

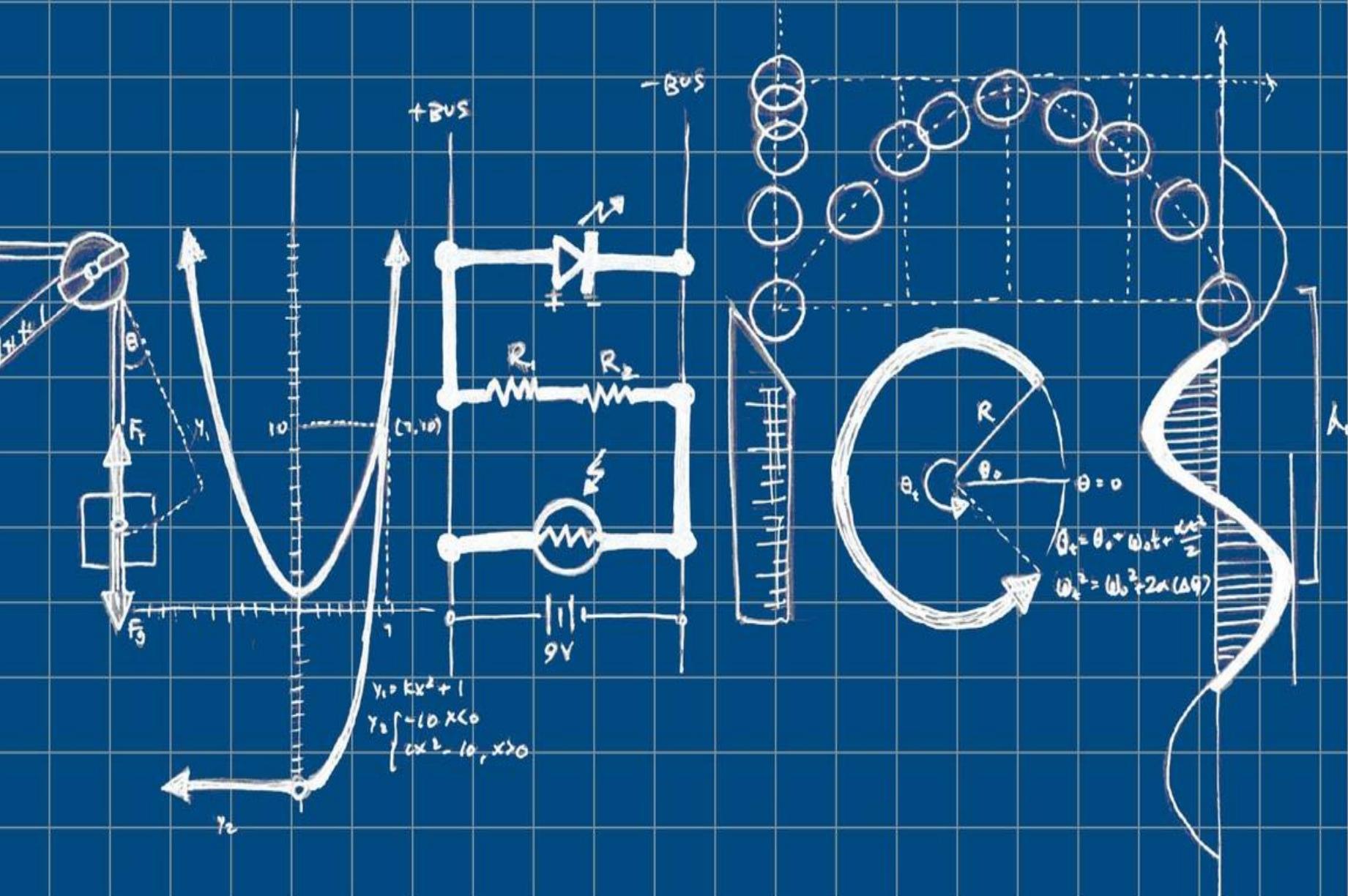
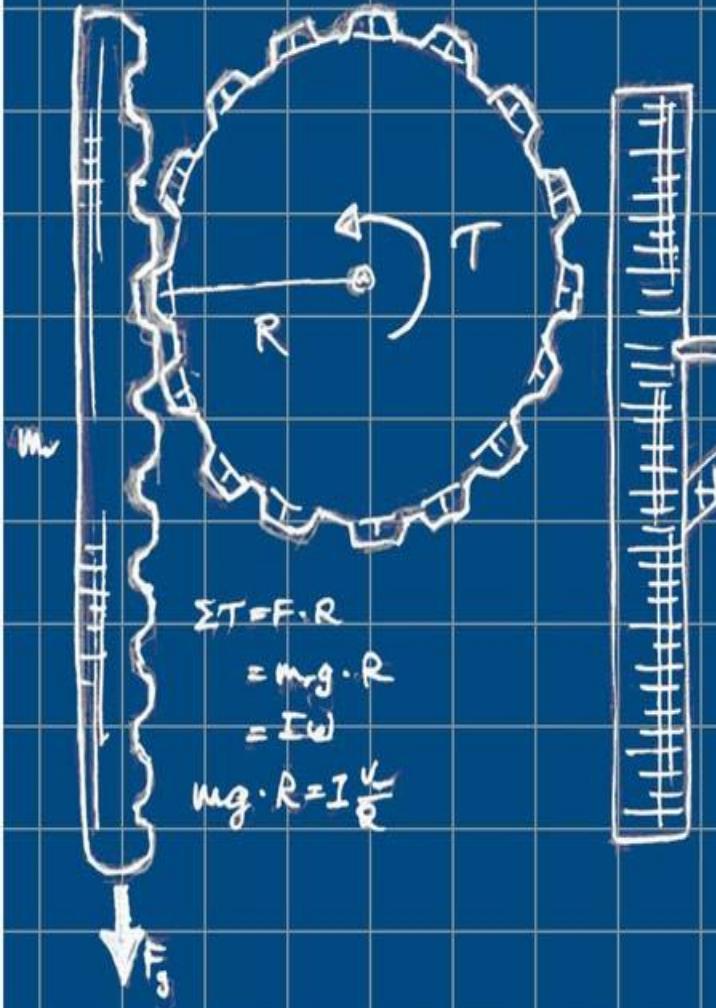


