CLASS NOTES OF "APPLIED PHYSICS-B"

Technical Classes

✅ Technical Classes के Course में उपलब्ध फीचर्स

1. सभी कक्षाएं स्मार्ट बोर्ड पर Live
2. विशेषज्ञ शिक्षको द्वारा पठन पाठन
3. Lecture के दौरान डाउट सॉल्विंग
4. Recorded Lecture (VOD)
5. प्रत्येक क्लास का PDF नोट्स
6. SBTE Exam की तैयारी के लिए ब्रह्मास्त्र क्लास
7. Laptop में क्लास देखने की सुविधा

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नोट :-

1. सभी ऑफलाइन कक्षाएं Technical Classes के कैंपस तथा सभी ऑनलाइन कक्षाएं Technical Classes के एप्लीकेशन पर चलेगी।

2. यह नोट्स टेक्निकल क्लासेस के स्टूडेंट्स के लिए है, तथा क्लास करने के बाद अधिक प्रभावी होगा।

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2400102B

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Distinguish between fundamental and derived physical quantity. *TSO 1b.* Estimate the errors in the measurement of given physical quantity. *TSO 1c.* Derive dimensional formula of given physical quantity. *TSO 1d.* Apply dimensional analysis for inter conversion of units. *TSO 1e.* Establish relation among physical quantities using dimensional analysis. *TSO 1f.* Use dimensional analysis to check the correctness of a given equation.	**Unit-1.0 Unit and Measurements** 1.1 Physical quantities, fundamentals and derived units and system of units 1.2 Accuracy, precision and errors (systematic and random) in measurements, Method of estimation of errors (absolute and relative) in measurement, propagation of errors, significant figures 1.3 Dimensions and dimensional formulae of physical quantities, Principle of homogeneity of dimension in an equation 1.4 Applications of dimensions: conversion from one system of units to other, corrections of equations and derivation of simple equations. 1.5 Ancient astronomical instruments: Chakra, Dhanuryatra , Yasti and Phalaka yantra . (IKS)	**CO1**
TSO 2a. Explain the various terms related to SHM. *TSO 2b.* Distinguish between mechanical and electromagnetic waves with examples. *TSO 2c.* Differentiate between longitudinal and transverse waves with examples. *TSO 2d.* Find the relation between the terms used to describe wave motion. *TSO 2e.* Explain the principle of Superposition of waves	**Unit-2.0 Simple Harmonic and Wave Motion** 2.1 Periodic and Oscillatory Motion 2.2 Simple Harmonic Motion (SHM): Displacement, velocity, acceleration, time period, frequency and their interrelation 2.3 Types of waves: Mechanical and Electromagnetic, Transverse and longitudinal waves, wave velocity, frequency and wave length and their relationship, wave equation, amplitude, phase, phase difference, Superposition of waves	**CO2**
TSO 3a. Derive an expression for electric field experienced by electric charge in the vicinity of another electric charge(s). *TSO 3b.* Differentiate between electric potential and potential difference. *TSO 3c.* Apply Gauss' law to find the electric field intensity due to charge bodies. *TSO 3d.* Describe factors affecting the capacitance of a given capacitor. *TSO 3e.* Find the expression for magnetic field caused by current carrying circular wire at the center.	**Unit-3.0 Electrostatics, Electromagnetism and Electric Current** 3.1 Electric Charge, Coulomb's law, Electric field, Electric lines of force and their properties, Electric flux, Electric potential and potential difference, Electric dipole 3.2 Gauss' law, electric field intensity due to straight charged conductor, charged plane sheet and charged sphere 3.3 Dielectric, Capacitance of capacitor (parallel plate), Factor affecting capacitance of capacitors 3.4 Magnetic field and its units, Biot Savart Law Magnetic field due to current caring wire:	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3f. Explain Faraday's law of electromagnetic induction and Lenz's with applications. *TSO 3g.* Explain the terms required to describe the AC current	straight and circular wire, Lorentz force (force on moving charge in magnetic field) 3.5 Magnetic flux, Faraday's law of electromagnetic induction, Lenz's law, Self and Mutual induction, eddy current, motional emf 3.6 DC and AC currents, Average, rms and Peak value of AC current	
TSO 4a. Distinguish material on the basis of band gap. *TSO 4b.* Explain the various terms related to movement of charge carrier inside the semiconductors. *TSO 4c.* Explain the formation of depletion layer in a given pin junction. *TSO 4d.* Use V-I characteristic of explain the working of given p-n junction device.	**Unit-4.0 Semiconductor Physics** 4.1 Energy band and band gap, insulator, semi-conductor, conductor 4.2 Intrinsic and Extrinsic semiconductors, Drift velocity, drift and diffusion current, Mobility, current density, law of mass action. 4.3 Depletion layer and barrier Potential, p-n junction and V-I characteristics, Half wave and full wave rectifier 4.4 Photocells, Solar cells; working principle and engineering applications.	**CO4**
TSO 5a. Apply the concept of photoelectric effect to explain the of photonic devices. *TSO 5b.* Explain Laser, components of laser and its various engineering applications. *TSO 5c.* Explain propagation of light in optical fiber and applications of optical fiber. *TSO 5d.* Describe the properties of nanomaterials and its various applications.	**Unit-5.0 Modern Physics** 5.1 Photoelectric effect; threshold frequency, work function, Stopping Potential, Einstein's photoelectric equation. 5.2 Lasers: Energy levels, ionization and excitation potentials; spontaneous and stimulated emission; population inversion, pumping methods, types of lasers): He Ne Laser, p-n junction diode laser, engineering and medical applications of lasers. 5.3 Optical fibers: Total internal reflection, acceptance angle and numerical aperture, Optical fiber types, applications in telecommunication, medical and sensors. 5.4 Nanotechnology: Properties (optical, magnetic and dielectric properties) of Nanomaterials and its application, Bhasma (Ancient Ayurveda, IKS)	**CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2400102B

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use Vernier caliper to measure the known and unknown dimensions of a given small object. *LSO 1.2.* Estimate the mean absolute error up to two significant figures.	1.	Vernier caliper	CO1
LSO 2.1. Use screw gauge to measure the diameter/ thickness of a given object. *LSO 2.2.* Estimate the mean absolute, relative and percentage errors up to three significant figures.	2.	Screw gauge	CO1
LSO 3.1. Use Spherometer to measure radius of curvature of given convex and concave mirror/surface.	3.	Spherometer	CO1

1st SEMESTER

APPLIED PHYSICS A/B

Date :- 21/08/2024

LEC. No. :- 01

UNIT-01 Unit & Measurement

Q. Science ?

विज्ञान

बहुत + ज्ञान

" systematic knowledge of anything to know about what & how of that thing ".

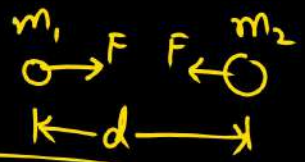
$$F = G\frac{M_e M_p}{(R_e + e)^2}$$

M_p

Pen drop ⇒ what = ? Gravitation

⇒ how = ? F.O.A

⇒ why = ?



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

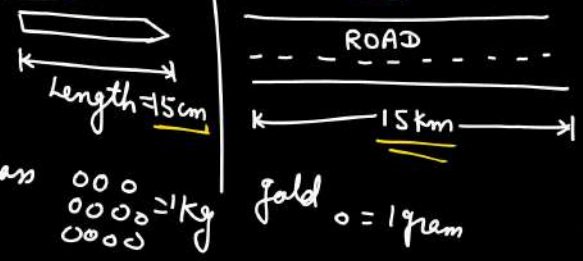
Unit - 01

Unit & dimension :-

Unit :-

Physical Quantity — Length (लम्बाई) =

15 cm, 15 km, 5 m → standard



आँगन = 1 बिघा

P.Q. → Mass

1 kg, 1 gram, 1 quintal → Standard

Unit :-

"units are the standard in which any physical quantity is represented"

Ex→ Length = 1 m, 10 cm, 15 km → unit

Area = 2 m^2, 10 Acre, 5 hectare

Mass = 100 g, 50 kg, 5 quintal

Physical quantity (P.Q.) :-

"Anything which can be measured with the help of any instrument is known as physical quantity".

Ex. → 50g / 2m ⇒ Length = 2m

(Tape)

Mass = 50 gram

(weighing machine)

Physical quantity

Length ⇓ scale / chain / Tape / calliper

Mass ⇓ wt. machine

volume ⇓ container

Area ⇓ chain / Planeometer

speed / velocity ⇓ speedometer

current ⇓ Ammeter

voltage ⇓ voltmeter

Length = 5 m
n u

Mass = 2 kg
number unit

Time = 10 min

current = 100 Amp

volatge = 420 volt

* $\boxed{P.Q. = n \times u}$

$\Downarrow$ number, unit

$\Downarrow$ Magnitude

$\Downarrow$ मात्रा

- Any P.Q. is represented in form of n.u, where-

✓ n = magnitude

✓ u = unit

Ex→ Length = 10 cm

⇒ n = 10

⇒ u = cm

1 m = 100 cm

n_1 u_1 n_2 u_2

m > cm $(u_1 > u_2)$

1 < 100 $(n_1 < n_2)$

PYQ ***

$$\boxed{u \propto \frac{1}{n}}$$ ****

- "u is inversely proportional to n".

P.Q :-

Types of P.Q. :-

Any P.Q. is devided into two group -

7:00 to 8:00 am

M, W, F

I Fundamental Physical quantity / Base P.Q.

(मूल भौतिक राशि) :-

II Derived / Dependent P.Q.

III Suplementary Physical quantity

APPLIED PHYSICS- A

LEC. NO. - 02

28/08/2024

Unit-01

Unit & Dimension :-

Unit :- units are the internationally accepted standards of a physical quantity.

Ex. → Length = 15 cm

Physical quantity :-

Any quantity which can be measured via any instrument is known as physical quantity.

Ex → Length (5m), Distance (5m), speed (5 km/s), Temp^r, current, voltage, Heat etc.

(5 km/s) → (n × u)

Any P.Q. can be devided in two categories :-

Fundamental/Base P.Q. (7)

i) Mass (kg)
ii) Length (m)
iii) Time (s)
iv) Temperature (K)
v) Electric current (A)
vi) Amount of substance (mole)
vii) Luminous intensity (cd)

Derived P.Q. (infinite)

Area = $l \times b$ = m × m

Area = m^2

volume = m^3 (l b h)

velocity = $\frac{dist.}{time}$

acc^n = $\frac{velocity}{time}$ = $\frac{dist.}{time^2}$

• Force = m × a

Suplimentary Physical quantity :- (2)

i) Plane angle (Radian)

ii) Solid angle (steradian)

System of unit :-

	Length	Mass	Time	
1.	metre	Killogram	second	⇒ MKS system
2	centimeter	gram	second	⇒ CGS system / French system
3.	Feet	Pound	second	⇒ FPS system / British system

S.I system (International system)

Dimension Analysis :-

Dimension :-

Dimensions are power in which any P.Q. is represented in terms of the Fundamental Physical Quantity.
(7)

- mass [M]
- Length [L]
- Time [T]

Temp^r [K], [θ]

Electric current [I], [A]

Amount of substance [MOL]

Luminious intensity [Cd]

Ex. → Area = Length × width = [L] · [L]

$= [L^2] = [M^0 L^2 T^0]$

volume = Length × width × height

$= [L] \times [L] \times [L]$

$= [L^3] = [M^0 L^3 T^0]$

velocity = $\frac{\text{distance}}{\text{Time}} = \frac{[L]}{[T]}$

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

acceleration :-

$$a = \frac{\Delta v}{\Delta t} = \frac{[LT^{-1}]}{[T]} = [LT^{-2}] = [M^0 L^1 T^{-2}]$$

Rate = $\frac{\quad}{t}$

gradient = $\frac{\quad}{t}$

$$a = \frac{\Delta V}{\Delta t}$$

*****

Force :-

$$F = m \times a = [M] \times [LT^{-2}] = [MLT^{-2}]$$

work :-

$$W = \vec{F} \cdot \vec{S} = |F| \cdot |S| \cdot \cos\theta = [MLT^{-2}] \cdot [L] \cdot [M^0 L^0 T^0] = [ML^2T^{-2}]$$

Note :- Trigonometrical ($\sin\theta / \cos\theta / \tan\theta$), exponential ($e^x, e^y$) & logrithmeic ($\log x, \log y$) terms doesn't have any dimensions.

