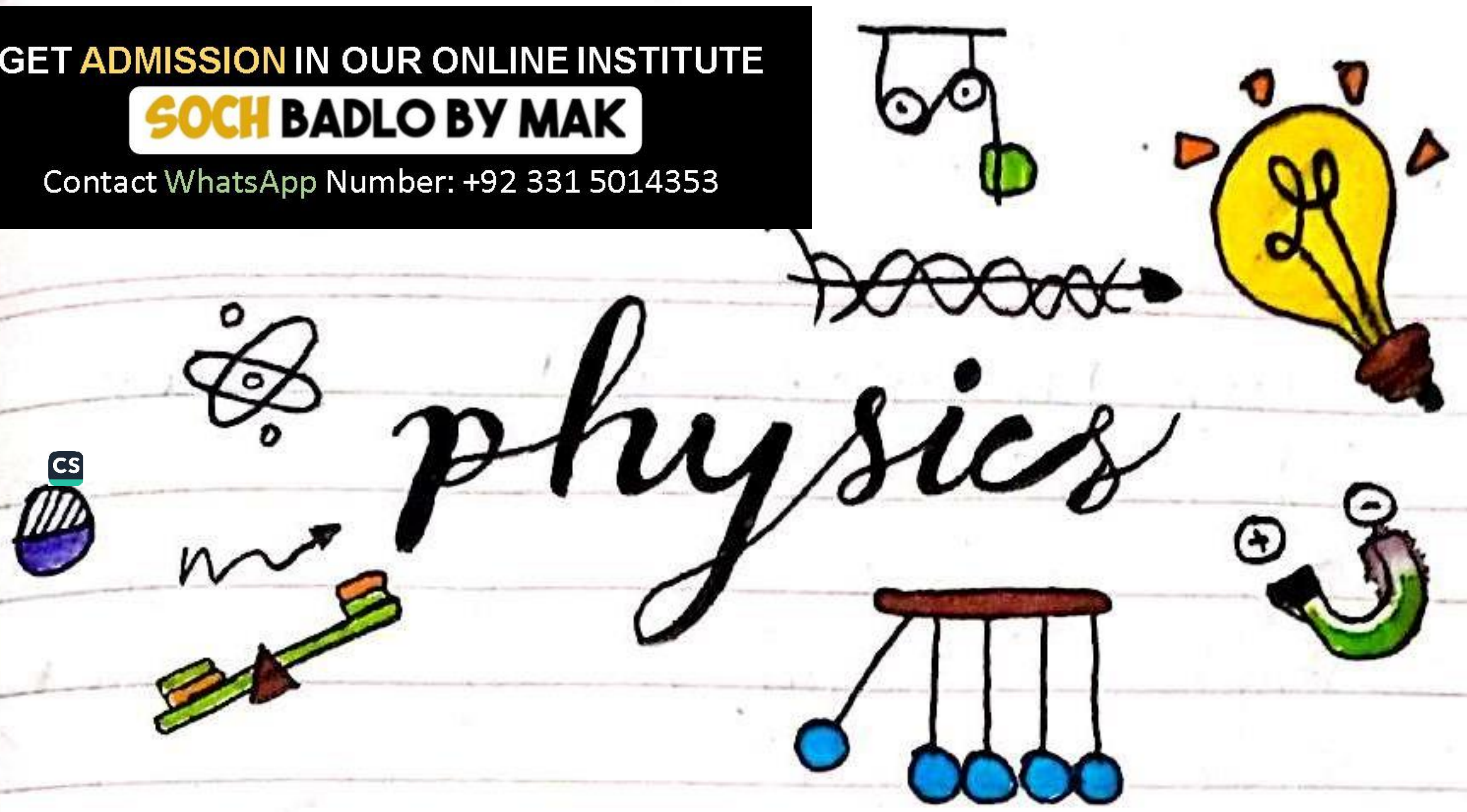


Physics :-

Observation and Experiment

(Mass, energy relationship)

