Yashveer
@yashveerSholiya

Physics Notes

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Unit and Dimention

Introduction :-

The word 'physics' Comes from the greek word meaning - 'nature'

Today physics is treated as the most fundamental branch of Science and find numerous application of life

It also deal with matter in relation to Energy and the accurate measure of same.

☆ "PHYSICS" is a branch of Science which deals with nature and natural phenonmena

Physical quantities

A Quantity, measured under physics, is Called physical quantities.

☆ All the term we use in physics are Called physical quantities.

EXAMPLE :- Mass, time, velocity, acceleration, Force, torque, Current etc. are Called phy. quantities

[[UNIT]]

☆ [Unit of a physical quantity is its standard]

[[Unit Example]]

Suppose If the answer is 20 of any quantity equation than what you think it is correct? Not

because Every physical quantity need a unit

If the answer will be like :-
60 or 20 kg, 20 watt, 20 gram, 20 km

than it is Correct becouse Now we have both physical quantity and its unit for representing it

20 kg, km, m/s, h, etc

numerical Value

UNIT

-: It also having a formula :-

Physical quantity $\boxed{Q = n \times u}$ Unit

Numerical Value

Different unit System

There are various unit systems which are used to describe measurement of physical quantites

There are 3 type of unit system

1. CGS – Centimeter-gram-Second
2. FPS – foot – pound – Second
3. MKS – meter – kilogram – Second

↑ Length ↑ MASS ↑ Time

there is an 'international system of unit' which was accepted international in 1960. It is called S.I System.

S.I. UNIT

The SI system of units has seven fundamental units.
and two supplementary fundamental units as:-

1	Length	metre	m
2	MASS	Kilogram	Kg
3	Time	Second	S
4	Electric Current	Ampere	A
5	Temperature	Kelvin	K
6	Amount of Substance	mole	mol
7	Luminous Intensity of Light	Candela	cd

The two Supplementry fundamental units

(1)	Plane Angle	Radian	rad
(2)	Solid angle	Steradian	sr

DERIVED UNITS

① we know that there is 7 fundamental units which are independent and do not depend upon other units

② the rest of units (physical quantities) are not independent and they need two or more than two fundamental units of derive them.

OR

- Those units, which need two or more than two fundamental units, are Called derived units.

Example

① speed :- m/s
② acceleration :- m/s^2
③ force :-
④ Density :- kg/m^3

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Principle of Dimention Homogenity

1. According to the principle, dimentions of all the terms of LHS and RHS of an equation should be same.

2. If dimentions of both sides are not same, then equation is said to be incorrect.

USE of Principle of Dimention Homogeneity

Principle of dimentional homogeneity use for

1. To check the correctness of equation,
2. To derive relationship among various physical quantities.
3. To Convert numerical values of one unit System into another unit System,

1. To check Dimension Correctness of Equation

[[USE]]

step-1 physical quantities of both sides of an equation should be same.

step-2 If It is not equal in both side than the equation is incorrect

step-3 And If the equations are equal in both side than the equation said to Carrect

LETS TAKE AN 'EQUATION'

Equation of Motion

Displacment ⟷ $\boxed{s = ut + \frac{1}{2}at^2}$ → Time^2

initial velocity, Time, Acceleration

$\boxed{S} = \boxed{ut} + \frac{1}{2}at^2$

$t = \boxed{t}$

$S = \boxed{L}$ → Length

$u = \boxed{L}$

$t = \boxed{t}$ → Time

Dimention of Acceleration

$a = \boxed{LT^{-2}}$

L.H.S $\boxed{S} = \boxed{ut + \frac{1}{2}at^2}$ R.H.S

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$$s = ut + \frac{1}{2}at^2$$

$\boxed{L}$ $\boxed{LT^{-1}} \times \boxed{T}$ $\frac{1}{2}$ $\boxed{LT^{-2}} \times \boxed{T^2}$

How dimention are Calculate

① $s = ut + \frac{1}{2}at^2$ — for an Example

$$s = ut + \frac{1}{2}at^2$$

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

$$[L] = [L] + \boxed{\frac{1}{2}}[L]$$

there is a special rule for numerical value

RULE:-1 Do not write numerical value on equation when solving it [like in the Example ↑] $\frac{1}{2}$

RULE:-2 Dimention only can multiply They will need Add

Example:- ① $[LT^{-1}] \times [T] = [L]$ they will only multiply.

