ARJUNA NEET BATCH

UNITS AND MEASUREMENTS

LECTURE - 01

MR*

TODAYS GOAL

- Physical Quantity ✓
- Units ✓
- Conversion of Unit ✓

Physics

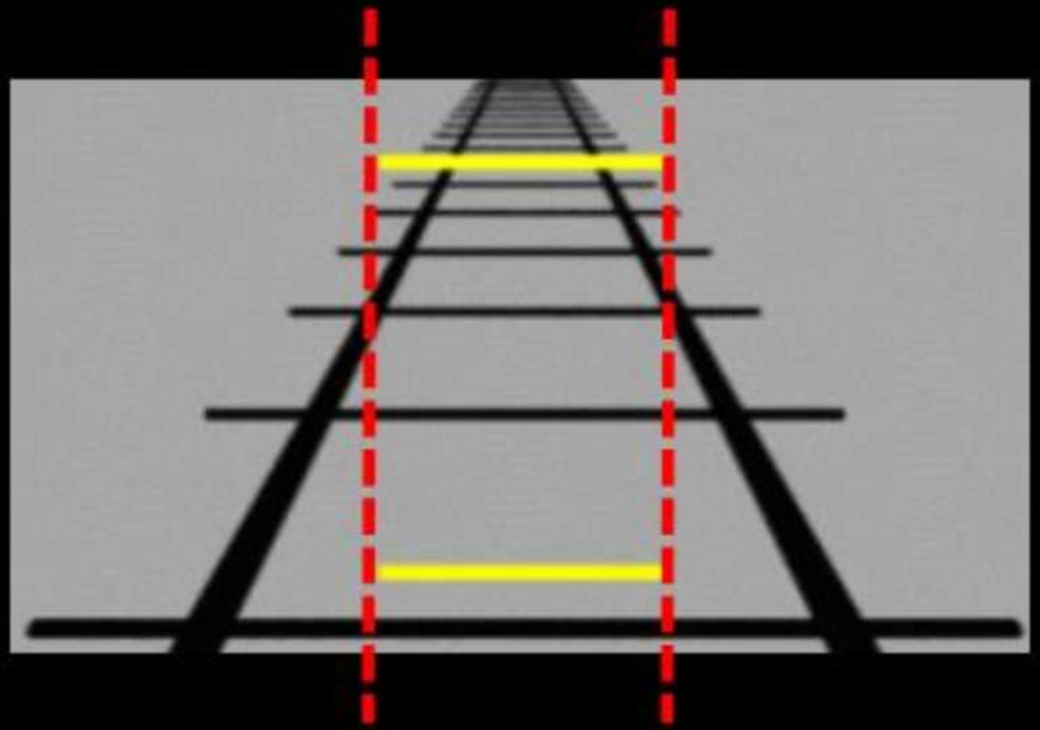
↳ Study of nature is called Physics.

UNITS AND MEASUREMENTS

When we observe a railway track it does not appear to be parallel.

But actually the tracks are parallel !!

Observation need not be always correct ..



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MEASUREMENT

The purpose of experiment is to establish the laws, hence measurement of different physical quantities is extremely important.

- ***Can't trust just on observation***
- ***Experimentation is essential..***

For this we require precise calculation.

→ physical qu

Ex: **- In Ohm's law, we can say the ratio of voltage to current may be constant, may not be constant !!**

$\frac{V}{I}$ = Resistance.

We need to measure things for accurate results…..

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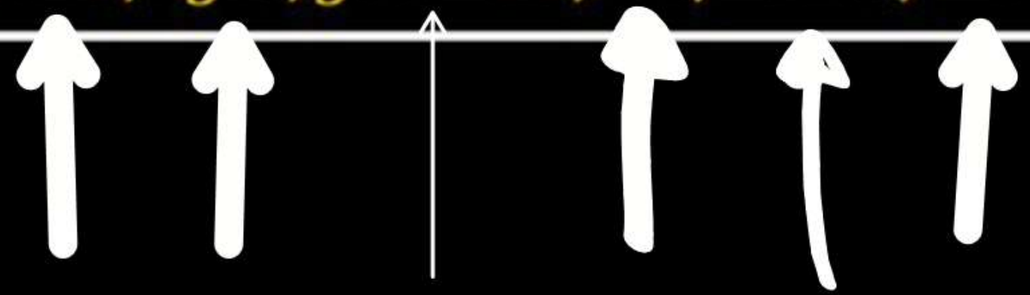
Physical quantity

A quantity that can be measured is called as physical quantity.
Ex : Length, mass, velocity, temperature,
area , volume, density etc...are measurable quantities.

