# UNITS AND DIMENSIONS

I$^{st}$

- Physical quantity → A physical quantity in physics that can be measured. e.g mass, length, time, temperature, force, velocity and many others

* Measurement of physical quantity = Numerical value X Unit

e.g ① Mass of a body = 10 X kg

10 → Numerical Value; kg → unit

② Length of a wall = 20 X m

20 → Numerical value; m → unit

- Physical quantities are further divided in to two types:-

① Fundamental physical quantities

② Derived physical quantities

## *Fundamental physical quantities →

Those physical quantities which donot depend upon any other quantity.

e.g → There are seven fundamental physical quantities.

| S.NO | Fundamental physical quantities | Fundamental Unit (Symbol) |
|---|---|---|
| 1. | Mass | Kilogram (kg) |
| 2. | Length | Meter (m) |
| 3. | Time | Second (s) |
| 4. | Temperature | kelvin (K) |
| 5. | Electric current | Ampere (A) |
| 6. | Luminous intensity | candela (cd) |
| 7. | Amount of substance | mole (mol) |

- Two supplementary fundamental physical quantities (in case of circular motion)

| SNO | Supplementary physical qnty | Supplementary Unit (Symbol) |
|---|---|---|
| 1. | Plane Angle | radian (rad) |
| 2. | Solid Angle | steradian (st) |

## (* *) Derived physical quantities →

The physical quantities which are deriv-ed from fundamental quantities and which depend upon them are defined as derived quantities.

e.g → Velocity, acceleration, area, force etc.

- Except this seven fundamental and two supplementary physical quantities all other quantity are fundamental quantity

- **Units** → The units of physical quantities are also of two types.
  ① Fundamental Unit ② Derived Units.

- **DIMENSIONS:** → Dimension of a physical quantity are the powers to which the fundamental units of mass, length, time etc must be raised in order to represent that physical quantity.

* Each fundamental unit is represented by a **capital letters** and it is enclosed in **capital brackets** i.e [M], [L], [T] etc.

Capital letters

Capital brackets

• Units and Dimensional formulae of physical quantities

| S.No | Physical quntity and its symbol | Dimensional formulae | SI Units | CGS Units |
|---|---|---|---|---|
| 1. | Length or distance (l) | $[M^0 L^1 T^0]$ | Meter (m) | Centimeter (cm) |
| 2. | Displacement (S) | $[M^0 L^1 T^0]$ | Meter (m) | Centimeter (cm) |
| 3. | Mass (m) | $[M^1 L^0 T^0]$ | kilogram (kg) | Gram (g) |
| 4. | Time (t) | $[M^0 L^0 T^1]$ | Second (s) | second (s) |
| 5. | Area (A) | → Length × breadth<br>→ $[L]^1 \times [L]^1 = [L]^{1+1}$<br>→ $[M^0 L^2 T^0]$ | meter² ($m^2$) | Centimeter² ($cm^2$) |
| 6. | Volume | → Length × breadth × height<br>→ $[L]^1 \times [L]^1 \times [L]^1$<br>→ $[L]^{1+1+1}$<br>→ $[M^0 L^3 T^0]$ | meter³ ($m^3$) | Centimeter³ ($cm^3$) |

| S.No | Physical quanty and its symbol | Dimensional formulae | S I Unit | CGS unit |
| --- | --- | --- | --- | --- |
| 7. | Velocity or Speed ($v$) → | $V = \frac{\text{Distance}(s)}{\text{Time}(t)}$ <br> $V = \frac{[L]^1}{[T]^1}$ <br> $= [L]^1[T]^{-1}$ <br> $= [M^0 L^1 T^{-1}]$ | $\frac{\text{meter}(m)}{\text{second}(s)}$ <br> $(m s^{-1})$ | $\frac{\text{Centimeter}(cm)}{\text{second}\ (s)}$ <br> $(cm\, s^{-1})$ |
| 8. | Acceleration (a) → | $a = \frac{\text{Velocity}(v)}{\text{Time}(t)}$ <br> $= \frac{\text{Distance/Time}}{\text{Time}}\ [\because v = \frac{s}{t}]$ <br> $= \frac{\text{Distance}}{\text{Time} \times \text{Time}} = \frac{[L]^1}{[T]^1 \times [T]^1}$ <br> $= \frac{[L]^1}{[T]^{1+1}} = [L]^1[T]^{-2}$ <br> $= [M^0 L^1 T^{-2}]$ | $\frac{\text{meter}}{(\text{second})^2}$ <br> $\Rightarrow \frac{m}{s^2}$ <br> $\Rightarrow m s^{-2}$ | $\frac{\text{centimeter}}{(\text{second})^2}$ <br> $\frac{cm}{s^2}$ <br> $cm\, s^{-2}$ |