# SAFALTA CLASS™

An Initiative by **अमरउजाला**

# JOIN INDIAN AIR FORCE





# PHYSICS (भौतिक विज्ञान)

- The scientific study of matter and energy and interaction between them.
- भौतिक विज्ञान विज्ञान की वह शाखा है, जिसमें ऊर्जा के विभिन्न स्वरूपों तथा द्रव्य से उसकी अन्योन्य क्रियाओं का अध्ययन किया जाता है।

**PHYSICS** 

**Units and  
Measurement**

**FOR AIR FORCE EXAM 2021**

# TYPES OF QUANTITIES (राशियाँ के प्रकार)

---

- *Physical quantities* are all those quantities which are physically present and they can be measured.

 राशि  $\Rightarrow$  kg

- *Non-physical quantities* are those quantities which cannot be seen neither can they be measured.

# Units (मात्रक)

---

**Every measurement has two parts. The first is a number (n) and the next is a unit (u).**

हर माप के दो भाग होते हैं। पहला एक संख्या (n) है और अगला एक इकाई (u) है।

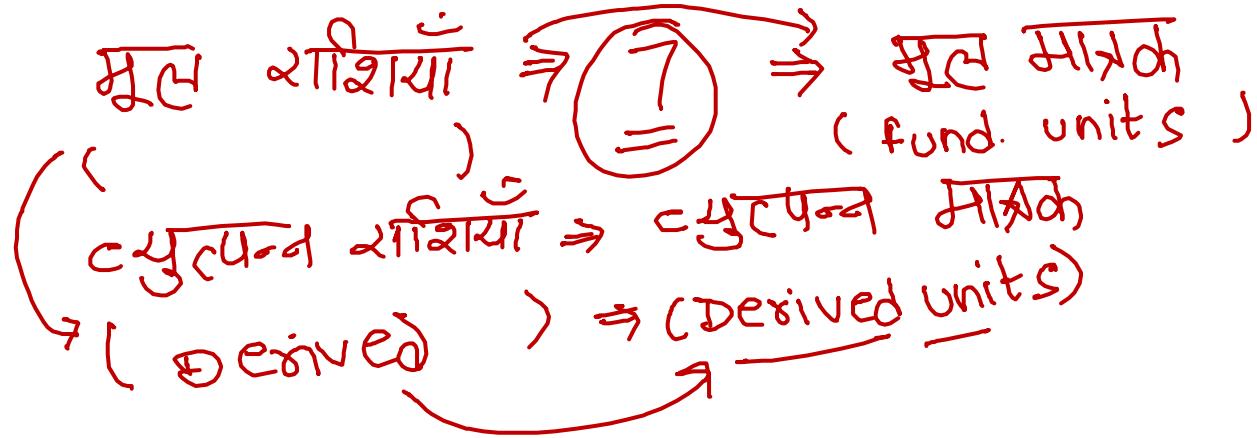
$$Q = nu.$$

**Units are decided by : General Conference on Weights and Measures  
(Conférence Générale des Poids et Mesures, CGPM)**

# Fundamental and Derived Quantities

## (मौलिक और व्युत्पन्न राशियाँ)

- The quantities that are independent of other quantities are called fundamental quantities. mass
- जो मात्राएँ अन्य राशियों से स्वतंत्र होती हैं, उन्हें मौलिक मात्राएँ कहा जाता है।
- The units that are used to measure these fundamental quantities are called fundamental units.  $\text{kg} = \text{m a}$
