ENGINEERING PHYSICS

1st SEM

MECHANICAL ENGG.

Under SCTE&VT,Odisha

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⇒ what is science?

The systematic knowledge earned through observation, experiment and logic is known as science.

⇒ The word science is derived from latin word "scientia" which means "to know".

⇒ science is devided into two types

(1) Physical science

(2) Biological science

Physical science

⇒ The branch of science which deals with non-living things is called as physical science.

EX/:- Physics, chemistry, Engeneering etc.

Biological science

⇒ The branch of science which deals with life is called as Biological science.

EX/:- Botany, zoology, medical science etc.

⇒ what is physics?

It is the science of nature which describes laws or principles that explain how natural world works.

⇒ The word physics is derived from a greek word "PHYSIS" which means "nature".

⇒ It deals with matter and energy around us.

⇒ It deals with chapters like
(1) mechanics
(2) heat and thermodynamics (heats motion)
(3) Electricity
(4) optics
(5) Nuclear physics
(6) Atomic physics

Physical quantity

⇒ Anything which can be measured and in terms of which laws of physics are expressed is called physical quantity
Ex:- mass, length, time, force, velocity, speed, energy etc.

⇒ Physical quantities are of two types
(1) Fundamental physical quantities
(2) Derived ,, ,,

Fundamental quantities

⇒ The physical quantities ~~those~~ which can be measured directly are called fundamental quantities

or

⇒ The physical quantities which do not depend on others to be measured is known as fundamental quantities.

EX/:- mass, length, time, electric current, Temperature, Luminous intensity, amount of substance.

Derived quantities

The Physical quantities which depend on fundamental quantities to be measured are called derived quantities.

EX/:- Force, Power, acceleration, volume, area etc.

magnitude of Physical quantities

~~The Physical quantities which depend on fundamental quantities to be measured~~

It is the product of a number and a unit

mathmatically, $m = nu$

where n = number

u = unit of the physical quantity

For a physical quantity

$$n_1 u_1 = n_2 u_2$$

where n_1 and u_1 are number and unit of 1st system

$1m = 10^2 cm$

$n_2 \; u_1 \quad n_1 \; u$

n_2 and u_2 are number and unit in ~~sec~~ 2nd system

$$1m = 100cm$$
$$\downarrow\ \downarrow\quad \downarrow\ \downarrow$$
$$n_1\ u_1\quad n_2\ u_2$$

⇒ For a physical quantity

$$\boxed{n \propto \frac{1}{u}}$$

Unit

⇒ A constant quantity (value) in terms of which other quantities are expressed is called unit

OR

⇒ A standard of measurement may be called a unit.

Ex:- meter, kilogram, centimeter, ~~kilog~~ second etc.

Standard or standard unit

⇒ An internationally accepted and well defined symbol use to measure physical quantities is called standard ~~or~~ unit.

~~Ex~~:- standard of mass kilogram, standard of length meter, standard of time second

Multiples and sub-multiple of units

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

EXAMPLES

⇒ multiple units of length
deca meter, hectometer, tera meter

⇒ multiple units of mass
deca gram, hecto gram, tera gram.

⇒ multiple units of time
deca second, hectosecond, tera second

⇒ Sub-multiple units of length
decimeter, centi meter, micrometer

⇒ Sub-multiple units of mass
centi gram, micro gram, miligram

⇒ sub-multiple units of time
centi second, mili second, micro second

Types of unit

⇒ There are four types of units.

(1) Fundamental units
(2) Derived units
(3) Suplimentary units
(4) Practical units

Fundamental units

⇒ The units of fundamental quantities are called fundamental units

Ex/:- meter, kg, second, centimeter, gram etc.

Derived units

⇒ The units of derived quantities are called derived units.

Ex/:- m/s (speed), m/s² (acceleration), Newton (force), Jule etc.

Suplimentary unit

⇒ The units of suplimentary quantities (plane angle and solid angle) are called suplimentary units

Ex/:- unit of plane angle - radian.
symbol - rad
Ex:- degree, radian

1 ly → 9.46 × 10^{15} m

unit of solid angle - steradian

symbol - sr

Practical units

⇒ The units which are neither fundamental nor derived and have a special name and are use in our day to day life are called Practical units.