| S.No | Physical quantity and its symbol | Dimensional formulae | SI unit | CGS unit |
|---|---|---|---|---|
| 9. | Momentum (P) | $P = \text{mass} \times \text{velocity}$ | $\frac{\text{Kilogram} \times \text{meter}}{\text{second}}$ | $\frac{\text{gram} \times \text{centimeter}}{\text{second}}$ |
| | | $\Rightarrow \text{mass} \times \frac{\text{Distance}}{\text{Time}}$ | | |
| | | $\Rightarrow \frac{[M]^1 \times [L]^1}{[T]^1}$ | $\frac{Kg \times m}{s}$ | $\frac{g \times cm}{s}$ |
| | | $= [M]^1 [L]^1 [T]^{-1}$ | $Kg\, m\, s^{-1}$ | $g\, cm\, s^{-1}$ |
| | | $= [M L T^{-1}]$ | | |
| 10. | Force (F) | $F = \text{mass} \times \text{Acceleration}$ | $\frac{\text{kilogram} \times \text{meter}}{(\text{second})^2}$ | $\frac{\text{Gram} \times \text{Centimeter}}{(\text{second})^2}$ |
| | | $\Rightarrow \frac{\text{mass} \times \text{Velocity}}{\text{Time}}$ | | |
| | | $\Rightarrow \frac{\text{mass} \times \text{Distance}/\text{Time}}{\text{Time}}$ | | |
| | | $\Rightarrow \frac{\text{mass} \times \text{Distance}}{\text{Time} \times \text{Time}}$ | $\frac{Kg \times m}{s^2}$ | $\frac{g \times cm}{s^2}$ |

| S.No | Physical qnty and its symbol | Dimensional formulae | SI Unit | CGS Unit |
|---|---|---|---|---|
| | | $\Rightarrow \frac{[M]^1 \times [L]^1}{[T]^1 \times [T]^1}$<br>$\Rightarrow \frac{[M]^1 [L]^1}{[T]^{1+1}} = \frac{[M]^1 [L]^1}{[T]^2}$<br>$\Rightarrow [M]^1 [L]^1 [T]^{-2}$<br>$\Rightarrow [M L T^{-2}]$. | $kg\,m\,s^{-2}$<br>Newton (N) | $g\,cm\,s^{-2}$<br>Dyne ~~(D)~~ (Dyn) |
| 11 | Impulse (I) | I = Force × time<br>= mass × acceleration × time<br>⇒ mass × $\frac{\text{Velocity}}{\text{Time}}$ × time<br>⇒ mass × $\frac{\text{Distance}}{\text{Time}}$<br>$\Rightarrow \frac{[M]^1 \times [L]^1}{[T]^1} = [M]^1 [L]^1 [T]^{-1}$<br>$= [M L T^{-1}]$ | Newton × second<br>N s<br>$kg\,m\,s^{-1}$ | Dyne × second<br>Dyn s<br>$g\,cm\,s^{-1}$ |