- इन मूलभूत मात्राओं को मापने के लिए जिन इकाइयों का उपयोग किया जाता है, उन्हें मूलभूत इकाइयाँ कहा जाता है।
- There are four systems of units namely C.G.S, M.K.S, F.P.S, and S.I.



## Fundamental

## System of units

### Quantity

C.G.S.

M.K.S.

F.P.S.

Length

centimeter

Meter

foot

Mass

gram

Kilogram

pound

Time

second

Second

second

	लंबाई	द्रव्यमान	समय
CGS	सेंटीमीटर	ग्राम	सेकंड
MKS	मीटर	किलोग्राम	सेकंड
FPS	फुट	पौंड	सेकंड

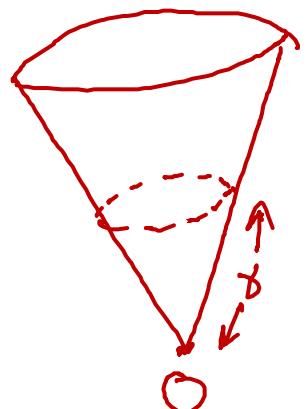
# FUNDAMENTAL UNITS (मूल मात्रक)

Physical quantity	Unit ( <u>SI</u> )	Symbol
Length पृष्ठालाई	Meter मीटर	m
Mass जटियमान	kilogram किलोग्राम	kg
Time समय	second सेकंड	s
Electric current विद्युत धारा	ampere एम्पेर	A
Thermodynamic temperature तापमान	kelvin केल्विन	K
Intensity of light चमोत तीव्रता	candela कैंडेला	cd
Quantity of substance पदार्थ की मात्रा	mole मोल	mol

<u>राशि</u>	<u>मात्रक</u>	<u>संकेत</u>
लम्बाई (दूरी)	मीटर	m
द्रव्यमान	किग्रा.	kg
समय	सेकेण्ड	s
ताप	कैलिवन	K
विद्युत धारा	ऐम्पियर	A
ज्योति तीव्रता	कैण्डला	कैण्ड Cd
पदार्थ की मात्रा	मोल	मोल mol
पूरक मूल मात्रक		
तलीय कोण	रेडियन	(रेडियन) Rd
घन कोण	स्टेरेडियन	(स्टेरेडियन) Srd

# SUPPLEMENTARY UNITS (पूरक मात्रक )

Plane angle ✓	$\frac{2\pi}{3}$	radian ✓	rad
Solid angle ✓	$\frac{3\pi}{4}$	steradian ✓	sr



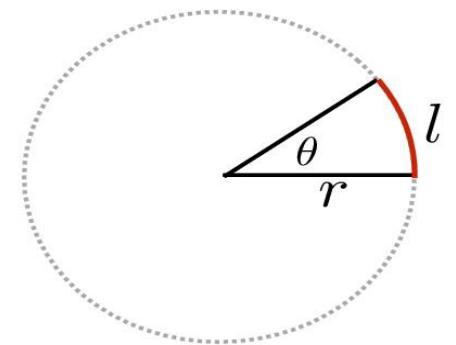
$$\omega = \frac{A}{r^2}$$

A hand-drawn diagram of a cone. A vertical line segment connects the apex to the center of the circular base. Three line segments meet at the apex to form a solid angle.

