Date 11/07/2013

UNIT, DIMENSION & ERRORS

UNIT

1.> Physical Quantities :-

I.> The Quantity which can be measerd are known as physical Quantity.

II.> Physical Quantity $\boxed{p = nu}$

n = Numerical constant.

u = Unit of the q'1ty.

e.g length = 5cm

$n = 5$, u = cm.

2.> Unit :-

I.> The physical Quantity is measured by the comparsion of it with a "standered reference" that standered reference is known as Unit of that Quantity.

II.> Physical Q. by $\boxed{p = nu}$

In different system.

$p = n_1u_1 = n_2u_2 = n_3u_3 = - - - -$

$= nu$ = constant.

$\boxed{n \propto \frac{1}{u}}$, $(u\uparrow\ n\downarrow)$

e.g. length = 1m = 100cm = 1000mm.

3.> System of Units :-

(I) C.G.S System :- Centrimeter. gram. second.

Another name → French or Metric System.

(II) F.P.S System :- Foot. Pound. Second System.

Another name → British System

III.) M.K.S System :- Meter Kilogram Second Systems
Another name :- French or Metric System.

IV) S.I System :-
⇒ Full name of this system is International System of Units.
⇒ The S.I System is the modified form of M.K.S System.
⇒ According to S.I System there are seven fundamental Quantites & two supplimentory Quantites.

Fundamental and Derived Quantites :-
I.) Fundamental Quantites :-
or Base Quantites :-
I.) The Quantites which donot depend on any other Quantites or,
The Quantites which can be freely express are Known as Fundamental (Base) Quantites.

II.) According to S.I System there are seven fundamental Quantites → next page

Supplimentry	S.I. Unit	Symbol
I.) plane angle	radian	θ Or rad.
II.) Solid angle	Steradian	Sr Or Srad

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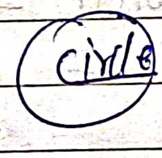
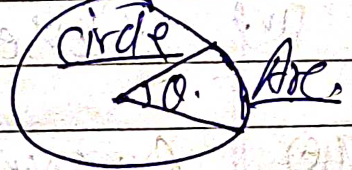
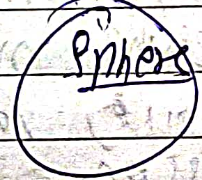
Fundamental	S.I unit	Symbol of unit.
Mass	kilogram	kg
length.	meter	m.
Time	Sec.	S.
Temperature	Kelvin	K.
Eletric current	Ampere	A
luminous intensity	candela	cd.
Amount of Substance.	mole	mol or M.

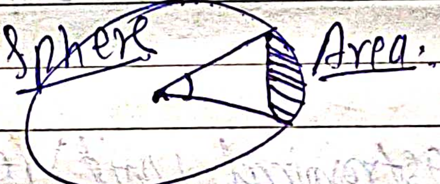
$$\boxed{\text{Plain angle } \theta = \frac{\text{Arc}}{\text{radius}}}$$





$$\text{Solid angle } (\Omega) = \frac{\text{Area}}{(\text{radius})^2}$$





Derived Quantities :-

i) The Quantities which depends up on Fundamental Quantites or,
The Quantities which requires Fundamental Quantities to represent are known as Derived Quantities.

ii) Ex:- Speed $= \frac{\text{distance}}{\text{time}} = \frac{\text{length}}{\text{time}}$.

$\text{accel}^n = \frac{\text{velocity}}{\text{time}} = \frac{\text{displacement}}{(\text{time})^2} = \frac{\text{length}}{(\text{time})^2}$

Que) Which of the following are not a physical Quantities or Quantity.

Ex- (i) length, (ii) time, (iii) kilogram.
(iv) light year.

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(iii) Kilogram – Unit of physical ~~Qty~~ Quantity of mass.
(iv) light year = unit of distance.

Que. Which of the following are units of physical fundamental Quantities.
(i) Ex: Mass, (ii) temperature, (iii) milli second,
(iv) passec.

(iii) milli second = Unit of time.
(iv) Passec = Unit of distance.

