## Set of Quantities having same Dimensions

| Sr. No. | Quantities | Dimensions |
|---|---|---|
| 1 | strain, refractive index, relative density, angle, solid angle, phase, distance gradient, relative permeability, relative permittivity, angle of contact, Reynolds number, coefficient of friction, mechanical equivalent of heat, electric susceptibility, etc. | $[M^0L^0T^0]$ |
| 2 | Mass or inertial mass | $[M^1L^0T^0]$ |
| 3 | Momentum and impulse | $[M^1L^1T^{-1}]$ |
| 4 | Thrust, Force, weight, tension, energy gradient | $[M^1L^1T^{-2}]$ |
| 5 | Pressure, stress, Young's modulus, bulk modulus, shear modulus, modulus of rigidity, energy density | $[M^1L^{-1}T^{-2}]$ |
| 6 | Angular momentum and Planck's constant | $[M^1L^2T^{-1}]$ |
| 7 | Acceleration, g and gravitational field intensity | $[M^0L^1T^{-2}]$ |
| 8 | Surface tension, free surface energy (energy per unit area), force gradient, spring constant | $[M^1L^0T^{-2}]$ |
| 9 | Latent heat and gravitational potential | $[M^0L^2T^{-2}]$ |
| 10 | Thermal capacity, Boltzmann constant, entropy | $[M^1L^2T^{-2}K^{-1}]$ |
| 11 | Work, Torque, internal energy, potential energy, kinetic energy, moment of force, $(q/C^2)$, $(LI^2)$, $(qV)$, $(V^2C)$, $(I^2Rt)$, $(VIt)$, $(V^2t/R)$, $(PV)$, $(RT)$, $(mL)$, $(mc\ \Delta T)$ | $[M^1L^2T^{-2}]$ |
| 12 | Frequency, angular frequency, angular velocity, velocity gradient, radioactivity, $(R/L)$, $(1/RC)$, $(1/(LC)^{1/2})$ | $[M^0L^0T^{-1}]$ |
| 13 | $(l/g)^{1/2}$, $(m/k)^{1/2}$, $(L/R)$, $(RC)$, $(LC)^{1/2}$, time | $[M^0L^0T^1]$ |
| 14 | $(VI)$, $(I^2R)$, $(V^2/R)$, Power | $[M^1L^2T^{-3}]$ |

## Rules for Counting Significant Figures

**For numbers greater than 1**

•All non-zero digits are significant

•All zeroes between two non-zero digits are significant. The location of the decimal does not matter.

•If the number is without a decimal point, then the trailing zeroes are not significant.

•Trailing zeroes in the decimal part are significant.

**For numbers less than 1**

•Any zero to the right of a non-zero digit is significant.

•All zeroes between the decimal point and the first non-zero digit are not significant,

## Fundamental or Base Quantities

The quantities which do not depend upon other quantities for their complete definition are known as *fundamental* or *base quantities*.
e.g.: length, mass, time, etc.

## Derived Quantities

The quantities which can be expressed in terms of the fundamental quantities are known as *derived quantities*
e.g.: Speed (= distance/time), Volume, acceleration, force, pressure, etc.

## Units of Physical Quantities

The chosen reference standard of measurement in multiples of which, a physical quantity is expressed is called the *unit* of the quantity.
e.g.: Physcial Quantity = Numerical Value x Unit

## Supplementary Units

| | |
|---|---|
| Radian (rad) | for measurement of plane angle |
| Steradian (sr) | for measurement of solid angle |

## Prefixes used for different Powers of 10

| Power of 10 | Prefix | Synbol | Power of 10 | Prefix | Symbol |
|---|---|---|---|---|---|
| $10^{18}$ | exa | E | $10^{-1}$ | deci | d |
| $10^{15}$ | peta | P | $10^{-2}$ | centi | c |
| $10^{12}$ | tera | T | $10^{-3}$ | milli | m |
| $10^{9}$ | giga | G | $10^{-6}$ | micro | μ |
| $10^{6}$ | mega | M | $10^{-9}$ | nano | n |
| $10^{3}$ | kilo | k | $10^{-12}$ | pico | p |
| $10^{2}$ | hecto | h | $10^{-15}$ | femto | f |
| $10^{1}$ | deca | da | $10^{-18}$ | atto | a |

