

## Unit -1



### Chapter -1

## Units & Measurement

- \* Need of Measurement
- \* Units of Measurement
- \* System of Units
- \* S.I Units
- \* Fundamental & Derived Units
- \* Significant figures
- \* Dimension of Physical Quantities
- \* Dimensional Analysis
- \* & its Applications





## Need of Measurement

HAPPY EVER AFTER

- Measurement makes Communication easier.
- By Measuring Physical Quantity We can define property of material
- We can measure mass, weight & different physical properties like distance, speed, force & Energy etc.
- Measurement is the system by which we can compare the physical quantity with a Unit.

## Physical Quantities

HAPPY EVER AFTER

Physical Quantities are those by which laws of Physics can be expressed Easily.

For eg: Temperature, Speed, electric current etc.

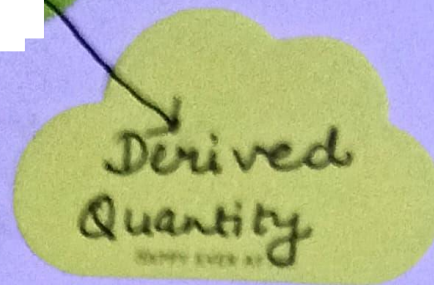
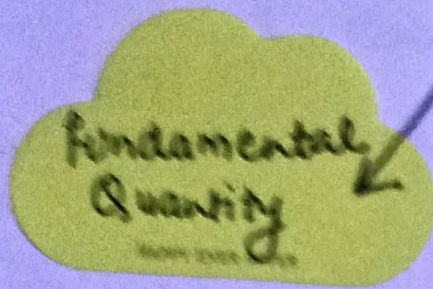
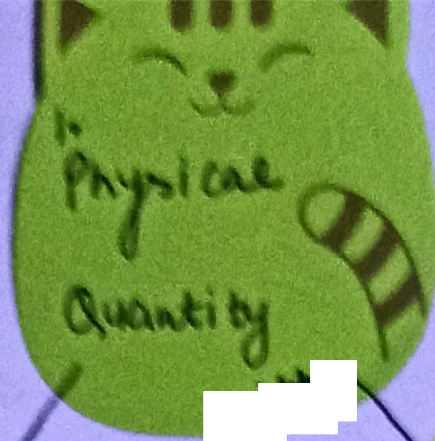
### Types of Physical Quantities

Physical Quantities are of two types

1. Fundamental Quantities
2. Derived Quantities







- Fundamental Quantities are those which are not dependant on other physical Quantities

- Seven fundamental & Base Quantities are

1. Mass
2. length
3. Time
4. Electric current
5. Temperature
6. Luminous Intensity
7. Amount of Substance

- Derived Quantities are those which are dependant on fundamental Quantities.

- All Physical Quantities other than 7 fundamental Quantities are known as Derived Quantities.

For eg: Velocity  
Density  
Momentum  
Power etc.

What do you mean by Measurement of a Physical Quantity?

- Measurement of a Physical Quantity is the process of comparing this Quantity with a standard Amount of Physical quantity.





Measurement of Physical Quantity = Numerical value of Physical Quantity  $\times$  Size of Unit

$$\Rightarrow Q = nu$$

Where  $n$  = numerical value

$U$  = Unit of Physical Quantity

$$Q = n_1 u_1 = n_2 u_2$$

Let length of a Table

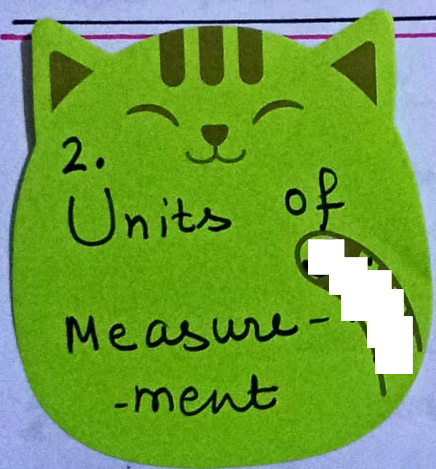
$$\Rightarrow 5m = 500cm$$

$$\text{if } u_1 > u_2$$

$$\Rightarrow n_1 < n_2$$

• This means smaller the size of Unit, larger will be numerical value.

$$n \propto \frac{1}{u} \quad \text{or} \quad nu = \text{Constant}$$



**Ques: What are fundamental & Derived Units? Give Some Examples.**

• Fundamental Units - fundamental Units are simpler Units which can't be further resolved into simpler Units.  
foreg: Units of fundamental Quantities such as





Mass, length & time are known as fundamental Units

**Derived Units** - All other physical Unit other than fundamental Units which can be expressed in terms of fundamental Unit are known as derived Units.

for eg! Unit of speed =  $\frac{\text{metre}}{\text{second}}$  is a derived Unit which is expressed in the terms of fundamental Units of length & time.

**Q. What is a System of Units? Mention the various types of system of Units.**

A. A complete set of Units which is used to measure all kinds of fundamental & derived quantities is known as system of Units.

1. **cgs system**: It is based on centimetre, gram & second as fundamental Units of mass, length & time respectively.

2. **fps system**: It is based on foot, pound & second as fundamental Unit of length, mass & time respectively.

3. **mks system**: It is based on metre, kilogram & second as fundamental Units of length, mass & time respectively.



4. SI: The International System of Units: It is based on seven basic Units & two supplementary Units.

### Basic S.I quantities & Units

| Basic Physical quantity | Basic Unit | Symbol |
|-------------------------|------------|--------|
| 1. length               | metre      | m      |
| 2. Mass                 | Kilogram   | kg     |
| 3. Time                 | second     | s      |
| 4. Electric Current     | ampere     | A      |
| 5. Temperature          | Kelvin     | K      |
| 6. Luminous Intensity   | Candela    | cd     |
| 7. Quantity of Matter   | mole       | mol    |

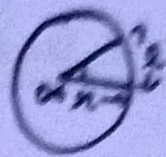
### Supplementary S.I Units

| Supplementary quantity | Basic Unit | Symbol |
|------------------------|------------|--------|
| 1. Plane Angle         | radian     | rad    |
| 2. Solid Angle         | steradian  | sr     |



(a) Radian (rad) - It is plane angle subtended at centre of a circle by an arc equal to its length to the radius of the circle.

$$\theta \text{ in radian} = \frac{\text{Arc}}{\text{Radius}} = \frac{l}{r}$$



(b) Steradian (sr) : It is solid angle subtended at centre of a sphere by surface of a sphere.

$$\Omega \text{ (in Steradian)} = \frac{\text{Surface Area}}{(\text{radius})^2}$$

## Advantages of S.I System

(i) S.I is a coherent system of Units All derived units can be obtained by simple multiplication or division of fundamental units without introducing any numerical factor.

