GA

PHYSICS → 25 → 100 marks + 60 marks (Chem)

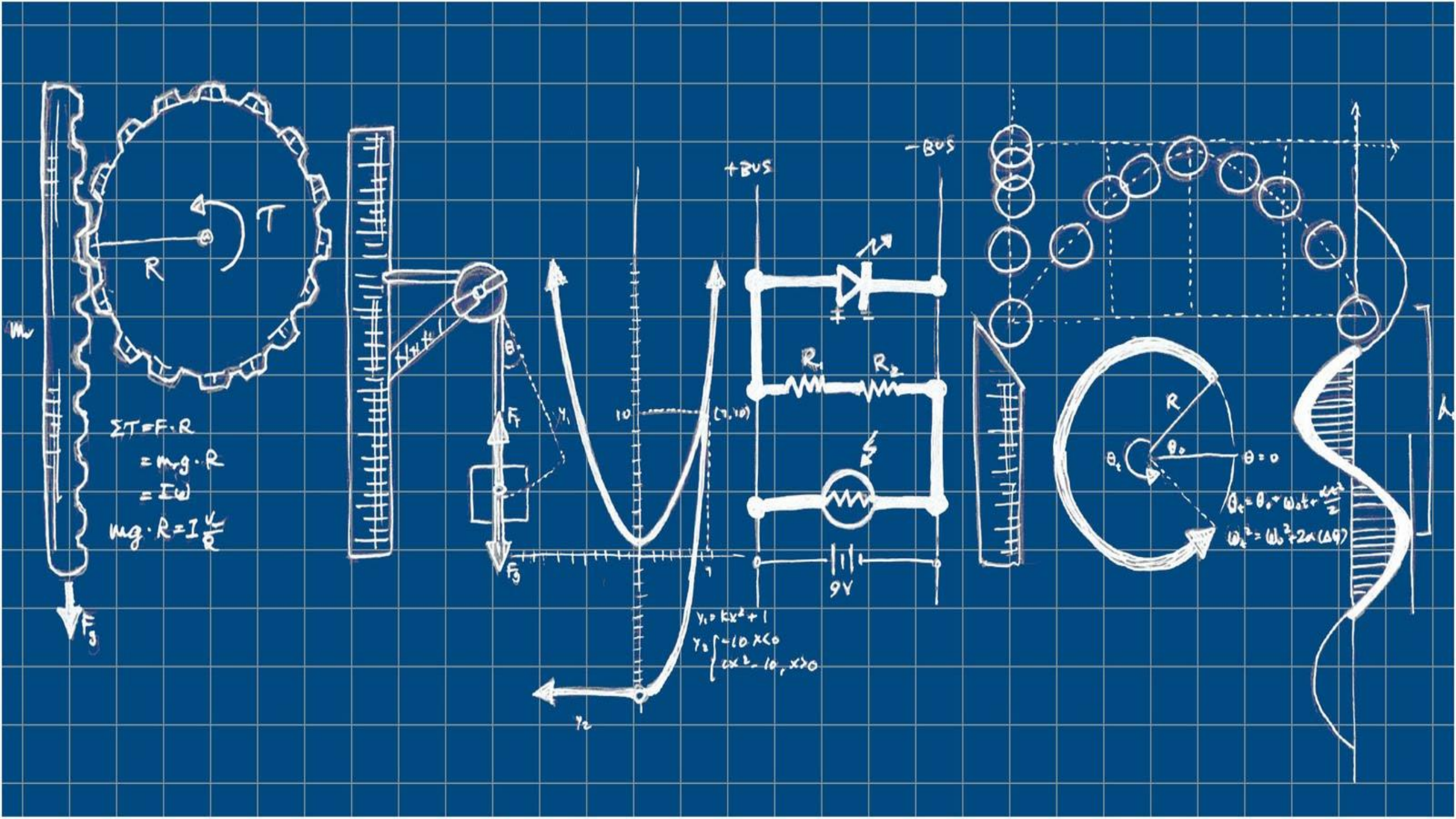
SAFALTA CLASS™

An Initiative by अमर उजाला

सेवा परमो धर्मः

NDA

NATIONAL DEFENCE ACADEMY


R
T
$\Sigma T = F \cdot R$
$= mg \cdot R$
$= I\omega$
$mg \cdot R = I\frac{v}{R}$
F_g
F_T
θ
y_1
y_2
10
(7, 10)
7
$y_1 = kx^2 + 1$
$y_2 \begin{cases} -10 & x < 0 \\ cx^2 - 10, & x > 0 \end{cases}$
+BUS
−BUS
R_1
R_2
9V
R
θ_0
$\theta = 0$
$\theta_f = \theta_0 + \omega_0 t + \frac{\alpha t^2}{2}$
$\omega_f^2 = \omega_0^2 + 2\alpha(\Delta\theta)$