## Angles and Solid Angles

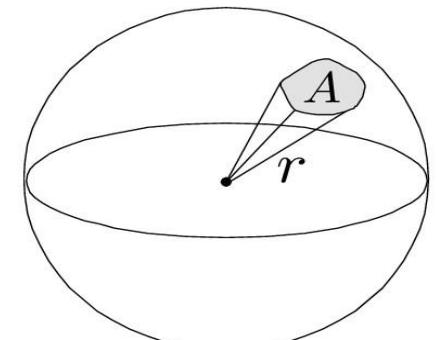
Angle: ratio of subtended arc length on circle to radius

- $\theta = \frac{l}{r}$
- Circle has  $2\pi$  radians



Solid angle: ratio of subtended area on sphere to radius squared

- $\Omega = \frac{A}{r^2}$
- Sphere has  $4\pi$  steradians





# DERIVED QUANTITIES & UNITS (व्युत्पन्न मात्रक)

---

- *The quantities that are derived using the fundamental quantities are called derived quantities.*
- मौलिक मात्राओं का उपयोग करके जो मात्रा प्राप्त की जाती है उसे व्युत्पन्न मात्राएं कहा जाता है।
- *The units that are used to measure these derived quantities are called derived units.*
- इन व्युत्पन्न मात्राओं को मापने के लिए जिन इकाइयों का उपयोग किया जाता है, उन्हें व्युत्पन्न इकाइयाँ कहा जाता है।

$$\text{Speed} = \frac{\text{Dist}}{\text{Time}} \text{ m/s}$$

---

Derived  
cyclized

$$\frac{F \cdot d}{F \cdot a}$$

मुल दूरी  
मुल " "

Physical quantity	SI unit	Symbol
Frequency	hertz	Hz
Energy	joule	J
Force	newton	N
Power	watt	W
Pressure	pascal	Pa
Electric charge or quantity of electricity	coulomb	C
Electric potential difference and emf	volt	V
Electric resistance	ohm	$\Omega$
Electric conductance	siemen	S
Electric capacitance	farad	F
Magnetic flux	weber	Wb
Inductance	henry	H
Magnetic flux density	tesla	T
Illumination	lux	Lx
Luminous flux	lumen	Lm

# SOME STANDARD UNITS

Imp

लंग्गनार्ड

तंखाई

- Angstrom is the unit of length used to measure the wavelength of light.

Light (गति)  $\Rightarrow \underline{\underline{1 \text{ \AA}}} = \underline{\underline{10^{-10} \text{ m}}}$

- Fermi is the unit of length used to measure nuclear distances.

फर्मी

$\underline{\underline{1 \text{ Fermi}}} = \underline{\underline{10^{-15} \text{ m}}} \text{ (Femto)}$

परमाणु की विमा

- Nano meter is the unit of length used to measure wavelength of light.

$\underline{\underline{1 \text{ nm}}} = \underline{\underline{10^{-9} \text{ m}}} \text{ (गति) Light}$

- A light year is the unit of length for measuring astronomical distances.