(ii) S.I is a national system of Units It assigns only one unit for a given physical quantity. For example all forms of Energy<sup>in S.I</sup> are measured in joule & in mks system mechanical energy is measured in joule, heat energy in Calorie & Electrical energy in Kilowatt hour.

(iii) S.I is a metric System Multiples & Submultiples of S.I units can be expressed as power of 10.



iv) S.I is an Absolute System of Units

It does not use gravitational units.

vi) S.I is An Internationally accepted System of Units.

Q. What do you mean by dimensions of Physical Quantity? Explain with the help of an example.

A. Dimensions of a Physical quantity are the powers to which the fundamental quantities must be raised to represent that quantity completely.

for example  $\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{\text{Mass}}{L \times B \times H}$

$$\text{Dimensions of density} = \frac{[M]}{[L][L][L]} = [M^1 L^{-3} T^0]$$

\* Dimension of density are 1 in mass  
-3 in length  
0 in Time.

Q. What do you mean by dimensional formula & dimensional equation? Give examples.

Expression which shows how & which of the fundamental quantities represent the dimensions of a physical quantity is known as dimensional formula of the given physical quantity.





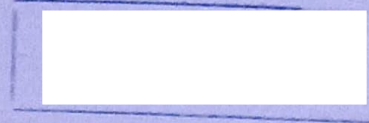
Examples: Dimensional formula of velocity is  $[M^0 L^1 T^{-1}]$   
& that of work is  $[M^1 L^2 T^{-2}]$ .

### Dimensional equation

Equation obtained by

Equating a physical quantity with its  
dimensional formula is known as

Dimensional equation



Example:

Dimensional equation of force is Force  $= [M^1 L^1 T^{-2}]$





# Dimensional formulae & S.I Units

## Mechanical Quantities

| S. No. | Physical Quantity                    | Relation with other Quantities                                                   | Dimensional Formula                                                            | S.I Unit            |
|--------|--------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------|---------------------|
| 1.     | Area                                 | $L \times B$                                                                     | $L \times L = [M^0 L^2 T^0]$                                                   | $m^2$               |
| 2.     | Volume                               | $L \times B \times H$                                                            | $L \times L \times L = [M^0 L^3 T^0]$                                          | $m^3$               |
| 3.     | Density                              | $\frac{\text{Mass}}{\text{Volume}}$                                              | $\frac{M}{L^3} = [M^1 L^{-3} T^0]$                                             | $kg\ m^{-3}$        |
| 4.     | Relative Density OR Specific gravity | $\frac{\text{Density of object}}{\text{Density of water}}$                       | $\frac{[M^1 L^{-3} T^0]}{[M^1 L^{-3} T^0]} = [M^0 L^0 T^0]$<br>* Dimensionless | Unitless            |
| 5.     | Speed or velocity                    | $\frac{\text{Distance}}{\text{time}}$                                            | $\frac{L}{T} = [M^0 L^1 T^{-1}]$                                               | $ms^{-1}$           |
| 6.     | Acceleration OR Acc. due to gravity  | $\frac{\text{change in velocity}}{\text{time}}$                                  | $\frac{L T^{-1}}{T} = [M^0 L^1 T^{-2}]$                                        | $ms^{-2}$           |
| 7.     | Momentum                             | Mass $\times$ Velocity                                                           | $M \times [L^1 T^{-1}] = [M^1 L^1 T^{-1}]$                                     | $kg\ ms^{-1}$       |
| 8.     | Force                                | Mass $\times$ Acceleration                                                       | $M \times L T^{-2} = [M^1 L^1 T^{-2}]$                                         | $N$                 |
| 9.     | Work                                 | Force $\times$ distance                                                          | $M^1 L^1 T^{-2} \times L = [M^1 L^2 T^{-2}]$                                   | $J$                 |
| 10.    | Energy                               | Amount of work                                                                   | $[M^1 L^2 T^{-2}]$                                                             | $J$                 |
| 11.    | Power                                | $\frac{\text{Work}}{\text{Time}}$                                                | $\frac{M^1 L^2 T^{-2}}{T} = [M^1 L^2 T^{-3}]$                                  | $W$                 |
| 12.    | Pressure                             | $\frac{\text{Force}}{\text{Area}}$                                               | $\frac{M^1 L^1 T^{-2}}{L^2} = [M^1 L^{-1} T^{-2}]$                             | $Pa$ or $N\ m^{-2}$ |
| 13.    | Moment of force OR Torque ( $\tau$ ) | Force $\times$ $\perp$ distance                                                  | $M^1 L^1 T^{-2} \times L = [M^1 L^2 T^{-2}]$                                   | $N\ m$              |
| 14.    | Gravitational constant 'G'           | $\frac{\text{Force} \times (\text{distance})^2}{\text{Mass} \times \text{Mass}}$ | $\frac{M^1 L^1 T^{-2} \times L^2}{M^2} = [M^{-1} L^3 T^{-2}]$                  | $N\ m^2\ kg^{-2}$   |
| 15.    | Impulse                              | Force $\times$ time                                                              | $M^1 L^1 T^{-2} \times T = [M^1 L^1 T^{-1}]$                                   | $N\ s$              |