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

TOPICS

1. UNIT & DIMENSION } 1 Q
2. RECTILINEAR MOTION ✓
3. PROJECTILE MOTION
4. NEWTON'S LAWS OF MOTION
5. FRICTION ✓

} 3-4 Q

6. UNIFORM CIRCULAR MOTION

7. WORK ENERGY POWER

8. ROTATIONAL MOTION

(1 - 2) Q

9. PROPERTIES OF MATTER
(Elasticity, Surface tension, Fluid mechanics) } 1

10. GRAVITASTION } 2 Q

11. SOUND & WAVES } 1

12. CURRENT ELECTRICITY → Resistance प्रतिरोध

13. MAGNET & MAGNETIC EFFECT OF CURRENT

14. ELECTROMAGNETIC INDUCTION AND A.C.

} 2-3 Q

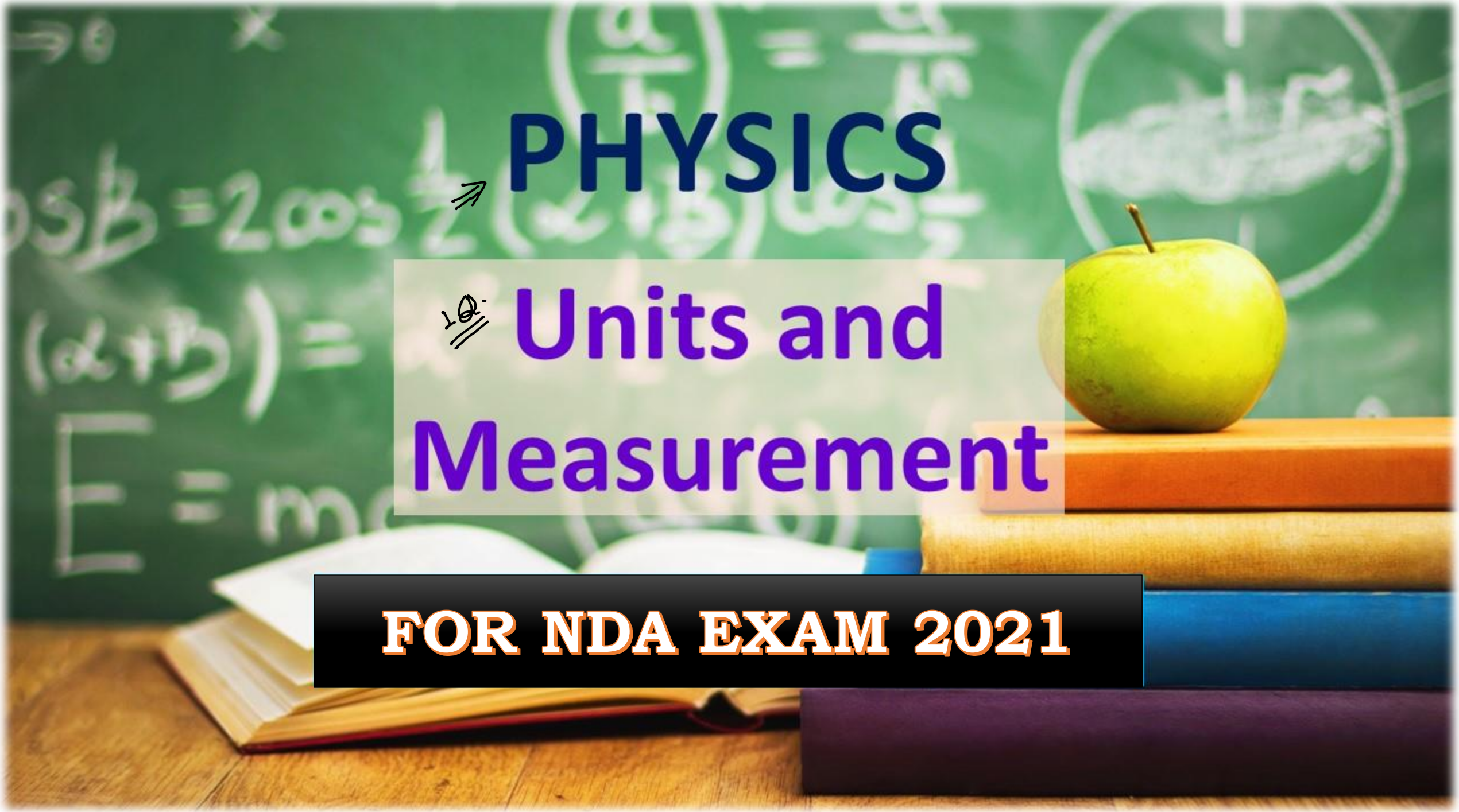
15. HEAT , KTG , THERMODYNAMICS } 2-3 Q

16. RAY OPTICS & WAVE OPTICS } 3-4 Q

