text{Area} &= l \times b \\ &= 1.024 \times 0.0513 \end{aligned}$$

$$\text{Area} = 0.0525 \text{ m}^2$$

The length of wire is measured as 12.5 mm and the diameter of a wire is 0.04 mm. Which measurement is more accurate?

$$l = 12.5 \text{ mm}$$

$$d = 0.04 \text{ mm}$$

The length, breadth and height of an object are 5.24 m, 2.001 m, and 15.3 cm respectively. Calculate the volume of object up in the proper no. of significant digits.

$$l = 5.24 \text{ m}$$

$$b = 2.001 \text{ m} = 15.3 \text{ cm} = 0.153 \text{ m}$$

$$h = 15.3 \text{ cm} \quad 100$$

$$l \times b \times h = 5.24 \times 2.001 \times 0.153$$

=

While measuring the length of a rod by vernier callipers, the following four observations are obtained: 3.45 cm, 3.47 cm, find the average length of the rod up to proper significant digits.

$$\text{Avg. length} = \frac{3.45 + 3.46 + 3.44 + 3.47}{4}$$

$$= \frac{13.82}{4}$$

$$= 3.455$$

$$= 3.45 \text{ cm}$$

Que- The mass of a solid is measurement as 84.0g and volume as 14 cm³. Calculate density of the solid and express the result in proper significant digits.

$$m = 84.0 \text{ g}$$

$$V = 14 \text{ cm}^3$$

$$\rho = \frac{m}{V}$$

$$= \frac{84}{14} = 6 \text{ g/cm}^3$$

Absolute error

Difference between actual value and measured value is called absolute error.

$$| \Delta x | = | x_0 - x_m |$$

The error in measurement of length is 10 cm. The error in measurement of mass is 20 g. The error in measurement of time is 5 s. The error in measurement of temperature is 1°C.

$$\Delta x = 10 \text{ cm}$$

$$\Delta m = 20 \text{ g}$$

$$\Delta t = 5 \text{ s}$$

$$\Delta T = 1^\circ \text{C}$$

$$m = 9$$

$$v$$

$$\Delta x = 10 \text{ cm}$$

$$\Delta m = 20 \text{ g}$$

$$\Delta t = 5 \text{ s}$$

$$\Delta T = 1^\circ \text{C}$$

Significant Digits

1) Write numbers after rounding off to the nearest uncertain digits 2.746 and 5.325
2.75 and 5.32

2) Write the product of 2.5×2.5 with their suitable significant figures

$$2.5 \times 2.5 = 6.25$$

$$= 6.3$$

3) Each side of a cube is measured to be 7.203 m. Find the volume of the cube with appropriate significant figures

$$7.203 \text{ m} = a$$

$$\text{Volume} = a^3$$

$$= 7.203 \times 7.203 \times 7.203$$

$$= 373.715487$$

$$\text{Hence } 373.7 \text{ m}^3$$

4) The length, breadth and thickness of a strip are respectively 10.5 cm, 1.6 cm and 0.45 cm. Calculate the volume of strip upto proper significant figures

$$\text{Length} = 10.5 \text{ cm}$$

$$\text{Breadth} = 1.6 \text{ cm}$$

$$\text{Thickness} = 0.45 \text{ cm}$$

$$\text{Volume} = \text{Length} \times \text{Breadth} \times \text{Thickness}$$

$$= 10.5 \times 1.6 \times 0.45$$

$$= 7.5825$$

$$= 7.6 \text{ cm}^3$$

While measuring the length of a rod by vernier calliper the following four observations are obtained 3.45 cm, 3.46 cm, 3.44 cm and 3.47 cm. Find Absolute and relative error.