$$\underline{\underline{c = 3 \times 10^8 \text{ m/s}}}$$

$$\underline{\underline{T = 1 \text{ Year}}}$$

1 Light year = distance traveled by light in 1 year

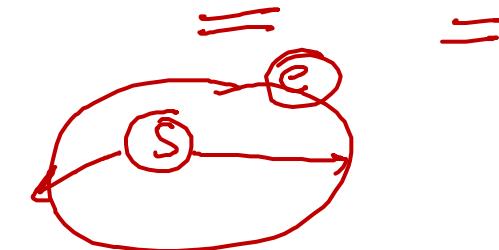
प्रकाश दूरी

$$= \underline{\underline{9.4605 \times 10^{15} \text{ m}}} \checkmark$$

- Astronomical unit = Mean distance between the sun and earth

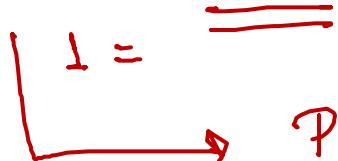
सौरोतीय दूरी

$$= \underline{\underline{1.5 \times 10^{11} \text{ m}}} \checkmark$$



परखें  $\Rightarrow$  दूरी का मैत्रि वटा मात्रा

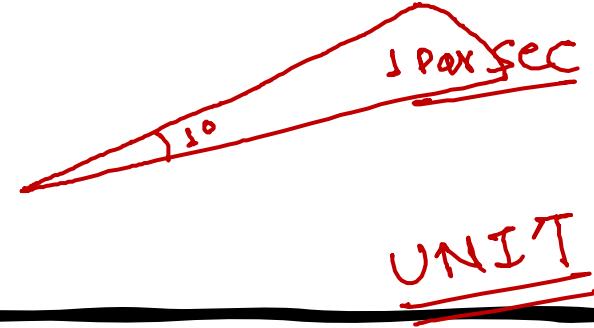
- Parsec = 3.26 light years =  $3.084 \times 10^{16} \text{ m}$



Parallactic Second

# FOR MASS:

ग्रहान



$$1 \text{ CSL} = 1.4 \times \text{mass of Sun}$$

$$1 \text{ दृश्य सीमा} = 1.4 \times \text{सूर्य का दृश्यान्त}$$

=

⇒

Star

① Black Hole  $\Rightarrow 1 \text{ CSL}$

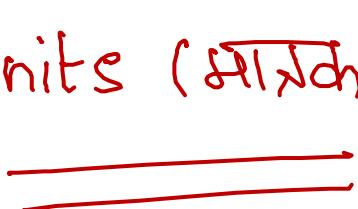
② White Dwarf  $\Rightarrow \leq 1 \text{ CSL}$

# Dimensions (विमाएं)

---

- Dimensions of a physical quantity are the powers to which the fundamental units are raised to obtain one unit of that quantity.
- किसी भौतिक राशि की विमाएं वे घातें होती हैं जो उस भौतिक राशि के व्युत्पन्न मात्रक प्राप्त करनें के लिए मूल मात्रकों पर चढ़ाई जाती हैं।

विमा (Dim. Formula)  $\Rightarrow$  Units (मात्रक)



$\Rightarrow$  Cap. Lat.  $\Rightarrow \underline{A, B}$

$\Rightarrow [ \quad ] \equiv$

# DIMENSIONAL FORMULA (विमीय सूत्र)

Physical Quantity	Units(SI)	Units(CGS)	Notations
Mass	<u>kg</u> (kilogram)	<u>g</u>	$\checkmark [ \underline{M} ]$
Length	<u>m</u> (meter) $\checkmark$	<u>cm</u> $\rightarrow$	$\checkmark [ L ]$
Time	<u>s</u> (second) $\checkmark$	<u>s</u>	$\checkmark \checkmark [ T ]$
Temperature	<u>K</u> (kelvin)	$^{\circ}\text{C}$	$\checkmark [ \theta, K ]$ Theta
Current	<u>A</u> (ampere)	<u>A</u>	$\checkmark [ I \text{ or } A ]$
Luminous intensity	<u>cd</u> (candela)	—	<u>cd</u>
Amount of substance	<u>mol</u>	—	<u>mol</u> } X

# HOW TO WRITE DIMENSIONAL FORMULA

STEP 1 : Write down the formula of the physical quantity.

अभियंक वर्त्ता नापना

STEP 2 : Write down or derived the unit. मात्रा निकेत !

STEP 3 : Write down the obtained units in the form of Dimension symbols.

