

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

Some Fundamental Constants (cont)

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

Order of Magnitude

Power of 10 required to represent a quantity.

$49 = 4.9 \times 10^1 \approx 10^1 \rightarrow$ order of magnitude = 1

$0.051 = 5.1 \times 10^{-2} \approx 10^{-2} \rightarrow$ order of magnitude = -2

System of Units

	MKS	CGS	FPS	MKSQ	MKSA
(i) Length	Length (m)	Length (cm)	Length (ft)	Length (m)	Length (m)
(ii) Mass	Mass (kg)	Mass (g)	Mass (pound)	Mass (kg)	Mass (kg)
(iii) Time	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	ohm 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 ε ₀	C ² /N m ²
Specific Heat	J/kg °C	Permeability of free space μ ₀	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, $\Delta x = \pm (\Delta a + \Delta b)$

Error in Product and Division

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

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

