In order to make the measurement of a physical quantity we have, first of all, to evolve a standard for that measurement so that different measurements of same physical quantity can be expressed relative to each other. That standard is called a **unit** of that physical quantity.

- **System of Units:-**

  (a) C.G.S (Centimeter-Grand-Second) system.

  (b) F.P.S. (Foot-Pound-Second) system.

  (c) M.K.S. (Meter-Kilogram--Second) system.

  (d) M.K.S.A. (Meter-Kilogram-Second-Ampere) unit.

- **Dimensional Formula:-**

Dimensional formula of a physical quantity is the formula which tells us how and which of the fundamental units have been used for the measurement of that quantity.

- **How to write dimensions of physical quantities:-**

  (a) Write the formula for that quantity, with the quantity on L.H.S. of the equation.

  (b) Convert all the quantities on R.H.S. into the fundamental quantities mass, length and time.

  (c) Substitute M, L and T for mass, length and time respectively.

  (d) Collect terms of M,L and T and find their resultant powers (a,b,c) which give the dimensions of the quantity in mass, length and time respectively.

- **Characteristics of Dimensions:-**

  (a) Dimensions of a physical quantity are independent of the system of units.

  (b) Quantities having similar dimensions can be added to or subtracted from each other.

  (c) Dimensions of a physical quantity can be obtained from its units and vice-versa.

  (d) Two different physical quantities may have same dimensions.

  (e) Multiplication/division of dimensions of two physical quantities (may be same or different) results in production of dimensions of a third quantity.

PHYSICAL QUANTITY	SYMBOL	DIMENSION	MEASUREMENT UNIT	UNIT
Length	s	L	Meter	m
Mass	M	M	Kilogram	Kg
Time	t	T	Second	Sec
Electric charge	q	Q	Coulomb	C
luminous intensity	I	C	Candela	Cd
Temperature	T	K	Kelvin	ºK
Angle	q	none	Radian	None
Mechanical Physical Quantities (derived)				
PHYSICAL QUANTITY	**SYMBOL**	**DIMENSION**	**MEASUREMENT UNIT**	**UNIT**
Area	A	L^2	square meter	m^2
Volume	V	L^3	cubic meter	m^3
velocity	v	L/T	meter per second	m/sec
angular velocity	w	T^{-1}	radians per second	1/sec
acceleration	a	LT^{-2}	meter per square second	m/sec^2
angular acceleration	a	T^{-2}	radians per square second	$1/sec^2$
Force	F	MLT^{-2}	Newton	$Kg\ m/sec^2$
Energy	E	ML^2T^{-2}	Joule	$Kg\ m^2/sec^2$
Work	W	ML^2T^{-2}	Joule	$Kg\ m^2/sec^2$
Heat	Q		Joule	$Kg\ m^2/sec^2$

		ML^2T^{-2}		
Torque	t	ML^2T^{-2}	Newton meter	Kg m^2/sec^2
Power	P	ML^2T^{-3}	watt or joule/sec	Kg m^2/sec^3
Density	D or ρ	ML^{-3}	kilogram per cubic meter	Kg/m^3
pressure	P	$ML^{-1}T^{-2}$	Newton per square meter	Kg m^{-1}/sec^2
impulse	J	MLT^{-1}	Newton second	Kg m/sec
Inertia	I	ML^2	Kilogram square meter	Kg m^2
luminous flux	f	C	lumen (4Pi candle for point source)	cd sr
illumination	E	CL^{-2}	lumen per square meter	cd sr/m^2
entropy	S	$ML^2T^{-2}K^{-1}$	joule per degree	Kg m^2/sec^2K
Volume rate of flow	Q	L^3T^{-1}	cubic meter per second	m^3/sec
kinematic viscosity	n	L^2T^{-1}	square meter per second	m^2/sec
dynamic viscosity	m	$ML^{-1}T^{-1}$	Newton second per square meter	Kg/m sec
specific weight	g	$ML^{-2}T^{-2}$	Newton per cubic meter	Kg m^{-2}/sec^2
Electrical Physical Quantities (derived)				
Electric	I	QT^{-1}	Ampere	C/sec

current				
emf, voltage, potential	E	$ML^2T^{-2}Q^{-1}$	Volt	Kg m^2/sec^2C
resistance or impedance	R	$ML^2T^{-1}Q^{-2}$	ohm	Kgm^2 /$secC^2$
Electric conductivity	s	$M^{-2}L^{-2}TQ^2$	mho	$secC^2$/Kg m^3
capacitance	C	$M^{-1}L^{-2}T^2 Q^2$	Farad	sec^2C^2/Kgm^2
inductance	L	ML^2Q^{-2}	Henry	Kg m^2 /C^2
Current density	J	$QT^{-1}L^{-2}$	ampere per square meter	C/sec m^2
Charge density	r	QL^{-3}	coulomb per cubic meter	C/m^3
magnetic flux, Magnetic induction	B	$MT^{-1}Q^{-1}$	weber per square meter	Kg/sec C
magnetic intensity	H	$QL^{-1}T^{-1}$	ampere per meter	C/m sec
magnetic vector potential	A	$MLT^{-1}Q^{-1}$	weber/meter	Kg m/sec C
Electric field intensity	E	$MLT^{-2}Q^{-1}$	volt/meter or newton/coulomb	Kg m/sec^2 C
Electric displacement	D	QL^{-2}	coulomb per square meter	C/m^2
permeability	m	MLQ^{-2}	henry per meter	Kg m/C^2
permittivity,	e	$T^2Q^2M^{-1}L^{-3}$	farad per meter	sec^2C^2/Kgm^3
dielectric constant	K	$M^0L^0T^0$	None	None

frequency	f or n	T^{-1}	Hertz	sec^{-1}
angular frequency	W	T^{-1}	radians per second	sec^{-1}
Wave length	l	L	Meters	M

- **Principle of homogeneity:-**

It states that " the dimensional formulae of every term on the two sides of a correct relation must be same."

- **Types of error:-**

(a) Constant errors:- An error is said to be constant error if it affects, every time, a measurement in a similar manner.

(b) Systematic errors:- Errors which come into existence by virtue of a definite rule, are called systematic errors.

(c) Random error or accidental error:- Error which takes place in a random manner and cannot be associated with a systematic cause are called random or accidental errors.

(d) Absolute error:- $\Delta x_i = x_i - \bar{x}$

- **Relative Error:-**

$$\delta x_r = \frac{\bar{\Delta x}}{\bar{x}}$$

- **Percentage Error:-**

$$\delta x_p = \frac{\bar{\Delta x}}{\bar{x}} \times 100$$