Intensity of light ✓ Intensity of sound ✓

Non-physical quantity

A quantity that can not be measured is called as non physical quantity.
Ex: sound , light , goodness ,love, hatred, like etc .....



* Inertia ?? → does not have unit.
↳ Inertia is a Property not a Physical quantity.

Which of the following is not a physical quantity?

(a) length (P.Q)

(b) mass (P.Q)

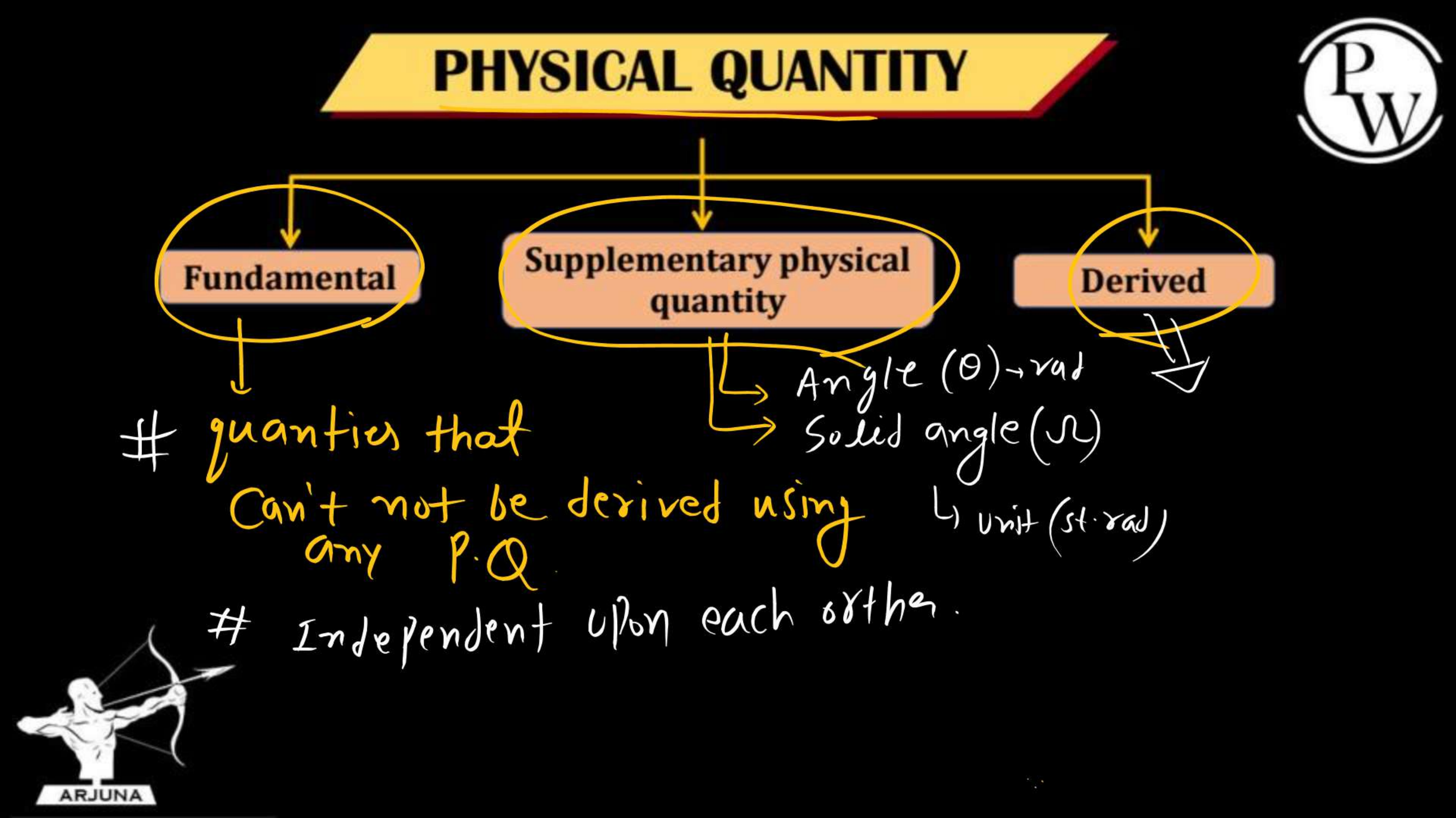
(c) time (P.Q)

(d) air, sound, light, goodness, Inertia.