$\vec{v}$

$m = \frac{1}{2} m v^2$

Energy :-

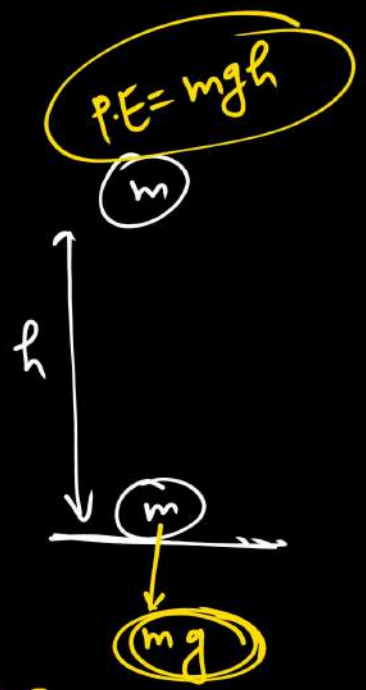
→ I) $K.E = \frac{1}{2} m v^2$

$[K.E] = [M^0 L^0 T^0][M][LT^{-1}]^2 = [ML^2T^{-2}]$

→ II) Potential energy $(P.E) = mgh$

$[P.E] = [M] \cdot [LT^{-2}] \cdot [L]$

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



$W = F \cdot S$

$= mg \cdot (-h)$

$= -mgh$

$W = -(P.E)$

momentum ($\vec{p}$) = mass × velocity

$$[\vec{p}] = [M] \times [LT^{-1}]$$

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

Impulse :- Force × small time

$$= F_{net} \times (\Delta t)$$

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

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

Both momentum and Impulse have same dimension formula:

APPLIED PHYSICS :-

LEC. No. :- 03
DATE :- 30/08/24

Dimensional analysis :-

Dimension :-

Dimensions are the power in which any P.Q. is represented in terms of fundamental or Base P.Q.

Ex. :→ velocity = "Rate of change of displacement"

$$v = \frac{\text{disp.}}{\text{time}} = \frac{\text{Length}}{\text{Time}}$$

$$[v] = \frac{[L]}{[T]} = [L^1 T^{-1}]$$

$$x^{-5} = \frac{1}{x^{5}}$$

$$\frac{1}{x^3} = x^{-3}$$

FUNDAMENTAL or BASE Quantity :- 7

(i) Mass → [M]
(ii) Length → [L]
(iii) Time → [T]
(iv) Temp^r → [K] or [θ]
(v) Current → [I] or [A]
(vi) Amount of substance → [Mol]
(vii) Luminious intensity → [Cd]

Rate = $\frac{\text{disp.}}{\text{time}}$

temp^r gradient = $\frac{\text{temp}^r}{\text{length}}$

M.W

momentum = (M × V)

Impulse = (F × Δt)

Q. Force = Mass × acc^n

$= [M] \times [LT^{-2}]$

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

acc^n = "Rate of change of velocity"

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

$[a] = \frac{v}{t} \rightarrow \frac{[\frac{L}{t}]}{[t]} = \frac{[L]}{[t^2]}$

$= [LT^{-2}]$

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

Q. Dimension of force → $[MLT^{-2}]$

Q. Dimensional eq^n of force →

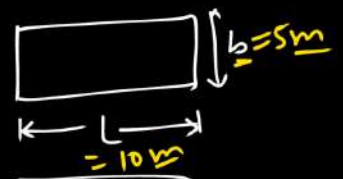
$$[F] = [MLT^{-2}]$$

Q. what is the dimension of Time in Force = −2

Q. what is the dimension of Mass in Force = 1

$$\text{Area} = L \times b = [L] \times [L] = [L^2]$$

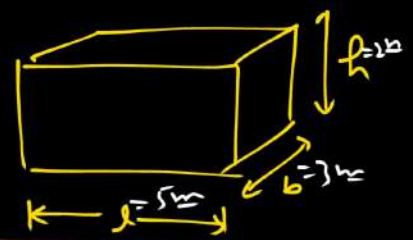
$$[A] = [L^2]$$



$$\boxed{A = L \times b}$$

Q. $$\text{volume} = L \times b \times h = [L] \times [L] \times [L] = [L^3]$$

$$[V] = [L^3]$$



$$\boxed{V = l \times b \times h}$$

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{[M]}{L \times b \times h} = \frac{[M]}{[L][L][L]}$$

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

$$\boxed{\text{density } (\rho) \text{ घनत्व} = \frac{\text{Mass}}{\text{volume}}}$$

FORCE = Mass × acc^n

$= [M] \times [LT^{-2}]$

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

acc^n = "Rate of change of velocity"

त्वरण = "वेग में परिवर्तन के दर को त्वरण कहते हैं।"

$a = \frac{V}{[t]} = \frac{[LT^{-1}]}{[T]} = [LT^{-2}]$

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

Work = Force × Displacement

(कार्य) = (बल) × (विस्थापन)

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

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

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

$$F = m \times a$$

$$= [M] \times [LT^{-2}]$$

$$\boxed{[F] = [MLT^{-2}]}$$

M.
L.
T.
Temp.
current
L.I
A.O.S

$$a = \frac{v}{t} = \frac{\left[\frac{L}{T}\right]}{[T]}$$

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

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

$$[P] = \frac{\text{Force} \times \text{disp.}}{\text{Time}}$$

$$= \frac{[\text{mass} \times \text{acc}^n] \times [\text{disp.}]}{\text{Time}}$$

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

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

M
$[D$
$[T]$

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

Power = Rate of change of work

शक्ति = कार्य करने के दर को शक्ति कहते हैं।

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

Energy =

$[E] = [W] = [\text{Force} \times \text{disp.}]$

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

→ Kinetic energy $= \frac{1}{2}mv^2$

(गतिज ऊर्जा)

$= [M^0L^0T^0] \cdot [M][LT^{-1}]^2$

$= M^1L^2T^{-2}$

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

$a = \frac{v}{T} = \frac{[\frac{d}{T}]}{[T]}$

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

→ Potential energy $= mgh$

(स्थितिज ऊर्जा)

$= [M][LT^{-2}][L]$

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

Energy (ऊर्जा) :-

Energy ⇒ "capacity of doing work"

शक्ति = "कार्य करने की क्षमता"

$[E] = [W] = F \times \text{disp}$

$\frac{1}{2}, 2, 5$ → constant number have zero dimension

$[\frac{1}{L}] = [M^0L^0T^0]$

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

APPLIED PHYSICS

LEC. NO. :- 05

DATE :- 02/08/24

UNIT - 01

Dimensions :-

Mass - M
Length → L
Time → T
current → I/A
Temp^r → K
A.O.S → mol
L.I → cd

Impuse :- $\boxed{I = F \times \Delta t}$ *

$$[I] = [F] \times [\Delta t]$$

$$= [m \times a] \times [T]$$

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

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

Impulse :-

If a large force is acted for a very small interval of time then the product of the force and that small interval of time is known as Impulse.

Momentum (P) :- "It is defined as the Product of mass and velocity"

(संवेग)

$$P = m \times v$$

momentum, mass, velocity

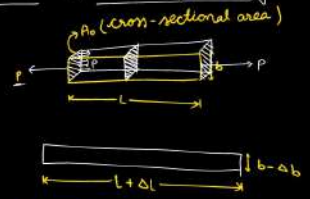
$$[P] = [M] \times [v]$$

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

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

- Both momentum and impulse have same dimension.

Stress, strain and modulus of Elasticity :-



***** **stress (σ)** :- It is defined as the internal resistance force per unit c/s Area.

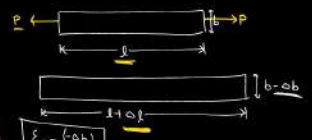
(sigma)

$$\boxed{\sigma = \frac{P}{A_0}}$$

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

strain (ε) :- It is defined as the ratio of change in dimension (length/width) to the original dimension

Epsilon



$$\boxed{\varepsilon_l = \frac{\Delta l}{l}} \qquad \boxed{\varepsilon_b = \frac{(-\Delta b)}{b}}$$

$L \Rightarrow [L] = m$

$[\varepsilon] \Rightarrow [M^0L^0T^0]$ No unit

$$[\varepsilon_l] = \frac{[\Delta l]}{[l]} = \frac{[L]}{[L]} = [L^0] = [M^0L^0T^0]$$

- Strain is a dimensionless and unitless quantity

Modulus of elasticity (E) :-

"HOOKE'S LAW :

stress is directly proportion to strain within the portional limit.

$$\sigma \propto \varepsilon$$

$$\sigma = E\varepsilon$$

$$\boxed{E = \frac{\sigma}{\varepsilon}}$$

$$[E] = \frac{[\sigma]}{[\varepsilon]} = \frac{\frac{[P]}{[A]}}{[M^0L^0T^0]} = \frac{\frac{[MLT^{-2}]}{[L^2]}}{[M^0L^0T^0]}$$

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

Both Young's modulus of elasticity and stress have same dimension

stress (σ)

$$\boxed{\sigma = \frac{P}{A} = \frac{F}{A}}$$

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

$$\boxed{[\sigma] = [M L^{-1} T^{-2}]}$$

strain (ε)

$$\boxed{\varepsilon = \frac{\Delta l}{l}}$$

$$[\varepsilon] = \frac{\cancel{[L]}}{\cancel{[L]}}$$

$$\boxed{[\varepsilon] = [M^0 L^0 T^0]}$$ ***

M.O.E (E)

$$\sigma \propto \varepsilon$$

$$\sigma = E\,\varepsilon$$

$$\boxed{E = \frac{\sigma}{\varepsilon}}$$

$$[E] = \frac{[M L^{-1} T^{-2}]}{[M^0 L^0 T^0]}$$

$$\boxed{[E] = [M L^{-1} T^{-2}]}$$ ***

पढ़ाई

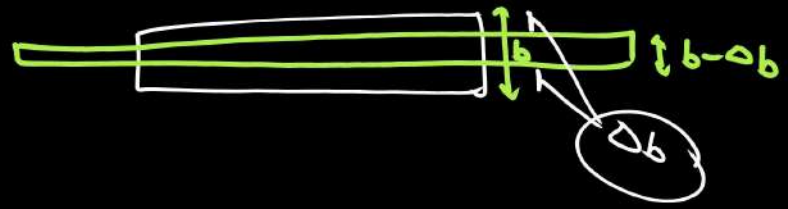
60%

40% → 2 hour, 4 hour → PYQ, Problem, Revision

self study ⇒

IMFOA (अंतरआणविक बल)

$\sigma = \frac{P}{A_0}$



Dimension analysis :-

APPLIED PHY.

LEC. No. :- 05

UNIT- 01

DATE - 08/9/24

✓ Force → $[M^1 L^1 T^{-2}]$

Force = mass × acc^n

$= M \times \left(\frac{\Delta v}{T}\right)$

$= M \times \left(\frac{\frac{\Delta L}{T}}{T}\right) = M \times \Delta L \times \frac{1}{T^2}$

Moment = Force × $\perp^{r}$ distance

(Rotation effect)

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

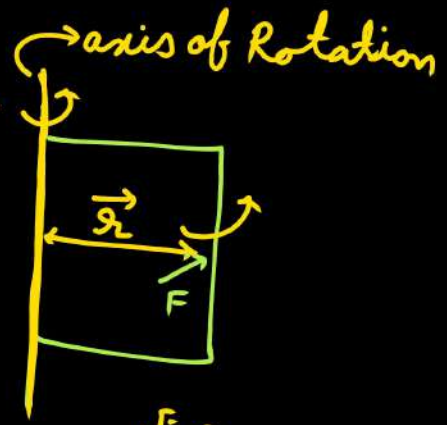
$= [ML^2T^{-2}]$

Torque :- $\vec{r} \times \vec{F}$

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

$\times \rightarrow$ vector

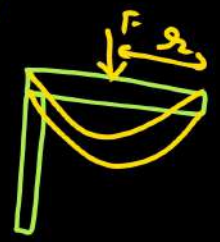
$\bullet \rightarrow$ scalar



Bending moment = F × $\perp^{r}$ distance

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

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



Dimension :-

[M] ← Mass
[L] ← Length
[T] ← Time
[A]/[I] ← current (Amp.)
[θ]/[K] ← Temp^r
[MoL] ← Amount of subs.
[Cd] ← Luminious Intensity

Power :- "Rate of doing work"

(शक्ति) (~~ऊर्जा~~) = कार्य करने की दर को ऊर्जा कहते हैं।

$$\boxed{\text{Power} = \frac{\text{work}}{\text{Time}}}$$

$$[P] = \frac{(\text{Force} \times \text{disp})}{\text{Time}} = \frac{[\text{mass} \times \text{acc}^n] \times [\text{disp.}]}{[\text{Time}]}$$

$$= \frac{\left[\text{mass} \times \frac{\text{dist.}}{\text{Time}^2}\right] \times [\text{disp}]}{[\text{Time}]}$$

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

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

$$v = u + at$$

$$a = \frac{(v-u)}{t} = \frac{(\Delta v)}{t}$$

$$a = \frac{\left(\frac{\text{dist}}{\text{time}}\right)}{\text{time}} = \frac{\text{dist.}}{\text{time}^2}$$