Ex:- (1) Light year

(1) Light year

⇒ It is a biger practical unit of length

⇒ defination - It is the distance traveled by light in vaccume in one year at it's speed. $v = \frac{s}{t} \Rightarrow s = vt$

$1ly = 9.46 \times 10^{15} m$

$1ly = s = vt = (3 \times 10^8 m/s) \times 1 year$

$= 3 \times 10^8 m/s \times 365 \times 24 \times 3600 \times s$

$= 9.46 \times 10^{15} m$

$= 9.46 Pm$

(2) Astronomical unit (A.U)

⇒ It is a biger practical unit of length definition

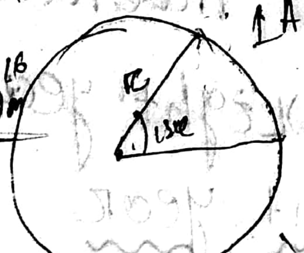
⇒ It is the average distance between sun and the earth.

i.e $1 A.U = 1.496 \times 10^{11} m$

Parallactic second (par sec)

⇒ 1 par sec is defind as the distance at which an arc of 1 A.U subtends an angle of 1 second.

$1 par sec = 3.084 \times 10^{16} m$



⇒ It is a biger practical (macroscopic) unit of length

Angstroam (Å)

⇒ It is a smaller (microscopic) unit of length.

$1 Å = 10^{-10} m$

micron (μ)

⇒ It is a smaller practical unit of length.

$1 \mu = 10^{-6} m$

Fermi (fm)

⇒ It is a smaller practical unit of length

1 fm = 10^{-15} m

A.M.U (Atomic mass unit/ u)

⇒ It is a smaller practical unit of mass

~~[illegible]~~ 1u = 1.66×10^{-27} kg

Characteristics of standard unit

1) It should be invariable (not change with place and time)

2) It should be in destructible. (not change temperature and pressure)

3) It should be accessible (easily available)

4) It should be re-producable

5) ~~It should be universally~~

5) It should be internationally accepted

⇒ Find the relation between a light year and astronomical unit

Solution

$1ly = 9.46 \times 10^{15}$ m —— (i)

$\therefore 1m = \frac{1ly}{9.46 \times 10^{15}}$

$1 A.U = 1.496 \times 10^{11}$ m —— (ii)

$\therefore 1m = \frac{1A.U}{1.496 \times 10^{11}}$

From eq^n (i and (ii)

$\frac{1ly}{9.46 \times 10^{15}} = \frac{1AU}{1.496 \times 10^{11}}$

OR

$$1\,ly = \frac{1\,A.U \times 9.46 \times 10^{15}}{1.496 \times 10^{11}}$$

$$1\,ly = A.U\ \frac{9.46}{1.496} \times 10^{15-11}$$

$$1\,ly = \frac{9.46}{1.496} \times 10^{4}\,A.U$$

$$1\,ly = 6.328 \times 10^{4}\,A.U$$

(2) Find relation between Parsec and Astronomical unit.

$$1\ \text{Par sec} = 3.084 \times 10^{16}\,m$$

$$1\,m = \frac{1\ \text{Parsec}}{3.084 \times 10^{16}} \quad \text{—— (i)}$$

$$1\ \text{Astronomical unit} = 1.496 \times 10^{11}\,m$$

$$\therefore 1\,m = \frac{1\,A.U}{1.496 \times 10^{11}} \quad \text{—— (ii)}$$

From equation (i) and (ii)

$$\frac{1\ \text{Par sec}}{3.084 \times 10^{16}} = \frac{1\,A.U}{1.496 \times 10^{11}}$$

$$\Rightarrow 1\ \text{Par sec} = \frac{3.084 \times 10^{16}\,A.U}{1.496 \times 10^{11}}$$

$$\Rightarrow 1\ \text{Parsec} = \frac{3.084\,A.U}{1.496} \times 10^{16-11}$$

$\Rightarrow$ 1 Par sec $= \frac{3.084 \text{ AU}}{1.496} \times 10^5$

$\Rightarrow$ 1 Par sec $=$ 2.06×10^5 AU

1 Par sec = 3.258 ly

(3) How many nano meters are there in Pico meter?