| S. No | Physical Quantity                                             | Relation with other Quantities                                               | Dimensional Formula                                               | S.I Unit                    |
|-------|---------------------------------------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------|-----------------------------|
| 16.   | Stress                                                        | $\frac{\text{Force}}{\text{Area}}$                                           | $\frac{M^1 L^1 T^{-2}}{L^2} = [M^1 L^{-1} T^{-2}]$                | $N \cdot m^{-2}$            |
| 17.   | Strain                                                        | $\frac{\text{Change in dimension}}{\text{Original dimension}}$               | $[M^0 L^0 T^0]$<br>Dimensionless                                  | Unitless                    |
| 18.   | Coeff. of Elasticity                                          | $\frac{\text{Stress}}{\text{Strain}}$                                        | $\frac{[M^1 L^{-1} T^{-2}]}{[M^0 L^0 T^0]} = [M^1 L^{-1} T^{-2}]$ | $N \cdot m^{-2}$            |
| 19.   | Surface Tension                                               | $\frac{\text{Force}}{\text{length}}$                                         | $\frac{[M^1 L^1 T^{-2}]}{[M^0 L^1 T^0]} = [M^1 L^0 T^{-2}]$       | $N \cdot m^{-1}$            |
| 20.   | Surface Energy                                                | $\frac{\text{Work}}{\text{Area}}$                                            | $\frac{[M^1 L^2 T^{-2}]}{L^2} = [M^1 L^0 T^{-2}]$                 | $J \cdot m^{-2}$            |
| 21.   | Angle                                                         | $\frac{\text{Arc}}{\text{Radius}}$                                           | $\frac{L}{L} = [M^0 L^0 T^0]$<br>Unitless                         | rad                         |
| 22.   | Angular Velocity ( $\omega$ )                                 | $\omega = \frac{\theta}{t} = \frac{\text{Angle}}{\text{Time}}$               | $\frac{1}{T} = [M^0 L^0 T^{-1}]$                                  | $\text{rad s}^{-1}$         |
| 23.   | Ang. Acceleration                                             | $\alpha = \frac{\text{Ang. Velocity}}{\text{Time}}$                          | $\frac{T^{-1}}{T} = T^{-2} = [M^0 L^0 T^{-2}]$                    | $\text{rad s}^{-2}$         |
| 24.   | Mom. of Inertia                                               | $\text{Mass} \times (\text{distance})^2$                                     | $[M^1 L^2 T^0]$                                                   | $kg \cdot m^2$              |
| 25.   | Radius of gyration                                            | Distance                                                                     | $L = [M^0 L^1 T^0]$                                               | m                           |
| 26.   | Ang. Momentum<br>L                                            | $L = m v r$<br>$L = \text{mass} \times \text{velocity} \times \text{radius}$ | $M \times L^1 T^{-1} \times L = [M^1 L^2 T^{-1}]$                 | $kg \cdot m^2 \cdot s^{-1}$ |
| 27.   | T-ratios<br>( $\sin \theta$ , $\cos \theta$ , $\tan \theta$ ) | $\frac{\text{length}}{\text{length}}$                                        | $[M^0 L^0 T^0]$ Dimensionless                                     | —                           |
| 28.   | Time period                                                   | Time                                                                         | $[M^0 L^0 T^1]$                                                   | s                           |



| S. No              | Physical Quantity        | Relation with other Quantities                                                            | Dimensional Formula                                                              | S.I Unit             |
|--------------------|--------------------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|----------------------|
| 29.                | Coefficient of Viscosity | $\frac{F \times r}{A \times \Delta v}$ = Force $\times$ distance / Area $\times$ velocity | $\frac{M^1 L^{-1} T^{-2} \times L}{L^2 \times L^1 T^{-1}} = [M^1 L^{-1} T^{-1}]$ | $N m^{-2} s$ or Pa s |
| 30.                | frequency                | $\frac{1}{\text{Time period}}$                                                            | $\frac{1}{T} = [M^0 L^0 T^{-1}]$                                                 | $s^{-1}$ or Hz       |
| 31.                | Planck's constant (h)    | $h = \frac{\text{Energy}}{\text{frequency}}$                                              | $\frac{M^1 L^2 T^{-2}}{T^{-1}} = [M^1 L^2 T^{-1}]$                               | J s                  |
| 32.                | Velocity gradient        | $\frac{\text{Velocity}}{\text{distance}}$                                                 | $\frac{[M^0 L^1 T^{-1}]}{[L]} = [M^0 L^0 T^{-1}]$                                | $s^{-1}$             |
| 33.                | Pressure gradient        | $\frac{\text{Pressure}}{\text{Distance}}$                                                 | $\frac{M^1 L^{-1} T^{-2}}{L} = [M^1 L^{-2} T^{-2}]$                              | $Pa\ m^{-1}$         |
| 34.                | Force Constant           | $\frac{\text{Force}}{\text{displacement}}$                                                | $\frac{M^1 L^1 T^{-2}}{L} = [M^1 L^0 T^{-2}]$                                    | $N m^{-1}$           |
| Thermal Quantities |                          |                                                                                           |                                                                                  |                      |
| 35.                | Heat or Enthalpy         | Energy                                                                                    | $[M^1 L^2 T^{-2}]$                                                               | J                    |
| 36.                | Specific heat            | $\frac{\text{Heat}}{\text{Mass} \times \text{Temp}}$                                      | $\frac{M^1 L^2 T^{-2}}{M \cdot K} = [M^0 L^2 T^{-2} K^{-1}]$                     | $J kg^{-1} K^{-1}$   |
| 37.                | Latent Heat              | $\frac{\text{Heat}}{\text{Mass}}$                                                         | $\frac{M^1 L^2 T^{-2}}{M} = [M^0 L^2 T^{-2}]$                                    | $J kg^{-1}$          |
| 38.                | Boltz man's Constant     | $\frac{\text{Energy}}{\text{Temperature}}$                                                | $\frac{M^1 L^2 T^{-2}}{K} = [M^1 L^2 T^{-2} K^{-1}]$                             | $J K^{-1}$           |



## Electrical Quantities

| S. No | Physical Quantity          | Relation with other Quantities                                        | Dimensional Formula                                                                                          | S.I. Unit           |
|-------|----------------------------|-----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|---------------------|
| 39.   | Electric Charge            | $q = I \times t = \text{Time} \times \text{Current}$                  | $[M^0 L^0 A T]$                                                                                              | C                   |
| 40.   | Electrical Potential V     | $V = \frac{W}{Q} = \frac{\text{Work}}{\text{Charge}}$                 | $\frac{M^1 L^2 T^{-2}}{A T} = [M^1 L^2 T^{-3} A^{-1}]$                                                       | V (volt)            |
| 41.   | Resistance                 | $\frac{\text{Potential difference}}{\text{Current}}$                  | $\frac{M^1 L^2 T^{-3} A^{-1}}{A} = [M^1 L^2 T^{-3} A^{-2}]$                                                  | $\Omega$ (ohm)      |
| 42.   | Capacitance                | $\frac{\text{Charge}}{\text{Pot. difference}} = \frac{q}{V}$          | $\frac{[A T]}{[M^1 L^2 T^{-3} A^{-1}]} = [M^{-1} L^{-2} T^4 A^2]$                                            | F (farad)           |
| 43.   | Inductance                 | $\frac{\text{EMF}}{\text{Current/time}} = \frac{\text{Voltage}}{I/t}$ | $\frac{M^1 L^2 T^{-3} A^{-1}}{A / T} = [M^1 L^2 T^{-2} A^{-2}]$                                              | H (henry)           |
| 44.   | Permittivity of free space | $\epsilon_0 = \frac{q_1 q_2}{F r^2}$                                  | $\frac{A T \cdot A T}{M^1 L^1 T^{-2} \times L^2} = \frac{A^2 T^2}{M^1 L^3 T^{-2}} = [M^{-1} L^{-3} T^4 A^2]$ | $C^2 N^{-1} m^{-2}$ |
| 45.   | Electric dipole moment     | $p = q \times 2l$                                                     | $A T \times L = [M^0 L^1 T^1 A^1]$                                                                           | Cm                  |