M.L.T

velocity $= \frac{\text{disp.}}{\text{Time}} = \frac{[L]}{[T]} = [L\,T^{-1}]$

work = Force × disp

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

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

Force = Mass × acc^n

$= [M] \times [LT^{-2}]$

$= [MLT^{-2}]$

Pressure $= \frac{\text{Force}}{\text{Area}} = \frac{[MLT^{-2}]}{[L^2]}$

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

Impulse = Force × (Δt)

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

density $= \frac{\text{Mass}}{\text{volume}} = \frac{[M]}{[L^3]} = [ML^{-3}]$

acc^n $= \frac{\Delta v}{T} = \frac{[LT^{-1}]}{[T]} = [LT^{-2}]$

energy =

→ K.E $= \frac{1}{2}mv^2 = [M^0L^0T^0][M][LT^{-1}]^2$

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

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

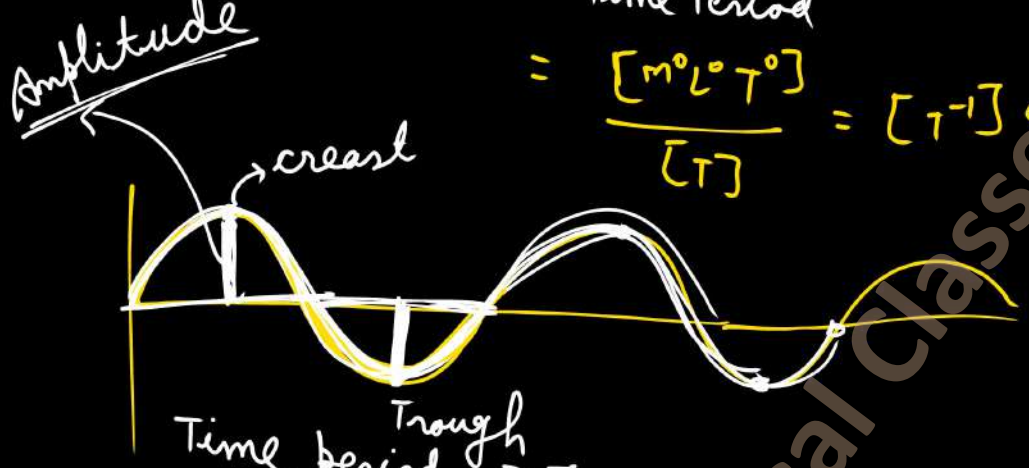
Momentum (p) = mass × velocity
संवेग

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

$= [MLT^{-1}]$

Frequency (f) = $\frac{1}{\text{Time Period}}$ (per second $\frac{1}{s}$ or Hertz)

$= \frac{[M^0L^0T^0]}{[T]} = [T^{-1}]$ or $[M^0L^0T^{-1}]$

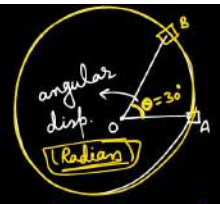


Time period [T] = [T]

$$\boxed{f \propto \frac{1}{T}}$$

Amplitude → [L]

wave length → [L]



Circular Motion

$[\text{angular disp.}] = [M^0 L^0 T^0]$

• NOTE :- Angular displacement has unit (Radian) but no dimension.

Rectilinear Motion

$[\text{disp.}] = [L]$

• angular velocity $= \dfrac{\text{angular disp.}}{\text{Time}}$ (Radian / sec)

$= \dfrac{[M^0 L^0 T^0]}{[T]} = [M^0 L^0 T^{-1}]$ or $[T^{-1}]$

• velocity $= \dfrac{\text{disp.}}{\text{Time}}$

$[v] = \dfrac{[L]}{[T]} = [LT^{-1}]$

NOTE :- Both angular velocity and frequency have same dimension.

angular acc^n (α) :-

angular acc^n $= \dfrac{\text{angular velocity}}{\text{time}}$

$= \dfrac{[T^{-1}]}{[T]} = [T^{-2}]$ ***

acc^n (a) :-

$a = \dfrac{\text{velocity}}{\text{time}}$

$a = \dfrac{[LT^{-1}]}{[T]} = [LT^{-2}]$

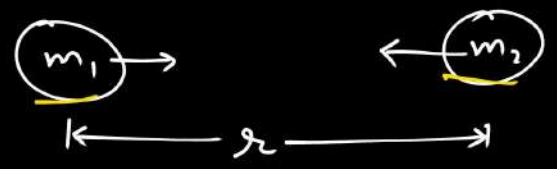
APPLIED PHY

UNIT - 01

LEC. No. - 06/07

Dimension analysis :-

Gravitational constant :-



- $F \propto m_1 \cdot m_2$ —— (I)

  $F \propto \frac{1}{r^2}$ —— (II)

$\Rightarrow F \propto \frac{m_1 m_2}{r^2}$

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

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

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

$$\boxed{[G] = [M^{-1} L^3 T^{-2}]} \; ***$$

L → Length/Dist.
M → Mass
T → Time

g = acc^n due to gravity = $9.81\ m/s^2$

G = Universal gravitation const = $6.67 \times 10^{-11}\ \frac{N\text{-}m^2}{kg^2}$

Plank's constant :-

$\boxed{E = h\nu}$ *

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

$\boxed{E = \frac{hc}{\lambda}}$ *

$\Rightarrow [h] = \frac{E \cdot \lambda}{c} = \frac{[ML^2T^{-2}] \cdot [L]}{[LT^{-1}]} = [ML^2T^{-1}]$

$K.E = \frac{1}{2} m v^2$

$= [M^0L^0T^0][M][LT^{-1}]^2$

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

E = Energy $\Rightarrow [E] = [W] = [ML^2T^{-2}]$

* $\boxed{h = \text{Plank's constant} \Rightarrow [h] = ?}$

ν = frequency $\Rightarrow [T^{-1}]$

c = speed of light $\Rightarrow [LT^{-1}]$

λ = wave length. $\Rightarrow [L]$

$E = mgh$

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

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

$W = F \times disp$

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

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

Important Points:-

i) constant numbers (ex:- $2, \frac{1}{2}, 100, 500$) doesn't have any dimension. $\rightarrow [M^0 L^0 T^0]$

ii) Trigonometrical function doesn't have any dimension. $\sin(\omega t + \phi) \rightarrow [M^0 L^0 T^0]$

iii) Logrithmic function & exponential function doesn't have any dimension.

$\log(\underbrace{x}_{[M^0 L^0 T^0]})$, $e^{\underbrace{(x+1)}_{(M^0 L^0 T^0)}}$

$\boxed{e = 2.6}$

Principal of Homogenity :-

- A/c To this Principle "only those P.Q. can be added (+) or subtracted (−) which have same dimension".

① $\boxed{S = ut + \frac{1}{2}at^2}$

S = distance Travelled $[L]$

u = Initial velocity $[LT^{-1}]$

t = time $[T]$

a = acc^n $[LT^{-2}]$

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

$V^2 = u^2 + 2aS$

③ $V = u + at$

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

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

L.H.S

$[S] = [L]$

R.H.S.

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

$\frac{1}{2}at^2 = [M^0L^0T^0][LT^{-2}][T^2] = [L]$

$[L] = [L] + [L]$

Q. Find the dimension of a, b, c, d & e -
where -

$$\boxed{S = a + bt + ct^2 + \frac{(d+t)^3}{e}}$$

where - s = distance [L]
t = time

$[a] = ?\ [L]$

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

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

$[S] = [a] \Rightarrow [a] = [L]$

$\Rightarrow [S] = [bt]$

$[L] = [b][T]$

$\Rightarrow [b] = \frac{[L]}{[T]} = [LT^{-1}]$

$[c] = ?\ [LT^{-2}]$

$[d] = ?\ [T]$

$[e] = ?\ [L^{-1}T^{3}]$

$[S] = [ct^2]$

$\Rightarrow [L] = [c] \cdot [T^2]$

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

$[c] = [LT^{-2}]$

$\Rightarrow (d+t) \Rightarrow [d] = [T]$

$(d+t)$

$[d] = [T]$

$[S] = \frac{(d+t)^3}{e}$

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

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

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

$[S] = \frac{[d+t]^3}{e}$

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

$\Rightarrow [e] = \frac{[T^3]}{[L]} = [T^3L^{-1}]$ $\quad [e] = [L^{-1}T^3]$

H.W

Find the dimension of a, b, c, d & e

II $S = a \sin(bt + c)$ $\Longrightarrow$ $S = a \cdot \sin(bt + c)$

III $W = a \cdot S \cdot \cos(bt^2 + ct + d)$

IV $F = m\,b$

$[S] \rightarrow$ distance

$t \rightarrow$ Time

W = work done

F = Force

m = mass

$[S] = [a]$

$[a] = [L]$

$[M^0 L^0 T^0]$

$bt + c = M^0 L^0 T^0$

$[c] = M^0 L^0 T^0$

$[b][T] = M^0 L^0 T^0$

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

Principle of homogenity :-

Only those terms can be added or subtracted whose dimensions are same.

Ex = $V^2 = u^2 + 2as$

$[M^0 L^2 T^{-2}]$ $[L^2 T^{-2}]$ $[LT^{-2}][L]$

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

APPLIED PHY.

LEC. NO. :- 7

DATE :- 13/09/24

UNIT - 01

Use of dimension analysis :-

There are three (3) use of dimension analysis-

I) To convert one system of unit into the other system.

II) To check the correctness of an eqn.

III) To make a new formula with the given P.Q.

1) To convert one system of unit to the other system of unit :-

$$\boxed{P.Q. = n \times u}$$

n → Magnitude (परिमाण)

u → unit (मानक)

P.Q	
Mass	= 3 kg
Length	= 5 km
Time	= 2 hours

$$n_1 u_1 = n_2 u_2$$

$$n_2 = n_1 \times \frac{u_1}{u_2}$$

$$\boxed{n_2 = n_1 \times \frac{[M^a L^b T^c]_1}{[M^a L^b T^c]_2}}$$

$[M]$ Mass = 5 kg

$[L]$ Length = 3 km

$[T]$ Time = 3 hour

***

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

Q. convert 5N force into its CGS unit.

$5N = ?\ dyne$

$$\boxed{n_1 \cdot U_1 = n_2 \cdot U_2}$$

$$n_2 = n_1 \cdot \frac{U_1}{U_2}$$

$$= n_2 \frac{[M^a L^b T^c]_1}{[M^a L^b T^c]_2}$$

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

Force

MKS | CGS | FPS

$F = m \times a = kg \cdot \frac{m}{s^2}$ | $gm \cdot \frac{cm}{s^2}$ | $P \cdot \frac{F}{s^2}$

Newton | dyne

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

For mass- $a = 1$, $b = 1$, $c = -2$

$$n_2 = n_1 \times \left[\frac{M_1}{M_2}\right]^1 \times \left[\frac{L_1}{L_2}\right]^1 \times \left[\frac{T_1}{T_2}\right]^{-2}$$

$5N = ?\ dyne$

$$n_2 = n_1 \left[\frac{kg}{gm}\right]^1 \times \left[\frac{m}{cm}\right]^1 \times \left[\frac{s}{s}\right]^{-2}$$

$$= 5 \left[\frac{1000\ gm}{gm}\right]^1 \times \left[\frac{100\ cm}{cm}\right]^1 \times \left[\frac{s}{s}\right]^{-2}$$

$$= 5 \times 1000 \times 100 \times 1$$

$$\boxed{5N = 5 \times 10^5\ dyne}$$

MKS

$F = m \times a = kg \cdot \frac{m}{s^2}$

CGS

$gm \cdot \frac{cm}{s^2}$

*****

$$\boxed{1N = 10^5\ dyne}$$

***

convert the S.I unit (MKS unit) of Energy into the C.G.S. unit.

H.W

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

2nd use :-

To check the correctness of an eqn :-

Any eqn is said to be dimensionally correct, when dimension of each term on both side of the eqn is same.

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

Q. check weather the given eqⁿ is dimensionally correct or not ?

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

For given eqⁿ to be dimensionally correct the dimension of all the terms on both side of the eqⁿ must be same.

L.H.S - $[T] = [T]$ —— (I)

R.H.S - $\left[2\pi\sqrt{\frac{l}{g}}\right] = [M^0L^0T^0]\,[M^0L^0T^0]\cdot\left[\frac{L}{LT^{-2}}\right]^{1/2}$

$\pi \approx \frac{22}{7}$

$= \left[\frac{1}{T^{-2}}\right]^{1/2}$

$= [T^2]^{1/2}$

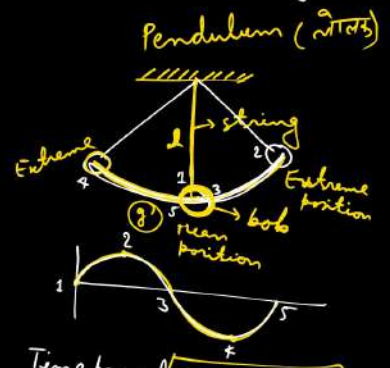
$= T^{2\times 1/2}$

$= [T]$ —— (II)

From eqⁿ (I) & (II) –

$[T] = [T]$

So the given eqⁿ is dimensionally correct.