1 Pico meter $= 10^{-12}$ m

$\therefore$ 1 meter $= \frac{\text{pm}}{10^{-12}}$ ——— (i)

1 nm $= 10^{-9}$ m

$\therefore$ 1 m $= \frac{1\text{nm}}{10^{-9}}$ ——— (ii)

From eq^n (i) and (ii)

$\frac{\text{Pm}}{10^{-12}} = \frac{1\text{nm}}{10^{-9}}$

$\Rightarrow$ Pm $= \frac{1\text{nm}}{10^{-9}} \times 10^{-12}$

$\Rightarrow$ Pm $= 10^{-12-(-9)} = 10^{-12+9} = 10^{-3}$ nm

$\therefore$ 10^{-3} nm are present in 1pm.

(4) How many tera meters are their in one mega meter

1 mega meter $= 10^6$ m

1 tera meter $= 10^{12}$ m

$\frac{1\text{tm}}{1\text{Mm}} = \frac{10^{12}}{10^6}$

$\Rightarrow$ $= 10^{12-6} = 10^6$. 1 megameter $= 10^6$ tm

(5) How many micrometers are their in one giga meter?

1 giga meter $= 10^{9} m$

$\therefore 1m = \frac{1gm}{10^{9}} = 10^{-9} gm$ ——— (i)

1 micrometers $= 10^{-6} m$

$\therefore 1m = \frac{1\mu m}{10^{-6}} = 10^{6} \mu m$ ——— (ii)

From eq^n (i) and (ii)

$10^{-9} gm = 10^{6} \mu m$

$\Rightarrow 1gm = \frac{10^{6} \mu m}{10^{-9}}$

$\Rightarrow 1gm = 10^{6+9} \mu m$

$\Rightarrow 1gm = 10^{15} \mu m$

System of unit:

=> There are four types of system of unit.

(1) M.K.S system
(2) C.G.S system
(3) F.P.S system
(4) S.I system (International system)

S.I. ~~system of u~~

=> M.K.S system couldnot cover whole/all branches of physics so in 1971 a conference on weights and measures decided a new system of units which is called International system of units.

=> shortly it is represented S.I unit according to French name "Le systeme International d units"

=> This system conteins seven fundamental units and two suplymentary units

S.I fundamental units

(i) meter (m) - unit of length
(ii) kilogram (kg) - unit of mass
(iii) second (s) - unit of time
(iv) kelvin (K) - unit of temperature

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(v) ampere - (A) unit of electric current

(vi) ~~luminous intensity~~ Candela - (cd) unit of luminous intensity

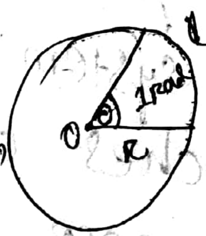
(vii) mole - (mol) - unit of amount of substances

S.I. Suplimentary units

(i) radian (rad) - unit of plane angle

(ii) steradian (sr) - unit of solid angle

radian



=> one radian $l = r$
is defind as $\theta = 1$ radian
the ~~unit of~~ $\theta = \frac{l}{r} = 1$
plane angle subtended at the centre of a circle by an arc whose magnitude is equal to the magnitude of its radious.

when $l = r$, $\theta = \frac{l}{r} = \frac{r}{r} = 1$ radian

steradian

=> $\omega = \frac{\text{surface area}}{(\text{Radius})^2}$

1 steradian is defind as the solid-angle subtended at centre of a sphere

is equal to the square magnitude square of the magnitude of its radius

when surface area (A) = (radius)^2

$$\omega = \frac{\text{surface area}}{(\text{Radius})^2} = \frac{\text{Radius}^2}{\text{Radius}^2}$$

= 1 steradian

⇒ Total solid angle / maximum solid angle subtended at the centre of the sphere is 4π Sr.

$$\omega = \frac{S.A}{(\text{radius})^2} = \frac{4\pi R^2}{R^2} = 4\pi$$

Advantages of S.I

⇒ It is an absolute system

⇒ It is a coherent system of unit.