| S.No | Physical quantity with its symbol | Dimensional Formulae | SI Unit | CGS Unit |
|---|---|---|---|---|
| (12) | Weight (wt) | Mass x Acceleration due to gravity → m x g → $[MLT^{-2}]$ | Kilogram meter second$^{-2}$ — $\frac{kg\,m}{(s)^2}$ — $kg\,m\,s^{-2}$ — Newton (N) | gram centimeter second$^{-2}$ — $\frac{g\,cm}{(s)^2}$ — $g\,cm\,s^{-2}$ — Dyne (Dyn |
| (13) | Tension (T) | → $[MLT^{-2}]$ (Same as Force) | → Newton (N) $kg\,m\,s^{-2}$ | → Dyne (Dyn) $g\,cm\,s^{-2}$ |
| (14) | Thrust | → $[MLT^{-2}]$ ( " ) | → Newton (N) $kg\,m\,s^{-2}$ | → Dyne (Dyn) $g\,cm\,s^{-2}$ |
| (15) | Normal Reaction (N) | → $[MLT^{-2}]$ ( " ) | → Newton (N) $kg\,m\,s^{-2}$ | → Dyne (Dyn $g\,cm\,s^{-2}$ |
| (16) | Force constant | → $\frac{Force}{Extension} = \frac{[MLT^{-2}]}{[L]^1}$ → $[MLT^{-2}][L]^{-1} \Rightarrow [ML^{1-1}T^{-2}]$ → $[M.L^0T^{-2}]$ | → $\frac{Kilogram}{(second)^2}$ → $kg\,s^{-2}$ → $Nm^{-1}$ | → $\frac{gram}{(second)^2}$ → $g\,s^{-2}$ → ~~Dynam~~ Dyn $cm^{-1}$ |

| S.No | Physical quantity and its symbol | Dimensional formulae | S I Unit | C G S Unit |
|---|---|---|---|---|
| 17. | Work (W) | W = Force . Displacement $\Rightarrow [M^1 L^2 T^{-2}]$ | Newton . meter — N m — Joule | Dyne . centimeter — Dyn. cm — Erg |
| 18. | P Energy (E) | Capacity of doing work — $[M^1 L^2 T^{-2}]$ | Joule | Erg |
| 19. | Kinetic Energy ($E_K$) | $E_K = \frac{1}{2} mv^2$ — $[M^1 L^2 T^{-2}]$ | Joule | Erg |
| 20. | Potential Energy (U) | (i) $U = mgh$ <br> (ii) $U = \frac{1}{2} k x^2$ (P.E of a spring) (Elastic P.E) <br> (iii) $U = -\frac{GMm}{r}$ (Gravitational P.Energy) <br> (iv) $U = \pm k \frac{q_1 q_2}{r}$ (Electric P.E) <br> $\rightarrow [M^1 L^2 T^{-2}]$ | " <br> Joule <br> " | " <br> Erg <br> " |
| 21. | Pressure (P) | $P = \frac{Force}{Area}$ <br> $\rightarrow [M^1 L^{-1} T^{-2}]$ | $\frac{Newton}{meter^2} \Rightarrow Nm^{-2}$ <br> $\rightarrow$ Pascal (Pa) | $\frac{Dyne}{Centimeter^2} \Rightarrow \frac{Dyn}{cm^2}$ |

| No | Physical quantity with its symbol | Dimensional formulae | SI Unit | CGS Unit |
|---|---|---|---|---|
| 22. | Stress<br>→ Tensile stress ($\sigma$) or Linear "<br>→ shear stress ($\tau$)<br>→ volume stress | → The reactional force is generated in a body per unit area of cross-section as a result of deforming force applied on the body<br>→ $[M^1L^{-1}T^{-2}]$ $\left(\frac{\text{Force}}{\text{Area}}\right)$ | → $\frac{N}{m^2}$<br>→ $Nm^{-2}$<br>→ $kg\,m^{-1}s^{-2}$ | → $\frac{Dyn}{cm^2}$<br>→ $Dy\,cm^{-2}$<br>→ $g\,cm^{-1}s^{-2}$ |
| 23. | Modulus of Elasticity (E) | → $E = \frac{\text{stress}}{\text{strain}}$<br>→ $E = \frac{M^1L^{-1}T^{-2}}{\text{No dimension}}$<br>→ $[M^1L^{-1}T^{-2}]$ | → $\frac{Nm^{-2}}{\text{No unit}}$<br>→ $Nm^{-2}$<br>→ $kg\,m^{-1}s^{-2}$ | → $\frac{Dyn\,cm^{-2}}{\text{No unit}}$<br>→ $Dyn\,cm^{-2}$<br>→ $g\,cm^{-1}s^{-2}$ |
| 24. | Young's modulus of elasticity (E) | → (i) $Y = \frac{\text{Linear stress}}{\text{Linear strain}}$<br>(ii) $Y = \frac{MgL}{\pi r^2 l}$<br>→ $[M^1L^{-1}T^{-2}]$ | → $\frac{N}{m^2}$<br>→ $Nm^{-2}$<br>→ $kg\,m^{-1}s^{-2}$ | → $\frac{Dyne}{cm^2}$<br>→ $Dyne\,cm^{-2}$<br>→ $g\,cm^{-1}s^{-2}$ |