Time period $(T) = 2\pi\sqrt{\frac{l}{g}}$

Ex → check weather the given eqn is dimensionally correct not ?

$$S = ut + 10at^2$$

Time — 6:30 am

application of dimension analysis :-

APPLIED PHYSICS

UNIT - 01

LEC. No. :- 08

DATE :- 14/09/24

1. To convert one system of unit into the other system of unit
2. To check the correctness of eqn
3. To Form a new eqn/Formula

Q. $5N \longrightarrow 5 \times 10^5$ dyne $\quad \boxed{1N = 10^5 \text{ dyne}}$

SI $\qquad$ C.G.S

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

Q. Convert SI unit of Energy into its CGS unit?

Learn – SI unit = Joule
CGS unit = Erg
$\boxed{1J = 10^7 \text{ erg}}$

$1J = ?$ erg

$n_1 \quad u_1 \quad \boxed{n_2} \quad u_2$

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

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

we have Energy = work = Force × disp.

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

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

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

$$n_2 = n_1 \times \left[\frac{M_1}{M_2}\right]^1 \times \left[\frac{L_1}{L_2}\right]^2 \times \left[\frac{T_1}{T_2}\right]^{-2}$$

Energy $= kg \cdot \frac{m}{s^2} \times m$

SI/MKS $= \frac{kg\, m^2}{s^2}$ $\qquad$ CGS $= \frac{gram - cm^2}{s^2}$

$$n_2 = 1 \times \left[\frac{kg}{gram}\right]^1 \times \left[\frac{m}{cm}\right]^2 \times \left[\frac{s}{s}\right]^{-2}$$

$$= 1 \times \left[\frac{10^3\, gram}{gram}\right]^1 \times \left[\frac{100\, cm}{cm}\right]^2 \times \left[\frac{s}{s}\right]^{-2}$$

$n_2 = 1 \times 10^3 \times 100 \times 100 \times 1$

$\boxed{n_2 = 10^7}$

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

$n_1 \quad u_1 \quad n_2 \quad u_2$

② To check the correctness of an eqⁿ :-

"Any eqⁿ is said to be dimensionally correct when dimension of each term on both side of equation is same"

Ex. → $\boxed{S = u \cdot t + 100 \cdot a \cdot t^2}$ → check weather the given eqⁿ is dimensionally correct or not.

L.H.S – $[S] \rightarrow$ displacement

$[S] = [L]$ —— (1)

R.H.S –

1st Term ⇒ ut → u = velocity, t = time

$[ut] = [u] \cdot [t]$

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

$= [L]$

2nd Term = $100\,a\,t^2$

$100 \rightarrow$ constant

$a \rightarrow$ accⁿ

$t \rightarrow$ Time

$[100\,a\,t^2] = [100] \cdot [a] \cdot [t^2]$

$= [M^0L^0T^0] \cdot [LT^{-2}] [T^2]$

$= [L]$

Since the dimension of each term on each side of the eqⁿ is same, so the given eqⁿ is dimensionally correct.

✓ $\boxed{S = ut + \frac{1}{2} a t^2}$

✗ $\boxed{S = ut + 100\,a\,t^2}$

• NOTE :- An eqⁿ which is dimensionally correct need not be physically correct but if any eqⁿ is physically correct then it must be dimensionally correct.

Q. If the given eqⁿ is dimensionally correct then you have to find the dimension of a, b, c, d & e.

$$\boxed{v = a + bt + ct^2 + \left(\frac{d}{(e+t^2)^3}\right)}$$

Solⁿ:-

since – The given eqⁿ is dimensionally correct.

⇒ Dimension of each term on each side of the eqⁿ must be same.

L.H.S

||

R.H.S

$[v] \rightarrow [LT^{-1}]$

$[a] = [bt] = [ct^2] = \left(\frac{d}{[e+t^2]^3}\right)$

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

② $[LT^{-1}] = [bt] \Rightarrow [b] = \frac{[LT^{-1}]}{[T]} = [LT^{-2}]$

③ $[LT^{-1}] = [ct^2] \Rightarrow [c] = \frac{[LT^{-2}]}{[T^2]} = [LT^{-3}]$

④ $[LT^{-1}] = \frac{d}{[e+t^2]^3} \Rightarrow [d] = [LT^{-1}][T^2]^3 = [LT^{-1}][T^6] = [LT^5]$

• $e + t^2 \Rightarrow [e] = [T^2]$ ⟹ { P.O.H ⇒ only those terms can be added or subtracted whose dimensions are same }

$[e] = [T^2]$

III) 3rd use –

To Make a new relation :–

Q. If Time period of a pendulum depends upon the length of string, mass of bob and acc^n due to gravity then find the relation among them?

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

Sol^n :– given –

$T \propto l^a$ —— (I)

$T \propto m^b$ —— (II)

$T \propto g^c$ —— (III)

On combining eq^n (I), (II) & (III) –

$T \propto l^a m^b g^c$

$\boxed{T = K\, l^a m^b g^c}$ —— (a)

For given eq^n (a) to be correct – when dimension of each term on both side of the eq^n should be same.

L.H.S – $[T] = [T]$

R.H.S – $K\, l^a m^b g^c$

$K \rightarrow$ constant $[M^0 L^0 T^0]$

$l \rightarrow$ length $[L]$

$m \rightarrow$ mass $[M]$

$g \rightarrow$ acc^n due to gravity $[LT^{-2}]$

$[K\, l^a m^b g^c] = [K]\cdot[l]^a\cdot[m]^b\,[g]^c$

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

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

For eq^n to be correct –

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

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

$\Rightarrow b = 0$

$\Rightarrow a + c = 0 \Rightarrow a = -c = -\left(-\frac{1}{2}\right) = \frac{1}{2}$ $\boxed{a = \frac{1}{2}}$

$\Rightarrow -2c = 1$

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

using the value of $a = \frac{1}{2}$, $b = 0$ & $c = -\frac{1}{2}$ in eq^n (a) –

$T = K\, l^a m^b g^c$

$T = K\, l^{1/2} m^0 g^{-1/2}$

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

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

From experiment we get – $K = 2\pi$

$\boxed{T = 2\pi\sqrt{\frac{l}{g}}}$ ****

$$h = \frac{4\sigma\cos\theta}{\rho g D}$$

σ = surface Tension = $\left[\frac{\text{Force}}{\text{length}}\right]$

θ = angle of contact

ρ = density of water $\left(\rho = \frac{\text{mass}}{\text{volume}}\right)$

g = acc^n due to gravity

D = Dia of the tube

$$h = \frac{4\sigma\cos\theta}{\rho g D}$$

Q. If height of water (h) rise in the manometer depends upon the dia of tube (D), density of liquid (ρ), acc^n due to gravity (g), surface tension of the liquid (σ) and the cosine of angle of contact ($\cos\theta$) then find the relation among them.

Sol^n – given –

$h \propto D^a$ —— (i)

$h \propto \rho^b$ —— (ii)

$h \propto g^c$ —— (iii)

$h \propto \sigma^d$ —— (iv)

$h \propto \cos\theta^e$ —— (v)

combining the above relation –

$$h \propto D^a \rho^b g^c \sigma^d (\cos\theta)^e$$

$$\boxed{h = K D^a \rho^b g^c \sigma^d (\cos\theta)^e} \quad \text{—— (a)}$$

For the given eq^n to be True, the dimension of each term on both side of the eq^n must be same.

$[h] = [K D^a \rho^b g^c \sigma^d (\cos\theta)^e]$

LHS

$[h] = [L] = [M^0 L^1 T^0]$

RHS

$[K D^a \rho^b g^c \sigma^d (\cos\theta)^e]$

$[K] \rightarrow [M^0 L^0 T^0]$

$[D] \rightarrow [L]^a$

$[\rho] \rightarrow \left[\frac{[M]}{[L^3]}\right]^b = [M^b L^{-3b}]$

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

$[\sigma] = [F] = \left[\frac{[M L T^{-2}]}{[L]}\right]^d = [M^d T^{-2d}]$

$[\cos\theta]^e = [M^0 L^0 T^0]^e = M^0 L^0 T^0$

$[M^{b+d} L^{a-3b+c} T^{-2c-2d}]$

$[L^1] = [M^{b+d} L^{a-3b+c} T^{-2c-2d}]$

$\Rightarrow b + d = 0$

$a - 3b + c = 1$

$-2c - 2d = 0$

$c = -a$ $\boxed{c = -a}$

$\boxed{b = -d}$

$a - 3b + (-a) = 1$

$-3b = 1$

$\boxed{b = -\frac{1}{3}}$

V.V.I. ----

20 → 19

Limitation of dimension analysis :-

sun →

⇓

10 am ***

APPLIED PHY.

UNIT- 01

LEC. NO. :- 09

DATE :- 15/09/24

use of Dimension analysis :-

(i) change one system of unit to another system.

(ii) To check the correctness of an eq^n.

(iii) To make a new relation with the given P.Q.

Significent Figure :-

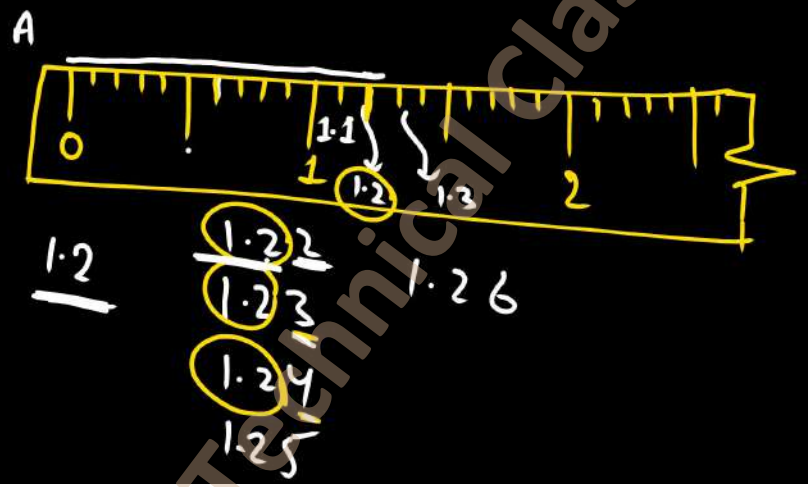
- Significent figures tells us about the nos. of digit we are sure of.

राम => 12.1 Km

राहुल => 12 Km

रोहन => 12.134 Km

- It consist of sure digits and one doughtfull digit.



Rules for finding the Nos. of significent figures :-

1. All Non-zero digits are significent.

(1, 2, 3, 4, 5, 6, 7, 8, 9)

Ex → 456

S.F. = 3

45670

S.F = 4

4567

S.F = 4

Zero (0)

- Leading (सबसे आगे) or starting
- Trapped / Between (बीच में)
- Ending / Trailing (सबसे अंत में)

② Every Trapped zero or zero b/w two significant figure is always significant.

48005 — SF = 5

48000 — SF = 2

00480 — SF = 2

048040 — SF = 4

③ Ending / Trailing zeros are significent if and only if they are present after decimal.

Ex. → 4.20 ⇒ S.F = 3

420 → SF = 2

0.420 ⇒ S.F = 3

0.4200 ⇒ S.F = 4

0.04200 ⇒ S.F = 5

④ starting zero or leading zero are never significent.

040 ⇒ SF = 1

0.40 ⇒ S.F = 2

0.040 ⇒ S.F = 2

0.00040 ⇒ S.F = 2

0.0004004 ⇒ S.F = 4

0.0004000 ⇒ S.F. = 4

5. Powers of Ten are never significant.

$5400000 \Rightarrow \boxed{S.F = 2}$

$5.4 \times \boxed{10^5} \times \Rightarrow \boxed{S.F = 2}$

$\times$

$\boxed{54.0 \times 10^5 \times \Rightarrow \boxed{S.F = 3}}$

6. Real Nos. or constant values have infinite significent Figure.

$\pi = \frac{22}{7}$ → Infinite sig Figure

$e = 2.6$ → " " " "

• speed of light ⇒ " " " "

$(3 \times 10^8 \, m/s)$

⇓

S.F = 1

a

⇒ $P = 4 \times a$ → $\boxed{S.F = \infty}$

a

⇒ $\boxed{P = 3 \times a}$

I) 489 ⟹ $\boxed{S.F = 3}$

II) 4890 ⇒ S.F = 3

III) 04890 ⇒ S.F = 3

IV) 04809 0 ⇒ S.F = 4

V) 0.04809 0 ⇒ S.F = 5

VI) 0.048090 ⇒ S.F = 5

VII) Refrective index of glass is $= \frac{4}{3} = 1.33$ ⇒ $\boxed{S.F = \infty}$

$\boxed{\mu = \frac{c}{v}}$

⇓

Infinity.