② $[L] = [L] + [L]$ they will never add.

[L.H.S] [R.H.S]

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To Derive Relationship Among various physical quantities

[I] DIMENTION RELATIONSHIP

Question:-1 Time period of a Simple pendulum may depend upon mass of bob (m), length of string (l) and acceleration due to gravity (g). Derive the relationship of T with m, l and g.

Step-1 Every physical quantity have an power like a, b, c

OR Example $[M^a L^b T^c]$ power of mass, Length and Time.

Rule:1 Always put the powers of Physical quantities

Rule:2 ANAlys the Question Carefully

Rule:3 AlwAys MAKE OR USE BRAKETS ([ ]) in Every dimention presentation

Rule:4 USE K Constant in the place of propotional ($\propto$)

Rule:5 Compare Dimention of both Side

Rule:6 Solve the value of a, b, c variables power

Rule:7 putt the value of a, b and c in equation.

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Proportional Symbol — the power of Dimentions

Solving:- 1 $T \propto m^a l^b g^c$

$\propto$ It removes by Applying K Constant

2 $T = K m^a l^b g^c$

Mass length gravitation force

3 Now write the dimention of both side :-

$$[M^0 L^0 T] = [M]^a [L]^b [LT^{-2}]^c$$

Remove K Now (Not Required)

$$[M^0 L^0 T] = [M^a L^{b+c} T^{-2c}]$$

☆ Combining dimention and also distribution of power.

?

$$[M^a L^{\boxed{b+c}} T^{-2c}]$$

Becouse, we can see that the dimention [L] means Length is arives at two place ① first is length Indivitualy and ② second with the formula of Gravitional force - $[LT^{-2}]$

—×—×—×—×—×—×—×—×

① $[M]^a [L]^b [LT^{-2}]^c$ $[M]^{a \, block} [L]^{block} [LT^{-2}]^c$

② $[M^a [L]^b [LT^{-2}]]$

$[M]^a [L]^b [LT^{-2}]^c$

Mohan block LALita block block

$[M]^a [L]^b [L\,T^{-2}]^c$ — ~~[LT]~~

Lavish Lavish Tanisha

Mohan A block मे रहता है

B block मे LALitA or Lavish रहता है. और Lavish कभी कभी C block मे भी जाता है.

c block मे Tanisha रहती है जिसके block मे Lavish आता है

---

4. Compare the dimention M, L, T, both side

$a=0$ [becouse we don't have value of M in this equation]

$b+c=0$

$-2c=1$

Explain HOW?

I $[M^0 L^0 T^1] = [M^a L^{b+c} T^{-2c}]$

1 power
Here ~~value~~ of
$m=0$ $\longleftrightarrow$ Here m power is $m=a$ that says value of $a=0$

proved-1

$\boxed{a=0}$

II $[M^0L^0T^1] = [M^a L^{b+c} T^{-2c}]$

Here is the ~~value~~ power of
$L=0$

Here is the ~~value~~ power of
~~b+c~~ $L = b+c$

value of $\boxed{b+c=0}$

III $[M^0L^0T^1] = [M^a L^{b+c} T^{-2c}]$

Here is the power of
$T=1$

Here is the power of
$T=-2c$

The value of power
$\boxed{-2c=1}$

\- 5. Solving the equation of powers a, b, c

$\boxed{a=0}$ where it come from?

$\boxed{b=\frac{1}{2}}$ WhAT is this? How it is possible?

ONly the thing is matter, How the value of b is Solved

★ It is solved by the value of c

Now we have to find the value of C

$\boxed{C = -\frac{1}{2}}$ Solved value of C

Now, Depress it for MORE DETAIL

$\boxed{-2C=1}$

This is the value which is use for comparing the Dimention powers.

(1) $-2C=1$

(2) $\boxed{C=-\frac{1}{2}}$

[Here we got the value of C] [AFTER solving it]

⇒ ([[Now we solve "b" by the value of C.]])