Which of these is a physical quantity?

(a) acceleration
(b) like
(c) dislike
(d) hatred

PHYSICAL QUANTITY



quantities that Can't not be derived using any P.Q.

Independent upon each other.

Angle (θ) → rad

Solid angle (Ω)

↳ Unit (st·rad)

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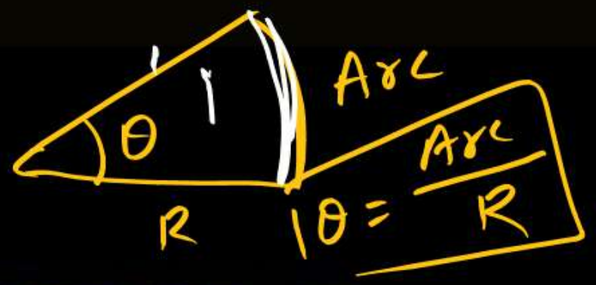
What is a fundamental quantity?

A physical quantity which does not depend on any other physical quantity for its measurement is called a **fundamental physical quantity.**

Ex mass, length, time

Fundamental quantities

Fundamental quantity	S.I. Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
temperature	kelvin	k
Amount of substance	mole	mol
Electric current	ampere	A
Luminous intensity	candela	cd



There are seven fundamental quantities.

$\Omega = \frac{Area}{R^2}$

Supplementary quantities

(Unit)

1. Plane angle	radian	rad
2. Solid angle	(steradian)	st.rad

(θ) (2-D angle)

(Ω) (3-D Angle)

There are two supplementary quantities.

DERIVED QUANTITY

The physical quantity which is derived from more than one fundamental quantity is called derived physical quantity.

Ex: ***Area, density, force, acceleration, work, etc..***

$\text{Area} = (\text{Length})^2$

$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{m}{(L)^3}$

$\text{velocity} = \frac{\text{displacement}}{\text{time}} = \frac{\text{length}}{\text{time}}$

$\text{acc}^n = \frac{\text{velocity}}{\text{time}} = \frac{L}{T^2}$

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SOME DERIVED QUANTITIES

Velocity (m/s) → $\text{Velocity} = \dfrac{\text{displacement}}{\text{time}} = \dfrac{L}{T}$

Acceleration (m/s^2) → $\text{Acceleration} = \dfrac{\text{Velocity}}{\text{time}} = \dfrac{L}{T^2} = m/s^2$

Work ($kg\text{-}m^2/s^2$) or joule → Work = force × displacement = (mass × acc^n) × disp^n

A quantity that can be measured is called a...

(a) Physical quantity

(b) Non physical quantity

(c) Quantity

(d) Either (b) or (c)

The physical quantities which are expressed in terms of more than one fundamental quantity are called....

(a) derived physical quantities.

(b) fundamental physical quantities.

(c) physical quantities

(d) supplementary physical quantities

There are _____ fundamental quantities.

(a) seven
(b) three
(c) six
(d) sixteen

May

Length ✓
time ✓
Temp ✓
Current ✓
Amount of sub. ✓
Luminl Intensity → Light energy Per unit time Per unit Area.

Acceleration is a derived physical quantity, which depends on _____ fundamental quantities.

(a) 2
(b) 3
(c) 5
(d) Zero

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

Charge is a _____ quantity.

(a) fundamental

(b) derived

(c) Non-physical

(d) Supplementary quantity

$I = \frac{Q}{time}$

fundamental

charge = I x time

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Which of the following group of physical quantity can be considered as a group of Fundamental physical quantity.