1.33 ⇒ S.F = 3

Theory of error :-

- However accurately we measure anything there is some error associated with it.
- Accurate reading / True measurement can not be possible.

$$\boxed{\text{Error} = \underbrace{T.V}_{\text{True value}} - \underbrace{M.V}_{\text{measured value}}}$$

✓ There are ~~two~~ Following Four types of error –

I) Systematic Error
II) Random Error
III) Gross error
IV) Least count error

I) Systematic Error :-

- These are the errors which follows a regular pattern.
- These are one sided (i.e. either positive or negative).
- If the cause behind the systematic error is found out then it can be reduced.

cause of systematic error :-

I) Due to the fault in Instrument.
II) Due to the wrong experimental Procedure.
III) Due to Personal error.

II) Random error :-

- These are those types of error which doesn't follow a regular pattern.
- These are accedental errors.
- The cause behind these types of error is very difficult to found.
- These are not one sided. (They may be negative or may be positive both)

Cause behinds the Random error :-

- Due to the carelessness of the person.
- Due to some natural disasters (earthquake, high wind speed)

numerical

Error analysis :-

(I) True value / Mean error

(II) Absolute error

(III) Mean absolute error

(IV) Relative error

(V) Percentage error

$\boxed{\text{Error} = \text{True value} - \text{measured value}}$

True value / mean value (x or $\bar{x}$) :-

• Let we have measured a length of a Pen - and the reading obtains are. 4.1, 4.2, 4.3, 4.0, 4.4

Then find the –

(i) Mean value / True value $(x) = \frac{4.1+4.2+4.3+4.0+4.4}{5}$

$= \frac{21.0}{5}$

$\boxed{x/x_m = 4.2}$

(ii) Absolute error

(iii) Mean Absolute error

(iv) Relative error

(v) Percentage error

ii) Absolute error = True value – Measured value

$\Delta x_1 = x_m - x_1 = 4.2 - 4.1 = 0.1$

$\Delta x_2 = x_m - x_2 = 4.2 - 4.2 = 0$

$\Delta x_3 = x_m - x_3 = 4.2 - 4.3 = -0.1$

$\Delta x_4 = x_m - x_4 = 4.2 - 4.0 = 0.2$

$\Delta x_5 = x_m - x_5 = 4.2 - 4.4 = -0.2$

iii) Mean Absolute error $(\Delta x) = \frac{|\Delta x_1| + |\Delta x_2| + |\Delta x_3| + |\Delta x_4| + |\Delta x_5|}{5}$

$= \frac{0.1 + 0 + 0.1 + 0.2 + 0.2}{5}$

$= \frac{0.6}{5}$

$\boxed{\Delta x = 0.12}$

(iv) Relative error $= \frac{\Delta x}{x_m} = \frac{0.12 \times 10}{4.2 \times 10} = \frac{2}{70}$

(v) Percentage error $= \frac{\Delta x}{x_m} \times 100$

$= \frac{2}{70} \times 100 = \frac{20}{7} = 2.8\%$

Propagation of error :-

1) Addition & substraction :-

- Errors are always added in addition and subtraction.

$l_1 = 12\,cm \pm 1\,cm$ $\qquad$ $l_2 = 15\,cm \pm 2\,cm$

True value $\qquad$ error

$l_1 + l_2 = (12+15) \pm (1+2) = 27 \pm 3$ cm Ans.

$l_2 - l_1 = (15-12) \pm (1+2) = 3 \pm 3$ cm Ans.

Q. Two resistors having their resistance $3\Omega \pm 0.1\Omega$ and $5\Omega \pm 0.2\Omega$ are connected in series then find the equivalent resistance.

$R_1 = 3\Omega \pm 0.1\Omega$

$R_2 = 5\Omega \pm 0.2\Omega$

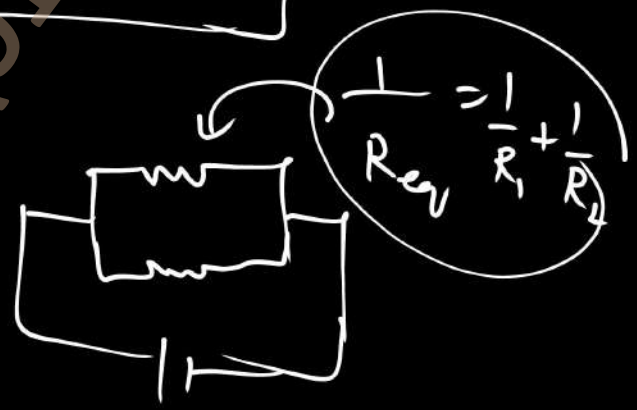
$R_{eq} = ?$

$$\boxed{R_{eq} = R_1 + R_2}$$

$$= (3\Omega \pm 0.1\Omega) + (5\Omega \pm 0.2\Omega)$$

$$= 8\Omega \pm 0.3\Omega$$

$$\boxed{R_{eq} = 8 \pm 0.3\Omega}$$



$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

Q. Find the temperature difference of two places A & B where temp^r at A is $27 \pm 3°C$ & temp^r at B is $33 \pm 2°C$.

$T_1 = 27 \pm 3°C$

$T_2 = 33 \pm 2°C$

$\Delta T = ?$

$\Delta T = T_2 - T_1$

$= (33 \pm 2°C) - (27 \pm 3°C)$

$= 6 \pm 5°C$ Ans.

Multiplication & devision :-

$A = a \pm \Delta a$

$B = b \pm \Delta b$

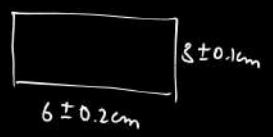
$$\boxed{\frac{\Delta m}{m} = \frac{\Delta a}{a} + \frac{\Delta b}{b}}$$

$(A \times B)$

$\Downarrow$

$M = (a \times b) \pm \Delta m$

Q Find the area of a rectangle having the length 6 ± 0.2 cm & width 3 ± 0.1 cm.



$A = l \times b$

$= (6 \pm 0.2) \times (3 \pm 0.1)$

$\boxed{A = a \pm \Delta a}$

$a = (6 \times 3) = 18$

$\frac{\Delta a}{a} = \frac{\Delta l}{l} + \frac{\Delta b}{b}$

$\Rightarrow \frac{\Delta a}{18} = \frac{0.2}{\cancel{6}\,30} + \frac{0.1}{30}$

$\Rightarrow \Delta a = 18 \times \left(\frac{1}{30} + \frac{1}{30}\right)$

$\Rightarrow \Delta a = \cancel{18}^{6} \times \left(\frac{2}{\cancel{30}\,10}\right)$

$= \frac{12}{10}$

$\boxed{\Delta a = 1.2}$

$A = a \pm \Delta a$

$= 18 \pm 1.2 \text{ cm}^2$

Q. Find the density of a substance having $m = 12 \pm 0.2\,kg$ and volume $= 3 \pm 0.1\,m^3$.

density $\boxed{(\rho) = \frac{m}{V}}$

$$\boxed{\frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + \frac{\Delta V}{V}}$$

$\rho = \frac{m}{V}$

$\rho = \rho \pm \Delta\rho$

$m = 12 \pm 0.2$

$V = 3 \pm 0.1$

$\rho = \frac{12}{3} = 4$

$\Rightarrow \frac{\Delta\rho}{4} = \frac{0.2}{12} + \frac{0.1}{3}$

$\Rightarrow \Delta\rho = 4 \times \left(\frac{1}{60} + \frac{1}{30}\right)$

$= 4 \times \left(\frac{1+2}{60}\right)$

$= \frac{3}{15}$

$\boxed{\Delta\rho = 0.2}$

$\rho = \rho \pm \Delta\rho$

$= 4 \pm 0.2\ kg/m^3$ Ans.

Note -

① Mean value / True value $(x_m \text{ or } x) = \dfrac{x_1 + x_2 + x_3 + x_4 + x_5}{5}$

② Absolute error - (+ve, -ve & 0)

$\Delta x_1 = x_m - x_1$

$\Delta x_2 = x_m - x_2$

$\Delta x_3 = x_m - x_3$

$\Delta x_4 = x_m - x_4$

$\Delta x_5 = x_m - x_5$

+ve $x_m > x_{1,2,3,\ldots}$

-ve $x_m < x_{1,2,3\ldots}$

0 $x_m = x_{1,2,3,\ldots}$

③ Mean Absolute error $(\Delta x) = \dfrac{|\Delta x_1| + |\Delta x_2| + |\Delta x_3| + |\Delta x_4| + |\Delta x_5|}{5}$

④ Relative error $= \dfrac{\Delta x}{x_m}$

⑤ Percentage error $= \dfrac{\Delta x}{x_m} \times 100$

Random error :-

21:28 51%

AP-B

Units: T2400102B

	Units
	Unit-1.0 Unit and Measurements 1.1 Physical quantities, fundamentals and derived units and system of units 1.2 Accuracy, precision and errors (systematic and random) in measurements, Method of estimation of errors (absolute and relative) in measurement, propagation of errors, significant figures 1.3 Dimensions and dimensional formulae of physical quantities, Principle of homogeneity of dimension in an equation 1.4 Applications of dimensions: conversion from one system of units to other, corrections of equations and derivation of simple equations. 1.5 Ancient astronomical instruments: Chakra, Dhanuryatra , Yasti and Phalaka yantra . (IKS)
	Unit-2.0 Simple Harmonic and Wave Motion 2.1 Periodic and Oscillatory Motion 2.2 Simple Harmonic Motion (SHM): Displacement, velocity, acceleration, time period, frequency and their interrelation 2.3 Types of waves: Mechanical and Electromagnetic, Transverse and longitudinal waves, wave velocity, frequency and wave length and their relationship, wave equation

① Physical quantity :-

Any quantity which can be measured with any instrument is known as physical quantity.

Ex → Length → Scale / Chain / Tape / EDME

Area → Planeometer

speed → speedometer

Temp^r → Thermometer.

Fundamental and derived quantity :-

मूल व्युत्पन्न

P.Q

Fundamental quantity

Those P.Q which are independent i.e. which doesn't depends on any other P.Q. is known as F.P.Q.

- They are 7 in numbers.

		SI
(i) Mass	→	Kg
(ii) Length	→	m
(iii) Time	→	S
(iv) Current	→	A
(v) Temperature	→	K / ~~°C~~
(vi) Luminous Intensity	→	Cd
(vii) Amount of substance	→	MOL

suplementry P.Q. (2)

- → Plane angle (Radian)
- → Solid angle (Steradian)

Derived quantity

Those P.Q. which depends on the F.P.Q. is known as the Derived P.Q.

- They are ∞ in number.

Ex. ⇒ velocity $= \frac{L}{T}$

→ Area $= (L \times L)$

→ density $= \frac{M}{V}$

Units and system of units:-

units:- units are the standard in which any P.Q. is represented.

$$PQ = n \times u$$

$n \Rightarrow$ Magnitude, $u \Rightarrow$ unit

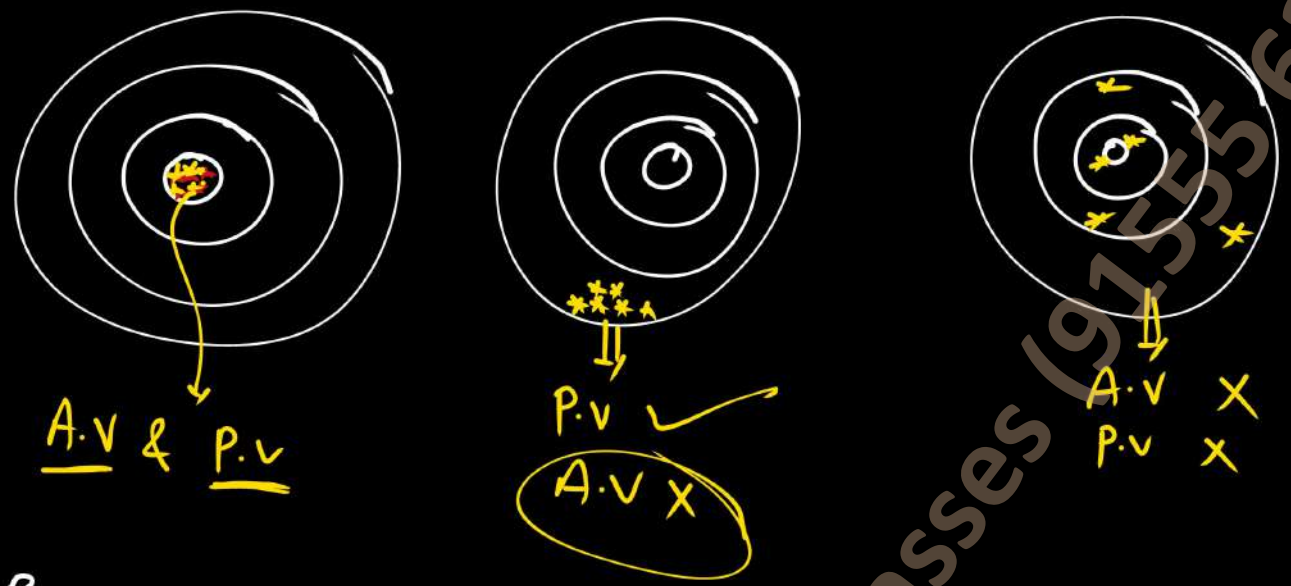
$$\boxed{n_1 u_1 = n_2 u_2}$$

$$\Rightarrow \boxed{n \propto \frac{1}{u}} \quad ***$$

Systems of unit:-

	Length	Mass	Time
(i)	Metre	Kilo	Second
(ii)	C.m	Gram	S " $\Rightarrow$ French
(iii)	Feet	Pound	S " $\Rightarrow$ British

(1.2) Accuracy, Precision and errors :-



Precision :- It is the degree of accuracy i.e. How accurate the all values are.

