UNIT-01

UNIT & DIMENSION

INTRODUCTION

Physics is a branch of natural science which deals with the Physical world and laws governing its behaviour. The knowledge in this discipline is through observations followed by critical analysis and interpretation.

=> Any Physical Phenomenon can be described quantitatively which involves certain measurable quantities and are called OBSERVABLE OR PHYSICAL quantities.

The Physical quantity which can't be expressed in terms of any other quantity are called FUNDAMENTAL quantity

The Physical quantity which can be expressed in terms of any other quantity are called DERIVED quantity.

There are seven fundamental quantity which are

as follows.

Sl no	Physical quantity	Name of unit	symbol
1	Mass	Kilogram	Kg
2	Length	Metre	m
3	Time	second	sec
4	Thermodynamic Temperature	Kelvin	K
5	Electric Current	Ampere	A
6	Amount of Substance	mole	mole
7	Luminous of intensity.	Candela	Cd

systems of units are as follows.

1) CGS system (Centimetre, Gram, second)

2) FPS System. (Foot, Pound, second)

3) MKS System (Metre, Kilogram, second)

4) SI system (international system)

=> When a physical quantity is expressed in terms of fundamental quantity it is written as the Product of different Power of fundamental quantity. The Power of fundamental quantity in that expression is called DIMENSION.

=> DIMENSION FORMULA of a Physical quantity is the formula which express how and which of the fundamental quantities have been used for the measurement of that quantity.

Ex MASS $[M]$ Dimension formula.

Dimension of mass is 1 w.r.t M

Area =Length x breadth or L x L = $[M^0L^2T^0]$ Dimensional formula

Dimension of area is 0, 2 ,0 w.r.t Mass, Length & Time.

Velocity = Displacement/time = $\frac{L}{T}$= $[M^0L^1T^{-1}]$

Acceleration = velocity/Time = = $[M^0L^1T^{-2}]$

Dimensional formula of Physical quantities

Sl No	Physical Quantities	Relation	Dimensional Formula
1	Length	Fundamental quantity	$[M^0L^1T^0]$
2	Time	Fundamental quantity	$[M^0L^0T^1]$
3	Temperature	Fundamental quantity	$[M^0L^0T^0K^1]$
4	Current	Fundamental quantity	$[M^0L^0T^0K^1]$
5	Force	Mass X Displacement	$[M^1L^1T^{-2}]$
6	Work	Force X Displacement	[M'L² T-²]
7	energy	Mass X acceleration due to gravity X height	[M'L² T-²]
8	Pressure	Force/Area	$[M^1L^{-1}T^{-2}]$
9	Power	Work/Time	$[M^1L^2T^{-3}]$
10	Stress	Force/ Area	$[M^1L^{-1}T^{-2}]$

11	Charge	Current X Time	$[M^0L^0T^1A^1]$
12	Potential difference	Work/charge	$[M^1L^2T^{-3}A^{-1}]$
13	Resistance	Potential difference /current	$[M^1L^2T^{-3}A^{-2}]$
14	wave length	Velocity/frequency	$[M^0L^1T^0]$
15	Frequency	1 / time period	$[M^0L^0T^{-1}]$

PRINCIPLE OF HOMOGENEITY

It States that the dimensional formula of every term on the two sides of a correct relation must be homogeneous.

To convert the value of a Physical quantity from one system to another Let us convent a work of 1 joule into erg.

M.KS Work CGS

M_1 = 1 Kg	$[M^1L^2T^{-2}]$	M_2 = 1 gm
L_1 =1met	a = 1	L_2=1 cm
T_1 = 1 sec	b = 2	T_2= 1 sec
n_1 = 1	c = -2	n_2= ?

$n_1\ [M_1^aL_1^b\ T_1^C] = n_2[M_2^aL_2^bT_2^c]$

$n_2 = \frac{1000\ gm}{1gm}\ x\ \frac{100\ cm}{1cm}\ x\ \frac{100\ cm}{1cm}\ x\ \frac{1\ sec}{1\ sec}$

1 joule = 10^7erg.

PROBLEM

Convert 1 Newton into dyne (ANS I N = 10^5dyne).

=> To check the correctness of a given relation.

Consider the relation S= ut +$\frac{1}{2}at^2$

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

R.HS $[M^0L^1T^{-1}][M^0L^0T^1]$ + [M°L'T -²] $[M^0L^0T^2]$ (1/2 has no Dimension)

` = $[M^0L^1T^0]$ + $[M^0L^1T^0]$

Since the dimensional formula of all terms in LHS & RHS are homogeneous, equation is dimensionally connect.

PROBLEM

i) Check V²-u² = 2as

ii) Check F = MV/R

iii) Check V = u + at

iv) Check T = 2π $\sqrt{\frac{l}{g}}$

Ans (I, iii, iv correct but ii is not correct)

=>To derive the relation between various Physical quantities. Consider the case of a simple Pendulum. The time Period

of simple pendulum (T) depends upon mass (m) effective length (L) and acceleration due to gravity (g).

T α M^a

α L^b

α g^c

T = K $M^aL^bg^c$ where. K-dimension less constant quantity

Dimensional formula of T, M, L & g are $[T^1]$ [M'] [L'] & $[L^1T^{-2}]$ respectively.

L·H·S of equation 1 is $[T^1]$

R. H.S of equation 1 is $[M^a]$ $[L^b][L^cT^{-2c}]$ b = $[m^aL^{b+c}T^{-2c}]$

From LHS & RHS a = 0, b + c =0 & -2c=1

Hence a=0 c = -1/2 & b = 1/2

using the value of a b & c in equation 1 we get

T = K $L^{1/2}g^{-1/2}$ or T = K √(l/g)

Short Answer Question

1 State the principle of homogeneity.

2 Define Dimension .

3 Write down the types of unit system .

4 Write the dimensional formula of force , power.

5 Write the dimensional formula energy , stress .

6 Write the dimensional formula current potential difference.

7 Write the dimensional formula resistance , wavelength .

8 Write the dimensional formula work , frequency .

Five mark questions

1) Check the correctness of the equation $V^2-u^2 = 2as$ using dimensional analysis .

2) Check the correctness of the equation $F = MV^2/R$ using dimensional analysis .

3) Check the correctness of the equation V = u+at using dimensional analysis .

4) Check the correctness of the equation T = 2π √l/g using dimensional analysis .

5) Check the correctness of the equation $S = ut + \frac{1}{2}at$ using dimensional analysis .