## Magnetic Quantities

| S.No | Physical Quantity | Relation with Other Quantities                          | Dimensional Formula                                             | S.I Units     |
|------|-------------------|---------------------------------------------------------|-----------------------------------------------------------------|---------------|
| 46.  | Magnetic field    | $B = \frac{F}{qV \sin \theta}$                          | $\frac{M^1 L^1 T^{-2}}{A T^1 T^{-1}} = M^1 L^0 T^{-2} A^{-1}$   | T (tesla)     |
| 47.  | Magnetic flux     | $\phi = B \cdot A$<br>Magnetic field Area               | $M^1 L^0 T^{-2} A^{-1} \times L^2$<br>$[M^1 L^2 T^{-2} A^{-1}]$ | Wb<br>(Weber) |
| 48.  | Magnetic Moment   | Current $\times$ Area                                   | $A \times L^2$<br>$[M^0 L^2 T^0 A^1]$                           | $A m^2$       |
| 49.  | Pole Strength     | $\frac{\text{Magnetic Moment}}{\text{Magnetic length}}$ | $\frac{A L^2}{L} = [M^0 L T^0 A^1]$                             | $A m$         |

## Abbreviations in Powers of ten

| Multiple  | Prefix | Symbol | Sub Multiple | Prefix | Symbol |
|-----------|--------|--------|--------------|--------|--------|
| $10^1$    | deca   | da     | $10^{-1}$    | deci°  | d      |
| $10^2$    | hecto  | h      | $10^{-2}$    | centi° | c      |
| $10^3$    | kilo   | k      | $10^{-3}$    | milli° | m      |
| $10^6$    | Mega   | M      | $10^{-6}$    | micro  | $\mu$  |
| $10^9$    | giga   | G      | $10^{-9}$    | nano   | n      |
| $10^{12}$ | tera   | T      | $10^{-12}$   | pico   | p      |
| $10^{15}$ | Peta   | P      | $10^{-15}$   | femto  | f      |
| $10^{18}$ | exa    | E      | $10^{-18}$   | atto   | a      |





# Four types of Dimensional Quantities

## 1. Dimensional Constants

Quantities whose values are constant & they possess dimensions.

for eg: Universal Gravitational Constant  $G$   
Planck's Constant  
Universal Gas Constant.

## 2. Dimensionless Constants

Quantities which are constants & dimensionless.

for eg: Pure number 1, 2, 3, ...  
Mathematical constants  $\pi$ ,  $e$  (exponential) etc

## 3. Dimensional Variables:

Quantities which are variable & they have dimensions.

for eg: Area, Volume, density etc.

## 4. Dimensionless Variables

Quantities whose values are variable & they do not have dimensions.

for eg: Angle, Specific gravity & strain



## Uses of Dimensional Equations: (Applications)

1. Conversion from one system to another
2. Checking the correctness of formulae
3. Derivation of formulae.

### Checking the correctness of formulae

To check correctness of formulae we use

### Principle of Homogeneity of dimensions

- According to this principle only that formula is correct in which dimensions of units on one side of relation are equal to their respective dimensions on other side.

Concept Used

### Q.1 Check the correctness of given formulae

1. de - Broglie wavelength  $\lambda = \frac{h}{mv}$

2. Escape velocity  $v = \sqrt{\frac{2GM}{R}}$

Sol. 1

$$\lambda = \frac{h}{mv}$$

$\lambda$  = Wavelength

$m$  = mass

$v$  = velocity

$$\lambda = [L]$$

$$h = [M^1 L^2 T^{-1}]$$

$$v = [M^0 L^1 T^{-1}]$$



L.H.S

$\lambda$

$[L]$

$[L]$

R.H.S

$\frac{h}{mv}$

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

$[L]$

L.H.S = R.H.S [Correct]

2.

$$V = \sqrt{\frac{2GM}{R}}$$

V = Velocity

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

G = Gravitational Constant

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

M = Mass

$= [M]$

R = Radius

$= [L]$

L.H.S

V

$[M^0 L^1 T^{-1}]$

R.H.S

$\sqrt{\frac{2GM}{R}}$

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

$\sqrt{L^2 T^{-2}} = L^1 T^{-1}$

L.H.S = R.H.S [Correct]



## Q.2 Check the correctness of $E = mc^2$

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

$m = \text{Mass} = [M^1]$

$c = \text{velocity of light} = [M^0 L^1 T^{-1}]$

L.H.S  
 $E = [M^1 L^2 T^{-2}]$

R.H.S  
 $mc^2 = [M^1][L^1 T^{-1}]^2$   
 $= [M^1 L^2 T^{-2}]$

L.H.S

= R.H.S [Correct]

## Q.3 Critical velocity ( $v$ ) of flow of a liquid through a pipe of radius ( $r$ ) is given by

$$v = \frac{\eta}{\rho r}$$

Where  $\rho$  is density &  $\eta$  is coefficient of viscosity

Check if the relation is correct dimensionally?

Sol.  $v = \text{velocity} = [M^0 L^1 T^{-1}]$

$r = \text{radius} = [M^0 L^1 T^0]$

$\eta = \text{coefficient of viscosity} = [M^1 L^{-1} T^{-1}]$

$\rho = \text{density} = [M^1 L^{-3} T^0]$

L.H.S  
Velocity  
 $[M^0 L^1 T^{-1}]$

R.H.S  
 $\frac{\eta}{\rho r} = \frac{[M^1 L^{-1} T^{-1}]}{[M^1 L^{-3}][L^1]}$   
 $= [M^0 L^1 T^{-1}]$





$$L.H.S = R.H.S \quad [\text{Correct}]$$

Q.4 Check the correctness of relation

$$h = \frac{2\sigma \cos \theta}{\pi^2 dg}$$

Sol.  $h = \text{height} = [M^0 L^1 T^0]$   
 $\sigma = \text{Surface Tension} = [M^1 L^0 T^{-2}]$   
 $\cos \theta = [M^0 L^0 T^0]$   
 $\pi = [M^0 L^1 T^0]$   
 $d = \text{density} = [M^1 L^{-3} T^0]$   
 $g = \text{Acc. due to gravity} = [M^0 L^1 T^{-2}]$

L.H.S  
 $[M^0 L^1 T^0]$

$$[M^0 L^1 T^0]$$

R.H.S  
 $\frac{2\sigma \cos \theta}{\pi^2 dg} = \frac{[M^1 L^0 T^{-2}]}{[L^2][M^1 L^{-3} T^0][M^0 L^1 T^{-2}]}$   
 $= [M^0 L^0 T^0]$

$$L.H.S \neq R.H.S \quad [\text{Incorrect}]$$

Q.5 Rate of flow ( $V$ ) of a liquid through a pipe of radius ( $r$ ) Under a pressure gradient ( $\frac{P}{L}$ ) is given by  $V = \frac{\pi P r^4}{8 \eta L}$