17. MODERN PHYSICS

18. SEMICONDUCTORS

} 2-3 Q


PHYSICS
Units and
Measurement
FOR NDA EXAM 2021

TYPES OF QUANTITIES (राशियाँ के प्रकार)

भौतिक

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

e.g:- Length , mass ,

अभौतिक

- **Non-physical quantities** are those **quantities** which cannot 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।

$$Q = nu.$$

⇒ CGPM

Units are decided by : General Conference on Weights and Measures

⇒ (**Conférence Générale des Poids et Mesures**, **CGPM**)

Fundamental and Derived Quantities

(०-9)

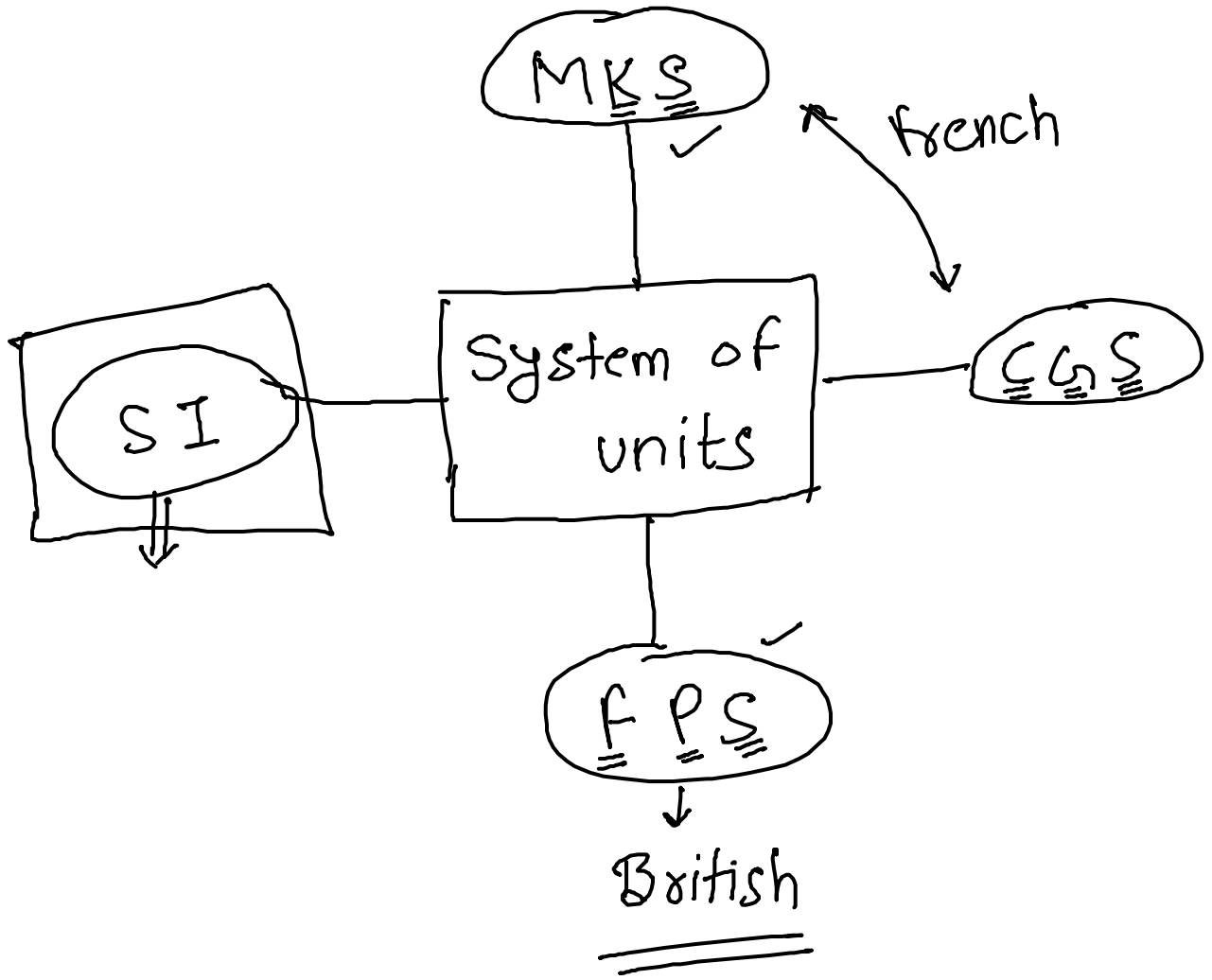
(मौलिक और व्युत्पन्न राशियाँ)