Que. Arrange the following units of length in increasing order.
Fermi, Astronomical unit, light year
passec.

Passec > light year > Astronomical unit > Fermi.

$\boxed{1\ \text{fermi} = 10^{-15}\ m}$

Astronomical Unit :– Average distance between sun & earth.

$\boxed{1\ AU = 1.49 \times 10^{11} m}$

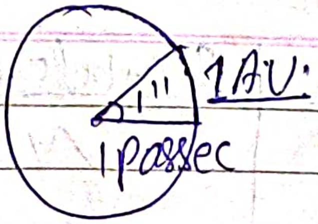
Light year :– distance travelled by light in one year.

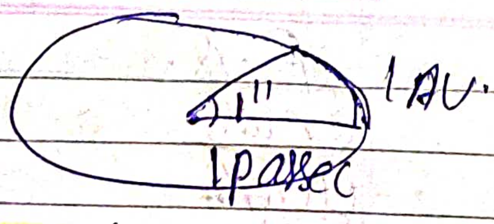
$\boxed{1\ \text{light year} = 9.46 \times 10^{15} m}$

Passec :– Fullname :– Parallectic Second → distance measure

$1\ \text{passec} = 3.08 \times 10^{16} m.$

angle = $\frac{\text{Arc}}{\text{radius}}$





Que: Which of the following statements is/are true:—
A Physical quantity :—

T i) can not have unit & Dimension.
T ii) can have unit but not Dimension. — Imp
F ~~iii)~~ can have dimension but not unit.

Ex:- i) Strain, Relative density, R.I. etc.
ii) plane angle, Solid angle.

Dimensions :-

1) Defination:- When a drive quantity express any terms of fundamental quantity then the power raised on fundamental quantities are known is Dimensions of ~~the~~ that quantity.

Ex:- Speed = $\frac{\text{distance}}{\text{time}}$ = (Length)^1 × (time)$^{-1}$ → Dimension

Speed = (length)^1 × (time)$^{-1}$

Ex2:- acceleration = $\frac{\text{velocity}}{\text{time}}$ = (length)^1 × (time)$^{-2}$

2) Dimensional formula:- When a drive quantity express in terms of fundamental quantities then this express is known as dimensional formula of that quantity.

Ex:-
Force = mass × Accel^n.

$\boxed{\text{Force} = (\text{mass})^1 \times (\text{length})^1 \times (\text{time})^{-2}}$

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$3.28 \times 9.8 = 2624 + 2952 = 32.144$

Fundamental Quantity

F.Q.	Symbols of Dim.	Symbol of unit
Mass	M	Kg
length	L	m.
time	T	s.
temperature	K or θ.	K
luminous intensity	cd	cd
Amount of sub.	M	mol or U.
Current	A	A

Ex:- dimes. formula.

force. ⇒ $[F] = [MLT^{-2}]$

Solved Example Page→14

Ex. The acceleration due to gravity is $9.8 m/s^2$. Give its value in ft/s^2

Sol:- As. 1m = 3.28 ft.

∴ $9.8 m/s^2 = 9.8 \times 3.28 ft/s^2$

$= 32.144 \ ft/s^2 \approx 32 \ ft/s^2.$

Question for Practice

Q1) The value of Gravitational constant G in M.K.S system is $6.67 \times 10^{-11} N\text{-}m^2/kg^2$. What will be its value in C.G.S System.?

Sol:- $G = 6.67 \times 10^{-11} N\text{-}m^2/kg^2$ in M.K.S System.

$1N = 10^{5}$ dyne.

$1m = 100cm$; $1m^2 = 10000 cm^2$

$1kg = 1000g.$

$G = 6.67 \times 10^{-11} \dfrac{\times 10^{+5} dyne \times \cancel{10000}\ 10^2 cm^2}{\cancel{10^6}\ 10^2}$

$= \cancel{6.67 \times 10^{-19.126}}\ dyne\text{-}cm^2/g^2.$

$= 6.67 \times 10^{-11} \times 10^{3}$ dyne $-cm^2/g^2$

$= 6.67 \times 10^{-8}$ dyne $-cm^2/g^2$

dimension formula

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Q 2.) Name the smallest and largest units of length.