## Some Fundamental Constants

| Constant | Symbol | Value |
|---|---|---|
| Gravitational Constant | G | $6.6*10^{-11}$ $Nm^2kg^{-2}$ |
| Speed of Light in Vacuum | c | $3*10^{8}$ $ms^{-1}$ |
| Permeability of vacuum | μ | $4\pi*10^{-7}$ $Hm^{-1}$ |
| Permittivity of vacuum | ε | $8.85*10^{-12}$ $Fm^{-1}$ |
| Planck's Constant | h | $6.63*10^{-34}$ Js |
| Atomic Mass Unit | amu | $1.66*10^{-27}$ kg |
| Energy equivalent of 1 amu | MeV | 931.5 MeV |
| Electron rest mass | $m_e$ | $9.1*10^{-31}$= 0.511 MeV |
| Avogadro constant | $N_a$ | $6.02*10^{23}$ $mol^{-1}$ |
| Faraday Constant | F | $9.648*10^{4}$ C $mol^{-1}$ |

## Some Fundamental Constants (cont)

| | | |
|---|---|---|
| Stefan-Boltzmann Constant | σ | $5.67*10^{-8}$ W $m^{-2}K^{-4}$ |
| Wien Constant | b | 2.89*10*-3^ mK |
| Rydberg Constant | $R_\infty$ | $1.097*10^{7}$ $m^{-1}$ |
| Triple point for water | K / $^oC$ / $^oF$ | 273.16K (0.01$^oC$) |
| Molar volume of ideal gas | $m^3$ $mol^{-1}$ | 22.4 L = $22.4*10^{-3}$ $m^3$ $mol^{-1}$ |

## Order of Magnitude

Power of 10 required to represent a quantity.
$49 = 4.9*10^{1} \approx 10^{1}$ → order of magnitude = 1
$0.051 = 5.1*10^{-2} \approx 10^{-2}$ → order of magnitude = -2

## System of Units

| | MKS | CGS | FPS | MKSQ | MKSA |
|---|---|---|---|---|---|
| (i) | Length (m) | Length (cm) | Length (ft) | Length (m) | Length (m) |
| (ii) | Mass (kg) | Mass (g) | Mass (pound) | Mass (kg) | Mass (kg) |
| (iii) | Time (s) | Time (s) | Times (s) | Time (s) | Time (s) |
| (iv) | - | - | - | Charge (Q) | Current (A) |

## Fundamental Quantities in S.I. System

| Sr. No. | Physical Quantity | Name of Unit | Symbol |
|---|---|---|---|
| 1 | Mass | kilogram | kg |
| 2 | Length | meter | m |
| 3 | Time | second | s |
| 4 | Temperature | kelvin | K |
| 5 | Luminous Intensity | candela | Cd |
| 6 | Electric Current | ampere | A |
| 7 | Amount of Substance | mole | mol |

## Dimensional Formula

The relation which expresses physical quantities in terms of appropriate powers of fundamental quantities.

## Use of Dimensional Analysis

To check the dimensional correctness of a given physical relation.

To derive relationship between different physical quantities.

To convert units of a physical quantity from one system to another.

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## Units of Important Physical Quantities

| Physical Quantity | Unit | Physical Quantity | Unit |
|---|---|---|---|
| Angular acceleration | rad $s^{-2}$ | Frequency | hertz |
| Moment of Inertia | kg $m^2$ | Resistance | kh $m^2$ $A^{-2}$ $s^{-3}$ |
| Self-Inductance | henry | Surface Tension | N/m |
| Magnetic Flux | weber | Universal Gas Constant | J $K^{-1}$ $mol^{-1}$ |
| Pole Strength | A m | Dipole Moment | C m |
| Viscosity* | poise | Stefan Constant | W $m^{-2}$ K^-4* |
| Reactance | ohm | Permittivity of free space $\varepsilon_o$ | $C^2$/N $m^2$ |
| Specific Heat | J/kg $^oC$ | Permeability of free space $\mu_o$ | weber/ A m |
| Strength of magnetic field | N $A^{-1}$ $m^{-1}$ | Planck's Constant | J s |
| Astronomical distance | Parsec | Entropy | J/K |

## Error in Summation and Difference

x = a + b then, $\triangle x = \pm (\triangle a + \triangle b)$

## Error in Product and Division

$$\frac{\Delta X}{X} = |a|\frac{\Delta Y}{Y} + |b|\frac{\Delta Z}{Z}$$

If $X = Y^aZ^b$ then the maximum possible fractional error in X is given by the above equation

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