$\boxed{b+C=0}$

[the values, when we compare the power of dimention]

Now, get back to Solving the value of [b+c]

$$\boxed{b+c=0}$$

put VALUE of C

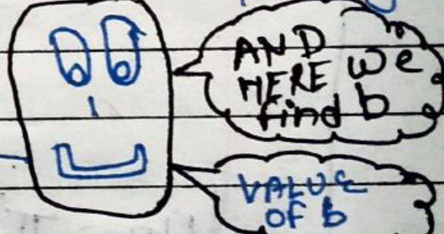
① $b + -\frac{1}{2} = 0$

② $b + -\frac{1}{2} = 0$

③ $b = \boxed{\frac{1}{2}}$

[when we take any digit Right Side to left Side from the equal Sign (=)]

(−) removes when we take Any digit any side of equal Sign (=)



6. putting the values of a,b,c in equation ①

$a=0$, $b=\frac{1}{2}$, $c=-\frac{1}{2}$

Putting values on equation:-

$$\underset{\text{value of A}}{a}\quad T = Km^0 l^{1/2} g^{-1/2} \quad \underset{\text{value of B}}{b} \quad \underset{\text{value of C}}{c}$$

☆ — [Now, there is a gamechanging and Important point]

☆☆☆ → [If there is an (negetive power) than you have to put it in upon (Divide)]

[How] LET'S 👁.

$$T = \frac{K l^{1/2}}{g^{1/2}}$$

[when an power get into upon than negetive Sign is remove]

$$T = K\sqrt{\frac{l}{g}}$$

How This under root COMES?

Please always remember that: when you see $\sqrt{\frac{a^{1/2}}{b^{1/2}}}$ when their is 1/2 in both upon $\sqrt{\frac{a^{1/2}}{b^{1/2}}}$ — uper Side — Doon Side than it will change into whole underroot $\sqrt{\frac{a}{b}}$ ← Example.

To Convert Numerical Value of ONE unit System to Another unit System

$\boxed{\text{Convert OR change unit System}}$

Let Considered ~~Numerical value~~ Physical quantity whose numerical value is n_1 in unit System u_1 and numerical value become n_2 in unit System u_2 as :—

$$\boxed{n_1 \times u_1 = n_2 \times u_2 = \text{Constant}}$$

Don't know what is matter behind writting this :-

Suppose $M_1L_1T_1$ are fundamental units in one unit System and $M_2L_2T_2$ are fundamental unit in another unit system. If a,b,c are dimentions of M,L,T then

1. $$\boxed{n_1[M_1^a L_1^b T_1^c] = n_2[M_2^a L_2^b T_2^c]}$$

→ Just for writting (for formality)

2. $$\boxed{n_2 = n_1\left[\frac{M_1}{M_2}\right]^a\left[\frac{L_1}{L_2}\right]^b\left[\frac{T_1}{T_2}\right]^c}$$

→ These 2 step are for defining quantites properly

[Now Start Converting]

Q- Let's Convert 1 Joule work into CGS system.

CALCULATION Start

Dimention of work $= [ML^2T^{-2}]$

Magnitude of work in SI System, $n_1 = 1$

$$u_1 = [M_1L_1^2T_1^{-2}]$$

Similarly, in C.G.S system, $n_2 = ?$

Centimeter, gram, Second

[There the solving begins from....]

1 $u_2 = [M_2 L_2^{2} T_2^{-2}]$

$n_2 = n_1 \left[\frac{u_1}{u_2}\right]$ Dimentions

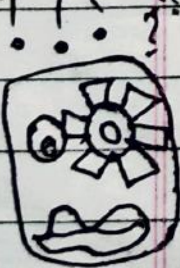
$n_2 = 1 \left[\frac{M_1}{M_2}\right]\left[\frac{L_1}{L_2}\right]^{2}\left[\frac{T_1}{T_2}\right]^{-2}$

$= 1 \left[\frac{kg}{g}\right]\left[\frac{m}{cm}\right]^{2}\left[\frac{s}{s}\right]^{-2}$ ← Converting this unit into this unit

$= 1 \left[\frac{1000g}{g}\right]\left[\frac{100cm}{cm}\right]^{2}\left[1\right]^{-2}$

$= \boxed{10^7}$ NOT final Answer

??? ???



but how they Solve it

I DON'T KNOW WHAT IS THIS

HOW it CALCULATED

gram centimeter second

Therefore, $\boxed{1 \text{ Joule} = 10^7 g\, cm^2 s^{-2}}$

FINAL SOLVED ANSWER

EXERCISE....

Example 1 check the correctness of equation, $v^2 = u^2 + 2as$, using dimentional analysis —

Solution

$$v^2 = u^2 + 2as$$

$$[LT^{-1}]^2 = [LT^{-1}]^2 + 2[LT^{-2}] \times [L]$$

$$[L^2T^{-2}] = [L^2T^{-2}] + [L^2T^{-2}]$$

eq-①

eq-②

Dimention of both Side are Same, therefore equation is Correct. by using dim.