Sol:- Smallest unit of length = fermi

1 fermi = 10^{-15} m.

largest unit of length = passec.

1 passec = 3.08×10^{16} m.

Q.3.) (A)

(a) Base unit —— (v) kg

(b) Derived unit —— (i) N

(c) Supplementary unit —— (iv) rad.

Que) The Dimension of $\frac{EJ^2}{M^5 G^2}$ = ?

E = Electric field
M = mass.
J = angular momentum
G = Gravitational const.

Soln:- $F = qE \Rightarrow E = \frac{F}{q} = \frac{MLT^{-2}}{I \cdot T}$

$= \frac{[MLT^{-3}A^{-1}][ML^2T^{-1}]^2}{M^5[M^{-1}L^3T^{-2}]^2}$

$= M^0 L^{-1} T^{-1} A^{-1}$ Ans

Que) The Dimension of $\frac{h}{I}$ = ?

h = plank constant
I = moment of inertia.

① Time ② frequency ③ length ④ NOT.

$E = h\nu \Rightarrow h = \frac{E}{\nu} = \frac{ML^2T^{-2}}{T^{-1}} = [ML^2T^{-1}]$

$[I] = mr^2 = [M^1L^2T^0]$

$\boxed{E = \text{energy}}$ ν = frequency

$\frac{h}{I} = \frac{[ML^2T^{-1}]}{[M^1L^2T^0]} = T^{-1} =$ Frequency.

Que) The dimension of $\frac{E^2}{\mu_0}$ = ?

E = Electric field.
μ_0 = permeability.

① $M^1L^1T^{-2}$ ② $M^{-1}L^{-3}T^{-2}$ ③ $M^1L^1T^{-4}$ ④ NOT

Short Cut: $\frac{\frac{1}{2}\epsilon_0}{\epsilon_0} \times \frac{E^2}{\mu_0} \Rightarrow [M^1L^{-1}T^{-2}][L^2T^{-2}]$

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

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Energy density $= \frac{1}{2}\epsilon_0 E^2 =$ Energy/Vol $= ML^{-1}T^{-2}$

$\frac{1}{\sqrt{\mu_0\epsilon_0}} = c \Rightarrow \frac{1}{\mu_0\epsilon_0} = c^2 \Rightarrow (LT^{-1})^2 = \frac{1}{\mu_0\epsilon_0}$.

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Que The Dimension of $\frac{CV}{\rho\,\epsilon_0} = ?$ | C = capacitance, V = potential, ρ = sp. Resistance, ϵ_0 = permittivity.

(1) charge (2) current (3) time (4) NOT.

(I) $C = \frac{\epsilon_0 A}{d}$, (II) $R = \frac{\rho l}{A} \Rightarrow$ (III) $\rho = \frac{RA}{l}$

$\Rightarrow \frac{\epsilon_0 A}{d} \times \frac{V \times d}{RA \times \epsilon_0} = \frac{V}{R} =$ current. Ans

Que The dimension of $\frac{e^2}{\epsilon_0 hc} = ?$ | e = charge of e⁻, h = plank const., c = speed of light

(1) mass (2) length (3) angle (dimensionless) (4) time.

$F = \frac{1}{4\pi\epsilon_0}\frac{q^2}{r^2} = \frac{1}{\epsilon_0} \times \frac{e^2}{r^2} \Rightarrow \frac{e^2}{\epsilon_0} = F \cdot r^2$

$E = \frac{hc}{\lambda} \Rightarrow hc = E\lambda$ | E = energy = F.r

$\frac{e^2}{\epsilon_0 hc} = \frac{Fr^2}{E\lambda} = \frac{Fr^2}{F \cdot S\, \lambda} = \frac{r}{\lambda} =$ Dimension less.

$= M^0L^0T^0 =$ angle.

W = F.S

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9.> L. heat and gravitational potential. (velocity)^2.