# IMPORTANT DIMENSIONAL FORMULAS

## • SPEED / VELOCITY : $\frac{\text{माल}}{\text{समय}}$ /

$$\textcircled{1} \quad \text{Speed (माल)} = \frac{\text{Dist}}{\text{Time}}$$

$$\textcircled{2} \quad \text{माल} \text{ (unit)} \Rightarrow \frac{\text{metres}}{\text{sec}}$$

$$\textcircled{3} \quad \frac{[L]}{[T]} = \underline{\underline{[LT^{-1}]}}$$

## • AREA, VOLUME & DENSITY :

✓

✓

✓

$$\text{Area} = l \times b \stackrel{(1)}{\Rightarrow} m^2 \stackrel{(2)}{\Rightarrow} [L^2] \checkmark$$

$$\text{Volume} = l \times b \times h \Rightarrow m^3 \Rightarrow [L^3] \checkmark$$

$$\begin{aligned} \text{Density} &= \frac{\text{mass}}{\text{volume}} \Rightarrow \frac{\text{kg}}{m^3} \Rightarrow \frac{[M]}{[L^3]} \\ &\Rightarrow \underline{\underline{[ML^{-3}]}} \end{aligned}$$

## • ACCELERATION OR GRAVITATIONAL ACCELERATION :

=

✓ ✓

$$\text{Acceleration} = \frac{dv}{dt} \Rightarrow \frac{m}{s^2} \Rightarrow \frac{[L]}{[T^2]}$$

$\vec{a}$

$$\Rightarrow [LT^{-2}]$$

✓

$$g \Rightarrow \underline{\underline{[LT^{-2}]}}$$

## • FORCE :

---

$$\vec{F} = m \vec{a}$$

$\Rightarrow$  Newton

$$\Rightarrow kg - \frac{m}{s^2} \Rightarrow \frac{kg \cdot m}{s^2}$$

$$\Rightarrow \frac{[M] [L]}{[T^2]}$$

$$\Rightarrow \underline{\underline{[MLT^{-2}]}}$$

## • WORK , ENERGY & TORQUE :

✓

$$\text{જાહીર કાર્ય} = \text{બળ} \times \text{પ્રવાહિત દૂરી$$

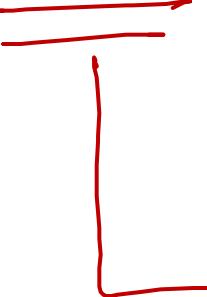
$$= F \times d$$


---

$$\text{કાર્ય} = F \cdot d \Rightarrow \text{Joule}$$

$$\Rightarrow m a \cdot d \Rightarrow \frac{\text{kg} \cdot \text{m}}{\text{s}^2} \times [\text{m}]$$

$$\text{Work} = \text{Energy} = \text{Torque} \Rightarrow \frac{\text{kg} \cdot \text{m}^2}{\text{s}^2}$$



$$\Rightarrow \frac{[\text{M}] [\text{L}^2]}{[\text{T}^2]}$$

$$\text{કાર્ય} \Rightarrow \frac{[\text{M L}^2 \text{T}^{-2}]}{\text{સ્કોર}}$$

## • POWER :

কার্য

---

$$P = \frac{W}{t} \Rightarrow \frac{[ML^2T^{-2}]}{[T]}$$

কার্য  $\Rightarrow [ML^2T^{-3}]$

## • PRESSURE :

G1Q1

---

$$P = \frac{F}{A} \Rightarrow \frac{[MLT^{-2}]}{[L^2]}$$

$$\Rightarrow \underline{\underline{[ML^{-1}T^{-2}]}}$$

- IMPULSE :

$$\underline{\text{Impuls}} = F \cdot \Delta t$$

---

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

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

- **SURFACE TENSION :**



## **• GRAVITATIONAL CONSTANT :**

---

- GRAVITATIONAL FIELD :

---

- **SPRING CONSTANT :**

---

- Permittivity of free space :

---

- Permeability of free space :

Free Space



# Dimensionless quantities (विमाहीन राशियाँ)

- Dimensionless quantities are those which do not have dimensions but have a fixed value.  
वे राशियाँ जिनकी विमा(मात्रक) नहीं होती हैं।
- Dimensionless quantities without units: Pure numbers,  $\pi$ ,  $e$ ,  $\sin \theta$ ,  $\cos \theta$ ,  $\tan \theta$  etc.
- Dimensionless quantities with units: Angular displacement - radian, Joule's constant - joule/calorie, etc.