- The quantities that are independent of other quantities are called fundamental quantities.
- जो मात्राएँ अन्य राशियों से स्वतंत्र होती हैं, उन्हें मौलिक मात्राएँ कहा जाता है।

(1) mass → मूल राशि ⇒ Kg (मात्रक)

- The units that are used to measure these fundamental quantities are called fundamental units.
- 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 SI.


MKS
French
System of units
SI
CGS
FPS
British

Fundamental Quantity	System of units		
	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 (SI)	Symbol
Length	Meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Intensity of light	candela	cd
Quantity of substance	mole	mol

राशि	मात्रक	संकेत
लम्बाई (दूरी)	मीटर	m
द्रव्यमान	किग्रा.	kg
समय	सेकेण्ड	s
ताप	कैल्विन	K
विद्युत धारा	ऐम्पियर	A
ज्योति तीव्रता	कैण्डला	कैण्डCd
पदार्थ की मात्रा	मोल	मोलmol
पूरक मूल मात्रक		
तलीय कोण	रेडियन	(रेडियन)Rd
घन कोण	स्टेरेडियन	(स्टेरेडियन) Srd

SUPPLEMENTARY UNITS (पूरक मात्रक)

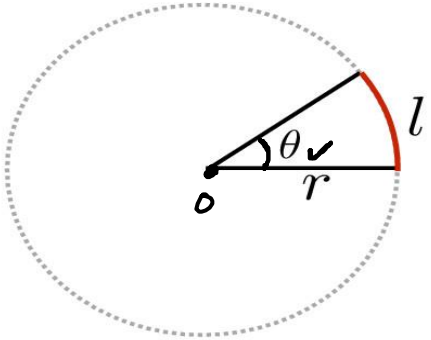
Plane angle	radian	rad
Solid angle	steradian	sr

ठोस का कोण

Angles and Solid Angles

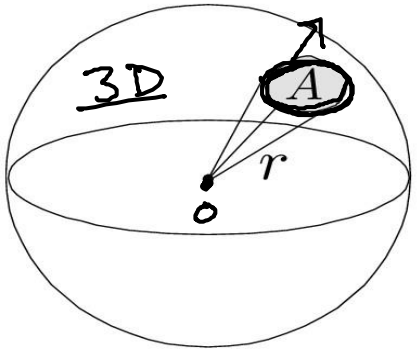
Angle: ratio of subtended arc length on circle to radius