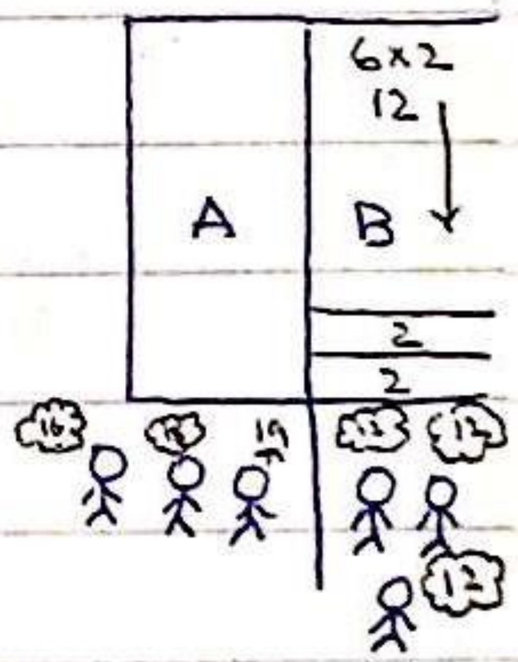
① qualitative → like smell, taste hearing, touch, sight

② Quantitative → number and measurment

Chapter no - 01

-: Measurment :-

Estimation of Physical Quantities :-



withdata

one is without any data → This observation is more correct

"Sometimes to estimate a big thing we break into smaller Pieces and to estimate small thing we break into big Piece."

-: Estimation of some :-

Diameter of H-atom = 10^{-10} m (Angstrom)

One day = 10^5, One year = 10^7, Human lifetime = 10^9

~~One~~ 1 light-year = 10^{16}, Mass of Earth = 10^{25}

Age of Universe = 10^{18}

From Big Formulas to Basic derivation

Torque = $r \times F$

Torque = $l \times ma$

Torque = $m \times kg (ms^{-2})$

Torque = kgm^2s^{-2}

Potential Energy = mgh

Mass, length

Time

[redacted] :-

→ SI unit

OR **Dimension :—**

PKMZ

Dimension → SI units

kg → mass → [M]

m → length → [L]

s → time → [T]

> Dimension is the Symbolic representation of all basic units

Eg :- Velocity dimension
↓
meter/second
$[LT^{-1}]$

$E = mc^2$

$E = [M][LT^{-1}]^2$

$[ML^2T^{-2}]$ $[M][L^2T^{-2}]$

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

Density :- $kgms^{-3}$
↓
$[ML^{-3}]$

Force = $kgms^{-2}$

$[MLT^{-2}]$

Torque = $r \times F$
↙ m ↘ N
$[ML^2T^{-2}]$

Acceleration :-
ms^{-2}
↙ L ↘ T^{-2}
$[LT^{-2}]$

Volume of Sphere $\frac{3}{4}$ $\frac{4}{3}\pi r^3$

CS CamScanner

S No	Physical Quantity	Dimension
1	Mass	[M]
2	length	[L]
3	Time	[T]
4	Electric current	[I]
5	Temperature	[θ]
6	intensity of light	[J]
7	Number of moles	[N]

→ Qualitative nature of different Formulas

Dimension is basically a study ... other base quantities in ... particular quantity

(e.g :- Torque, L, F) ē

- **Dimensional Variables** (P.Q → SI unit (✓)
- **Dimensional Constant** (constant → SI unit (✓) (G, η, h)
- **Dimensionless Variable** (P.Q → SI unit (✗) (η, stain)
- **Dimensionless constant** (P.Q (✗) → SI unit (✗) π, (1, 2, 3, 4 ...)

Advantages of Dimension :-

	P.Q	SI Unit	Example
Dimensional variables	✓	✓	length, mass, Force
Dimensional constant	✗	✓	G, η (eta), h, R
Dimensionless variable	✓	✗	Strain, refractive
Dimensionless constant	✗	✗	π, 1, 2, 3, ..., α, e

Conclusion :- Numbers do not have any unit don't have any dimension.

Quantities which do not have any SI unit ~~are~~ do not ~~called~~ have Dimension.

Advantages of Dimension :-

By using Dimensions we can check the homogenity of the equation
same type of things like mass with mass length with lengths (we add same P.Q)

First Equation of Motion:—

$$v_f = v_i + at$$

L.H.S:—

$v_f = ms^{-2}$

$v_f = [LT^{-1}]$ —— (i)

R.H.S:—

$v_i = ms^{-1}$ $at = ms^{-2}$ $t = s$

$v_i + at = ms^{-1} + ms^{-2} \cdot s$

$v_i + at = [LT^{-1} + LT^{-1}]$

$v_i + at = [LT^{-1}] + [LT^{-1}]$

$v_i + at = 2[LT^{-1}]$

Now we neglact 2 so

$v_i + at = [LT^{-2}]$ —— (i)