Where  $\eta$  is coefficient of viscosity. Check whether formula is correct or not?





$$V = \text{Rate of flow} = [M^0 L^3 T^{-1}]$$

$$\frac{\rho}{\ell} = \frac{M^1 L^{-1} T^{-2}}{L} = [M^1 L^{-2} T^{-2}]$$

$$\eta = [M^0 L^1 T^{-1}]$$

$$\eta = [M^1 L^{-1} T^{-1}]$$

L.H.S

V

$$[M^0 L^3 T^{-1}]$$

$$[M^0 L^3 T^{-1}]$$

R.H.S

$$\frac{\rho \eta^4}{\eta \ell}$$

$$\frac{[M^1 L^{-1} T^{-2}] [L^4]}{[M^1 L^{-1} T^{-1}] [L]}$$

$$[L^3 T^{-1}]$$

L.H.S = R.H.S [Correct]

Q.6 Find the dimensions of the quantity  $q$  from the expression:  $T = 2\pi \sqrt{\frac{m \ell^3}{3Yq}}$ , where  $T$  is time period of a bar of length  $\ell$ , mass  $m$  & Young's modulus  $Y$ .

Sol. Given expression  $T = 2\pi \sqrt{\frac{m \ell^3}{3Yq}}$

S.B.S

$$T^2 = 4\pi^2 \left( \frac{m \ell^3}{3Yq} \right)$$

$$q = \frac{4\pi^2 m \ell^3}{3Y T^2}$$



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

$$Q = [L^4] \quad \text{Answer}$$

Q.7 Check the correctness of relation

$$S_{nth} = u + \frac{a}{2}(2n-1)$$

Where

$S_{nth}$  = distance travelled in  $n^{\text{th}}$  second

$n$  = time

$a$  = Acceleration

$u$  = Initial velocity

Sol.  $S_{nth} = [L^1 T^{-1}]$

$$n = [M^0 L^0 T^1]$$

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

$$u = [M^0 L^1 T^{-1}]$$

L.H.S

$$[M^0 L^1 T^{-1}]$$

$$L^1 T^{-1}$$

R.H.S

$$u + \frac{a}{2}(2n-1)$$

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

$$= L^1 T^{-1} + L^1 T^{-1}$$

$$= L^1 T^{-1}$$

$$L.H.S = R.H.S \quad [\text{Correct}]$$





## Checking the Correctness of formulae:

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Try these Questions Yourself!

- Q.1. An Artificial Satellite of mass  $m$  is revolving in a circular orbit around a planet of  $M$  & radius  $R$ . if the radius of the orbit of the satellite be  $r$ , Justify by method of dimensions that time period of satellite is given by:

$$T = \frac{2\pi}{R} \sqrt{\frac{r^3}{g}}$$

- Q.2 Test dimensional Consistency of the following equations:

(i)  $V = u + at$       (ii)  $S = ut + \frac{1}{2}at^2$

(iii)  $V^2 - u^2 = 2as$

- Q.3. The viscous force ' $F$ ' acting on a small sphere of radius ' $r$ ' moving with velocity  $v$  through a liquid is given by  $F = 6\pi\eta rv$ .

Calculate dimensions of  $\eta$  (coefficient of viscosity)

- Q.4 Check the Correctness of relation of Time period of a Simple Pendulum

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

Where  $l$  = length

$g$  = acc. due to gravity





Q.8. Justify  $L+L=L$  &  $L-L=L$ .

Sol.  $L+L=L$  &  $L-L=L$  means  
 Only same type of physical quantities can be added & subtracted & again we will get same physical quantity.

for eg: distance can be added in distance only & we will get distance again.

Q.9 Pressure is defined as Momentum per Unit Volume. Is it true?

Sol. Pressure =  $\frac{\text{Force}}{\text{Area}} = \frac{M^1 L^1 T^{-2}}{L^2}$  .  $\frac{\text{Momentum}}{\text{Volume}}$

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

$$M^1 L^{-2} T^{-1}$$

So Answer is NO. It's Not true.



## Derivation of formulae:

Using Principle of Homogeneity we can derive formula of Physical quantity. Provided we know the factors on which the physical quantity depends.

For eg: Q.1 Derive an expression for time period ( $t$ ) of a simple pendulum which may depend upon: Mass, length of Pendulum & Acc. due to gravity.

Sol:

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

$$T = k m^a l^b g^c \quad \text{--- (1)}$$

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

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

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

According to Principle of Homogeneity

$$0 = a$$

$$\boxed{a=0}$$

$$0 = b + c$$

$$b = -c$$

$$b = -\left[-\frac{1}{2}\right]$$

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

$$1 = 0 - 2c$$

$$1 = -2c$$

$$\boxed{c = -\frac{1}{2}}$$

$$T = k m^0 l^{\frac{1}{2}} g^{-\frac{1}{2}}$$

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



Q.2 The velocity of transverse waves on a string may depend upon length ( $l$ ) of string

(ii) Tension  $T$  in the string

(iii) Mass per unit length of string

Derive the formula dimensionally.

$$v \propto l^a T^b m^c$$

$$v = k l^a T^b m^c \quad \text{--- (1)}$$

$$v = [M^0 L^1 T^{-1}] \quad l = [M^0 L^1 T^0] \quad T = [M^1 L^1 T^{-2}]$$

$$m = \text{mass per unit length} = [M^1 L^{-1} T^0]$$

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

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

Compare L.H.S & R.H.S

$$0 = b + c$$

$$\boxed{b = -c}$$

$$c = -b$$

$$\boxed{c = -\frac{1}{2}}$$

$$1 = a + b - c$$

$$1 = a - c - c$$

$$1 = a - 2c$$

$$1 = a - 2\left(-\frac{1}{2}\right)$$

$$1 = a + 1$$

$$\boxed{a = 0}$$

$$-1 = -2b$$

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

Put all these values in eq<sup>n</sup> (1)

$$v = k l^0 T^{1/2} m^{-1/2}$$

$$\boxed{v = k \sqrt{\frac{T}{m}}}$$



Q.3 Reynold number  $N_R$  (a dimensionless quantity) determines the condition of laminar flow of a viscous liquid through a pipe.  $N_R$  is a function of the density of the liquid ' $\rho$ ', its average speed ' $v$ ' and coefficient of viscosity ' $\eta$ '.  
Given that  $N_R$  is also directly proportional to ' $D$ ' (the diameter of pipe), show from dimensional considerations that  $N_R \propto \frac{\rho v D}{\eta}$ .