Accuracy :- It is the degree of perfection.

Propagation of error:-

addition & subtraction :-

- error are always added in addition and subtraction.

ex→ $A = a \pm \Delta a$

$B = b \pm \Delta b$

$A+B = (a+b) \pm (\Delta a + \Delta b)$

$A-B = (a-b) \pm (\Delta a + \Delta b)$

Ex→ $l_1 = 4 \pm 0.1\,m$

$l_2 = 2 \pm 0.5\,m$

$l_1 + l_2 = (4+2) \pm (0.1+0.5)$

$= 6 \pm 0.6$

$l_1 - l_2 = (4-2) \pm (0.1+0.5)$

$= 2 \pm 0.6$

multiplication & division :-

$A = a \pm \Delta a$

$B = b \pm \Delta b$

$A \times B = (a \times b) \pm \Delta(a.b)$

$A \div B = \left(\frac{a}{b}\right) \pm \Delta\left(\frac{a}{b}\right)$

$$\frac{\Delta(a.b)}{(a.b)} = \frac{\Delta a}{a} + \frac{\Delta b}{b}$$

$$\frac{\Delta(a/b)}{(a/b)} = \frac{\Delta a}{a} + \frac{\Delta b}{b}$$

Q.

$b = 2 \pm 0.2\,m$

$l = 3 \pm 0.1\,m$

$A = l \times b$

$= (3 \pm 0.1) \times (2 \pm 0.2)$

$= (3 \times 2) \pm \Delta A$

$A = 6 \pm 0.8\ m^2$

$$\frac{\Delta A}{A} = \frac{\Delta a}{a} + \frac{\Delta b}{b}$$

$$\Rightarrow \frac{\Delta A}{6} = \frac{0.1}{3} + \frac{0.2}{2}$$

$$\Rightarrow \frac{\Delta A}{6} = \frac{1}{30} + \frac{1}{10}$$

$$\Rightarrow \Delta A = 6\left(\frac{1+3}{30}\right) = \frac{6 \times 4}{30} = \frac{4}{5} = 0.8$$

Q. $m = 3\,kg \pm 0.2\,kg$

$V = 2 \pm 0.4\,m^3$

$\rho = ?$

$\rho = \frac{m}{V}$

$\rho = \rho_1 + \Delta\rho$

$\rho_1 = \frac{3}{2} = 1.5$

$\rho = 1.5 \pm 0.4\ kg/m^3$

$$\frac{\Delta\rho}{\rho} = \frac{\Delta a}{a} + \frac{\Delta b}{b}$$

$$\Rightarrow \frac{\Delta\rho}{1.5} = \frac{0.2}{3} + \frac{0.4}{2}$$

$$\Rightarrow \frac{\Delta\rho}{1.5} = \frac{1}{15} + \frac{1}{5}$$

$$\Rightarrow \Delta\rho = 1.5\left(\frac{1+3}{15}\right)$$

$$\Rightarrow \Delta\rho = 1.5 \times \frac{4}{15} = \frac{2}{5} = 0.4$$

Significant figures :-

sure digits — doubtfull digit

- Significant figures tells us about how sure we are about any readings.

(i) All Non-zero digits are significants.

Ex → 234 ⇒ S.F = 3

23400 ⇒ S.F = 5

(ii) Trapped zero (or) zero b/w any two significant number is always significant.

20034 ⇒ S.F = 5

(iii) Ending zeros are significant only when they are appears after decimals.

Ex → 0.23400 ⇒ S.F = 5

(iv) Initial / Starting zeros are never significant.

0.00023400 → S.F = 5

(v) Power of 10 is never be significant.

5×10^{4} ⇒ S.F = 1

(vi) Const value / Real numbers used in any formula have infinite significant figure.

speed of light (3×10^{8} m/s) ⇒ ∞

Perimeter of sq. $4 \times a$ ⇒ S.F = ∞

π, e ⇒ S.F = ∞

Errors :-

How hard we try, we are not able to find the True value.

$$\boxed{\text{Error} = M.V - T.V}$$

M.V = Measure value
T.V = True value

i) Mean error / True value :-

It is the avg of all the readings or measurement taken.

$$\boxed{x_m = \frac{x_1 + x_2 + x_3 + x_4 + x_5}{5}}$$

Absolute value :-

It is the difference of True value & the measured value.

$$\Delta x_1 = x_m - x_1$$
$$\Delta x_2 = x_m - x_2$$
$$\Delta x_3 = x_m - x_3$$
$$\vdots$$
$$\Delta x_n = x_m - x_n$$

- Absolute value may be +ve, -ve or zero.

iii) Mean absolute value :-

It is the avg. of all the absolute value with the positive sign.

$$\boxed{|\Delta x| = \frac{|\Delta x_1| + |\Delta x_2| + |\Delta x_3| + |\Delta x_4| + \cdots + |\Delta x_n|}{n}}$$

iv) Relative value :-

It is the Ratio of mean absolute value to the true value.

$$\text{Relative value} = \frac{|\Delta x|}{x_m}$$

v) Percentage value :-

$$\boxed{\frac{|\Delta x|}{x_m} * 100\%}$$

Types of error:-

error

Systematic error

- The follow a regular pattern.
- They are one sided (i.e. either positive or Negative)
- If we find the reason behind the systematic error, then they can be reduced.

They are caused due to -

i) Fault instrument

ii) Human error

iii) using wrong experiment technique / Procedure.

ex→ 

Random error

- They don't follow any regular pattern.
- They are not one sided (They can be positive or negative in the same experiment
- It is very difficult to find the reason behind the Random error.
- They are caused due to -

(i) carelessness

(ii) Natural disasters

1.3 Dimension and Dimension formula :-

⇓

Dimensions are the power in which any P.Q. is represented in terms of the Fundamental P.Q.

Ex:- Force = Mass × acc^n

$[F] = [M] \times [LT^{-2}]$

$* \boxed{[F] = [MLT^{-2}]}$

Mass → [M]

Length → [L]

Time → [T]

Energy = W.D = Force × disp.

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

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

stress = $\frac{\text{Force}}{\text{Area}} = \frac{[MLT^{-2}]}{[L^2]} = [ML^{-1}T^{-2}]$

Principle of homogenity :-

Only those P.Q. can be added or subtracted whose dimension's are same.

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

$$[LT^{-1}][T] \qquad [M^0L^0T^0]\cdot[LT^{-2}][T^2]$$

$$= [L] \qquad = [L]$$

Q. Find the dimension of a, b & c.

$$v = a + \frac{bt^2}{(c+s)}$$

v = velocity
t = time
s = distance

$$[v] = [a] \Rightarrow [a] = [LT^{-1}]$$

$$[c] = [s] \Rightarrow [c] = [L]$$

$$\frac{bt^2}{[L]} = [LT^{-1}]$$

$$\Rightarrow b = \frac{[L^2T^{-1}]}{[T^2]} = [L^2T^{-3}]$$

1.4

Application of dimension analysis :-

There are three (3) use of dimension analysis :-

I) Convert one system of unit into other.

II) To check the correctness of an eqn

III) To form a new formula.

(1) Convert one system of unit into other :-

$$n_1 u_1 = n_2 u_2$$

$$\Rightarrow n_2 = n_1 \frac{u_1}{u_2}$$

$$\Rightarrow \boxed{n_2 = [n_1] \times \frac{[u_1]}{[u_2]}}$$

$$\Rightarrow \boxed{n_2 = n_1 \times \left[\frac{m_1}{m_2}\right]^a \times \left[\frac{L_1}{L_2}\right]^b \times \left[\frac{T_1}{T_2}\right]^c}$$

$1N = \overset{10^5}{?}$ dyne

$\Downarrow$

$F = m \times a = [MLT^{-2}]$

$n_1 = 1$

$u_1 = N = kg \cdot \frac{m}{s^2} = [MLT^{-2}]$

$u_2 = dyne = g \cdot \frac{cm}{s^2}$

$n_2 = ?$

$1N = 10^5$ dyne

1 Joule $= 10^7$ erg

$\boxed{1 \text{ Joule} = 10^7 \text{ erg}}$

$$n_2 = n_1 \times \left[\frac{m_1}{m_2}\right]^a \left[\frac{L_1}{L_2}\right]^b \times \left[\frac{T_1}{T_2}\right]^c$$

$$= 1 \times \left[\frac{kg}{g}\right]^1 \left[\frac{m}{cm}\right]^1 \times \left[\frac{s}{s}\right]^{-2}$$

$$n_2 = 1 \times \left[\frac{10^3 \times g}{g}\right]^1 \times \left[\frac{100 \times cm}{cm}\right]^1$$

$$n_2 = 1 \times 10^3 \times 10^2$$

$$\boxed{n_2 = 10^5}$$

(11) Check the correctness of eqⁿ :-

An eqⁿ is said to be dimensionally correct when dimension of each term on both side of the eqⁿ is same.

ex- Check weather the given eqⁿ is dimensionally correct or not -

$$S = ut + 10at^2$$

LHS - $[S] = [L]$

R.H.S. $[ut] = [LT^{-1}]\cdot[T] = [L]$

$[10at^2] = [M^0L^0T^0][LT^{-2}][T^2] = [L]$

Since the dimension of all the term in L.H.S & R.H.S is same so the given eqⁿ is dimensionally correct.

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

The eqⁿ which is dimensionally correct need not be physically correct. but any eqⁿ is physically correct then it must be dimensionally correct.

To Make a new formula :-

$T \propto m^a$ — (I)

$T \propto l^b$ — (II)

$T \propto g^c$ — (III)

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

Combining eqn (I) & (II) & (III)

$T \propto m^a l^b g^c$

$\Rightarrow T = K m^a l^b g^c$ — (IV)

$\Rightarrow [T] = [K][m]^a \cdot [l]^b [g]^c$

$\Rightarrow [m^0 l^0 T^1] = [m^0 l^0 T^0] \cdot [m]^a [l]^b [LT^{-2}]^c$

$\Rightarrow [m^0 l^0 T^1] = [m^a L^{b+c} T^{-2c}]$

$\Rightarrow a = 0$

$b + c = 0$ $\quad b = 1/2$

$-2c = 1 \Rightarrow c = -1/2$

$\Rightarrow T = K m^0 l^{1/2} g^{-1/2}$

$T = K\sqrt{\frac{l}{g}}$ $\quad T = 2\pi\sqrt{\frac{l}{g}}$

Limitation of dimension analysis :-

(i) It is unable to give the value of constant.

(ii) It is not suitable when there is more than 3 terms.

$$h = \frac{4\sigma\cos\theta}{\rho g D} \quad *$$

X (iii) It is not used to derive a relation where there is more than one terms.

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

$s \propto u^x$

$s \propto t^y$

$s \propto a^z$

$s \propto u^x t^y a^z$

$$\boxed{s = k u^x t^y a^z}$$

X (iv) where the constant have dimension then this method is not valid.

$$\boxed{K \rightarrow M^0 L^0 T^0}$$

Ex → $F = G\frac{m_1 m_2}{r^2}$ → $M^0 L^0 T^0$

$G = \frac{N\text{-}m^2}{kg^2}$

$F \propto m_1 m_2$

$F \propto r^2$

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

* (v) This method is not applicable where there is Trigonometrical, logrithmic and exponential terms are used.