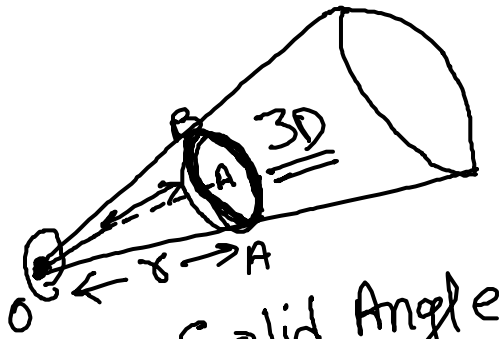
- $\theta = \frac{l}{r}$
- Circle has 2π radians



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

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





Solid Angle

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

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।

* Area क्षेत्रफल = l x b

= m x m = m^2

} Derived

व्युत्पन्न

SI

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	Ω
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

* Small units of Length (लम्बाई के छोटे मात्रक):-

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

$$1\ \text{Å} = 10^{-10}\ \text{m}$$

1 Å = 10^{-10} m (एंगस्ट्रॉम)

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

(फर्मी)

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

(नाभिक की त्रिज्या)

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

* Atom (Radius) (परमाणु की त्रिज्या) :→ Picometer

1 pm = 10^{-12} m

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

  1 Light year = distance traveled by light in 1 year = 9.4605×10^{15} m.

  प्रकाश वर्ष

- Astronomical unit = Mean distance between the sun and earth = 1.5×10^{11} m.

  खगोलीय दूरी

- Parsec = 3.26 light years = 3.084×10^{16} m

  → Largest unit of Length

  → * Parallactic Second:-

  Full form

FOR MASS :

1 CSL = 1.4 x mass of the Sun

1 चन्द्रशेखर सीमा = 1.4x सूर्य का द्रव्यमान

mass of star → $m_s > 1\,CSL$

⇓

Black Hole

$m_s \leq 1\,CSL$

⇓

White Dwarf

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 है जो उस भौतिक राशि के व्युत्पन्न मात्रक प्राप्त करनें के लिए मूल मात्रकों पर चढ़ाई जाती है |

$\vec{1} \rightarrow \vec{1}$

$[\ ]$

A, B

DIMENSIONAL FORMULA (विमीय सूत्र)

Physical Quantity	Units(SI)	Units(CGS)	Notations
Mass	kg(kilogram)	g	→ M
Length	m (meter)	cm	→ L
Time	s (second)	s	→ T
Temperature	K (kelvin)	°C	[K, θ] Theta
Current	A (ampere)	A	[A] I or A
Luminous intensity	cd (candela)	—	cd
Amount of substance	mol	—	mol

X

HOW TO WRITE DIMENSIONAL FORMULA

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

STEP 2 : Write down or derived the unit.

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

IMPORTANT DIMENSIONAL FORMULAS

- **SPEED / VELOCITY :**

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}, \quad \text{चाल} = \frac{\text{दूरी}}{\text{समय}}$$

$$= \frac{\text{meter}}{\text{second}} = \frac{m}{s} = \frac{[L]}{[T]}$$

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

• AREA, VOLUME & DENSITY :

① Area (क्षेत्रफल) = $l \times b \Rightarrow m \times m = [L][L] = [L^2]$

② Volume (आयतन) = $l \times b \times h \Rightarrow m \times m \times m = m^3$

$= [L^3]$

③ घनत्व = $\frac{\text{द्रव्यमान}}{\text{आयतन}} = \frac{M}{V} \Rightarrow \frac{Kg}{m^3}$

$= \frac{[M]}{[L^3]}$

$= [ML^{-3}]$

• ACCELERATION OR GRAVITATIONAL ACCELERATION :

त्वरण या गुरुत्वीय त्वरण (g)

(a)

$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{[LT^{-1}]}{[T]} = [LT^{-2}]$$

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

- **FORCE :**

$$F = ma \Rightarrow N \quad (SI)$$

$$= kg - \frac{m}{s^2} = [M] - \frac{[L]}{[T^2]}$$

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

• WORK , ENERGY & TORQUE :