All the p...
parts Acc...

Dimension...

Dimensional variables

Ex:- → mass → speed → force → length.

(4) Principal ... sions:-

(1) According ... added ...
Ex:- ✓ ... ✓ ...

2> According ... dimension ...
Ex:- ...
[M...

(5) **Que** x and y ... of the f...

(1) x/dy

(6) ...

All the physical quantities can be divided into two parts according to their dimensions.

Physical Quantity

- Dimensional quantity
  - Dimensional variables
    - Ex:- mass, speed, force, length.
  - Dimensional constant
    - Ex:- Gravitational constant, plank's constant, Gas constant, Speed of light in vacc.
- Dim-less quantity
  - Dim-less variable
    - Ex:- Strain, Rel. density, R.I, angle.
  - Dim-less constant
    - Ex:- 1, 2, 3, ...
    - Ex:- π, e.
    - Ex:- sin(—), cos(—), tan(—)
    - Ex:- log(—)
    - Ex:- power. $e^{(-)}$, $x^{(-)}$, $2^{(-)}$.

Principal of homogenity of dimensions :-

① According to this principal only those quantity can be added or subtracted which are having same dimension.

Ex:- ✓ force ± force. | ✗ force ± velocity

✓ velocity ± velocity.

2) According to this principal in a dimension equation dimension of both side should be equal.

Ex:- $K.E = \frac{1}{2} mv^2$

$[ML^2T^{-2}] = [ML^2T^{-2}]$

Que. x and y are two quantities of same dimension then which of the following operation is/are correct.

① $x \pm y$, ⑪ $x \cdot y$ ⑪ $x \times y$ ⑭ $\frac{x}{y}$ ⑤ $\log(\frac{x}{y})$.

⑥ $e^{(\frac{x}{y})}$ ⑦ All of these.

$= \frac{F}{L} = MLT^{-2}$ $a = m/s^2$ $B = MLT^{-2}$

Surface tension $= \frac{F}{L}$ $= LT^{-2}$ $\frac{}{ML^2T^{-2}}$

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(Que) x and y are quantities are different dimension then which of the is/are correct

(I) $x+y$, (II) $x-y$, (III) $x \times y$ (IV) $\frac{x}{y}$ (V) $\log(\frac{x}{y})$

(VI) $e^{-(\frac{x}{y})}$.

(5) Use of dimensional method :-

1.) To check the accuracy of dimensional eqn.

2.) To establish a relation among different physical quantities.

3.) To convert a P.Q. (Physical quantity) one system to another system of units.

1.) To check the accuracy :-

Q. Surface tension $T = \frac{rhdg}{2\cos\theta}$

where r = radius, h = height, d = density, g = accel^n due to gravity. then check the accuracy of eqn.

$\frac{F}{L}$ $[\cancel{F^1 M^0 L^0}] = [L][L][\frac{M}{L^3}][LT^{-2}]$

$= L^3 \cdot M T^{-2}$

$\frac{[MLT^{-2}]}{[L]} = [MT^{-2}L^0]$.

$[ML^0T^{-2}] = [ML^0T^{-2}]$ Ans

(Que) To prove $T = \frac{ehB}{8\pi m h}$ } e = charge of electron, h = plank const, B = magnetic field.

m = Mass

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9:30 a.m.

R. No. 43
Exi-2

if the eqn is dim... of x = ?

$T = \ldots$

$F \cdot r = e \times m \ldots$

$\boxed{M^x = M^1}$

$\boxed{x = 1}$

Exerc...

1.) The ratio of one ...

Soln $\frac{1u}{1n} = \ldots$

3.) joule x second is the ... Angular mo...

4.) List I (I...

(A.) Distance bet earth...

(B.) Inter atomic d...

(C.) Size of nucle...

(D.) wave length of ...

5.) (3) Energy = ...

I.m.p Dim.