ANCIENT ASTRONOMICAL INSTRUMENTS :-

IN ANCIENT TIME, INDIANS WERE USING ASTRONOMICAL INSTRUMENTS BASED ON SIMPLE MECHANISM TO MEASURE DISTANCE OF HUGE OBJECTS, HEIGHT OF HUGE OBJECT, HORIZONTAL AND VERTICAL ANGLES, POSITIONS OF STARS A PEAR.

* BHASKARACHARYA WAS ONE OF THE POPULAR INDIAN ASTROLOGER .

FOLLOWING ARE THE ASTRONOMICAL MEASUREMENT INSTRUMENTS:-

- 1. Chakra yantra
- 2. Dhanuryatra ytantra
- 3. Yasti Yantra and
- 4. Phalaka yantra

Jaipur (Jantar-Mantar) → time, day, year

सलिलेन समं साध्यं भ्रमेण वृत्तमवलम्बकेनोर्ध्वम्।
तिर्यक्कर्णेनान्यैः कथितैश्च नव प्रवक्ष्यामि।।7।।

"There are seventeen instruments in order to determine time, namely:

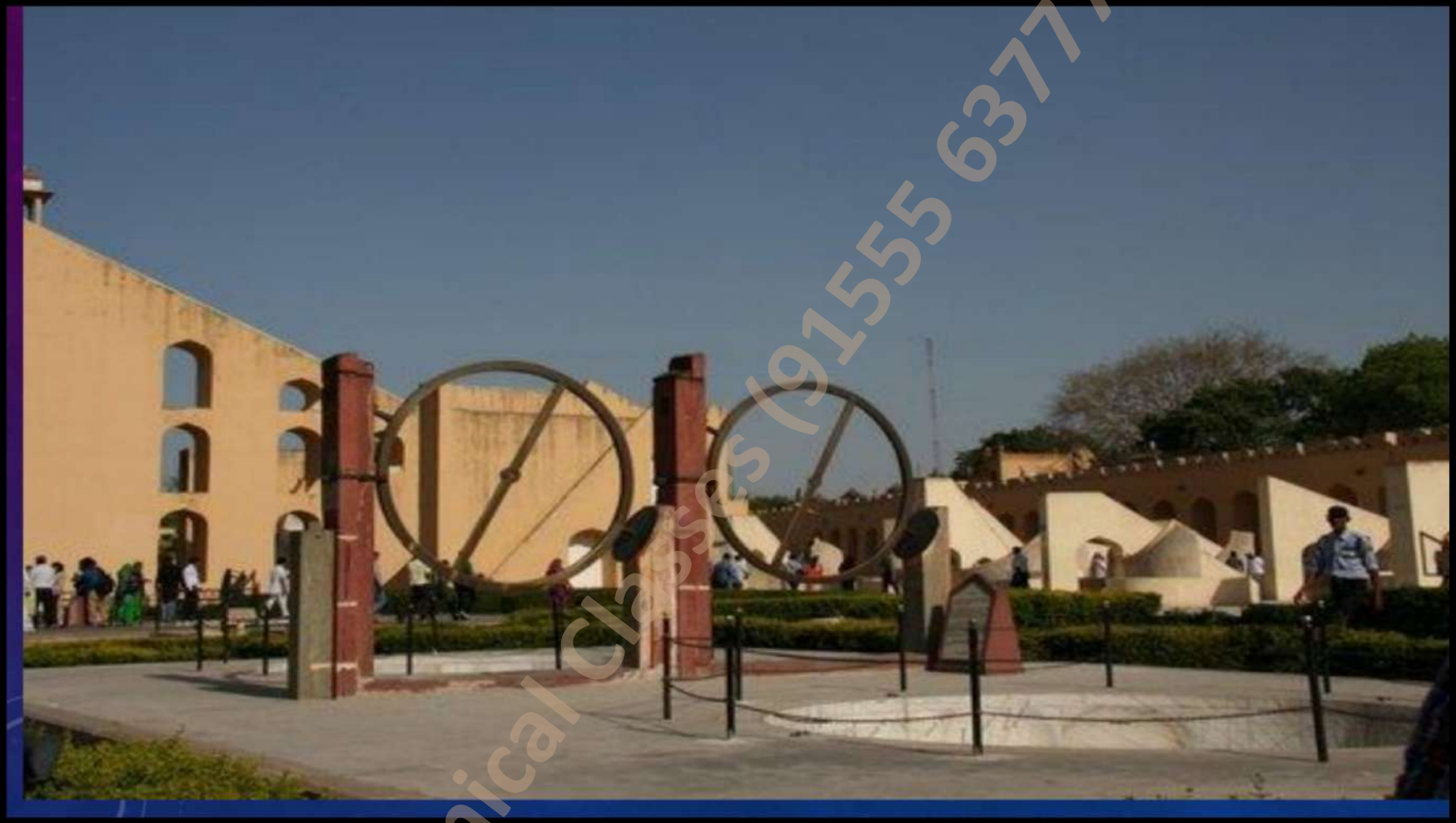
(1) the *dhanus* (semi-circle instrument),
(2) the *turya-golaka* (quarant),
(3) the *cakra* (circle instrument),
(4) the *yaṣṭi* (staff),
(5) the *śaṅku* (gnomon),
(6) the *ghaṭikā* (clepsydra),
(7) the *kapālaka* ("bowl", the hemispherical sundial),
(8) the *karttarī* ("scissors", a kind of equatorial sundial), and
(9) the *pīṭha* ("seat", a horizontal circle with a vertical gnomon).

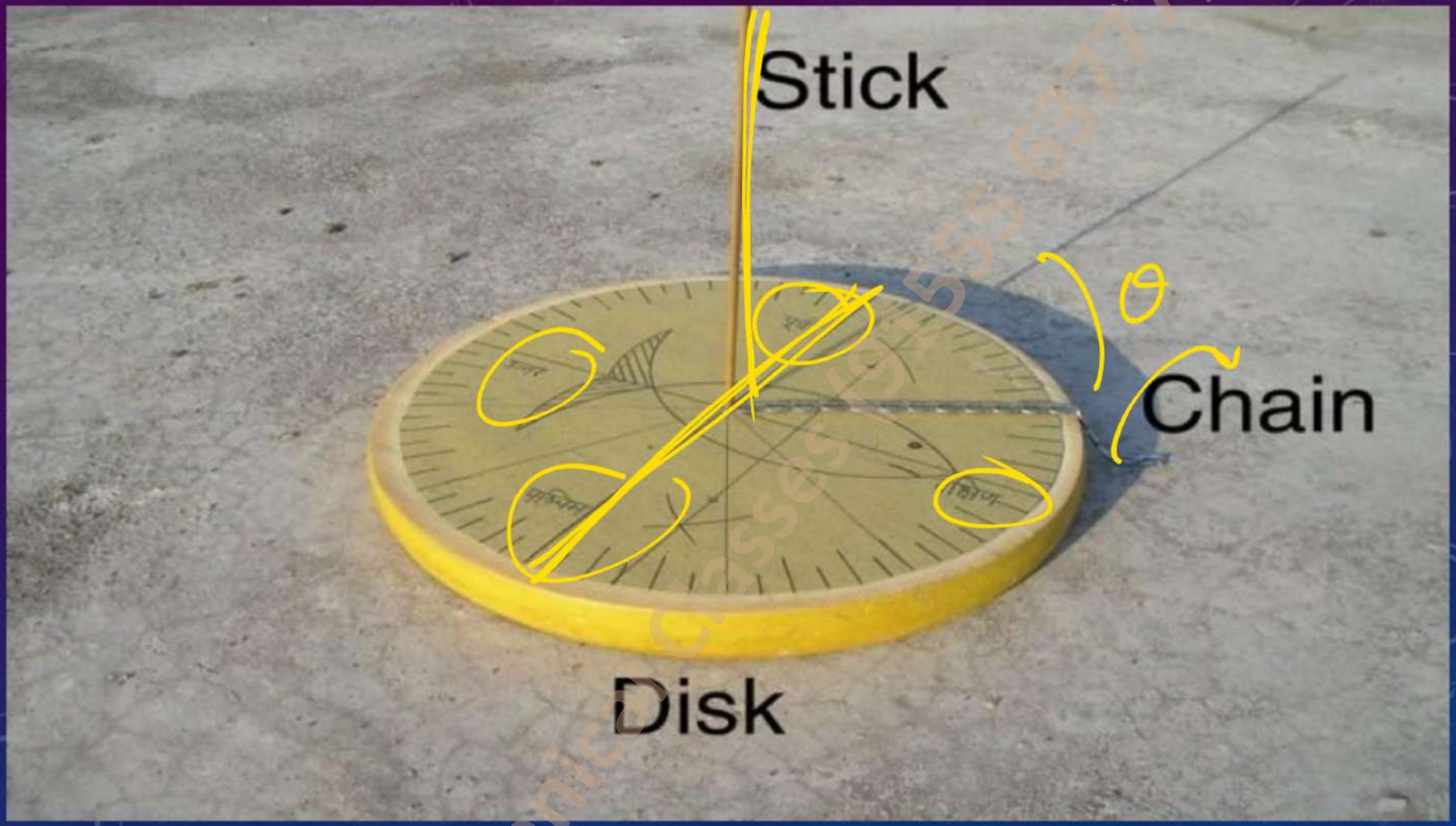
And also (10) water, (11) compasses (12) plumb line, (13) set square, (1
shadow, (15) midday, (16) the sun, and (17) the latitude. Among them, these eig
instruments are accessories for the purpose of knowing time.

- 1. Chakra yantra :- Bhaskaracharya
- One of the ancient astronomical instruments i.e. Disk instrument of Bhaskaracharya is also known as Chakra yantra.
- It is also called as disk machine.
- It is used for finding boundaries of planets and Stars using angular terms.
- It is used for angular marking.
- Chakra Yantra is also used to measure time
- Natta, Unnatta (Sanskrit) means the method to determine time from Shadow and for measurement of day .
- Chakra Yantra is also used to measure altitude i.e. Height of the place from sea level, Zenith distance of sun i.e. Angular distance, to determine longitude of planets i.e. Average angular position of planet.

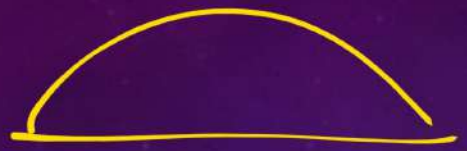
height

- Construction of chakra yantra is a simple wooden disk having hole at the centre.
- Hole diameter is such that the stick should fix vertically into the disk.
- Normaly height of the stick is approximately equal to diameter of the disk.
- Chain is fixed at the centre
- Many times this disk is in the suspended position





- 2) Dhanu Yantra :-



- Dhanu Yantra is known as chaapa Yantra.
- Chaapa is Sanskrit name means Semicircle.
- Dhanu Yantra is also called as Semicircular disk machine.
- It is used for measurement of vertical angle.
- Dhanu Yantra fixed arrow stick along the diameter of Semicircular disk
- At the centre of this disk string or chain with plumb bob is attached.
- The Vertical angular movement of arrow stick is noticed by plumb string position.

- Dhanu Yantra is used to measure :-
- 1)Height of terrestrial objects
- 2)diameter of the earth.
- 3)Circumference of earth
- 4)Diameter of moon.
- 5)Distance between moon and earth
- 6) For measurement of height of terrestrial objects like hill, tree.

$\tan\theta = \frac{P}{x}$

- Initially arrow stick is focused on the top of the object and then at the bottom of the object.
- The vertical angle is used to measure height of the object using trigonometric formulae sine, cos etc.

- 3) Yasti Yantra
- Yasti Yantra was developed by the great mathematician and astronomer Bhaskaracharya.
- Yasti Yantra is also knows as Dhi Yantra or Stick machine of Bhaskaracharya.
- It is also knows as cross staff.
- Yasti is a sanskrit word ond English meaning is stick Or rod or bar.
- By using Yasti yantra we can measure height of huge object on the earth, tree, hill, small mountain

- 4. Phalak yantra :-
- Phalak Yantra is a board or plate for finding time from Suns altitude.

- The altitude angle means angle which guides to know how sun appears in the sky.
- Altitude angle is the angle between imaginary line joining observer to sun and horizontal plane on earth.
- Some Phalak Yantra with pin and index arm for derermining time from suns altitude, to find time after after sunrise.

- Phalak Yantra is a flat plate having hole at the centre.
- Sunlight passes through this hole and incident on a marked surface by which angle of inclination of sun is determined.
- Bhaskaracharya developed phalak yantra to measure hour angle.

