
# ARJUNA NEET BATCH


## UNITS AND MEASUREMENTS

### LECTURE - 02

# SYMBOL FOR DIMENSIONS OF FUNDAMENTAL QUANTITIES

| | | |
|---|---|---|
| Length | : | L |
| Mass | : | M |
| Time | : | T |
| Temperature | : | K or θ |
| Current | : | I or A |
| Luminous Intensity | : | Cd |
| Amount of substance | : | mol |

Dir

Angle is solid

↳ have unit but does not have dimⁿ


**Dimension:** It is the power of fundamental unit or power of symbol of fundamental P.Q.

# DIMENSIONAL FORMULA

**Dimensional formula of a physical quantity(P) is**

$$P = [M^x L^y T^z]$$

velocity = $M^0 L^1 T^{-1}$ → dimensional formula

***Where x, y and z are dimensions of fundamental quantities M,L and T respectively.***

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velocity $= LT^{-1}$

acc$^n$ $= LT^{-2}$

Force $= MLT^{-2}$

**Work** = Force × disp$^n$ $= ML^2T^{-2}$

$Nm$ = Newton metre

**Energy** $= \left(\frac{1}{2}\right)mv^2 = ML^2T^{-2}$

Can't be in $Nm$

Energy → Joule

both have same dim$^n$

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{ML^2T^{-2}}{T} = ML^2T^{-3}$$

# PHYSICAL QUANTITIES HAVING SAME DIMENSIONAL FORMULA

- Distance, displacement, radius, light year, wavelength, radius of gyration, focal length, parsec , astronomical unit [L]
- Speed, velocity, velocity of light, velocity of sound ,terminal velocity , avg. velocity , orbital velocity [ $LT^{-1}$]
- Acceleration, avg acceleration, acceleration due to gravity, intensity of gravitational field, centripetal acceleration [ $LT^{-2}$]
- Impulse, change in momentum [$MLT^{-1}$]
- Force, weight, tension, thrust, gravitational force, spring force, electrostatic force. Magnetic force, normal reaction friction [$MLT^{-2}$]

Impulse = $\Delta P$ = Change in momentum

**Ex.** **Determine the dimension of temperature gradient**

→ Ratio

change in [ ]

With respect to distance.

**Step-1**

$$\text{temp. gradient} = \frac{\text{Temperature}}{\text{distance}}$$

$$\text{temp. gradient} = \frac{K^1}{L^1} = K^1 L^{-1}$$

# velocity gradiant $= \dfrac{L T^{-1}}{L} = T^{-1}$

IIT ⇒ Angular velocity $= \dfrac{\text{Angle}}{\text{time}} = \dfrac{1}{T} = T^{-1}$

frequency $= T^{-1}$

Ramlal


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# PRESSURE

$$P = \frac{\text{Force}}{\text{Area}}$$

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

$$\text{Pressure} = ML^{-1}T^{-2}$$

- **Surface tension :** Force Per Unit length

$$S = \frac{F}{L} = \frac{ML T^{-2}}{L} = MT^{-2}$$

- **Coefficient of friction :**

$$f_r = \mu N$$

$f_r$ → Friction Force, $N$ → Normal force

$$\mu = \frac{f_r}{N} = \underbrace{M^0 L^0 T^0}_{\text{dimn less}}$$

Energy density $= \frac{\text{Energy}}{\text{Volume}}$

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

$$= ML^{-1}T^{-2}$$

# Energy density & Pressure have same dimn

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# GRAVITATIONAL CONSTANT = ??

$$\left[\text{acc}^{n} \text{ due to gravity } g\right] = LT^{-2}$$

$$F = G\frac{m_1 m_2}{r^2}$$

$$MLT^{-2} = \frac{GM^2}{L^2}\, m$$

$$GM = L^3 T^{-2}$$

# $G = M^{-1} L^3 T^{-2}$ → Ans

# charge $I = \frac{Q}{T}$

$$Q = IT$$

$$= A^1 T^1$$

# PLANK'S CONSTANT

Same as surface tension.

- **Spring Constant :** / force constant

$F$ (spring force) $= K x$

$K$ → spring cost$^n$ / force const. $= \frac{F}{L} = MT^{-2}$

**Angular momentum** $L = r \times p$

$L = L(MLT^{-1})$

**Angular momentum** $= ML^2T^{-1}$

$E = hf$

$E$ ↑ Energy of Phot. $f$ → frequency

$h = \frac{E}{f} = \frac{ML^2T^{-2}T^{-1}}{T^{-1}}$

$h = ML^2T^{-1}$

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## Gas Constant

"$PV = nRT$"

$$R = \frac{[PV]}{nT} = \left[\frac{ML^2T^{-2}}{mol\ K^1}\right]$$

## Boltzman Constant

$$E = \left[\frac{3}{2}\right] K_B T$$

$$K_B = \frac{E}{Temp} = ML^2T^{-2}K^{-1}$$

$$\left[\begin{array}{l} T = Temp^{\circ} \\ E = energy \\ K_B = Boltzmul\ const^{n} \end{array}\right]$$