| S.No | Physical quantity and its symbol | Dimensional formulae | SI unit | CGS Unit |
|---|---|---|---|---|
| 25. | Bulk modulus of elasticity (k) | (i) $K = \frac{\text{Volume stress}}{\text{Volume strain}}$ | $N/m^2$ | $Dyne/cm^2$ |
| | | (ii) $K = \frac{PV}{v}$ | $Nm^{-2}$ | $Dyne\,cm^{-2}$ |
| | | → $[M^1L^{-1}T^{-2}]$ | → $kg\,m^{-1}s^{-2}$ | $g\,cm^{-1}s^{-2}$ |
| 26. | Modulus of rigidity ($\eta$) | (i) $\eta = \frac{\text{Shear stress}}{\text{Shear strain}}$ | $N/m^2$ | $\frac{Dyne}{cm^2}$ |
| | | (ii) $\eta = \frac{F}{A\phi}$ | $Nm^{-2}$ | $Dyne\,cm^{-2}$ |
| | | (iii) $[M^1L^{-1}T^{-2}]$ | $kg\,m^{-1}s^{-2}$ | $g\,cm^{-1}s^{-2}$ |
| 27 | Heat (Q) | Energy transffered on account of temperature difference; $M^1L^2T^{-2}$ (Same as work) | Joule; 1 Calorie ⇒ 4.186 Joule | ~~Ea~~ Erg |
| 28. | Internal Energy (U) and mechanical work has also | → The energy in a system on account of position and motion of molecules → $[M^1L^2T^{-2}]$ (Same as work | → Joule | → Erg |

| S.No | Physical quantity and its symbol | Dimensional formulae | SI Unit | CGS Unit |
| --- | --- | --- | --- | --- |
| 29. | Density (d) | $d = \frac{mass}{Volume} = \frac{[M]}{[L^3]}$ → $[M^1 L^3 T^0]$ | → $\frac{kg}{m^3}$ → $kg\,m^{-3}$ | → $\frac{gm}{cm^3}$ → $gm\,cm^{-3}$ |
| 30. | Angular Displacement (θ) | → $\theta = \frac{Arc}{radius} \Rightarrow \frac{[L]}{[L]}$ → $[M^0 L^0 T^0]$ → Dimensionless | → Radian (Rad.) | → Radian (Rad) |
| 31. | Angular Velocity (ω) | → $\omega = \frac{\theta}{t} \Rightarrow \frac{[M^0 L^0 T^0]}{[T]}$ → $[M^0 L^0 T^{-1}]$ → $[M^0 L^0 T^{-1}]$ | → $\frac{Radian}{second}$ | → $\frac{Radian}{second}$ |
| 32. | Angular acceleration (α) | → $\alpha = \frac{\omega}{t} \Rightarrow \frac{\theta/t}{t}$ $(\omega = \frac{\theta}{t})$ $= \frac{\theta}{t \times t} \Rightarrow \frac{\theta}{t^2} \Rightarrow \frac{[M^0 L^0 T^0]}{[T^2]}$ → $[M^0 L^0 T^{-2}]$ | $\frac{Radian}{(second)^2}$ → Radian $sec^{-2}$ → Rad $s^{-2}$ | → $\frac{Radian}{(second)^2}$ → Rad $s^{-2}$ |