Now it is proved that (i) is equal to (ii)
So this equation is dimensionally conect

Second equation of Motion:—

$$S = vt + \frac{1}{2}at^2$$

L.H.S:— $S \Rightarrow [L]$ —— (i)

R.H.S:— $v = ms^{-1}$ $t = s$ $a = ms^{-2}$ $t^2 = s^2$

$vt + \frac{1}{2}at^2 = m\cancel{s^{-1}} \cdot \cancel{s} + \frac{1}{2} m\cancel{s^{-2}} \cdot \cancel{s^2}$

$vt + \frac{1}{2}at^2 = 2m \times \frac{1}{2} \Rightarrow m$ —— (ii)

$vt + \frac{1}{2}at^2 = [L]$ —(iii)

Now it is proved that eq(i) and (iii) are dimensionally correct and this equation is homogenous equation

Deriving Wave length formula

$$\lambda \propto h^a m^b v^c$$

$$\Rightarrow \boxed{\lambda = (\text{constant})\, h^a m^b v^c} \longrightarrow (i)$$

$\Rightarrow \because E = hf \Rightarrow h = \frac{E}{f} \Rightarrow h = Ef^{-1}$

As $E = \frac{1}{2} m v^2$ So $f^{-1} = \frac{1}{f} = T$

$$h = [ML^2T^{-2}].[T]$$

$$\boxed{h = [ML^2T^{-1}]} \longrightarrow (ii)$$

$$\text{Mass} = [M] \longrightarrow (iii)$$

$$\text{Velocity} = [LT^{-1}] \longrightarrow (iv)$$

$$\lambda = [L] \longrightarrow (v)$$

Putting all the values in equation (i) then

$$[L] = (\text{constant})\, [ML^2T^{-1}]^a [M]^b [LT^{-1}]^c$$

$$[L] = (\text{constant})\, [M^a L^{2a} T^{-a}] [M^b] [L^c T^{-c}]$$

$$[L] = c\, [M^a . M^b] [L^{2a} . L] [T^{-a} . T^{-c}]$$

$$[L] = c\, [M^{a+b}] [L^{2a+c}] [T^{-a-c}]$$

Now For comparing we take

$$[M^0][T^0][L] = c\, [M^{a+b}][L^{2a+c}][T^{-a-c}]$$

$$[M^0T^0L^1] = c\, [M^{a+b}][L^{2a+c}][T^{-a-c}]$$

Now by comparing both sides

$\Rightarrow M^0 = M^{a+b}$ $\Rightarrow T^0 = T^{-a-c}$

$0 = a+b$ $0 = -a-c$

$\boxed{a = -b}$ — (i) $\boxed{a = -c}$ — (ii)

$\Rightarrow L^1 = L^{2a+c}$

$\Rightarrow 1 = 2a+c$

$\Rightarrow 2a = 1-c$

$\Rightarrow$ By Putting value of From eq (ii)

$\Rightarrow$ ~~2a = 1+a~~ $2(-c)+c = 1$

$-2c+c = 1$

$\boxed{c = -1}$ —(1) $\Leftarrow -c = 1$

Now put

$\Rightarrow a = -(-1) \Rightarrow \boxed{a = 1}$ — (2)

$\Rightarrow a = -b$

$\Rightarrow 1 = -b$

$\boxed{b = -1}$ — (3)

Now According to the equation (1), (2), (3)

~~LHS~~ $= \lambda$

$\lambda = (\text{constant})\, h^1 m^{-1} v^{-1}$

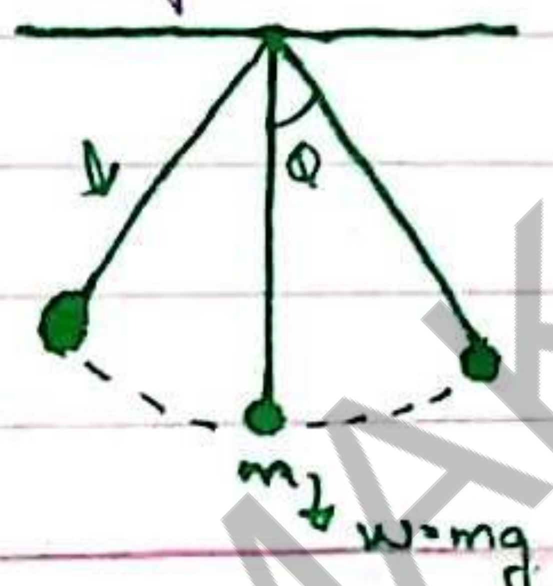
$$\boxed{\lambda = (\text{constant})\, \frac{h}{mv}}$$

Ans.