# Quantities Having the Same Dimensional Formula

---

1. *Impulse and momentum.*
2. *Work, energy, torque, the moment of force.*
3. *Angular momentum, Planck's constant, rotational impulse.*
4. *Stress, pressure, modulus of elasticity, energy density.*
5. *Force constant, surface tension, surface energy.*

6· Angular velocity, frequency, velocity gradient.

7· Gravitational potential, latent heat.

---

8· Thermal capacity, entropy, universal gas constant and Boltzmann's constant.

9· Force, thrust.

10· Power, luminous flux.

# Applications of Dimensional Analysis

---

- Verify the correctness of a physical equation.
- Derive a relationship between physical quantities.
- Converting the units of a physical quantity from one system to another system.

$$\begin{aligned} F &= ma \\ \text{LHS} &= \text{RHS} \\ &\equiv \equiv \end{aligned}$$

# Some Important Conversions

---

- $1 \text{ bar} = 10^6 \text{ dyne/cm}^2 = 10^5 \text{ Nm}^{-2} = 10^5 \text{ pascal}$
- $76 \text{ cm of Hg} = 1.013 \times 10^6 \text{ dyne/cm}^2 = 1.013 \times 10^5 \text{ pascal} = 1.013 \text{ bar}$
- $1 \text{ kmph} = 5/18 \text{ ms}^{-1}$
- $1 \text{ dyne} = 10^{-5} \text{ N}$ ,
- $1 \text{ H.P} = 746 \text{ watt}$

• 1 kilowatt hour =  $36 \times 10^5$  J

$$\vec{a} \Rightarrow \frac{m}{s^2} \Rightarrow \frac{[L]}{[T^2]} = \underline{\underline{[LT^{-2}]}}$$

• 1 kgwt = g newton

---

• 1 calorie = 4.2 joule

• 1 electron volt =  $1.602 \times 10^{-19}$  joule

• 1 erg =  $10^{-7}$  joule

# Some Important Physical Constants

---

- Velocity of light in vacuum ( $c$ ) =  $3 \times 10^8 \text{ ms}^{-1}$
- Velocity of sound in air at STP =  $331 \text{ ms}^{-1}$
- Acceleration due to gravity ( $g$ ) =  $9.81 \text{ ms}^{-2}$
- Avogadro number ( $N$ ) =  $6.023 \times 10^{23}/\text{mol}$
- Density of water at  $4^\circ\text{C}$  =  $1000 \text{ kgm}^{-3}$  or  $1 \text{ g/cc.}$
- Absolute zero =  $-273.15^\circ\text{C}$  or  $0 \text{ K}$

- **Atomic mass unit =  $1.66 \times 10^{-27}$  kg**
- **Quantum of charge (e) =  $1.602 \times 10^{-19}$  C**

---
- **Stefan's constant =  $5.67 \times 10^{-8}$  W/m<sup>2</sup>/K<sup>4</sup>**
- **Boltzmann's constant (K) =  $1.381 \times 10^{-23}$  JK<sup>-1</sup>**
- **One atmosphere = 76 cm Hg =  $1.013 \times 10^5$  Pa**
- **Mechanical equivalent of heat (J) = 4.186 J/cal**
- **Planck's constant (h) =  $6.626 \times 10^{-34}$  Js**

- Universal gas constant ( $R$ ) =  $8.314 \text{ J/mol-K}$
- Permeability of free space =  $4\pi \times 10^{-7} \text{ Hm}^{-1}$ 

---
- Permittivity of free space =  $8.854 \times 10^{-12} \text{ Fm}^{-1}$
- The density of air at S.T.P. =  $1.293 \text{ kg m}^{-3}$
- Universal gravitational constant =  $6.67 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$



[www.Youtube.com/safaltaclass](https://www.youtube.com/safaltaclass)



[www.Facebook.com/safaltaclass](https://www.facebook.com/safaltaclass)



[www.Instagram.com/safaltaclass](https://www.instagram.com/safaltaclass)



Google Play  
Store