| SNo | Physical quantity and its unit | Dimensional formulae | SI Unit | CGS Unit |
|---|---|---|---|---|
| 33. | Moment of Inertia (I) | → $I = mr^2$<br>→ $M^1L^2T^0$ | → kg $m^2$ | → gm $cm^2$ |
| 34. | Torque ($\tau$) | → (i) $\vec{\tau} = \vec{r} \times \vec{F}$<br>(ii) $\tau = I\alpha$<br>→ $M^1L^2T^{-2}$ | → Newton-meter<br>→ N-m<br>→ kg $m^2 s^{-2}$ | → Dyne-centimeter<br>→ Dyne-cm<br>→ $gcm^2 s^{-2}$ |
| 35. | Angular momentum (J) | → (i) $\vec{J} = \vec{r} \times \vec{p}$<br>(ii) $J = I\omega$<br>⇒ $M^1L^2T^{-1}$ | ⇒ Joule-sec<br>⇒ kg $m^2 s^{-1}$ | ⇒ Erg-sec<br>⇒ g $cm^2 s^{-1}$ |
| 36. | Kinetic Energy of rotation ($E_{rot}$) | → $E_{rot} = \frac{1}{2} I\omega^2$<br>→ $M^1L^2T^{-2}$<br>(same as torque) | → Joule<br>→ kg $m^2 s^{-2}$ | → Erg<br>→ $gcm^2 s^{-2}$ |
| 37. | Radius of gyration (k) | → $k = \sqrt{\frac{I}{M}} \Rightarrow \sqrt{\frac{ML^2T^0}{M}}$<br>→ $M^0L^1T^0$ | ⇒ Meter<br>⇒ m | ⇒ centimeter<br>⇒ cm |

| S.No | Physical quantity and its symbol | Dimensional formulae | SI Unit | CGS Unit |
|---|---|---|---|---|
| 38. | Time period (T) | Time taken by a particle in completing one osillation<br>$T = 2\pi\sqrt{\frac{m}{K}}$<br>$\rightarrow [M^0 L^0 T^1]$ | → Second | → Second |
| 39. | Gravitational Constant | $\rightarrow F = \frac{Gm^2}{r^2}$<br>$G = \frac{Fr^2}{m^2}$<br>$\rightarrow \frac{[M^1 L^1 T^{-2}][L^2]}{[M]^2}$<br>$\rightarrow \frac{[M^1 L^{1+2} T^{-2}]}{[M]^2}$<br>$\rightarrow [M^1 L^3 T^{-2}][M]^{-2}$<br>$\rightarrow [M^{1-2} L^3 T^{-2}]$<br>$\rightarrow [M^{-1} L^3 T^{-2}]$ | → $\frac{\text{Newton meter}^2}{(\text{Kilogram})^2}$<br>→ $N m^2 kg^{-2}$<br>→ $kg^{-1} m^3 s^{-2}$ | → $\frac{\text{Dyne centimeter}^2}{\text{gram}^2}$<br>→ $Dyn\ cm^2 g^{-2}$<br>→ $g^{-1} cm^3 s^{-2}$ |

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| S.No | Physical quantity and its symbol | Dimensional formulae | SI Unit | CGS Unit |
|---|---|---|---|---|
| 40 | Acceleration due to gravity (g) | (i) $g = \frac{Weight}{mass} = \frac{Wt}{m}$ | $\rightarrow \frac{meter}{second^2}$ | $\rightarrow \frac{centimeter}{second^2}$ |
| | | (ii) $g = \frac{GM}{R^2}$ | $\rightarrow \frac{kg^{-1} m^3 s^{-2} \times kg}{m^2}$ | |
| | | | $\rightarrow m s^{-2}$ | $\rightarrow cm\, s^{-2}$ |
| | | $\rightarrow M^0 L^1 T^{-2}$ | | |
| | | | $\rightarrow m\, s^{-2}$ | $\rightarrow cm\, s^{-2}$ |
| 41. | Intensity of gravitational field (Eg) | $\rightarrow E_g = -\frac{GM}{r^2}$ | $\rightarrow \frac{N}{kg}$ | $\rightarrow$ Dyne/gm |
| | | $\rightarrow M^0 L^1 T^{-2}$ | $\rightarrow N kg^{-1}$ | Dyne $gm^{-1}$ |
| 42. | Gravitational potential (Vg) | $\rightarrow V_g = -\frac{GM}{r}$ | $\rightarrow \frac{Joule}{kg}$ | $\rightarrow \frac{Erg}{gm}$ |
| | | $\rightarrow M^0 L^2 T^{-2}$ | $\rightarrow m^2 s^{-2}$ | $gcm^2 s^{-2}$ |
| | | | $\rightarrow J\, kg^{-1}$ | $\rightarrow Erg\, gm^{-1}$ |
| 43. | Orbital velocity ($V_s$) | $\Rightarrow V_s = \sqrt{\frac{GM}{r}} \Rightarrow R\sqrt{\frac{g}{R+h}}$ | $\Rightarrow \frac{m}{s}$ | $\Rightarrow \frac{cm}{s}$ |
| | Same for Escape Velocity ($V_e$) | $\Rightarrow [M^0 L^1 T^{-1}]$ | $\Rightarrow m s^{-1}$ | $\Rightarrow cm\, s^{-1}$ |
| | | $\Rightarrow V_e = \sqrt{\frac{GM}{r}} \simeq \sqrt{2Rg}$ | | |