$$n = \text{number of observations}$$

$$n = 4$$

$$x_1 = 3.45$$

$$x_2 = 3.46$$

$$x_3 = 3.44$$

$$x_4 = 3.47$$

$$\Sigma x_i = 3.45 + 3.46 + 3.44 + 3.47 = 13.82$$

$$x_a = \frac{\Sigma x_i}{n} = \frac{13.82}{4} = 3.455$$

$$= 3.46$$

$$\Delta x = x_0 - x$$

$$= 3.46 - 3.45 = 0.01$$

$$\Delta x_1 = 3.46 - 3.46 = 0.00$$

$$\Delta x_2 = 3.46 - 3.44 = 0.02$$

$$|\Delta x_4| = |3.46 - 3.47| = 0.01$$

$$\Delta x_{\text{mean}} = \frac{0.01 + 0.00 + 0.02 + 0.01 + 0.00}{4} = 0.01$$

$$= \frac{0.04}{4} = 0.01$$

$$\Delta_{\text{mean}} = 0.01$$

Relative error = Percentage error

$$\frac{\Delta x}{x} \times 100 = \frac{0.01}{3.46} \times 100$$

$$\approx \frac{100}{346}$$

$$\approx 0.3\%$$

Likhaan ka Anvesh

$$= x \text{ unit} \pm \Delta x$$

$$(3.46 \pm 0.3\%) \text{ cm}$$

Calculation of error.

(i) In addition.

If mass of particle is $(50.2 \pm 0.2)g$
and mass of another particle is $(30.0 \pm 0.1)g$
then, find the total mass

$$m_1 = (50.2 \pm 0.2)g$$

$$m_2 = (30.0 \pm 0.1)g$$

$$m_1 + m_2 = 50.2 + 30.0 \pm 0.2 \pm 0.1$$

$$= 80.2$$

$$\Delta m = \Delta m_1 + \Delta m_2$$

$$= 0.2 + 0.1$$

$$= 0.3$$

$$= (80.2 \pm 0.3)g$$

2) In Subtraction-

If length of two rods are measured
as $(25.0 \pm 0.2)cm$ and $(10.0 \pm 0.1)cm$
then, find the difference between the length
of rods

$$l_1 = (25.0 \pm 0.2) \text{ cm} \quad \text{or } (1.0 \pm 0.2) = l_1$$

$$\text{or } (2.0 \pm 0.1) = d$$

$$l_2 = (10.0 \pm 0.1) \text{ cm}$$

$$d \times l = \text{area}$$

$$= l_1 - l_2$$

$$= 25 - 10$$

$$0.2 \times 0.1 = 0.02$$

$$= 15.0$$

$$0.2 \times 0.1 = 0.02$$

$$\Delta A = \Delta l + \Delta d$$

$$\Delta A = \Delta l + \Delta d$$

$$\Delta l = 0.2 + 0.1$$

$$\Delta l = 0.2 + 0.1$$

$$= 0.3$$

$$2.0 \pm 0.1 = \Delta l$$

$$2.0 \pm 0.1 = \Delta l$$

$$A = 8(15.0 \pm 0.3) \text{ cm}^2$$

$$8 \times 15.0 = 120$$

$$0.3 \times 8 = 2.4$$

$$0.3 \times 8 = 2.4$$

Error in Multiplication

$$2.4$$

If length and breadth of a rectangle is $(12.0 \pm 0.2) \text{ cm}$ and $(5.0 \pm 0.1) \text{ cm}$, then find its area

$$\text{length} = (12.0 \pm 0.2) \text{ cm}$$

$$\text{breadth} = (5.0 \pm 0.1) \text{ cm}$$

$$\text{Area} = l \times b$$

$$\Delta A = \Delta l + \Delta b$$

$$A = 12.0 \times 5.0$$

$$= 60$$

$$\Delta A = \Delta l + \Delta b$$

$$= 0.2 + 0.1$$

$$= 0.3$$

$$l = (8.0 \pm 0.1) \text{ cm} \quad b = (4.0 \pm 0.5) \text{ cm}$$

$$b = (4.0 \pm 0.5) \text{ cm}$$

$$\text{Area} = ?$$

$$A = 8 \times 4 = 32$$

$$\frac{\Delta A}{A} = \frac{\Delta l}{l} + \frac{\Delta b}{b}$$

$$\frac{\Delta A}{32} = \frac{0.1}{8} + \frac{0.5}{4}$$

$$\frac{\Delta A}{32} = 0.4 + 4.0$$

$$\Delta A = 4.4$$

$$(8 \pm 0.1) \times (4 \pm 0.5) = 32 \pm 4.4$$

$$A = (10.0 \pm 0.2) \quad B = (5.0 \pm 0.1) \quad \text{or } (2.0 \pm 0.1) = 2$$