⇒ It is a rational system of unit. (sensible)

⇒ It is a metric system.

Dimension of Physical quantity (nature)

Dimensions of a physical quantity are defined as the powers to which fundamental quantities are raised to represent the nature of the physical quantities.

Length has Dimension [L]

mass has Dimension [M]

Time	"	[T]
Temp	"	[K]
electric current	"	[A]
luminous intensity	"	[cd]
amount of substance	"	[mol]

Ex: Dimensions of speed

$$[speed] = \frac{[Distance]}{[Time]} = \frac{[L]}{[T]}$$

$$= \frac{Length}{Time} = \frac{L}{T} = [L^1 T^{-1}]$$

Thus, Speed has 1 dimension in length and -1 dimension in time and "0" dimension in mass

i.e (0, 1, -1)
M L T

⇒ Dimension of acceleration

$$\text{acceleration} = \frac{\text{velocity}}{\text{time}}$$

$$= \frac{\frac{\text{Displacement}}{\text{time}}}{\text{time}} = \frac{\frac{\text{Length}}{\text{Time}}}{\text{Time}}$$

$$= \frac{\frac{L}{T}}{T} = \frac{L}{T} \times \frac{1}{T} = \frac{L}{T^2} = [L^1 T^{-2}]$$

$$= [M^0 L^1 T^{-2}]$$

Thus acceleration has 1 dimension in length and, -2 dimension in time and "0" dimension in mass.

(4) Dimension of Force

$$F = ma$$

$$= \text{mass} \times \frac{\text{velocity}}{\text{time}}$$

$$= \text{mass} \times \frac{\frac{\text{Displacement}}{\text{time}}}{\text{time}}$$

$$= M \times \frac{\frac{L}{T}}{T} = \frac{ML}{T^2} = MLT^{-2}$$

$$= [M^1 L^1 T^{-2}]$$

Thus Force has 1 dimension in length and mass and, -2 dimension in time. i.e (1, 1, -2)

time -1 dimension in time.

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→ Dimension of work 8→

~~energy~~ work = FS

$= [M^1 L^1 T^{-2}] [L^1]$

$= [M^1 L^2 T^{-2}]$

Thus work has 1 dimension in mass and 2 dimension in length

→ Dimension of energy 9.

energy = same as work

i.e $[M^1 L^2 T^{-2}]$

Thus energy has 1 dimension in mass and 2 dimension in length and -2 dimension in time

Dimension of momentum

momentum = mv ~~mass~~

$= [M] [L^1 T^{-1}]$

$= [M^1 L^1 T^{-1}]$

Thus momentum has 1 dimension in mass, and 1 di

8→ ~~Area~~ Dimeansion of Area

Area = Length x bregth

$= [L][L]$

$= [L^2]$

$= [M^0 L^2 T^0]$

Thus area has '0' dimension in ~~length~~ mass and, 2 dimension in length

9→ Dimension of volume

volume = Length x breath x height

$= L \times L \times L$

$= [L^3]$

$= [M^0 L^3 T^0]$

Thus volume has '0' dimension in mass and '3' dimension in length and '0' dimension in time.

~~10→~~ Dimension of kinetic energy

$E_k = \frac{1}{2} m v^2$

$= M(LT^{-1})^2 = [M^1 L^2 T^{-2}]$

~~Thus~~

10→ Dimension of Potential energy

$E_p = mgh = [M L^1 T^{-2} \cdot L^1] = [M^1 L^2 T^{-2}]$

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Important points/tools in Dimensions

Dimensional Formula

Dimensional formula of speed is [speed] is $[M^0L^1T^{-1}]$

[Force] is $[M^1L^1T^{-2}]$ etc.

Dimensional equation

$[speed] = [M^0L^1T^{-1}]$ etc.