| No. | Physical quantity and its symbol | Dimensional formulae | S I Unit | C G S Unit |
|---|---|---|---|---|
| 44. | Planck's constant (h) | → $h = \frac{\text{Energy}}{\text{frequency}}$<br>→ $[M^1 L^2 T^{-1}]$ | → Joule-s<br>→ $kg\ m^2 s^{-1}$ | → Erg-s<br>→ $gm cm s^{-1}$ |
| 45. | Energy flux ($\phi$) | ⇒ $[M^1 L^0 T^{-3}]$ | ⇒ Joulse $s^{-1} m^{-2}$ | ⇒ Erg $s^{-1} cm^{-2}$ |
| 46. | Poynting vector (S) | → $\vec{S} = \vec{E} \times \vec{H}$<br>$[M^1 L^0 T^{-3}]$ | → Joule $s^{-1} m^{-2}$<br>→ ~~kgm~~ $kg\ s^{-3}$ | → Erg $s^{-1} cm^{-2}$<br>→ $gm\ s^{-3}$ |
| 47. | Latent Heat (L) | → $Q = mL$<br>$L = \frac{Q(\text{heat energy})}{m(\text{mass}}$<br>$[M^0 L^2 T^{-2}]$ | → $J\ kg^{-1}$<br>→ $m^2 s^{-2}$ | → Erg $gm^{-1}$<br>→ $cm^2 s^{-2}$ |
| 48 | Specific heat (S) | ⇒ $Q = ms\theta$<br>$S = \frac{Q(\text{heat energy})}{m(\text{mass}) \times \theta(\text{temp})}$<br>$= \frac{[ML^2T^{-2}]}{[M][K]}$<br>$= [M^0 L^2 T^{-2} K^{-1}]$ | ⇒ $J\ kg^{-1} K^{-1}$<br>→ $m^2 s^{-2} K^{-1}$ | ⇒ Erg $gm^{-1} K^{-1}$<br>→ $cm^2 s^{-2} K^{-1}$ |

| S.No | Physical quantity and its Unit | Dimensional formulae | SI Unit | CGS Unit |
| --- | --- | --- | --- | --- |
| 49. | Boltzmann Constant (k) | $k = \frac{\text{Molar Gas Constant}}{\text{Avogadro's number}}$ $\Rightarrow [M L^2 T^{-2} k^{-1}]$ | $J k^{-1}$ $\Rightarrow kg\, m^2 s^{-2} k^{-1}$ | $\Rightarrow Erg\, k^{-1}$ $\Rightarrow gm\, cm^2 s^{-2} k^{-1}$ |
| 50. | Coefficient of thermal conductivity (k) | $\rightarrow Q = \frac{kA(\theta_1 - \theta_2)t}{d}$ $k = \frac{Qd}{A(\theta_1-\theta_2)t}$ $\rightarrow = \frac{[ML^2T^{-2}]}{[L][K][T]} \Rightarrow [ML^2T^{-2}][L]^{-1}[k]^{-1}[T]^{-1}$ $\rightarrow [M L^{2-1} T^{-2-1} k^{-1}]$ $\rightarrow [M L T^{-3} k^{-1}]$ | $\Rightarrow W m^{-1} k^{-1}$ (W → watt) $\Rightarrow kg\, m s^{-3} k^{-1}$ | $\Rightarrow g\, cm s^{-3} k^{-1}$ |
| 51. | Intensity of illumination | $\rightarrow \frac{\text{luminous intensity}}{\text{distance}}$ $\rightarrow \frac{[cd]}{[L^2]}$ $\rightarrow [M^0 L^{-2} T^0 cd]$ | $\rightarrow m^{-2} cd$ | $\rightarrow cm^{-2} cd$ |