Sol.  $K$  = a dimensionless constant

$$N_R = 1 = [M^0 L^0 T^0] \quad N_R \propto \rho^a v^b \eta^c D^1$$

$$\rho = [M^1 L^{-3} T^0] \quad N_R = K \rho^a v^b \eta^c D^1 \quad \text{--- (1)}$$

$$v = [M^0 L^1 T^{-1}]$$

$$\eta = [M^1 L^{-1} T^{-1}]$$

$$D = [L]$$

$$[M^0 L^0 T^0] = K [M^1 L^{-3} T^0]^a [M^0 L^1 T^{-1}]^b [M^1 L^{-1} T^{-1}]^c [L]^1$$

$$[M^0 L^0 T^0] = K [M^{a+0+c} L^{-3a+b-c+1} T^{-b-c}]$$

Equating the Powers of M, L & T we get

$$\begin{aligned} a+c &= 0 \\ a &= -c \\ a &= -(-1) \\ \boxed{a=1} \end{aligned}$$

$$\begin{aligned} -3a+b-c+1 &= 0 \\ -3(-1)+b-(-1)+1 &= 0 \\ 3-2+b+1 &= 0 \\ b+2 &= 0 \\ b &= -2 \\ \boxed{b=-2} \end{aligned}$$

$$\begin{aligned} -b-c &= 0 \\ -b &= c \\ b &= -c \\ b &= -(-1) \\ \boxed{b=1} \end{aligned}$$

Put all values in eqn (1)

$$N_R = K \rho^1 v^1 \eta^{-1} D$$

$$\Rightarrow \boxed{N_R = \frac{K \rho v D}{\eta}}$$



Q.4 Derive by method of dimensions an expression for Volume of a liquid flowing out per second through a narrow pipe. Assume that rate of flow of liquid depends on

(i) coefficient of viscosity ( $\eta$ ) of the liquid

(ii) radius ( $r$ ) of pipe

(iii) pressure gradient ( $\frac{P}{l}$ ) along the pipe.

Take  $K = \frac{\pi}{8}$

Sol. Let Volume flowing out per second through pipe be given by:

$$V = K \eta^a r^b \left(\frac{P}{l}\right)^c \quad \text{--- (1)}$$

$$V = [L^3 T^{-1}]$$

$$\eta = [M^1 L^{-1} T^{-1}]$$

$$r = [M^0 L^1 T^0]$$

$$P = M^1 L^{-1} T^{-2}$$

$$l = [M^0 L^1 T^0]$$

Put all these values in eq<sup>n</sup> (1)

$$[M^0 L^3 T^{-1}] = K [M^1 L^{-1} T^{-1}]^a [M^0 L^1 T^0]^b [M^1 L^{-2} T^{-2}]^c$$

Equating the powers of M, L & T

$$0 = a + 0 + c$$

$$a + c = 0$$

$$\boxed{a = -c}$$

$$\boxed{a = -1}$$

$$3 = -a + b - 2c$$

$$-a + b - 2c = 3$$

$$-(-1) + b - 2(1) = 3$$

$$1 + b - 2 = 3$$

$$b - 1 = 3, \boxed{b = 4}$$

$$-1 = -a + 0 - 2c$$

$$-1 = -a - 2c$$

$$-1 = -(-c) - 2c$$

$$-1 = c - 2c$$

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



Put all these values in eq<sup>n</sup> ①

$$V = K \eta^{-1} r^4 \left( \frac{\rho}{L} \right)^1$$

$$V = K \frac{\rho r^4}{L \eta}$$

### Try These Questions Yourself

- Q.1 The escape velocity  $v$  of a body depends upon  
 (i) the acceleration due to gravity of planet  
 (ii) Radius of Planet  $R$

Establish dimensionally the relationship between  $v$ ,  $g$  &  $R$ .

$$v = K \sqrt{gR}$$

- Q.2 The frequency  $\nu$  of an oscillating drop may depend upon radius  $r$  of the drop, density  $\rho$  of the liquid & surface tension  $S$  of liquid. Establish an expression for  $\nu$  dimensionally.

$$\nu = K \sqrt{\frac{S}{\rho r^3}}$$

- Q.3 Obtain an expression for the centripetal force  $F$  acting on a particle of mass  $m$  moving with velocity  $v$  in a circle of radius  $r$ . Take dimensionless constant  $K=1$

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

- Q.4 A small spherical ball of radius  $r$  falls with velocity through a liquid having coefficient of viscosity  $\eta$ . Find the viscous drag  $F$  on the ball assuming it depends on  $\eta$ ,  $r$  &  $v$ . Take  $K=6\pi$



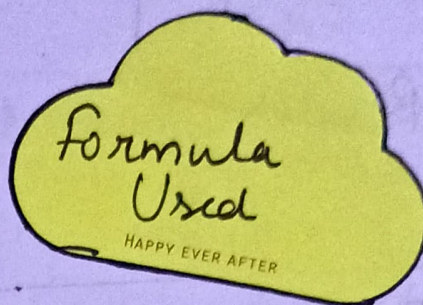
## Conversion from one system to another

This is based on the fact that

Magnitude of a physical quantity remains the same, whatever be the system of its measurement i.e.

$$Q = n_1 u_1 = n_2 u_2$$

$$n_2 = n_1 \left[ \frac{u_1}{u_2} \right]$$



$$n_2 = n_1 \frac{[M_1]^a [L_1]^b [T_1]^c}{[M_2]^a [L_2]^b [T_2]^c}$$

$$n_2 = n_1 \left[ \frac{M_1}{M_2} \right]^a \left[ \frac{L_1}{L_2} \right]^b \left[ \frac{T_1}{T_2} \right]^c$$

Ques 1 Convert 1 newton into dyne.

Sol<sup>n</sup> Newton is S.I Unit of force & dyne is c.g.s Unit of force.

SI  $\longrightarrow$  C.g.s

kg  $\longrightarrow$  g

m  $\longrightarrow$  cm

s  $\longrightarrow$  s





$$n_2 = 1 \left[ \frac{1 \text{ kg}}{1 \text{ g}} \right]^a \left[ \frac{1 \text{ m}}{1 \text{ cm}} \right]^b \left[ \frac{1 \text{ s}}{1 \text{ s}} \right]^c$$

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

$$a=1, b=1, c=-2$$

$$n_2 = 1 \left[ \frac{1000 \text{ g}}{1 \text{ g}} \right]^1 \left[ \frac{100 \text{ cm}}{1 \text{ cm}} \right]^1 \left[ \frac{1 \text{ s}}{1 \text{ s}} \right]^{-2}$$

$$n_2 = 1 [10]^3 [10^2]^1 [1]^{-2}$$

$$n_2 = 10^5 \text{ dyne}$$

Q2 Convert an energy of 5 Joule into ergs.