electric field $\Longrightarrow$ $F = qE$

↑ electrostudic force

$$E = \frac{F}{q} = \frac{M L T^{-2}}{[A T]}$$ ← time, ← Amp

$$E = M L T^{-3} A^{-1}$$

magnetic field

$$F = qvB$$

$$B = \frac{F}{qv} = \frac{M L T^{-2}}{A T (L T^{-1})} = M T^{-2} A^{-1}$$

Resistance

$R = \rho \frac{l}{A}$ ✗

$V = IR$

$R = \frac{V}{I}$ ✗

$H = I^2 R t$

$M L^2 T^{-2} = A^2 R T$

$R = M L^2 T^{-3} A^{-2}$ $A^2$

capacitance

$E = \frac{Q^2}{2C}$

$C = \frac{Q^2}{\text{Energy}} = \frac{A^2 T^2}{M L^2 T^{-2}}$ ✗

## Permitivity

$$F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1 Q_2}{r^2}$$

→ Dim$^n$ = ??

$$\varepsilon_0 = \frac{Q^2}{(4\pi) F r^2} = \frac{(AT)^2}{(MLT^{-2})L^2}$$

$$= M^{-1} L^{-3} T^4 A^2$$

## Permiability $\mu_0$

$$F = \frac{\mu_0}{4\pi}\frac{I^2 \ell}{d}$$

$\ell$ = length
$d$ = dist$^n$ b/w wire
$I$ = Current

$$\mu_0 = \frac{F}{I^2} = MLT^{-2}A^{-2}$$

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

$\Longrightarrow$ speed of light $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

$\mu_0$ : Permiability

$\varepsilon_0$ : permitivity

# DIMENSION LESS PHYSICAL QUANTITY

- **Angle/ Solid angle/ Strain**

  **Poisson's ratio, refractive index** ($\mu$)

  **Trigonometry formula/ exponential functions, relative permittivity,** $= \frac{\varepsilon_m}{\varepsilon_0}$

  **efficiency, ratio, pure no. specific gravity**, relative Permiability. efficiency

$$\mu = \frac{c}{v} = \text{dimensionless}$$

$$\text{Specific gravity} = \frac{\rho_m}{\rho_{water}}$$

$$\text{Strain} = \left(\frac{\Delta l}{l}\right) = \frac{\text{change in length}}{\text{length}}$$

Ratio of Wavelength = dimensionless

$$\sin\theta = \frac{P}{H} = \text{Dimn less.}$$

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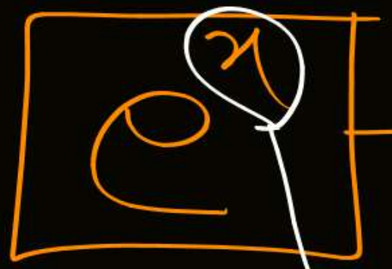
Pure no is dimⁿ less ✓

Sinθ / Cosθ / tanθ
(Angle)

→ dimⁿ less (मात्रक नहीं)




→ dimⁿ less

→ dimⁿ less (कुछ नहीं)


→ dimⁿ less

- **Pressure/ Energy density/ Bulk modulus/ Shear modulus/ Stress dimensions all have same**

Young modulus

this is given.

$$\text{Pressure} = M L^{-1} T^{-2}$$

$$\text{Stress} = \frac{\text{force}}{\text{Area}}$$

$$\text{Pressure} = \text{Stress} = Y \quad \text{(strain)}$$

$Y$ : dimⁿ less.

Young modulus

Modulus of elasitisity

Moment of Inertia = Moment of mass = $Md^2$
$= ML^2$.

- Angular momentum and Plank's constant have same dimensional formula $[ML^2T^{-1}]$ AIEEE / AIPMT / IIT / NEET / AIIMS.
- Electric field and potential gradient have same dimensional formula $[MLT^{-3}A^{-1}]$

$$E = \frac{V}{\ell} = \frac{\text{Potential}}{\text{Length}}$$

- Surface tension, surface energy, force gradient and spring constant have same dimensional formula $[ML^0T^{-2}]$
- Acceleration and gravitational field intensity have same dimensional formula $[M^0LT^{-2}]$

$$I = \frac{F}{m} = \text{acc}^n.$$

Torque = force x length

- Work, energy, moment of force or torque, moment of couple, kinetic energy, potential energy , heat energy ,mechanical energy $[ML^2T^{-2}]$
- Force constant, surface tension, spring constant, energy per unit area $[MT^{-2}]$
- Angular momentum, angular impulse, Planck's constant $[ML^{-2}T^{-1}]$
- Angular velocity, frequency, velocity gradient, decay constant, rate of disintegration $[T^{-1}]$
- Stress, pressure, modulus of elasticity, $[ML^{-1}T^{-2}]$

MR

| 2nd quadrant | Dimⁿ | A ?? | B ?? | P.Q does not have Dimⁿ | P.Q have Dimⁿ |
|---|---|---|---|---|---|
| 1st / 2nd | Unit | P.Q. does not have unit | P.Q have unit | C ?? | D ?? |


A → must not have dimⁿ
Ex - refractive Index

B → may or may not have dimⁿ
Ex - Angle

C → may or may not have Unit
Ex - Angle

D → must have Unit
Ex - Velocity

thanks
for watching