1. latent heat (L)

2. Self inductance (L)

meg. flux $\phi = L\ldots$

$= MLT^{-2}$

$\frac{}{ML^2T^{-2}}$

Donut 9:30 a.m. · P. No. 43 Ex: 2 · Page No. 90 Ex: 1. 1–15 · P. No. 93 Ex: 2 1, 6, 7, 8, 9, 10, 11, 13–19.

if the eqn is dimensionally correct then find out the value of $x = ?$

$$\tau = \frac{ehB}{8\pi m^x}$$

$$F \cdot r = \frac{e \times mvr \times F}{8\pi \times m^x \cdot qv}$$

$$\boxed{m^x = m^1}$$

$$\boxed{x = 1}$$

$F = qvB$

$B = \frac{F}{qv}$

$h = mvr$

Exercise – I. Page 90. → UNITS & Dimension.

1.) The ratio of one micron to one nanometer is

Soln $\frac{1\mu}{1n} = \frac{10^{-6}}{10^{-9}} = 10^3$ Ans (1.)

3.) joule × second is the unit of $= J \times$ sec. Time.

Angular momentum $= J \times$ sec. $= [M^1L^2T^{-1}]$ (3)

4.) List I (Item) — List II (Units of length)

(A.) Distance bet earth and stars.

(B.) Inter atomic distance in a solid

(C.) Size of nucleus.

(D.) Wave length of Infrared Laser.

5.) (3) Energy = $Kg \frac{m}{s}$ A

power = $\frac{\text{work}}{\text{Time}}$

work = force × distance

$G = \frac{Fr^2}{m_1m_2}$ | M.I. = mass × r^2

pressure = $\frac{F}{A}$

I.m.p Dim.

latent heat (L) Heat $\boxed{Q = mL.}$

$$L = \frac{Q}{m} = \frac{ML^2T^{-2}}{M} [L^2T^{-2}]$$

2.) Self inductance (L)

meg. flux $\phi = Li \Rightarrow L = \frac{\phi}{i} = \frac{B \cdot A}{i} = \frac{F}{qv} \times \frac{A}{i}$

v = velocity.

of electron

const

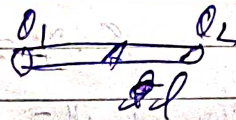
field.

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

$F = qvB$, $B = \frac{F}{qv}$.

→ Co-eff. of thermal conductivity (K)

$\left(\frac{\text{Heat}}{\text{time}}\right) \frac{Q}{t} = \frac{KA(\theta_1 - \theta_2)}{d}$



$\frac{M^1 L^2 T^{-2}}{T^1} = \frac{K L^2 \cdot \theta^1}{L^1}$

$[K] = [M^1 L^1 T^{-3} \theta^{-1}]$

3* → Power $= \frac{W}{t} = \frac{[ML^2T^{-2}]}{[T]} = [ML^2T^{-3}]$

$\frac{J}{sec}$ = watt (W).

→ Modulus of Elasticity $= \frac{\text{Stress}}{\text{Strain}} = \frac{F}{A}$

A: TO [2004] $= \frac{M L^1 T^{-2}}{L^2} = ML^{-1}T^{-2}$

2* → Coefficient of viscosity (η)

Force $F = 6\pi \eta r v$.

where r = sphere of radius, v = velocity, F = force

$\eta = \frac{F}{6\pi r v}$

$= \frac{M L T^{-2}}{[L][LT^{-1}]} = [ML^{-1}T^{-1}]$.

2* Resistance (R)

$V = IR$.

$R = \frac{V}{I} \times \frac{t}{q} = \frac{\text{work}}{q \times I}$

$V = \frac{\text{Work}}{q(\text{charge})}$, $I = \frac{q}{\text{Time}}$

$[C] = qV$.

$= \frac{M \cdot L^2 T^{-2}}{A^1 T^1 \times A^1} = ML^2T^{-3}A^{-2}$

2* Capacitance (C) :-

$Q = CV$.

[Forc

→ Megn

→ Sola

→ meg

→ curre

2* → Electr

→ Ang.