Joule — S.I Units of Energy

ergs — c.g.s Unit of Energy

S.I —————> c.g.s

kg —————> g

m —————> cm

s —————> s

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

$$n_2 = 5 \left[ \frac{1000 \text{ g}}{1 \text{ g}} \right]^1 \left[ \frac{100 \text{ cm}}{1 \text{ cm}} \right]^2 \left[ \frac{1 \text{ s}}{1 \text{ s}} \right]^{-2}$$

$$n_2 = 5 [1000]^1 [100]^2 [1]^{-2}$$

$$n_2 = 5 \times 10^7 \text{ erg}$$



Q.3 Convert a power of one mega watt on a system whose fundamental units are 10kg, 1dm, & 1minute.

$$n_2 = n_1 \left[ \frac{M_1}{M_2} \right]^a \left[ \frac{L_1}{L_2} \right]^b \left[ \frac{T_1}{T_2} \right]^c$$

Given  $\rightarrow$  Power = 1 MW =  $10^6$  Watt

$$\text{Power} = \frac{\text{Work}}{\text{time}} = \frac{M^1 L^2 T^{-2}}{T} = M^1 L^2 T^{-3}$$

$$\text{kg} \quad \text{---} \quad 10 \text{ kg}$$

$$1 \text{ m} \quad \text{---} \quad 1 \text{ dm}$$

$$1 \text{ s} \quad \text{---} \quad 1 \text{ minute}$$

$$n_2 = 10^6 \left[ \frac{1 \text{ kg}}{10 \text{ kg}} \right]^1 \left[ \frac{1 \text{ m}}{1 \text{ dm}} \right]^2 \left[ \frac{1 \text{ s}}{1 \text{ minute}} \right]^{-3}$$

$$n_2 = 10^6 \left[ \frac{1}{10} \right]^1 \left[ \frac{1 \text{ dm}}{1 \text{ dm}} \right]^2 \left[ \frac{(60)^{-1}}{1} \right]^{-3}$$

$$n_2 = 10^6 \times 10^{-2} \times (60)^3 \times 10^{-1}$$

$$n_2 = 216 \times 10^3 \times 10^6 \times 10^{-2} \times 10^{-1}$$

$$= 216 \times 10^{10}$$

$$n_2 = 2.16 \times 10^{12} \text{ new units of power}$$



## Conversion from one system to another

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Try these questions yourself:

Sciphy.in

Q-1 The value of Stefan's Constant is  $\sigma = 5.67 \times 10^8 \text{ J s}^{-1} \text{ m}^2 \text{ K}^{-4}$

Find its value in c.g.s system.

Ans  $5.67 \times 10^{-5} \text{ erg s}^{-1} \text{ cm}^2 \text{ K}^{-4}$

Q-2 When one metre, one kg & one minute are taken as fundamental units the magnitude of a force is 36 Units. What is the value of this force on c.g.s system?

Ans  $10^3 \text{ dyne}$

Very Short answer type of questions:

1. Can a quantity have constant value & be dimensionless?

Ans. Yes, Joule's mechanical equivalent of heat has a constant value, but is dimensionless.

2. Can a quantity have units but still be dimensionless?

Ans-2 Yes. For example angle is dimensionless but it has units.

3. Does a quantity have different dimensions in different system of units?

A-3. No a quantity has same dimensions in different system of units.





Q-4 All constants are dimensionless. Comment.

A-4. No all constants are not dimensionless.

For eg: Universal Gravitational Constant.

Q-5 Can there be a physical quantity which has no units & no dimensions.

A-5 Yes, for example strain has units & no dimensions.

Q-6 Calculate  $x$  in equation:

$$(\text{Velocity})^x = (\text{Pressure diff})^{3/2} \times (\text{density})^{-3/2}$$

$$[M^0 L^1 T^{-1}]^x = (M^1 L^{-1} T^{-2})^{3/2} \times (M^1 L^{-3} T^0)^{-3/2}$$

$$[M^0 L^1 T^{-1}]^x = M^{3/2 - 3/2} L^{-3/2 \cdot 1/2} T^{-3}$$

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

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

$$\boxed{x=3}$$

Q-7 Find value of  $x$  in the relation  $Y = \frac{T^x \cos \theta \cdot \tau}{L^3}$

Where  $Y$  is Young's Modulus,  $T$  is Time period,  $\tau$  = Torque  
 $L$  = length

$$T^x = \frac{Y L^3}{\cos \theta \cdot \tau} = \frac{[M^1 L^{-1} T^{-2}][L^3]}{[M^1 L^2 T^{-2}]} \Rightarrow \boxed{x=0}$$



The fact that quantities having different dimensions cannot be added or subtracted.

Q-1 The velocity  $v$  of a particle depends upon time  $t$ , according to the eq<sup>n</sup>  $v = a + bt + \frac{c}{d+t}$ .

Write the dimensions of  $a, b, c$  and

Sol:  $L^1 T^{-1} = a + b \times T + \frac{c}{d+t}$

$d+t \Rightarrow d = [T]$

$$\frac{c}{d+t} = L^1 T^{-1}$$

$$\frac{c}{T} = L^1 T^{-1} \Rightarrow L^1 T^{-1} \times T = [L^1]$$

$$bt = L^1 T^{-1}$$

$$b = \frac{L^1 T^{-1}}{T} = [L^1 T^{-2}]$$

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

Q-2 Write the dimensions of  $a/b$  in the relation

$F = a\sqrt{x} + bt^2$  Where  $F$  is Force,  $x$  is distance &  $t$  is time.

$$a\sqrt{x} = F$$

$$a = \frac{F}{\sqrt{x}} = \frac{M^1 L^1 T^{-2}}{L^{1/2}} = [M^1 L^{1/2} T^{-2}]$$



$$bt^2 = F$$

$$b = \frac{F}{t^2} = \frac{M^1 L^1 T^{-2}}{T^2} \Rightarrow [M^1 L^1 T^{-4}]$$

$$\frac{a}{b} = \frac{M^1 L^{1/2} T^{-2}}{M^1 L^1 T^{-4}} = [M^0 L^{-1/2} T^2]$$

Q3 Write dimensions of  $a/b$  in the relation

$$P = \frac{a - t^2}{bx}$$

$P = \text{Power}$

$$a = [T^2]$$

$$M^1 L^2 T^{-3} = \frac{T^2}{bxL} \Rightarrow b = \frac{T^2}{M^1 L^3 T^{-3}}$$

$$b = M^{-1} L^{-3} T^5$$

$$\frac{a}{b} = \frac{T^2}{M^{-1} L^{-3} T^5} = [M^1 L^3 T^{-3}] \quad \underline{\text{Ans}}$$

Q4 In the equation  $y = A \sin(\omega t - kx)$ , obtain dimensional formula of  $\omega$  &  $k$ . Given  $x$  is distance &  $t$  is time.

$$\omega t - kx = \theta$$

$$\omega t = \theta$$

$$\omega = \frac{\theta}{t} = [T^{-1}]$$

$$kx = \theta$$

$$k = \frac{\theta}{x} = [L^{-1}]$$



Q-5 In the expression  $P = E \ell^2 m^{-5} G^{-2}$

$E$  = Energy

$m$  = mass

$\ell$  = Angular Momentum

$G$  = gravitational Constant resp.