(a) Force, mass, time

(b) Mass, force, acceleration

(c) Velocity, momentum, mass

(d) Velocity, time displacement

Fundament → Independent upon each other. Rs → 10

(a) Force = $\frac{mass}{time}$

(b) Force = $m \times a$

(c) $P = mv$

(d) Velocity = $\frac{disp^{n}}{time}$

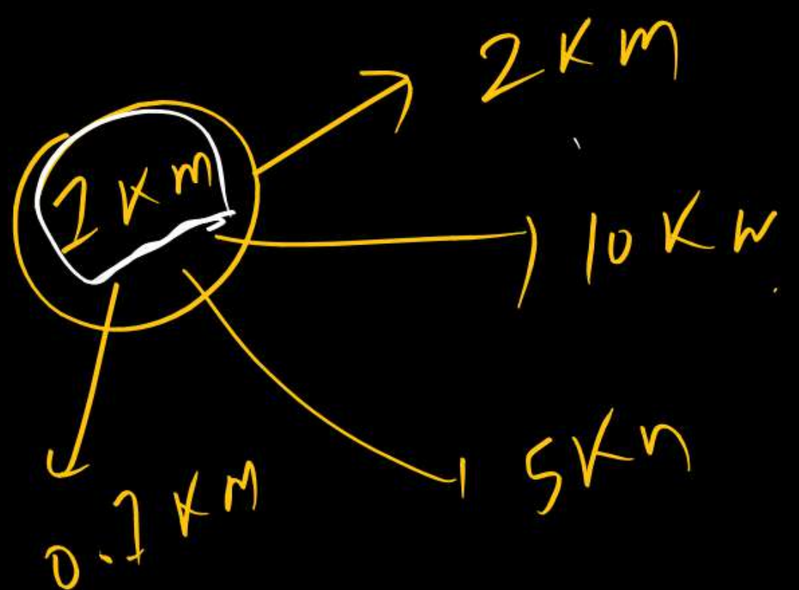
Measurable —quantity is→ Physical quantity

Example: mass, length, time, area , force, pressure etc.

A physical quantity —is→ Magnitude × Unit

UNIT

- Measurement of any quantity involves comparison with a certain basic, arbitrarily chosen, internationally accepted reference standard called *unit*.
- The units for the fundamental quantities are called *fundamental units*.
- The units of all other physical quantities can be expressed as combination of the fundamental units are called *derived units*.



length = 4 (1 hand)

UNIT

- In some wrong ways units were considered where physical quantities used to be measured .
- Length was measured with the help of a hand.

But, all hands are slightly of different sizes

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So, the units should have certain characteristics..

1 league = distance covered in one hour by walking

Ram lal

Kallu

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CHARACTERISTICS OF A UNIT

- The unit must be of suitable size and easily available.
- A unit should be easily available and reproducible at any place required .

→ unit must be invariant.

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CHARACTERISTICS OF A UNIT

- The unit must be universally accepted.
- A physical unit must be invariable and well defined.

1kg = 1000g

1kg = 1000 gram

Yesterday, a kilogram was 1000 grams but today its only 800 grams.

???

1kg = 800g

Pinki

Ram

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Which of the following is a characteristic of unit?

(a) The unit must be universally accepted

(b) It must be invariable and well defined

(c) It must be of suitable size and easily available

(d) all the above

Example :

Distance = 25 km

This actually means.

Measurement = n u

Distance = 25 times magnification of 1km

Magnitude

Unit

Magnitude is a measure of magnification of unit.

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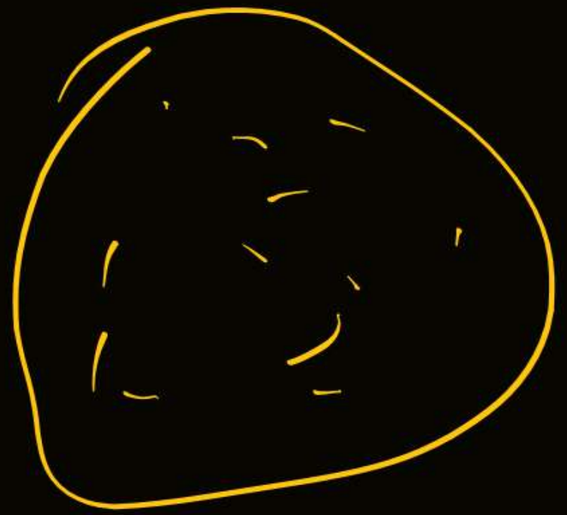
Rod

$$\text{length} = \underbrace{x\ m}_{\text{S.I unit}} = \underbrace{Y\ cm}_{\text{C.G.S}}$$