Example 2 check the Correctness of equation $v = \sqrt{2gh}$ using dimentional analysis.

$$v = \sqrt{2gh}$$

$$[LT^{-1}] = [LT^{-2} \times L]^{1/2}$$

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

$$[LT^{-1}] = [LT^{-1}]$$ — ?

equation Correct ✓

Example3 show that magnitude of linear momentum (ΔP) of a body is equal to product of force (F) acting on a body and time period (Δt) by using time analysis.

force

$$\Delta P = F \times \Delta t$$

Time period

momentum

Solving

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

$$[MLT^{-1}] = [MLT^{-1}]$$

HENCE PROVED

Dimention of both side are Same, So the equation is Correct

Example 4 ~~In vander waal~~ In vander waal's equation $\left(P+\frac{a}{V^2}\right)(V-b)=RT$ what are the dimention 'a' and 'b' Here P is pressure, V is volume, T is temprature and R is universal gas Constant.

Solution

$P =$ Pressure

$V =$ Volume

$T =$ Temperature

$R =$ Universal gas Constant (?)

$$\left(P + \boxed{\frac{a}{V^2}}\right)(V-b) = RT$$

dimention of $\frac{a}{V^2}$ = Dimention of (P) Pressure

(1) $\frac{a}{V^2} = P$ [CALCULATE]

(2) $\frac{a}{V^2} = P$

×

(3) $a = P \times V^2$

$= [ML^{-1}T^{-2}] \times [L^3]^2$

$= [ML^{-1}T^{-2}] \times [L^6]$

$$= [M L^5 T^2]$$

dimention of $(v-b)$

Here I am Confuse, but only thingk that we have to find only the value of b from $(v-b)$

$$(v-b)$$

dim. of b = dim. of volume (v)

$$[b] = [v]$$

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

Confusion: 1

$\left(P+\frac{a}{v^2}\right)$ - Always we have to remamber that is a Complete unit to Solve we cannot only Solve $\frac{a}{v^2}$ becouse is also $\left(P+\frac{a}{v^2}\right)$ a

[P] pressure in Solving unit which is not use in 2nd eq. $(v-b)$ becouse this unit only have two dimention only.

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Example 5 Determine the dimention of Constant a, b, c and d in the following equation.

$$v = a + bt^2 + \frac{c}{d+t}$$ where velocity is v and t is time.

Solution $$v = a + bt^2 + \frac{c}{d+t}$$

$$[L.H.S] = [v]$$

$$[R.H.S] = \left[a + bt^2 + \frac{c}{d+t}\right]$$

$$v = a + bt^2 + \frac{c}{d+t}$$

$$[LT^{-1}] = a + b[T^2] + \frac{c}{d+[T]}$$

dim. of $a = [LT^{-1}]$

dim of $b = a + b(t)^2$ $\left[a + b(t^2)\right]$

$$= b = \frac{a}{t^2}$$

$$b = \frac{\boxed{V}[LT^{-1}]}{T^2} = b = [LT^{-3}]$$

Velocity formula

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Now, the Imp. point is that – we should not find dimention of C directly we have to find value of d first.

find dimention of d

dimention of d = $\frac{c}{d+t}$

$= d+t$

$d = t$

dim. of d = dim. of T

dim. of C = $\frac{c}{d+t}$

$= V = a + bt^2 + \frac{c}{d+t}$

dim. of C = $v \times t$

$= [LT^{-1}] \times [T]$

$= [L]$

$[LT^{-1}] \times [T]$

$[LT^{-1}][T]$

$[LT^{-1+1}]$

$[L]$

HENCE PROVED

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Example 6 This distance Covered by a particle in time t is given by $x = a + bt + ct^2 + dt^3$. find the dimention of a, b, c, d.