Dimensions gives the nature of a physical quantity and also gives the unit of physical quantity

⇒ Dimension of a physical quantity doesn't give its magnitude

⇒ 1, 2, 3 ..... have no dimension.

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

$[2] = [M^0L^0T^0]$ ...

⇒ π has no dimensions

$[\pi] = [M^0L^0T^0]$

⇒ Angle has no dimension
i.e dimensionless quantity

$[angle] = [\theta] = [\frac{l}{r}] = [\frac{L}{L}] = [1] = [M^0L^0T^0]$

⇒ $\sin\theta, \cos\theta, \tan\theta, \sec\theta$
have no dimension.

$[\sin\theta] = [\frac{P}{h}] = [\frac{L}{L}] = [1] = [M^0L^0T^0]$

⇒ $\log x$ has no dimension
where x = 1, 2, 3, 4 ...

$[\log x] = [M^0L^0T^0]$

⇒ e^x has no dimension

$[e^x] = [M^0L^0T^0]$

where e = Irrational number

⇒ Dimensional variables
meaning :- (i) which have dimensions
(ii) whose magnitude are variable.

Ex :- speed, velocity, acceleration,
Force etc.

⇒ Dimensional Constant
meaning :- (i) which have dimesions
(ii) whose magnitude are constant.

Ex :- speed of light in vacuum (3×10^8 m/s),
Gravitational constant (G) (6.67×10^{-11} Nm^2/kg^2)

Non - Dimensional variable

⇒ meaning :- (i) which have no dimension.
(ii) whose magnitudes are variable

EX/:- Angle

Non- Dimensional constant

⇒ meaning:- (i) which have no dimension.
(ii) whose magnitudes are constant or fixed

EX/:- π, 1, 2, 3, 4 . . . . .

Principle of homogeneity of dimension

⇒ A physical equation is dimension correct if all terms of the equation have same dimension.

or

Physical quantities can be added or substracted if they have same dimensions

EX/:-

The position of a particle changes with time is given by $x = a + b + ct^2$
where a, b, c are constants.
find dimensional formula of a, b and c.

Sol^n According to the principle of homogeneity of dimension

$[a] = [x] = [L] = [M^0 L T^0]$

$[bt] = x$ or, $b = [\frac{x}{t}] = [\frac{L}{T}] = [LT^{-1}]$

$[ct^2] = [x]$ or $[c] = \left[\frac{x}{t^2}\right] = \left[\frac{L}{T^2}\right] = [LT^{-2}]$

) The position of a particle is given by
$x = a - bt - ct^2$
where a, b, c are constant
t = time in second
x = distance in meter
Find the dimension of a, b and c.

Solution

according to the principle of homogeneity of dimension.

$[a] = [x] = [L] = [M^0 L^1 T^0]$ = meter (unit)

$[bt] = [x]$ or $[b] = \left[\frac{x}{t}\right] = \left[\frac{L}{T}\right] = [M^0 L^1 T^{-1}]$ = meter/sec

$[ct^2] = [x]$ or $[c] = \left[\frac{x}{t^2}\right] = \left[\frac{L}{T^2}\right] = [M^0 L^1 T^{-2}]$ = meter/sec^2

Speed is given by $v = at + \frac{b}{(c+t)}$

Somya maharana

where t = time
Find [a], [b], [c]

Solution

$[at] = [v]$ or $[a] = \left[\frac{v}{t}\right] = \left[\frac{LT^{-1}}{T}\right] = [LT^{-2}]$

$[v] = \left[\frac{b}{c+t}\right]$ or $[b] = [v][c+t] = [LT^{-1}][T] = [L]$

$[c] = [T]$

An ideal gas equation is given by

$(P + \frac{a}{V^2})(V - b) = Rt$

where P = Pressure
V = volume
Find [a], [b].

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Solution

According to the principle of homogenity.