A I E [2008

Note:- Streng

→ Surfa

→ Spring

2* → dipol

* → Pro Pa

(W

→ Electri

[Force gradient] = ~~St~~ [spring constant] current

$M^1 L^{-1} T^{4} A^{-1}$

$C = \frac{Q}{V} \times \frac{Q}{Q} = \frac{Q^2}{W} = \frac{A^2T^2}{ML^2T^{-2}}$ Ans. $= M^{-1}L^{-2}T^{4}A^{2}$ Ans.

→ Magnetic permeability (μ_0) :-

$B = \frac{\mu_0 I}{2r} = \frac{F}{qv}$.

or,

$\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi x}$ ⇒ $\mu_0 = MLT^{-2}A^{-2}$ Ans.

$= \text{Force} \times (\text{current})^{-2}$

→ Solar constant $= \frac{\text{Energy}}{\text{Area} \times \text{time}} = ML^0T^{-3}$ Ans.

→ Mag. flux ⇒ $\phi = B \cdot A = \left(\frac{F}{qv}\right) A$ weber.

→ current density $j = \frac{I}{\text{Area}}$ ⇒ $[A^1L^{-2}]$.

current

milli ampere

→ Electric permittivity (ϵ_0)

$F = \frac{1}{4\pi\epsilon_0} \times \frac{q^2}{r^2}$

$\epsilon_0 = \frac{q^2}{F \times r^2} = \frac{A^2T^2}{[MLT^{-2}][L^2]}$

→ Ang. Acceleⁿ (α) $= \frac{\omega}{t} = \frac{\text{rad/s}}{\text{sec}} = \frac{\text{rad}}{s^2}$ ⇒ $[T^{-2}]$.

AIIE [2008]

Note :- Strength of magnetic field or magnetic field (B) :-

$F = qvB$ ⇒ $B = \frac{F}{qv}$ = (Tesla) = $[MT^{-2}A^{-1}]$

→ Surface Tension = Force/Length $= [ML^0T^{-2}]$

→ Spring const. $= kx$ ⇒ $K = \frac{F}{x} = [M^1L^0T^{-2}]$

→ dipole Moment = $\boxed{P = q \times l}$

→ Propagation const. (k) :- $\frac{2\pi}{\lambda}$ or, (wave number)

(wave number) ⇒ $[L^{-1}]$ or m^{-1}.

⇒ Electric Field (E) :- $F = qE$ ⇒ $E = \frac{F}{q}$

Force = charge × E

energy gradient = $\frac{\text{Energy}}{\text{Length}}$

→ Potencial (V) :-

$V = \frac{W}{q} = \frac{ML^2T^{-2}}{A^1T^1}$

→ Gravitational potencial

$V = \frac{W}{\text{mass}} = (LT^{-1})^2$

→ Energy gradient = $\frac{\text{Energy}}{\text{Length}}$

3★ → Time constant = $\frac{L}{R}$ = $\frac{\text{Inductance}}{\text{Resistance}}$ = time.

$\boxed{RC = \text{time}}$

Q. Dimes. of $\frac{L}{RCV} = \frac{\text{time}}{CV} = \frac{\text{time}}{\text{Charge}} = \frac{1}{\text{current}}$.

⇒ Boltzman constant :-

K.E at temp^n (T) ⇒ $E = \frac{3}{2}KT$

$[K] = \frac{ML^2T^{-2}}{\theta^1} = [ML^2T^{-2}\theta^{-1}]$

4.) Stefan's const(σ) ⇒ $\frac{E}{A\times t} = \sigma T^4$

$\sigma = \frac{E}{A\times t\times T^4} = [M^1L^0T^{-3}\theta^{-4}]$.

9/7/13.

Que Velocity gradient = $\frac{F}{\eta A}$ where F = force, η =, A = Area

If equation is dimensionally correct then find out dimension of η.

Sol: $\frac{[LT^{-1}]}{[L]} = \frac{MLT^{-2}}{\eta[L^2]}$

$\eta = [L^{-1}MT^{-1}] = [ML^{-1}T^{-1}]$.