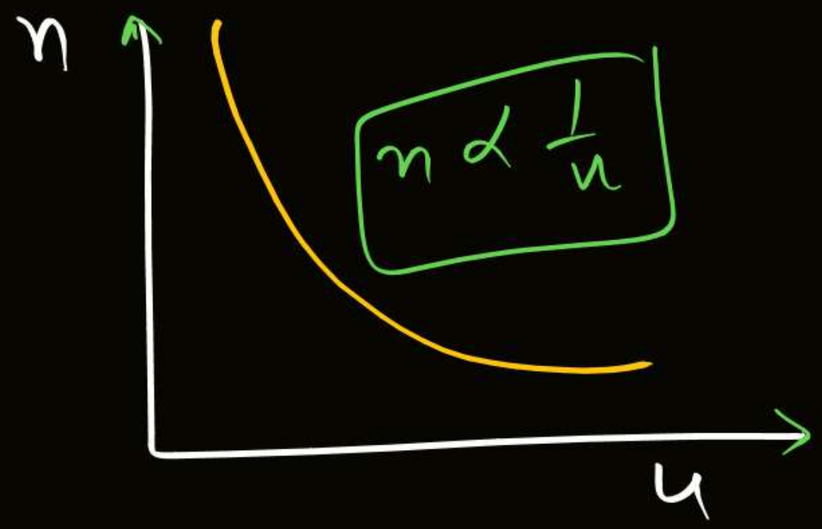
$$\text{Mass} = \underbrace{10\ kg}_{\text{S.I}} = 10 \times 10^{3}\ gm = \underline{10^{4}\ gm}$$

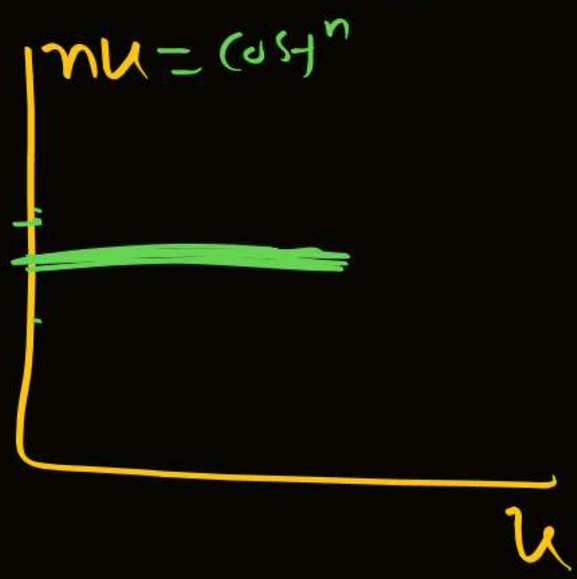
Measurment = $nu = \text{Cost}^n$

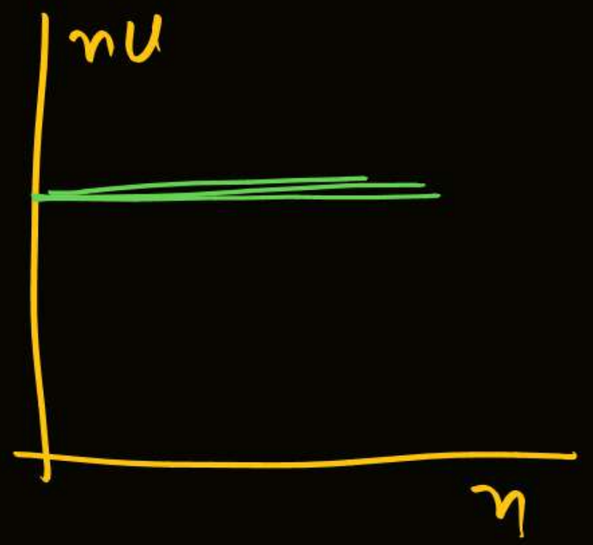
AIPMT-09

$nu = \text{Cost}^n$

$\downarrow n \propto \frac{1}{u\uparrow}$







Relation between magnitude & unit of a physical quantity

- The numerical value obtained on measuring a physical quantity is inversely proportional to its unit.

$$n \propto \frac{1}{U}$$

$$\Rightarrow n_1 U_1 = n_2 U_2$$

- where n_1 and n_2 are the numerical values of U_1 and U_2 are the units of same physical quantity in different systems.

Convert 50 m/s speed in C.G.S. Unit.

$$\text{speed} = \overbrace{n_1 u_1}^{S.I} = \overbrace{n_2 u_2}^{C.G.S}$$

$$\Rightarrow 50\ \text{m/s} = x\ \text{cm/s}$$

$$50 \times 100\ \text{cm} = x\ \text{cm}$$

$$x = 5000$$

Convert 5 grm/cm^3 density is M.K.S. unit ?

