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Chapter- 2
Units and Measurment

Unit :-

Measurment of any Physical Quantities involves Comparison with a certain basic, arbitarily chosen, internationally accepted reference standard called Unit.

The Standard of Measurment :- Although the no of physical quantities to be measured is very large, we require only a few, limited No. of units, being sufficent for expressing all the different physical quantities

Fundamental Unit :- The No. which are indepe-ndent to each other

Symbol	Name	Basic Quantity
M	Metre	length
Kg	Kilogram	mass
S	Second	Time
A	ampere	electric current
K	Kelvin	Thermodynamics
Mol	Mole.	Amount of substance
Cd	Candela	luminous

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The international System of Unit :-

In earlier time Scientist of different Countries were using different system the C.G.S. the FPS (or British) System and the MKS system were in use extensively till recently.

The base units for length, Mass and time in these systems were as follows :-

In CGS system they were centimetre gram and second respectively

In FPS system they were foot, Pound and second respectively

In MKS system they were metre, Kilogram and second respectively.

Measurment :-

To evaluate the things is known as measurment.

SI Base Quantities and Units :-

In the SI, there are seven fundamental or base units which are well- defined with internationally accepted definitions.

The standard symbol for the base units are universally accepted as such, being independent of the language of the written text in which these symbol are being used.

Base Quantities	Unit	Symbol	Year of adoption
1 Length	Metre	M	1983
Mass	Kilogram	Kg	1889
Time	Second	S	1967
Electric-Current	ampere	A	1948
Thermodynamic	Kelvin	K	1967

Supplementary Units :-
Besides these seven SI base units, there are two more units that are defined for both dimensionless quantities, Namely
(i) Plane angle and
(ii) Solid angle

SI derived units :-

Table 2.2 gives a some SI derived units expressed in terms of SI Base unit :-

S.No	Physical Quantities	Name	SI Unit / Symbol
1	Area	Square Metre	m^2
2	Volume	Cubic metre	m^3
3	Density, Mass density	Kg Per C.Metre	Kg/m^3 or Kg^{-3}
4	Current density	A Per Sq. Metre	A/m^2 or Am^{-2}
5	Specific Volume	Cubic Per Kg	m^3/Kg or $m^3 Kg^{-1}$
6	Concentration	Mole Per Cu.M	mol/m^3 or $mol\,m^{-3}$
7	Speed, velocity	Metre Per sec.	m/s or ms^{-1}
8	Angular velocity	radian Per sec.	rad/s^2 or rad/s^{-1}
9	Acceleration	Met. Per sec. Sq.	M/s^2 or ms^{-2}
10	Angular accele-ration	radian Per Sec./Square	rad/s^2 or $rad\,s^{-2}$

Table 2.3 Gives SI derived unit with special name, expressed in terms of SI base unit.

S.No	Physical Quantity	Name	Sym.	expression	exp. SI unit ba
1	Frequency	Hertz	Hz	–	s^{-1}
2	force, thrust	Newton	N	–	$kg\,ms^{2}$
3	Energy, work	Joule	J	Nm	$kg\,m^{2}s^{-2}$
4	Pressure, stress	Pascal	Pa	N/m^2 or Nm^{-1}	$kg\,m^{-1}$
5	Quantity of electricity	Columb	C	–	A s
6	electric potential, potential difference	volt	V	W/A or WA^{-1}	$kg\,m^{2}s^{-3}$
7	Power, radiant flux	watt	W	J/s or Js^{-1}	$A^{2}s^{4}$
8	Capacitance	farad	F	C/V	$kg\,m^{2}$
9	Electric resistance	ohm	Ω	V/A	m^{-2}
10	Conductance	siemens	S	A/V	$kg\,s^{2}$
11	Magnetic flux	weber	Wb	VS or JA	$kgm^{2}s^{2}$

Table 2.4 gives some SI derived units expressed by SI units with special names in terms of SI Base unit