---

where let

$a = x$

Q. $\int \frac{dx}{\sqrt{a^2-x^2}}$

L.H.S $\int$

R.H.S =

Q. $\int \frac{dx}{\sqrt{a^2-x^2}} =$

1 = (

1° = (

dim

5/7/13

2nd use :- To

Que escape velocity

gravitation con

earth d. then

Sol:- V =

V

velocity

Put Dimension:

where let x = disp. $G = \frac{MLT^{-2}[L^2]}{M^2} = M^{-1}L^3T^{-2}$ 10:15

a = disp.

$a^2 = x^2$ dimensionless.

Q. $\int \frac{dx}{\sqrt{a^2-x^2}} = \frac{1}{a}\sin^{-1}\left(\frac{x}{a}\right)$. then check the accurate of the equation.

L.H.S $\int \frac{disp.}{disp.}$ = Dimensionless.

R.H.S $= \frac{1}{disp.}$

L.H.S $\neq$ R.H.S

Incorrect

Q. $\int \frac{dx}{\sqrt{a^2-x^2}} = a^y \sin^{-1}\left(\frac{x}{a}\right)$ if eqn is dimen. correct then find out value of y = ?

dimensionless

$1 = a^y$ $\boxed{y=0}$ Ans

$1^0 = [L]^{y\,0}$

$M \to L, T$, $[M] = [L^0T^0]$

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

dimensionless → angle ✓, → strain ×

$z = x$

$3x + y - 3z = 1$

$\boxed{y=1}$

$-2x = -1$

$x = \frac{1}{2}$

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2nd use :- To establish relation among diff. Physical Q:-

Que escape velocity (V) on earth surface depends on gravitation constant G, radius of earth R and density of earth d. then established the formula of ecape velocity.

Sol:- $V \to G, R, d$

$V \propto G^x R^y d^z$

velocity $\boxed{V = k G^x R^y d^z}$

$x = ?$
$y = ?$
$z = ?$

Put Dimension:-

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$$[M^0 L T^{-1}] = [M^{-1} L^3 T^{-2}]^x [L]^y [M L^{-3}]^z$$

$$= M^{-x+z} L^{3x+y-3z} T^{-2x}$$

By comparison

$-x+z=0$ ~~$x=z$~~ — (1) $z=\frac{1}{2}$

$3x+y-3z=1$ — (2) $\Rightarrow y=1$

$-2x=-1$ — (3) $\Rightarrow x=\frac{1}{2}$

Escape velocity $v = K G^{\frac{1}{2}} R d^{1/2}$

$$\boxed{v = KR\sqrt{Gd}}$$

Actual vel. formula. $K=\sqrt{\frac{8}{3}\pi}$

$$v = R\sqrt{\frac{8}{3}\pi G d}$$

NOTE:- Limitation:-

1. We can not find out the dimensionless constant K. By this method.
2. If quantity depends on more than three(3) quantities then dimension formula may not be stablish by this method.
3. By dimensional method eqn having adding or subtraction can not be drive.

(Imp) volume flow rate (Q $\frac{m^3}{sec}$) depends on radius ~~Arr~~. (r) pressure gradient and cofficient of viscosity. then established the formula of vol flow rate.

$$\frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2} = \frac{F}{A} = $$

Sol:-
$$Q \propto r^x P_g^y \eta^z$$
$$Q = K r^x P^y \eta^z$$
$$[L^3T^{-1}] = [L]^x \left[\frac{MLT^{-2}}{[L]}\right]^y [ML^{-1}T^{-1}]^z$$
$$[M^0L^3T^{-1}] = [L^x][ML^{-2}T^{-2}]^y[ML^{-1}T^{-1}]^z$$
$$M^0L^3T^{-1} = L^{x-2y-z}\,T^{-2y-z}\,M^{y+z}$$

$-2y-z = -1$ —— (I) $\Rightarrow 2y+z = 1$

$x-2y-z = 3$ —— (II) $\quad x-1 = 3 \quad \boxed{x=4}$

$y+z = 0$ —— (III)

$2y+z = 1$ $\quad y=-z$

$+y = +1 \quad \boxed{y=1} \quad \boxed{z=-1}$

$$Q = K r^4 P_g^1 \eta^{-1}$$
$$\boxed{Q = \frac{K r^4 P_g^1}{\eta}}$$ Ans

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Ques ⑦ P.E of oscillation of a mass (m) is where k = const
$U = kx^3$ $\quad$ ~~k = const.~~

then time period of oscillation when depend(a). x = displacement

(I) proportional to a (II) inversly proportional to a.