Solution

$t = [T]$ Time

$x = [S]$ displacment

dim. of a = dim of x ⇐ displacment

dim of b = $x = a + bt$

$= b = \frac{a}{t}$

$b = \frac{[L]}{T}$ when lower digit goes upperside than negetive sign accurs

$b = [LT^{-1}]$

dim of c = $x = a + bt + ct^2$

$= a = ct^2$

$c = \frac{a}{t^2}$

$c = \frac{[L]}{[T^2]}$

$= [LT^{-2}]$

dim of d = $x = a + bt + ct^2 + dt^3$.

x/a — we can choose x or a they have same dim. [L]

put a

$a = dt^3$

$d = \frac{a}{t^3}$

$d = \frac{[L]}{[T^3]}$

$d = [LT^{-3}]$

HENCE PROVED

Example 7 Determine the dimention of a, b and c in the following equation.

$$V = at + \frac{b}{t+c}$$ where

V is velocity and t is time

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Solution

(1) $V = at + \frac{b}{t+c}$

Start finding dimention

dim of a = $v = at$

$a = \frac{v}{t}$

$a = \frac{[LT^{-1}]}{T}$

dim of a $= [LT^{-2}]$

(2) In this type of question first we find c

dim of c $= \frac{b}{t+c}$ c is equal to $[t]$

$c = [T]$

this always goes to multiply

(3) dim of b $= v = at + \frac{b}{t+c}$ Multiply

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$$\text{dim of } b = v \times t$$
$$= [LT^{-1}] \times [T]$$
$$= [L]$$

Example 8 Equation for displacment of a wave particle is given by

$$y = a \sin(At + Bx)$$

where y is instaneous dispacment, a is amplitude, t = time and x is position of particle origin. find the dimention of Constant A and B

Solution

x = displacment
a = amplitude
t = Time

we have to find value of A and B

$$\text{dim. of } A = At$$

$$\text{dim. of } A = \frac{1}{t}$$

$$A = \frac{1}{[T]}, \frac{1}{[T]}$$ when it goes to the uper side it contain a negetive sign.

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dim of B = Bx

$$B = \frac{1}{x} \leftarrow \text{given}$$

$$B = \frac{L}{[L]}$$

$$B = \boxed{L^{-1}}$$

(1) In this quation, we only use $y = a\sin\boxed{(At+Bx)}$ only use (At+Bx) this portion of question

(2) And, in the Calculation we always show angles like $\boxed{\sin}$ as $\theta \leftarrow$ Thitha

$$y = a\theta(At+Bx)$$

(3) we use K sensetive language like this question

$$y = a\theta(At+Bx)$$

Different

This (a) and This (A) ARE Different.

Example 9 Let x and a stand for distance in the equation $\int \frac{dx}{\sqrt{a^2-x^2}} = \frac{1}{a} \sin^{-1} \frac{a}{x}$

Trigonometric ratio are NOT taking while solving

check the Correctness of dimension.?

Answer $\int \frac{dx}{\sqrt{a^2-x^2}} = \frac{1}{a} \sin^{-1} \frac{a}{x}$

Now, we have to Cross Multiply $\frac{1}{a}$

$\int \frac{dx}{\sqrt{a^2-x^2}} \quad \frac{1}{a}$

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

Distance (a), Distance (x)] Given As Question

dim. of L.H.S $= \frac{a\,dx}{\sqrt{a^2-x^2}} = \frac{L \times L}{L^2} = \frac{L^2}{L} = [L]$

dim of R.H.S $= \frac{a}{x} = \frac{[L]}{[L]} = 1 \quad \boxed{\frac{\cancel{L}}{\cancel{L}} = 1}$

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Example 10 In a particular calculation of pressure, expression of pressure is given by:

$$P = F\sqrt{a} + \frac{b}{\sqrt{x}}$$

find the dimention of $a \times b$ where f is force and x is displacment

Solution

P = Pressure
f = force
x = displacment

Example 11 when a particle performs circular motion in a circular orbit, the Centripetal force (f) acting on the particle depends upon mass of particle (m) radius of circle (r) velocity of particle (v) Derive the formula for force (f) using dimention analysis

Solution → $f \propto m^a r^b v^c$ Step-1

Remove this ⟶

$f = K m^a r^b v^c$ —— (1)

we always mention the dim. [MLT] and put degree on it

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

Step-2

$[M^0 L T^{-1}] = [M^a L^{b+c} T^{-c}]$

Compare dim. both Side of MLT

Step-3

$a = 1$ — 1st Step

$b + c = 1$ 3 Step

$-c = -2$ 2 Step

Solve the a, bc equation

Step-4

$a = 1$

$b = 1$ [for find b value use value of c]