S.NO	Physical Quant	Name	Symbol	exp. in terms of SI ba. Unit
1	Magnetic Moment	Joule Pent	JT^{-1}	$m^{2}A$
2	Dipole Moment	Col met.	Cm	SAm
3	Surface tension	Newt/M	N/m	$kg\,s^{-2}$
4	Power density	watt Per m^2	w/m^{2}	$kg\,s^{-3}$
5	Torque, Couple	Newt-meter	Nm	$m^{2}kg\,s^{-2}$
6	Heat Capacity	Joule/Kelvin	J/K	$m^{2}kgs^{2}K^{-1}$
7	Radiant intensity	watt Per steradian	WSr^{-1}	$kgm^{2}s^{-3}Sr^{-1}$
8	Molar energy	Joule Per mole	J/mol	$m^{2}kgs^{-2}\,mol^{-1}$
9	Specific heat	Joule/Kg Kelvin	J/KgK	$m^{2}s^{-2}K^{-1}$
10	energy density	Joule/m^3	J/m^{3}	$kgm^{-1}s^{-2}$

Table 2.5: Some SI units retained for General use.

S.No	Name	Symbol	value in SI unit
1	Minute	min	60 s
2	Hour	h	60 min = 3600 s
3	Day	D	24h = 86400 s
4	Year	Y	365.25d = 3.156 × 10^7 s
5	dittre	L	1dm^3 = 10^{-3} m^3
6	tenntonne	t	10^3 kg
7	degree	°	1° = (π/180) rad
8	bar	bar	0.1 mPa = 10^5 Pa
9	Carat	C	200 Mg
10	roentgen	R	2.58 × 10^{-4} C/kg
11	Curie	Ci	3.7 × 10^{10} s^{-1}

Measurment of Mass – Mass of an object is a basic Property of matter. The quantity of matter possessed by an object is it mass, which doesn't depend on the temperature Pressure, environmental Conditions, or location of the object anywhere in space

Measurment of Inertial Mass :- The inertial mass of an object can be measured by using a device, called an inertial balance which utilises the inertia property of matter.

The inertial balance consists of a pair of long flat metallic strips. One end of the two flat strips, carrying a wooden block is firmly clamped to the top of a table.

An object of known inertia mass m_2 is placed on the pan and the time period of iberation T_2 of the inertial balance is measured, using a stop watch.

using eq.

$$\frac{m_2}{m_1} = \frac{T_2^2}{T_1^2}$$

$$m_1 = m_2 \times (T_1^2 / T_2^2) - (2.3)$$

Measurment of gravitational mass:- The gravitational mass of an object can be measured by a spring balance, common balances, physical balance or a platform balance.

Range of masses - The Masses of the object we come very over a wide range. The range of masses may vary from very tiny mass of the electron to the extremely huge mass of the known observable.

S.NO	Object	Order of Mass (Kg)
1	Electron	10^{-30}
2	Proton	10^{-27}
3	Neutron	10^{-27}
4	Uranium atom	10^{-25}
5	Red blood Cell	10^{-13}
6	Dust Particle	10^{-9}

Measurment of length - The objects we come across in the universe vary over a very wide range in sizes. You are quite aware of some direct methods, commonly employed for the measurment of length from 10^{-9} m to 10^{2} m.

Range of length - Various objects have size in this universe, varying over a wide range. These sizes may vary from the extremely small size (of the order of 10^{-15} m to 10^{-14} m) of a tiny Nucleus of an atom.

Measurment of time:- Presently, we are using the path length, light travels in a certain amount of time of (1/299,792,458) second to define a standard metre as the international standard of length.

Range of time interval - The time intervals of various events, occuring in the universe vary over a wide range. Table 2.10 gives the range and order of time intervals of some events, and occuren-ces.

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S.NO	Event	Order of Time interval
1	Age of the Universe	10^{17}
2	Time Since dinosaurs became extinct	10^{15}
3	Age of egyptian Pyramids	10^{11}
4	Average human life-span	10^{9}
5	Travel time for light from Nearest Star	10^{8}
6	Revolution Period of earth	10^{7}
7	Rotation and revolution Periods of the moon	10^{6}
8	Rotation Period of earth	10^{5}
9	Time Period of satellite	10^{4}

Binda
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