Show that  $P$  is a dimensionless quantity.

$$P = [M^1 L^2 T^{-2}] [M^1 L^2 T^{-1}]^2 [M]^{-5} [M^{-1} L^3 T^{-2}]^{-2}$$

$$P = [M^0 L^0 T^0]$$

Hence  $P$  is a dimensionless quantity.

### Limitation of Dimensional Analysis

1. This method gives <sup>us</sup> no information about dimensionless constants in the formula.
2. If a quantity depends on more than 3 factors having dimensions, formula cannot be derived.
3. We can not derive the formulae containing trigonometrical functions, exponential functions etc which have no dimensions.
4. Method of dimensions can not be used to derive an exact form of relation when it consists of more than one part on any side  
forex.  $S = ut + \frac{1}{2}at^2$  can not be obtained.



5. It gives no information whether a physical quantity is a scalar or a vector.

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Significant figure are digits

known reliably plus the first uncertain digit are known as significant digits.

• for eg  $374.5\text{m}$  has four significant figures.

• 3, 7 & 4 are certain & reliable.

• digit 5 is uncertain.

⇒ larger number of significant figures in a measurement, higher the accuracy of measurement & vice-versa.

### Common Rules for Counting Significant figures

(i) All non-zero digits are significant. So  $13.75$  has four significant figures.

(ii) All zeros between two non-zero digits are significant.

for eg:  $100.05\text{ km}$  has five significant figures.

(iii) All zeros to the right of a non-zero digit are not significant.

for eg:  $86400$  has 3 significant figures

# But such zeros will be significant if they come from a measurement.



foreg: 86400s has five significant figures.

(iv) All zeros to the right of a non-zero digit but to the left of a decimal point are significant.

for example 684700 has six significant fig.

(v) All zeros to the right of a decimal point are significant

foreg: 161cm, 161.0cm & 161.00cm have three four & five significant figures respectively.

(vi) All zeros to the right of a decimal point but to the left of a non zero digit are not significant. So 0.161cm & 0.0161cm both have 3 significant figures.

(vii) Number of significant figures does not depend on the system of units.

foreg 16.4cm

16.4m

& 0.000164km all have 3 significant figures.

(viii) Multiplying or dividing factors which are neither rounded number nor numbers representing measured values are exact. They have infinite number of significant digits.



For example -

Circumference  $S = 2\pi r$ , factor  $\pi$  is an exact number

It can be written as 2.0

2.00

2.000

## Arithmetic operations with Significant figures.

### 1. Significant figures in the sum or difference of two numbers.

In addition or subtraction the final result should retain same number of decimal places as that of the original number with minimum number of decimal places.

For example: Sum of three measurements of length (2.1m, 1.78m & 2.046m) = 5.926m

⇒ 5.926 is rounded off to 5.9m (upto smallest number of decimal places in 3 measurements).

# Similarly  $x = 12.587\text{m}$ ,  $y = 12.5\text{m}$

then  $x - y \Rightarrow 12.587 - 12.5 = 0.087\text{m}$

• So 0.087m is rounded off to 0.1m upto smallest number of decimal places in y.



## Significant figures in Multiplication & Division of numbers

In multiplication or division the final result should retain same number of Significant figures as that of original number with minimum number of significant digits.

for example  $x = 3.8$   $y = 0.125$

$$\text{So } x \times y = 3.8 \times 0.125 = 0.475$$

0.475 is rounded off to 0.48 (upto 2 significant figures)

Because least number of significant figures is 2 in ( $x = 3.8$ ).

Ques: State the rules for rounding off a measurement.

- (i) If the digit to be dropped is smaller than 5 then preceding digit is left Unchanged
- (ii) If the digit to be dropped is greater than 5, then preceding digit is increased by 1.
- (iii) If the digit to be dropped is 5 followed by non-zero digits, then preceding digit is increased by 1.
- (iv) If the digit to be dropped is 5 then preceding digit is left Unchanged it is even.
- (v) If the digit to be dropped is 5, then preceding digit is increased by 1 if it is odd.





Ques-1 Write the result of the following with regard to significant figures.

(i)  $876 + 0.4382 = 876.4382$

It is rounded off to 876.

(ii)  $8.0 - 0.42 = 7.58$  (Rounded off to 7.6)

Ques-2 Subtract  $2.5 \times 10^4$  from  $3.9 \times 10^5$  with due regard to significant figures.

$$\begin{aligned} y - x &= 3.9 \times 10^5 - 0.25 \times 10^5 \\ &= (3.9 - 0.25) \times 10^5 \\ &= 3.65 \times 10^5 \\ &= 3.6 \times 10^5 \text{ Ans.} \end{aligned}$$

Ques-3. Write number of significant figures in the following:

- (i) 5238 N — 4 significant figures
- (ii) 4200 kg — 4 significant figures
- (iii) 34.000 m — 5 significant figures
- (iv)  $0.02340 \text{ Nm}^{-1}$  — 4 significant figures.

Ques-4 5.74 g of a substance occupies  $12 \text{ cm}^3$ . Express its density by keeping the significant figures in view.



$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{5.74\text{g}}{1.2\text{cm}^3} = 4.783\text{g cm}^{-3}$$

$4.783\text{g cm}^{-3}$  is rounded off to  $4.8\text{g cm}^{-3}$ .

Q.5 Add  $6.75 \times 10^3\text{cm}$  to  $4.52 \times 10^2\text{cm}$

$$\Rightarrow 6.75 \times 10^3\text{cm} + 0.452 \times 10^3\text{cm}$$

$$= (6.75 + 0.452) \times 10^3$$

$$= 7.202 \times 10^3\text{cm} \text{ is rounded off to}$$

$$= 7.20 \times 10^3\text{cm}$$

Q.6 In the expression surface Area  $= 4\pi r^2$ , the factor 4 is an exact number. How many number of significant figures are there in the factor 4?

Sol. factor 4 is an exact number so number of significant figures are infinite