CamScanner

Single pendulum

Derive formula for the time period of Single pendulum using dimensional analysis



$$T \propto m^a l^b \theta^c g^d \quad \text{— (i)}$$

$$T = (\text{Constant})\, m^a l^b \theta^c g^d$$

Since the time period of Simple pendulum is in independent of "m"

$$\boxed{a = 0} \quad \text{— (1)}$$

$$\cancel{T = (\text{constant})\, l^a \theta^b g^c}$$

Since, theta "θ" has numerical value then we well neglect the 'θ' in Time period equation

$$\boxed{c = 0} \quad \text{— (2)}$$

$$T \propto m^a l^b \theta^c g^d$$

$$T \propto m^0 l^b \theta^0 g^d$$

$$g = ms^{-2} = [LT^{-2}]$$

$$T = (\text{constant})\, m^0 l^b g^d$$

$$[T] = (\text{constant})\, [M]^0 [L]^b [LT^{-2}]^d$$

$$[M^0][L^0][T]^1 = (\text{constant})\, [M]^0 [L]^b [L^d T^{-2}]^d$$

$$M^0 = M^a, \quad L^0 = L^{b+d}, \quad T^1 = T^{-2d}$$

$$\boxed{0 = a} \text{ —(5)} \quad 0 = b + d, \quad 1 = -2d$$

$$b = -d \qquad \boxed{\frac{1}{-2} = d} \quad \text{— (3)}$$

$$b = -\frac{1}{-2}$$

$$\boxed{b = \frac{1}{2}} \quad \text{— (4)}$$

Putting values from eq (ii). (iv) and (v)

$$T = (\text{Constant})\, m^{0}\, l^{\frac{1}{2}}\, g^{-\frac{1}{2}}$$

$$T = (\text{Constant}) \left(\frac{l}{g}\right)^{2}$$

$$T = \text{Constant} \sqrt{\frac{L}{g}}$$

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

Tip for this Question

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

(ii) $T = 2\pi\, l^{a}\, m^{b} \cdot g^{d}$

(iii) $T = 2\pi \left(\frac{L}{g}\right)^{\frac{1}{2}}$

(iv) $T = 2\pi\, L^{1/2}\, g^{-\frac{1}{2}}$

Limitation of Dimension :-

- $[ML^2T^{-2}]$ → work, → Energy, → Torque

- By Using dimension we can't derive trignometric, Algebric and logrithmic equation

- Dimenstion Analysis can not derive dimenstionless Constant when Solving possible equation.

  Example :- $T = 2\pi \sqrt{\frac{L}{g}}$ → Dimenstionless constant

- Dimenstion Analysis can not prove that why an equation dimenstionally correct but not phisically correct But if an equation is dimensionally wrong then it is also phisically wrong.

Rules of uncertainty:-

Quotient

Sum

$Z = A+B$, $A \pm \Delta A$

$B \pm \Delta B$

$(A \pm \Delta A) + (B \pm \Delta B)$

measurment

uncertainty

$A \pm \Delta A = 5.1 \pm 0.1\,cm$

$B \pm \Delta B = 4.3 \pm 0.1\,cm$

$Z + \Delta Z = 9.4 \pm 0.2$

Difference

$Z = A-B$

$A \pm \Delta A$

$B \pm \Delta B$

$A \pm \Delta A) - (B \pm \Delta B)$

$A - B) \pm (\Delta A + \Delta B)$

$9.3 \pm 0.2g$

$9.3 \pm 0.2g$

$3.6 \pm 0.4g$

Mutliply

$Z = A \times B$

$(A \pm \Delta A)(B \pm \Delta B)$

$(A \times B)(\Delta A\% + \Delta B\%)$

$(A \times B)(\Delta A + \Delta B)\%$

convert back Percentage uncertainty into fractional uncertainty.