(III) proportional to $\sqrt{a}$ (IV) inversly " to $\sqrt{a}$.

Sol:- (energy) $U = kx^3$.
$$T \propto m^x k^y a^z$$
$$[M^0L^0T^1] = [M]^x [ML^{-1}T^{-2}]^y [L]^2$$
$$M^0L^0T^1 = M^{x+y} L^{-y+z} T^{-2y}$$
$x+y=0$ —— (I) $\quad -y+z = 0$ —— (II)

S.H.M
$F = -kx$
$U = \frac{1}{2}kx^2$
$T = 2\pi\sqrt{\frac{m}{k}}$

$k = \frac{U}{x^3} = \frac{\text{Energy}}{[L^3]}$

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$-2y = 1 \Rightarrow y = \frac{1}{2}, z = \frac{1}{2}$

$T \propto a^{\frac{1}{2}}$

$\boxed{T \propto \frac{1}{\sqrt{a}}}$ Ans

Q. If force (F), length (L) and time (t) are taken as fundamental quantities then find out the Dimensional formula of mass (m)

$\text{Mass} \propto \cancel{\text{force}}\ F^x . l^y . t^z$

$= K\ [MLT^{-2}]^x [L]^y [T]^z$

$[L^0 T^0 M^1] = [M^x L^{x+y} T^{-2x+z}]$

$x = 1, \quad x+y = 0$

$x = -y \Rightarrow y = -1$

$-2x + z = 0$

$z = 2x$
$= 2$

$\text{mass} = K\ F^1 l^{-1} t^2$

$\boxed{\text{mass} = K \frac{F t^2}{l}}$ Ans

Short trick

$m \longrightarrow F, l, t$

$F = ma \quad \left(a = \frac{v}{t} = \frac{l}{t^2}\right)$

$F = m . \frac{l}{t^2}$

$m = \frac{F t^2}{l} \Rightarrow \boxed{[m] = [F^1 l^{-1} t^2]}$

Q. If force (F) length (l) and time (t) are taken as F.Q then the give the dimensi. formula of (1) first density. (2) nd pressure, (3) rd momentum. (4) K.E.

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(I) $d \rightarrow F, l, t$

$$d = \frac{m}{Vol} = \frac{F}{a \cdot Vol} = \frac{F \times t^2}{l \cdot l^3} = \frac{F \times t^2}{l^4}$$

2.) $pressure = \frac{Force}{Area} = \frac{F}{l^2}$

$$[P] = [F^1 l^{-2} t^0]$$

3.) $momentum\ (p) = mv = m\frac{l}{t} = \frac{F}{a} \times \frac{l}{t}$

$$[p] = [F^1 l^0 t^1]$$

$$= \frac{F}{l} \times t^2 \times \frac{l}{t}$$

2nd method

$$F = \frac{dP}{dt} \Rightarrow dp = F \cdot dt$$

$$\boxed{p = F \cdot t}$$

4.) $K.E = \frac{1}{2}mv^2$

$K.E \rightarrow F, l, t.$

(I) $K = \frac{1}{2}mv^2$

(II) $K = work = F \times l$

$$[K] = [F^1 l^1 t^0].$$

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3rd use.

(i) To convert the physical Quantity from one system to another system :-

⇒ Numerical constant of a physical quantity in one system is n_1 and unit of mass, length and time. are M_1, L_1, T_1. in another system numerical constant is n_2 and unit of mass, length, and time are M_2, L_2, T_2. and dimension of this quantity. are a, b & c.

1st	2nd
n_1	n_2
M_1	M_2
L_1	L_2
T_1	T_2