$E = W$

$P = \frac{W}{t}$

① Work $= F \cdot d$ ⇒ बल × विस्थापन

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

② Energy = Work = $[ML^2T^{-2}]$

ऊर्जा = कार्य

$KE = \frac{1}{2}mv^2$

$= Kg - (m/s)^2 = \frac{Kg-m^2}{s^2}$

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

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

③ बल आघूर्ण (τ) :- $\tau = f \times d$

$= N-M = [mL^2T^{-2}]$

- **POWER :**

$$P = \frac{W}{t}$$

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

$$P = [ML^2T^{-3}]$$

- **PRESSURE :**

दाब $(P) = \frac{F}{A}$ $\frac{\text{बल}}{\text{क्षेत्रफल}}$

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

$$= [ML^{-1}T^{-2}]$$

- **IMPULSE :**

आवेग = बल × समय

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

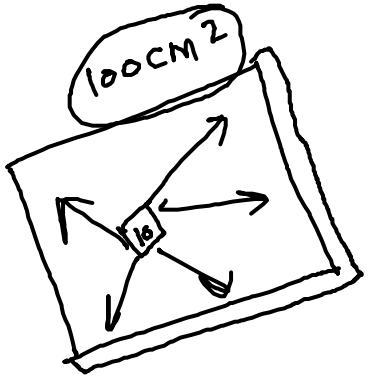
$= [MLT^{-1}]$

- **SURFACE TENSION :** (पृष्ठ तनाव):

$[MT^{-2}]$

$\Rightarrow \frac{\text{Joule}}{\text{meter}}$

$\Rightarrow W$



$W = 100\ J$ ✓

$A = 100\ cm^2$

$\Rightarrow \frac{J}{m^2} = \frac{N - \cancel{m}}{\cancel{m^2}}$

$= \frac{N}{m} = \frac{[ML\cancel{T}^{-2}]}{[\cancel{L}]}$

$= [MT^{-2}]$

• GRAVITATIONAL CONSTANT :

Imp

$G = ?$

$$F = G \frac{m_1 m_2}{r^2}$$

$$G = \frac{F - r^2}{m_1 m_2}$$

$$= \frac{N - m^2}{kg^2} = \frac{[MLT^{-2}][L^2]}{[M^2]}$$

$$= [M^{-1} L^3 T^{-2}]$$

- **GRAVITATIONAL FIELD :**

$$G.\text{Field} = \frac{\text{force}}{\text{mass}}$$

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

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

$$E = \frac{F}{q_0}$$

- **SPRING CONSTANT :**

- **Permittivity of free space :** ε_0

Imp

- **Permeability of free space :** (μ_0)

Dimensionless quantities (विमाहीन राशियां)

- Dimensionless quantities are those which do not have dimensions but have a fixed value.

वे राशियां जिनकी विमा(मात्रक) नहीं होती हैं।

- Dimensionless quantities without units: Pure numbers, π, e, sin θ, cos θ, tan θ 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.

Some Important Conversions

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

- 1 kilowatt hour = 36×10^5 J
- 1 kgwt = g newton
- 1 calorie = 4.2 joule
- 1 electron volt = 1.602×10^{-19} joule
- 1 erg = 10^{-7} joule

Some Important Physical Constants

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

- Atomic mass unit = 1.66×10^{-27} kg
- Quantum of charge (e) = 1.602×10^{-19} C
- Stefan's constant = 5.67×10^{-8} W/m^2/K^4
- Boltzmann's constant (K) = 1.381×10^{-23} JK^{-1}
- One atmosphere = 76 cm Hg = 1.013×10^5 Pa
- Mechanical equivalent of heat (J) = 4.186 J/cal
- Planck's constant (h) = 6.626×10^{-34} Js

- Universal gas constant (R) = 8.314 J/mol–K
- Permeability of free space = $4\pi \times 10^{-7}$ Hm^{-1}
- Permittivity of free space = 8.854×10^{-12} Fm^{-1}
- The density of air at S.T.P. = 1.293 kg m^{-3}
- Universal gravitational constant = 6.67×10^{-11} Nm^2kg^{-2}

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