$(A \times B)(\Delta A + \Delta B)$

$\frac{A \pm}{B}(\Delta A + \Delta B)$

Division

$Z = \frac{A}{B}$

$\frac{A \pm \Delta A}{B \pm \Delta B}$

convert fractional uncertainty into percent

$\frac{A}{B} \pm \Delta A\% + \Delta B\%$

$\frac{A}{B} \pm (\Delta A + \Delta B)\%$

convert back Percentage uncerty into fractional uncertainty

Example of Division:-

E $V \pm \Delta V = (7.3 \pm 0.1)\,V$

$I \pm \Delta I = (2.73 \pm 0.0051)\,A$

$R \pm \Delta R = ?$

By ohm law

$V = IR \Rightarrow R = \frac{V}{I}$

$R \pm \Delta R = \frac{V \pm \Delta V}{I \pm \Delta I}$

$R \pm \Delta R = \frac{7.3 \pm 0.1}{2.73 \pm 0.0051}$

$R \pm \Delta R = \frac{7.3}{2.73} \pm (0.1 \pm 0.0051)\%$

$$R \pm \Delta R = \frac{\cancel{V}}{I} \pm (\Delta V\% + \Delta I\%) \quad — x$$

$$\Rightarrow \Delta V\% = \frac{\Delta V}{V} \times 100 \Rightarrow \frac{0.1}{7.3} \times 100$$

$$\boxed{\Delta V\% = 1.3\%} \quad — (i)$$

$$\Delta I\% = \frac{\Delta I}{I} \times 100 \Rightarrow \frac{0.0051}{2.73} \times 100$$

$$\Delta I\% = 1.83\%$$

$$\boxed{\Delta I\% = 2\%} \quad — (ii)$$

Now

$$R \pm \Delta R = \frac{7.3}{2.73} \pm (1.3 + 2)\%$$

$$R \pm \Delta R = 2.67 \pm (3.3)\%$$

$$\boxed{R \pm \Delta R = (2.67 \pm 0.0801)\,\Omega}$$

Ans

POWER:-

$$(A)^n = (A^n \pm \Delta A)^n$$

$$(A \pm \Delta A\%)^n = (A^n \pm n\Delta A\%)$$

$$(A^n \pm n\Delta A\%) \quad — *$$

$$\downarrow$$

$$(A^n \pm n\Delta A)$$

Example:-

$$(L + \Delta L)^2 = (4.02 \pm 0.1)^2$$

$$[(4.02)^2 \pm 2.4875 \times 2$$

$$(L + \Delta L)^2 = 16.1604 \pm 4.975$$

$$(L \pm \Delta L^2) \Rightarrow 16.1604 \pm \cancel{0.199}\ 0.803$$

Example :- 02

$$(L \pm \Delta L)^8 \Rightarrow (4.02 \pm 0.1)^8$$

$$(L \pm \Delta L)^8 \Rightarrow [(4.02)^8 \pm 8(2.5)\%]$$

$$(L \pm \Delta L)^8 \Rightarrow [68203.7 \pm 20\%]$$

$$(L \pm \Delta L)^8 \Rightarrow \left[68203.7 \pm \frac{20 \times 68203.7}{100}\right]$$

$$(L \pm \Delta L)^8 \Rightarrow [68203.7 \pm 13640.74]$$

$$(L \pm \Delta L)^8 \Rightarrow [68204 \pm 13641]$$

Ans.

Uncertainties in Average value :-

(i) Find the average of measured value
(ii) Find the deviation of each value from average
(iii) The mean deviation is the uncertainty in the average.

Example :-

$$r_1 = 1.50cm \quad r_2 = 1.51cm \quad r_3 = 1.52$$

$$\bar{r} = \frac{r_1 + r_2 + r_3}{3} =$$

$$\bar{r} = 1.51cm$$

$$\Delta r_1 = \bar{r} - r_1 = 1.51 - 1.50 = 0.01cm$$

$$\Delta r_2 = \bar{r} - r_2 = 1.51 - 1.51 = 0$$

$$\Delta r_3 = \bar{r} - r_3 = 1.51 - 1.52 = 0.01cm$$

$$\Delta r = \frac{\Delta r_1 + \Delta r_2 + \Delta r_3}{3} = 0.007cm$$

we can use it as a displacement

$x = m = [L]$

20/07/24

Assigment 1.2 :-

Acceleration :- $ms^{-2} = [LT^{-2}]$

① $\frac{v}{t^2}$ (ii) $\frac{v}{x^2}$ (iii) $\frac{v^2}{t}$ (iv) $\frac{v^2}{x}$

Solution (i)