$[P] = \left[\frac{a}{V^2}\right]$

$\Rightarrow [a] = [P][V^2] = [M^1L^{-1}T^{-2}][L^6]$

$[a] = [M^1L^5T^{-2}]$

$[V] = [b]$

$\Rightarrow [b] = [L^3]$

(5) Force is given by $F = at + bt^2$

where t = time

Find $[a]$ and $[b]$

Solution

$[F] = [at]$

$[a] = \left[\frac{F}{t}\right] = \frac{[M^1L^1T^{-2}]}{[T]} = [M^1L^1T^{-3}]$

$[F] = [bt^2]$ or $[b] = \left[\frac{F}{t^2}\right] = \frac{[M^1L^1T^{-2}]}{[T^2]}$

$[b] = [M^1L^1T^{-4}]$

(6) If $y = r\sin(\omega t - kx)$

find $\left[\frac{\omega}{k}\right]$

where t = time

x = displacement

Since

$[\omega t] = [M^0L^0T^0]$

$[kx] = [M^0L^0T^0]$

$[\omega t] = [kx]$

or. $[v] = [\frac{x}{t}] = [\frac{L}{T}] = [LT^{-1}]$

(7) Find dimensional formula of 'x' in e^{-2xt}

where t = time

$[e^{-2xt}] = [M^0L^0T^0]$

$\therefore [-2xt] = [M^0L^0T^0]$

$\therefore [x] = \frac{[M^0L^0T^0]}{[t]} = [M^0L^0T^{-1}]$

(8) The position of a particle changes with time 'T' is given by

$S(t) = \frac{V_0}{\alpha}(1 - e^{-\alpha t})$

find $[\alpha]$ and $[V_0]$

$S(t) = \frac{V_0}{\alpha}(1 - e^{-\alpha t}) = \frac{V_0}{\alpha} - \frac{V_0}{\alpha}e^{-\alpha t}$

~~$[\frac{V_0}{\alpha}] = [S]$, $[V_0] = [S][\alpha]$~~

$[-\alpha t] = [M^0L^0T^0]$

$[\alpha] = \frac{[M^0L^0T^0]}{[t]} = \frac{[M^0L^0T^0]}{[T]} = [M^0L^0T^{-1}]$

$[\frac{V_0}{\alpha}] = [S]$ or $[V_0] = [S][\alpha]$

$[V_0] = [L][T^{-1}] = [M^0L^1T^{-1}]$

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Uses of dimension / dimensional analysis

(i) Dimensional analysis is used to convert a unit from one system to another system.

Problem - 1

Convert one Newton into dyne by dimension.

$[F] = [M^1L^1T^{-2}]$

we have $n_1 u_1 = n_2 u_2$

$n_1 [M_1 L_1 T_1^{-2}] = n_2 [M_2 L_2 T_2^{-2}]$

1 N = ? dyne

$$n_2 = \frac{n_1 [M_1 L_1 T_1^{-2}]}{[M_2 L_2 T_2^{-2}]}$$

or $n_2 = n_1 \left[\frac{M_1}{M_2}\right]^1 \times \left[\frac{L_1}{L_2}\right]^1 \times \left[\frac{T_1}{T_1}\right]^{-2}$

$= n_1 \left[\frac{kg}{g}\right] \times \left[\frac{m}{cm}\right] \times \left[\frac{sec}{sec}\right]^{-2}$

$= n_1 \left[\frac{1000 g}{g}\right] \times \left[\frac{100 cm}{cm}\right]$

$= 1000 \times 100$

$= 10^5$

(2) M.K.S (system-1) — Physical quantity: Force — C.G.S (system-2)

M.K.S (system-1)	Physical quantity	C.G.S (system-2)
$m_1 = 1kg$	Force	$m_2 = 1g$
$L_1 = 1m$	$a = 1$	$L_2 = cm$
$T_1 = 1 sec$	$b = 1$	$T_2 = 1sec$
$n_1 = 1$	$c = -2$	$n_2 = ?$

Physical quantity of system-1

$= n_1 [m_1^a L_1^b T_1^c]$

Physical quantity of system-2

$= n_2 [m_2^a L_2^b T_2^c]$

As the physical quantity are same for both the system so.