| S.NO | Physical quantity and its unit | Dimensional formula | SI Unit | CGS Unit |
|---|---|---|---|---|
| 52 | Current (I) | $[M^0 L^0 T^0 A]$ | Ampere | Stat-Ampere |
| 53 | Charge (q) → | $I = q/t$<br>$q \rightarrow I \times t$<br>→ $[M^0 L^0 T^1 A]$ | → Ampere-second<br>→ A S (Coulomb 'C') | → Stat-Ampere' second' |
| 54 | Electric potential (V) ⇒ | $V = \frac{\text{Workdone}}{\text{Charge}}$<br>⇒ $[M L^2 T^{-3} A^{-1}]$ | → Volt<br>→ $J C^{-1}$<br>→ $kg\, m^2 s^{-3} A^{-1}$ | → Stat volt<br>→ $Erg\, C^{-1}$<br>→ $gm\, cm^2 s^{-3} A^{-1}$ |
| 55. | Capacitance (C) → or Electric Capacity (C) → | $\frac{\text{charge}}{\text{Potential difference}}$<br>$\frac{[AT]}{[M L^2 T^{-3} A^{-1}]}$<br>→ $[M^{-1} L^{-2} T^4 A^2]$ | → farad (F)<br>→ $kg^{-1} m^{-2} s^4 A^2$ | → stat-farad<br>→ $gm^{-1} cm^{-2} s^4 A^2$ |
| 56. | Resistance (R) ⇒ | $[M L^2 T^{-3} A^{-2}]$ | ⇒ ohm ($\Omega$) | ⇒ Stat-ohm |

| S.No | Physical quantity and its Unit | Dimensional formulae | SI Unit | CGS Unit |
|---|---|---|---|---|
| 57 | Relative Density (RD) | → RD = Density of body / Density of water at 4°C → $[M^0L^0T^0]$ → Dimensionless | Unitless | Unitless |
| 58 | Strain | → Change in configuration / Original configuration → $[M^0L^0T^0]$ | → Unitless | → Unitless |
| 59. | T-ratio (sinθ, cosθ, etc) | ⇒ length/Length $[M^0L^0T^0]$ | → No units | → " |
| 60. | Possion Radio (σ) | → Dimensionless $[M^0L^0T^0]$ | → " | " |
| 61. | Limit of resolution of a telescope (dθ) | → $d\theta = \frac{1.22\lambda}{a}$ $[M^0L^0T^0]$ | → " | " |
| 62. | Relative permitivity ($\mu_r$) | → $\mu_r = \mu/\mu_0$ $[M^0L^0T^0]$ | → " | " |
| 63. | Form factor (f) or power factor cos(φ) or Quality factor | → Dimensionless $[M^0L^0T^0]$ | → " | " |

# Questions for Practice

Qs:1 The modulus of elasticity is dimensionally equivalent to.

(a) Stress (b) Surface tension

(c) Strain (d) Coefficient of viscosity

Ans (a) Stress has the same dimensions as those of modulus of elasticity $ML^{-1}T^{-2}$

Qs:2 If the unit of length, mass and time each be doubled, the unit of work is increased by

Ans (a) 2 times (b) 6 times

(c) 4 times (d) 8 times

Soln (a) workdone $W = ML^2T^{-2}$

If the unit of M, L, T is doubled,

therefore $W = (2M)(2L)^2(2T)^{-2}$

$= 2(W)$

Unit of work increases 2 times

Qs:3 $[M^1L^2T^{-3}]$ are the dimensions of

(a) work (b) power

(c) energy (d) angular momentum

Soln (b) Power $= \frac{\text{Work}}{\text{Time}} \Rightarrow \frac{\text{Force} \cdot \text{displacement}}{\text{time}}$