$\left[\frac{LT^{-1}}{(T)^2}\right]$

$[LT^{-1}] \cdot [T^{-2}]$

$\boxed{[LT^{-3}]}$

Solution (ii)

$\frac{[LT^{-1}]}{[L^2]}$

$[LT^{-1}] \cdot [L^{-2}]$

$\boxed{[L^{-1}T^{-1}]}$

Solution (iii)

$\frac{[LT^{-1}]^2}{[T]}$

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

$[L^2T^{-2}] \cdot [T^{-1}]$

$\boxed{[L^2T^{-3}]}$

Solution (iv)

$\frac{[LT^{-1}]^2}{[L]}$

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

$[L^2T^{-2}][L^{-1}]$

$\boxed{[LT^{-2}]}$

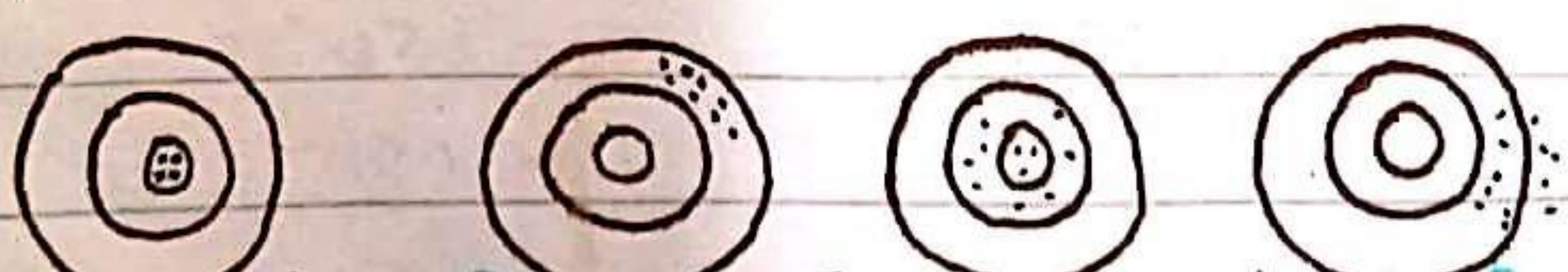
So $\frac{v^2}{x}$ dimension is equal to acceleration dimension (Answer is D)

Precious And Accuracy :-

Precious :- Apas main Qareeb Qareeb

Accuracy :- Near to exact value.

Example :-



Precious ✓	Precious ✓	Precious ✗	Precious ✗
Accuracy ✓	Accuracy ✗	Accuracy ✓	Accuracy ✗

Example with the help of number:-

example no:- 01

Exact value:- ($9.8 m/s^2$)

One girl:-	9.6, 9.7, 9.9, 10	Precious and Accurate
Second girl:-	7.1, 7.2, 7.3, 7.4	Precious not Acc
Third girl:-	9.9, 9.7, 10.1, 10.2	Accurate not Pr
Fourth girl:-	4.3, 11.2, 7.5, 8.3	not Precious not Accurate

Δx

شک

UNCERTAINTIES :-

غیر یقینی like

{50g ± 5g}

<= uncertainties

range between error

lack of surety in something is called uncertainties

→ uncertainly is not an error ←

Urdu Defination

Kisi chez main kitna error a sakta ha is called uncertainty.

Types:- 3

- Percentage uncertainty
- Absolute uncertainty
- Fractional uncertainty

Error :-

It is the doubt or difference in measured value from observed/accurate/true value.

=> error = observed value − True value

Types:-
- Personal
- Systmetic
- Random

Stair of Success

$\%\ un = \frac{\text{Absolute un}}{\text{Measured value}} \times 100$

Fr :- $\frac{\text{Absolute uncertainty}}{\text{Measured value}}$

Percentage uncertainty %

Fractional uncertainty

Relative uncertainty

Absolute uncertainty

پیڑی کی ٹوگی

(Second name)

like in june there is excaty hot

± 0.1 cm

least count

Example :-

(37.5 ± 0.1)

Absolute uncertainty = 0.1

$\text{Fractional uncertainty} = \frac{\text{absolute}}{\text{measured}} = \frac{0.1}{37.5}$

Fractional uncertainty = ±0.003

$\text{Percentage uncertainty} = \frac{\text{Absolute uncertainty}}{\text{measured value}} \times 100$

Percentage uncertainty = ±0.003 × 100

Percentage uncertainty = ±0.3%