What will be the percentage error in

$$P = A \times B?$$

$$P = A \times B$$

$$10 \times 5 = 50$$

$$10 \times 5 = 50$$

$$\frac{\Delta P}{P} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$$

$$\frac{\Delta A}{A} + \frac{\Delta B}{B} = \frac{\Delta P}{P}$$

$$\frac{\Delta P}{50} = \frac{0.2}{10} + \frac{0.1}{5}$$

$$\frac{2.0}{10} + \frac{1.0}{5} = \frac{\Delta P}{50}$$

$$\frac{\Delta P}{50} = \frac{1.0}{50} + \frac{1.0}{50}$$

$$\frac{1.0}{50} + \frac{1.0}{50} = \frac{\Delta P}{50}$$

$$\Delta P = 2$$

$$\Delta P = 2$$

$$P = (50 \pm 2)$$

$$\text{Percentage error} = \frac{2}{50} \times 100$$

$$= 4\%$$

Substratum: * Soil & water level

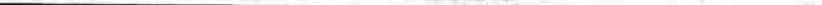
1978

200

_____ 2

$$Z \times Y \rightarrow \Omega, \quad \dots, \Omega$$

$$\Delta T = 0.5 + 0.4$$



200 200

17. $\Delta Z = 0$ (no change in internal energy)

7	200	
---	-----	--

$$= \frac{9}{4.5\%} \cdot 100 = 200$$

_____ d 1 13

If $Q = A \times B$ and the percentage error in A and B are 2% and 3% , respectively, then the maximum percentage error in Q is.

$$\frac{\Delta A}{A} \% = 2\%$$

A

$$\frac{\Delta B}{B} \% = 3\%$$

B

$$\frac{\Delta Q}{Q} \% = \frac{\Delta A}{A} \% + \frac{\Delta B}{B} \%$$

$$= 2 + 3 = 5\%$$

The length of a rectangle has 1% error and the breadth has 2% error. If $A = l \times b$, what is the maximum percentage error in Area.

$$\frac{\Delta l}{l} \% = 1\%$$

$$\frac{\Delta b}{b} \% = 2\%$$

$$\frac{\Delta A}{A} \% = \frac{\Delta l}{l} \% + \frac{\Delta b}{b} \% = 1 + 2 = 3\%$$

The volume of a cylinder is $V = \pi r^2 h$. If the percentage errors in radius and height are 2% and 1% respectively, the maximum percentage error in the volume is.

$$V = \pi r^2 h$$

$$\frac{\Delta r}{r} = 2\%$$

$$\frac{\Delta h}{h} = 1\%$$

$$\frac{\Delta V}{V} = 2 \frac{\Delta r}{r} + \frac{\Delta h}{h}$$

$$= 2 \times 2 + 1$$

$$= 4 + 1$$

$$= 5\%$$

$$\begin{aligned} 1 \mu\text{m} &= 10^{-6} \text{ m} \\ 1 \text{ nm} &= 10^{-9} \text{ m} \\ 1 \text{ \AA} &= 10^{-10} \text{ m} \\ 1 \text{ pm} &= 10^{-12} \text{ m} \\ 1 \text{ fermi} &= 10^{-15} \text{ m} \end{aligned}$$

$$1 \text{ \AA} = 10^{-1} \text{ nm}$$

Sol $1 \text{ \AA} = 10^{-10} \text{ m}$

$$= 10^{-1} \times (10^{-9}) \text{ m}$$

$$\begin{aligned} 1 \text{ \AA} &= 10^{-1} \text{ nm} \\ &= 0.1 \text{ nm} \end{aligned}$$

$$1 \mu\text{m} = \text{---} \text{ \AA}$$

$$1 \mu\text{m} = 10^{-6} \text{ m} \times \frac{10^{-10}}{10^{-10}}$$

$$= \frac{10^{-6}}{10^{-10}} (10^{-10} \text{ m})$$

$$= 10^4 \text{ \AA}$$

$$1 \mu\text{m} = 10^4 \text{ \AA}$$

Ques If length of a simple pendulum (suddenly) increases by 1% the increase in its time period will be nearly.

$$T = 2\pi \sqrt{\frac{L}{g}}$$

$$T \propto \sqrt{L}$$

$$T \propto L^{\frac{1}{2}}$$

$$\frac{\Delta T}{T} = \frac{1}{2} \left(\frac{\Delta L}{L} \right)$$

$$= \frac{1}{2} \times 1\%$$

$$= \frac{1}{2} \times \frac{1}{100} = 0.5\%$$

Dimensional formula of angular velocity = T^{-1}

The volume of a cube of side 2 cm is equal to $8 \times 10^{-6} \text{ m}^3$