$= \frac{[MLT^{-2}L]}{[T]} = [M^1L^2T^{-3}]$

Qs:-4 The physical quantity which has dimensional formula as that of $\frac{Energy}{mass \times length}$ is

(a) Force (b) power

(c) Pressure (d) Acceleration

Solⁿ (d) acceleration

$$\frac{energy}{mass \times length} = \frac{[ML^2T^{-2}]}{[M][L]} = [LT^{-2}]$$

Qs÷5 Which pairs does not have similar dimensions?

(a) work and energy (b) Pressure and stress

(c) Force and impulse (d) velocity and speed

Solⁿ (C) Force and Impulse

$$F = [MLT^{-2}] \; ; \; I = [MLT^{-1}]$$

Qs.6 If frequency $n = cm^x k^y$ for a spring then the value of x and y are

(a) $x = \frac{1}{2}$, $y = \frac{1}{2}$ (b) $x = -\frac{1}{2}$, $y = +\frac{1}{2}$

(c) $x = \frac{1}{2}$, $y = \frac{1}{3}$ (d) $x = \frac{1}{2}$, $y = -\frac{1}{2}$

Solⁿ (b) For a spring $n = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \Rightarrow \frac{1}{2\pi} k^{1/2} m^{-1/2}$

Compare it with $= cm^x k^y$

$\therefore x = \frac{-1}{2}$ $y = +\frac{1}{2}$

(7) The unit of Planck's constant h is that of-

(a) energy (b) work

(c) linear momentum (d) angular momentum

Sol^n (d) angular momentum

$$L = \frac{nh}{2\pi}$$

(8) The Poiseuille is the unit of

(a) pressure (b) friction

(c) surface tension (d) viscosity

Sol^n (d) Poiseuille is the CGS unit of viscosity.

(9) Which of the following quantities is dimensionless -

(a) Gravitational constant (b) Planck's constant

(c) power of a convex lens (d) Gas constant

Sol^n (C) power of a convex lens.

(10) The dimensional formula for Boltzmann's constant is -

(a) $[ML^2T^{-2}\theta^{-1}]$ (b) $[ML^2T^{-2}]$

(c) $[ML^0T^{-2}\theta^{-1}]$ (d) $[ML^2T^{-1}\theta^{-1}]$

Sol^n (a) $[ML^2T^{-2}\theta^{-1}]$

$$E = KT$$

$$K = \frac{E}{T} = \frac{[ML^2T^{-2}]}{[\theta]} \rightarrow [M^1L^2T^{-2}\theta^{-1}]$$

(11) Length can not be measured ...

(a) fermi (b) micron

(c) debye (d) light year

Sol^n (c) Debye is the unit of dipole moment and not of length.

Qs:-12 What are the dimensions of $k = \frac{1}{4\pi\varepsilon_0}$?

(a) $C^2N^{-1}m^{-2}$ (b) $Nm^2C^{-2}$

(c) $Nm^2C^2$ (d) Unitless

Ans (b) $Nm^2C^{-2}$

$\because f = \frac{kq^2}{r^2}$, $k = \frac{fr^2}{q^2} \Rightarrow \frac{N\text{-}m^2}{C^2}$

Q:-13 If M = mass, L = length, T = time and I = electric current then the dimensional formula for electrical resistance R is given by

(a) $[R] = [M^1L^2T^{-3}I^{-2}]$ (b) $[R] = [M^1L^2T^{-3}I^2]$

(c) $[R] = [M^1L^2T^3I^{-2}]$ (d) $[R] = [M^1L^2T^3I^2]$

(e) $[R] = [M^{-1}L^2T^{-3}I^{-2}]$

Sol^n (a) $[R] = [M^1L^2T^{-3}I^{-2}]$

$R = \frac{V}{I} = \frac{W}{qI} = \frac{Fd}{I^2t} \Rightarrow \frac{MLT^{-2}L}{I^2t}$

$= [ML^2T^{-3}I^{-2}]$