$+c = +2$

$b + c =$

$b + 2 = 1$ $b = -2+1$

$= b = -1$

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

put the value of a,b,c in eq — ① Step-5

$$F = K m^{1} r^{-1} v^{2}$$

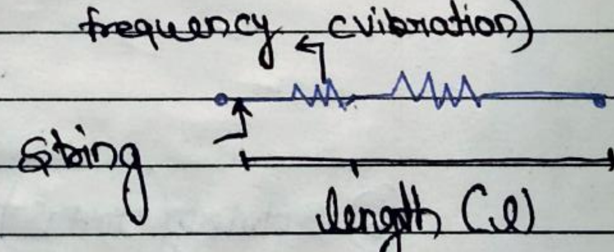
$$F = K \frac{mv^2}{r}$$ — we turn it down for remove negetive sign from (r)

$K = 1$ — Constant

$$f = \frac{mv^2}{r}$$ — final Answer.

Example 12. A string is fixed at its boths Ends. fundamental frequency of vibration (n) depends upon length of string (l), tension of string (T) and mass per unit length of string (m). Derive the formula of frequency using dimentional analyes.

Solution →



$n \propto l \; T \; M$

frequency — $n \propto l \; T \; m$ — mass

length Tention

$$n = K \, l^{a} T^{b} m^{c}$$

Step-1

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$$[M^0L^0T^{-1}] = [L]^a [MLT^{-2}]^b [ML^{-1}]^c$$

$$[M^0L^0T^{-1}] = [M^{b+c} L^{a+b-c} T^{-2b}]$$

Step-2 (1) write dimention of both side 1st
(2) differentiate the powers of dimention

Step-3

$$\cancel{a=1}\ b+c=0$$
$$\cancel{b=}\ a+b-c=0$$
$$-2b=-1$$

Step-4 solve these equations:-

Solving b first

(a) $-2b = -1$

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

Rember this thing negative sign change sometime some time Not.

(b) Solving (b+c)

value of b $\frac{1}{2}$ — $b+c = 0$

$$\frac{1}{2} + c = 0$$

$$c = -\frac{1}{2}$$

(c) Solving $a+b-c=0$
putt value of b and c

$$a+\frac{1}{2}+\frac{1}{2}=0$$

$$a+1=0$$

$$a=-1$$

put value of a, b, c in equation:-

$$n=K\,l^{-1}\,T^{1/2}\,m^{-1/2}$$
$$n\propto l^{-1}\,T^{1/2}\,m^{-1/2}$$

$$n\propto \frac{k\,l\,T^{1/2}}{m^{1/2}}$$ ½ changed into upon always at the end of equation

$$n=l\sqrt{\frac{T}{m}}$$

There is some problem in solving the End part of quation (k)

Example-13 Let a body is falling freely under the effect of gravity. Suppose velocity of body may depend upon mass of body 'm', acceleration due to gravity 'g' and height 'h', deduce the formula for velocity using dimentional analysis.

Solution

$$v \propto m\, g\, h$$
$$V = k\, m\, g\, h$$

put a, b, c

$$V = m^a g^b h^c$$
$$[LT^{-1}] = [M]^a [LT^{-2}]^b [L]^c$$

$$[LT^{-1}] = [M^a L^{b+c} T^{-2b}]$$

Comparing dimention of both side

$$\left.\begin{aligned} a &= 0 \\ b+c &= 1 \\ -2b &= -1 \end{aligned}\right]$$

It is very easy step = writting Dimention and power of other side

V. Imp.

step. Solving ~~equation~~ equation a,b,c.

$$a = 0$$

$$+2b = +1$$

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

$$b + c = 1$$

$$\frac{1}{2} + c = 1$$

$$c = 1 - \frac{1}{2}$$

$$c = 1/2$$

putt the ~~equation~~ value of a,b,c in equation

$$v \propto m^a g^b h^c$$

$$V = K \cdot m^0 g^{1/2} h^{1/2}$$

↳ $\boxed{k = 1}$ Constant

$$\therefore V = \sqrt{gh}$$

Here is value of $k = \sqrt{2}$

?

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Question. 14 Equation for velocity of a wave on Surface of liquid is

Lemda

$$V = \left[\frac{g\lambda}{2\pi}\right]^n$$

Lemda

where λ is wavelength of wave. find the value of n using dimentional analysis

Solution.

$$V = \left[\frac{g\lambda}{2\pi}\right]^n$$

$$[LT^{-1}] = [LT^{-2} \times L]^n$$

Lemda dimention

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

Now, In this type of question which contain power n like $\left[\frac{gh}{2\pi}\right]^n$ Imp.