→ S.I System.

$$\rho \text{ (density)} = \overbrace{5\ \text{grm/cm}^3}^{\text{C.G.S}} = \overbrace{x\ \frac{\text{kg}}{\text{m}^3}}^{\text{S.I}}$$

$$5\ \frac{\text{grm}}{\text{cm}^3} = x\ \frac{10^3\ \text{grm}}{(10^2)^3\ \text{cm}^3}$$

10^3

$1\text{m} = 10^2\text{cm}$

$x = 5 \times 10^3$

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Convert 1 newton into Dyne.

newton → S.I unit of force.

Dyne → C.G.S unit of force.

force = 1N = x Dyne

$$\frac{1\ kgm}{s^2} = x\ \frac{gram\ cm}{s^2}$$

$1N = 10^5$ Dyne

$$\frac{1 \times 10^3\ \cancel{gram} \times 10^2\ \cancel{cm}}{\cancel{s^2}} = x\ \frac{\cancel{gram\ cm}}{\cancel{s^2}}$$

$x = 10^5$

Convert 1 J in C.G.S unit ??

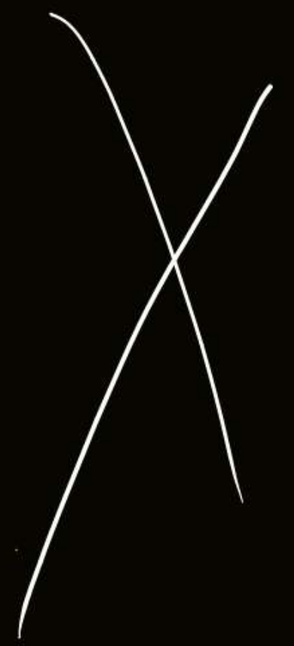
$$nu = Cst^{n}$$

$$1\ J = x\ erg$$

$$1\ \frac{kgm^2}{s^2} = x\ \frac{1\ grm \times cm^2}{s^2}$$

$$\boxed{1\ J = 10^{7}\ erg}$$

	S.I	C.G.S	F.P.S	Practical unit
Mass	kg	grm	Pound	chandrashakhar limit
Length	m	cm	foot	→ light year → Parsec → Astronomical unit
time	s	s	s	hr, shake
Current	A	boit	—	
Tempr	K	K	—	
Amount of sub	mol	mol	—	
Lumin Intensity	cd	=	—	



Dimension

→ Power of fundamental P.Q. in the formula of any physical quantity

Mass → M^1

Length → L^1

time → T^1

Current → A^1

Temp → θ^1 / K^1

Amount of sub. → mol^1

Lumi Intsity → cd^1

Suplementry physical quantity

→ Angle & Solid angle → dimension less

have unit but does not have dimension

Wavelength / disp^{n} / distance / Radius
focal length / Radius of curvature

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

$\Longrightarrow$ Different P.Q. have same Unit.

Mass → M^1

Length → L^1

time → T^1

velocity $= \frac{L}{T} = LT^{-1}$

accelration $= \frac{\text{velocity}}{\text{time}} = \frac{LT^1}{T} = LT^{-2}$

Force = mass × acc^n = MLT^{-2}

Work = Force × Length = $(MLT^{-2}) \times L = ML^2T^{-2}$

Energy $= \frac{1}{2}mv^2 = M(LT^{-1})^2 = M^1L^2T^{-2}$

Power $= \frac{\text{Work}}{\text{time}} = \frac{ML^2T^{-2}}{T} = ML^2T^{-3}$

Ratta

Velocity $\longrightarrow LT^{-1}$

acc^n $= LT^{-2}$

force $= ma = MLT^{-2}$

Work = Energy $= ML^2T^{-2}$

Power $= \frac{\text{work}}{\text{time}} = ML^2T^{-3}$

Momentum $P = mv$

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

Angular displ^{n} $= \theta = M^0 L^0 T^0 =$ dimen^{n}less.

Angular velocity/speed $= \frac{\theta}{T} = T^{-1}$

Frequency $= \frac{1}{\text{time}} = \frac{1}{T} = T^{-1}$

They both have diff^{n} unit but same dimen^{n}.

Torque = force x length $= MLT^{-2} \times L = ML^2T^{-2}$

Work & energy

H.W option. must have Dim
must be Dim^n less
may have Dim

Dim^n	?? (A)	??	P.Q have Dim^n	P.Q does not have Dim^n
Unit	P.Q is a unitless	P.Q have Unit (B)	?? (C)	?? (D)

unitless → Ratio
→ refractive Index

Ans (A) (B) (C) (D)

thanks
for watching