$$n_1 [m_1^a L_1^b T_1^c] = n_2 [m_2^a L_2^b T_2^c]$$

$$\Rightarrow n_2 = \frac{n_1 [m_1^a L_1^b T_1^c]}{[m_2^a L_2^b T_2^c]} = n_1 \left[\frac{m_1}{m_2}\right]^a \left[\frac{L_1}{L_2}\right]^b \left[\frac{T_1}{T_2}\right]^c$$

$$\Rightarrow n = 1 \left[\frac{1kg}{g}\right]^1 \left[\frac{1m}{1cm}\right]^1 \left[\frac{1sec}{1sec}\right]^{-2}$$

$$\Rightarrow n = \left[\frac{1000g}{g}\right] \left[\frac{100cm}{1cm}\right]$$

$$\Rightarrow n = 1000 \times 100 = 10^5$$

∴ 1 Newton = 10^5 dyne.

(3) Convert 10 Joule into erg by dimension

M.K.S (1st system)	P.Q work	C.G.S (2nd system)
$m_1 = 1kg$	$a = 1$	$m_2 = 1g$
$L_1 = 1m$	$b = 2$	$L_2 = 1cm$
$T_1 = 1sec$	$c = -2$	$T_2 = 1sec$
$n_1 = 10$		$n_2 = ?$

putting these in eq^n (1)

$$n_2 = 10 \left[\frac{1kg}{1g}\right] \left[\frac{1m}{1cm}\right]^2 \left[\frac{1sec}{1sec}\right]^{-2}$$

$= 10 \times \left[\frac{1000\,g}{g}\right]\left[\frac{10000\,m^2}{cm^2}\right]\left[\frac{1\,sec}{1\,sec}\right]^{-2}$

$= 10 \times 1000 \times 10000 \times \frac{1}{1^{-2}}$

$= 10^8$ erg

1) express 100 Joule work in a system where fundamental unit are 50g, 10meter and 5second

$(5^{-1})^{-2}$

MKS (1st system)	PQ work	C.G.S 2nd system
$m_1 = 1kg$	$a = 1$	$n_2 = ?$
$L_1 = 1m$	$b = 2$	$m_2 = 50g$
$T_1 = 1sec$	$c = -2$	$L_2 = 10m = 10\times10^2 = 10^3 cm$
$n_1 = 100$		$T_2 = 5sec$

$n_2 = n_1 \left[\frac{m_1}{m_2}\right]\left[\frac{L_1}{L_2}\right]^2\left[\frac{T_1}{T_2}\right]^{-2}$

$= 100\left[\frac{1kg}{50g}\right]^1 \times \left[\frac{1m}{10^3 cm}\right]^2\left[\frac{1sec}{5sec}\right]^{-2}$

$= 100 \times \left[\frac{10^3 g}{5\times10 g}\right]\left[\frac{10^2 cm}{10^3 cm}\right]^2\left[\frac{1}{5}\right]^{-2}$

~~$100 \times 20 \times 10^{-2}$~~

$= 100 \times \left[\frac{10^2}{5}\right]\left[\frac{1}{10}\right]^2\left[5^{-2}\right]$

$= 100 \times 20 \times \frac{1}{100}\frac{1}{25} = \frac{20}{25} = \frac{4}{5}$

Use-2

Dimensional analysis is used to check the correctness of a physical equation

(1) check the correctness of $v = u + at$

where u = I. V
v = F. V
a = acceleration
t = time

$[v] = [M^0 L^1 T^{-1}]$

$[u] = [M^0 L^1 T^{-1}]$

$[at] = [a][t]$
$= [M^0 L^1 T^{-2}][T]$
$= [L^1 T^{-1}]$

Since dimensions of all terms of the equation are same. So the equation is dimensionally correct.

(2) check the correctness of $v^2 = u^2 + 2as$

where v = F. V

$[v^2] = [L^1 T^{-1}]^2 = [L^2 T^{-2}]$

$[u^2] = [L^1 T^{-1}]^2 = [L^2 T^{-2}]$

$[2as] = [a][s] = [L T^{-2}][L] = [L^2 T^{-2}]$