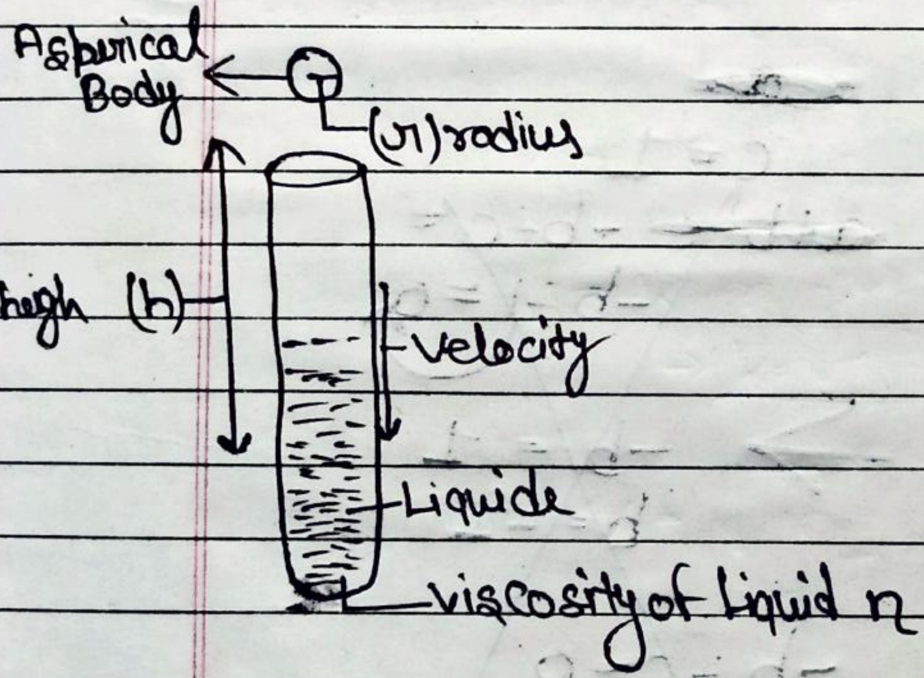
is Solved by a Special Methode

the last Solution Says

$$[L^2T^{-2}]^n \text{ — } ?$$

Example 15 A spherical body of radius r is falling inside a liquid of viscosity η with uniform speed v. Using dimentional analysis, derive the expression of viscous ~~faces~~ force acting on body

Solution :- Acording to Reading this question



step-1

$$f \propto r^a v^b \eta^c$$

$$f = k r^a v^b \eta^c$$

This is Not (h) height

This is viscocity

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$$[MLT^{-2}] = K[L]^a[LT^{-1}]^b [ML^{-1}T^{-1}]$$

$$\cancel{[MLT^{-2}] = K[L^a L T^{-1} a+b-c}$$

← Remember that Dimention are always Start with [M, L, T]

Step - 2

$$[MLT^{-2}] = k[M^c L^{a+b-c} T^{-b-c}]$$

— x — x — x — x — x — x

Step - 3 Writting dimention of both side a, b, c

$$= K[M^c L^{a+b-c} T^{-b-c}]$$ ← solve it

⇒

$c = 1$

$\cancel{a+b-c}$ $-b-c =$

$-b-1 = 0$

do NOT CALCULATE This NOW Just check It.

→ $-b = 1$

$b = -1$

$-b-c = 0$

$-1-1 = 0$

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$$c = 1$$
$$a + b - c = 1$$
$$-b - c = -2$$

Solve the equation

$$a = 1$$
$$b = 1$$
$$c = 1$$

put the value of a, b, c in equation(1)

$$F = k r^1 v^1 \eta^1$$
$$F = k r v \eta$$

Example 16. Using dimentional analysis, show the formula for time period of simple pendulum $T = 2\pi \frac{l}{g}$ is incorrect. Also deduce the correct relationship

Solution equation

$$T = 2\pi \frac{l}{g}$$

dimention of Left side (LHS) = Dim. of time
$$= [T]$$

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Dim. of RHS = $\dfrac{\text{dim. of length}}{\text{dim. of acc. due to gravity}}$

$$= \frac{[L]}{[LT^{-2}]}$$

$$= [T^2]$$

Since the dimention of both Side are not same
So, the equation is incorrect