Import question

obj / Fill / T&F

L-08

(i) Total Nos. of Fundamental quantity → 07

(ii) Unit of strain is → strain is a dimensionless unitless quantity

(iii) Energy → [ ]

(iv) S.F → 0.004850 ⇒ S.F = 4

(v) True value → Mean

(vi) $1N = 10^5$ dyne
$1J = 10^7$ erg

4 marks

*** (i) Limitation of dimension analysis
or
use of dimension analysis

(ii) difference b/w Random error & systematic error

(iii) Different system of unit

Numerical

(iv) $x_1 =$ $x_2 =$ $x_3 =$ $x_4 =$

→ True value
→ Absolute
→ mean Absolute
→ Relative
→ percentage

6 marks

(i) $S = a + bt + ct^2 + \frac{d}{(e+t^2)}$

(ii) 1N = ? dyne
⇓
Derive.

(iii) Rules for significant figures

(iv) Fundamental & Derived unit difference

APPLIED Physics - 'B'

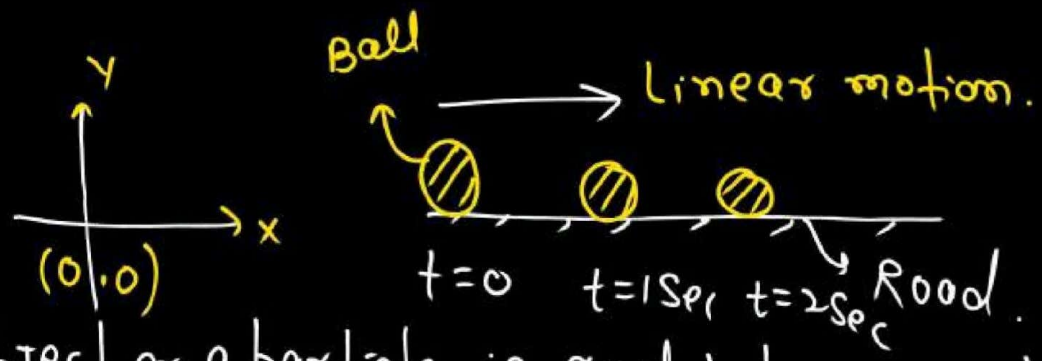
UNIT-02 - SIMPLE HARMONIC MOTION (SHM) and WAVE MOTION.

✓ Book :- NCERT - Physics - XI th & XII th

XI th physics → Vol - I, Volume - II

XII Physics → Vol - I, Vol - II

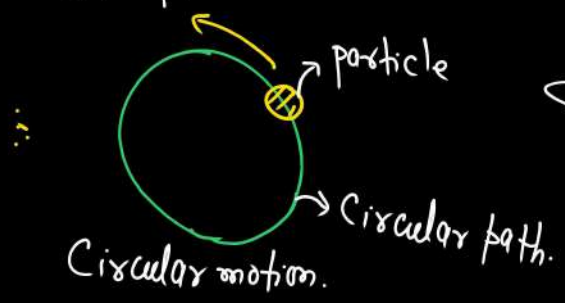
MOTION :→

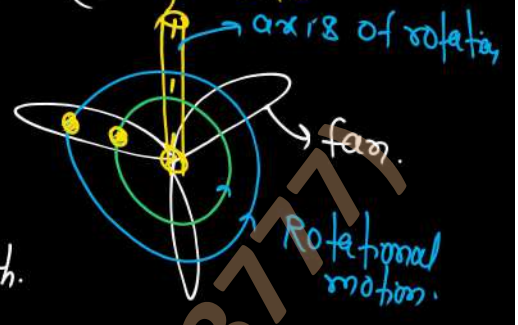


→ An object or a particle is said to be in motion when its position changes with respect to time.

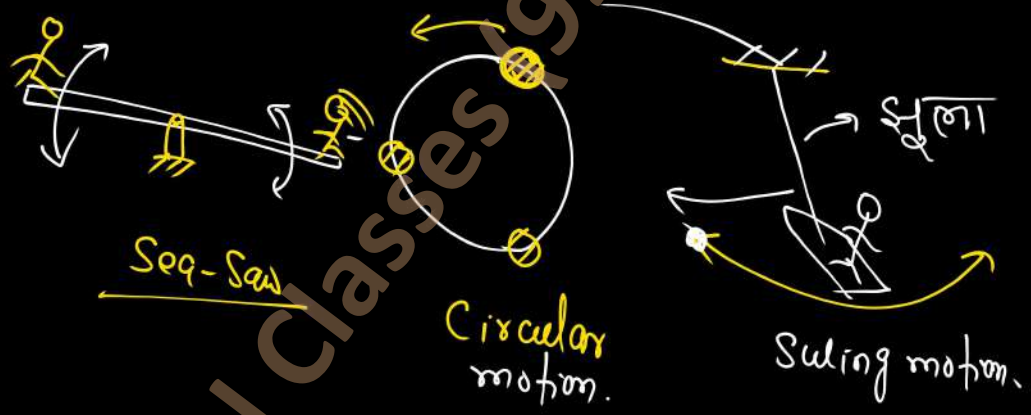
example :—

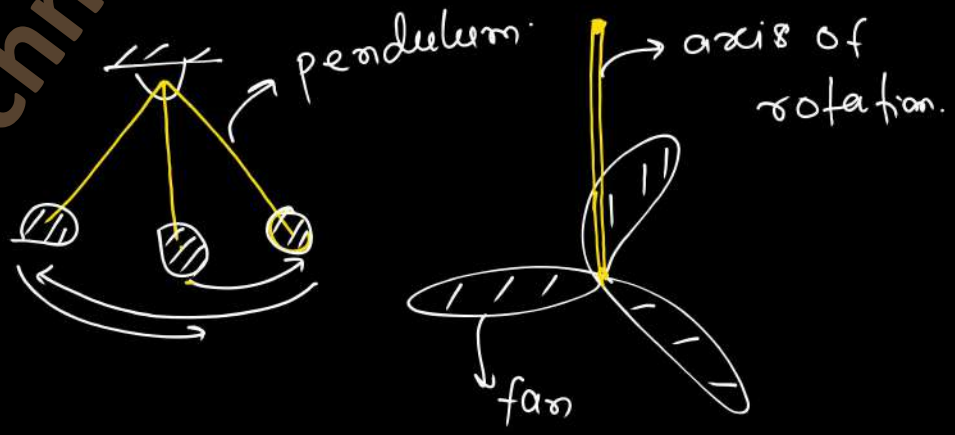
linear motion, Circular motion, Rotational motion, oscillatory motion, Simple harmonic motion (SHM) etc.





periodic motion :→





periodic motion :→

A motion said to be a periodic motion when it repeats its nature of motion after certain time interval.

→ example, Circular motion, rotational motion, motion of swing, See-saw motion, pendulum motion etc.

Time Interval (T) :→

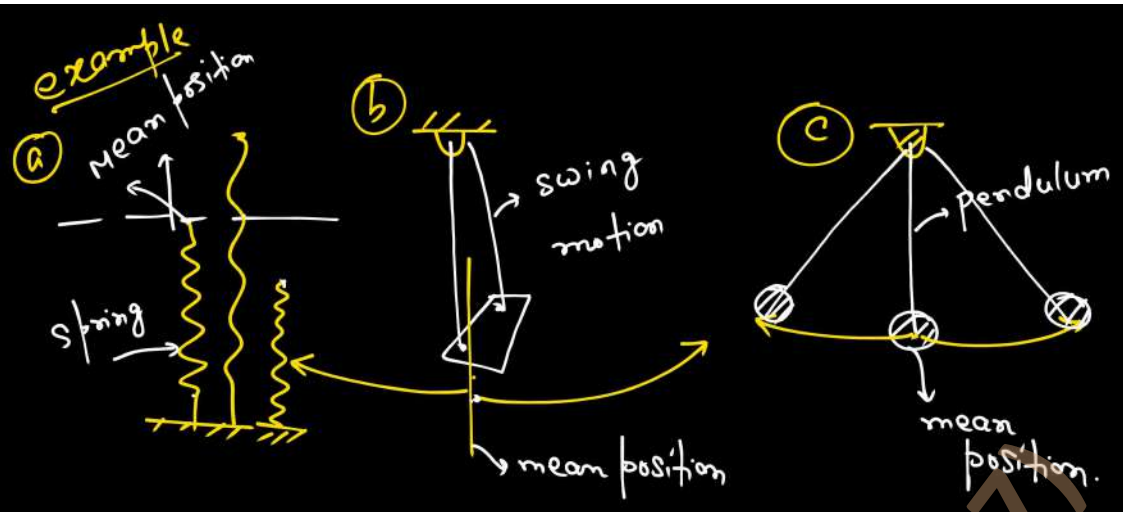
→ The total time after which a periodic motion repeats itself is called time interval (T).

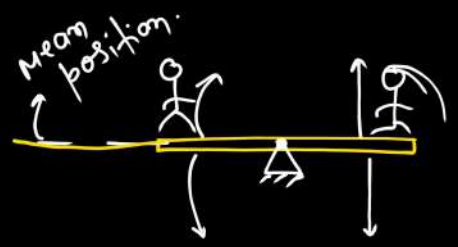
APPLIED Physics-B

oscillatory motion :→

→ A periodic motion in which an object moves "to and fro", or "back and forth" or "up and down" about a mean position, is called oscillatory motion.

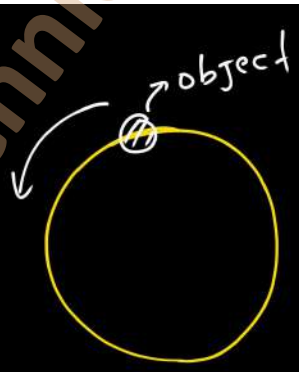
example





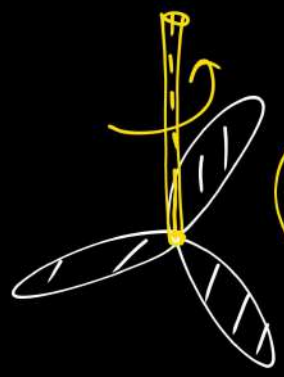
See-saw

example, → motion of swing, pendulum motion, vibration of spring, see-saw motion etc.



Circular motion

(periodic but not oscillatory motion)



(periodic but not oscillatory motion)

fan (Rotational motion)

Note:** (a) All oscillatory motion are periodic motion but all periodic motion are non oscillatory motion.

(b) Circular and Rotational motion are periodic but non oscillatory motion.

Q① A periodic motion may be oscillatory motion. (True/False)

Ans:— True.

Q② A periodic motion is always a oscillatory motion (True/False)

Ans False.

Q A oscillatory motion is always a periodic motion (True/False).

Ans:- True.

Mean position :→

→ Mean position is a point about which oscillatory motion takes place.

→ Mean position is also called equilibrium position.

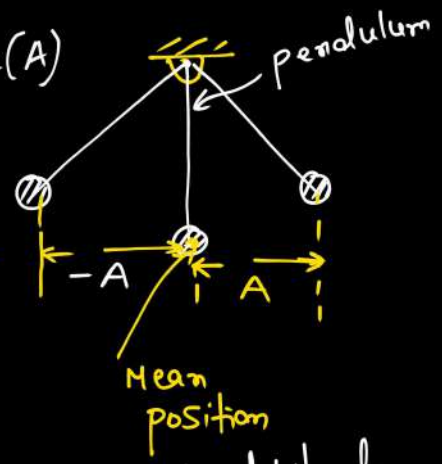
→ At Mean position total (net) force is zero.

APPLIED Physics – B

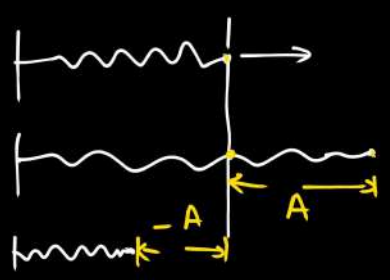
Some Important terminology related to oscillatory motion :→

ⓐ **Amplitude (A)** :→ The maximum displacement from mean position of an object under oscillatory motion is called amplitude (A) of the motion.

→ SI unit of amplitude (A) is meter (m).



example



A → Amplitude.

(b) Time period (T) :→

The total time required to complete one cycle of oscillatory motion is called Time period (T).

→ SI unit of time period (T) is sec.

(c) Linear frequency / frequency (ν) :→

→ The number of cycle completed per unit time is called frequency.

∵ 'T' sec completed = 1 cycle.

1 sec " = $\frac{1}{T}$ cycle

= frequency.

that is (i.e)

$$\boxed{\text{frequency}(\nu) = \frac{1}{T}}$$

where T = Time period.

→ SI unit of frequency sec^{-1} = Hertz (Hz)

unit → $minute^{-1}$ ≠ Hertz

(d) Angular frequency (ω) :→

→ Angular frequency is the angle turned in a unit time.

→ Angular frequency (ω) is given by

$$\boxed{\omega = \frac{2\pi}{T} = 2\pi\left(\frac{1}{T}\right) = 2\pi\nu}$$

T = Time period (sec.), ν = linear frequency.

→ SI unit of 'ω' is rad./sec.

APPLIED Physics-B.

SHM (Simple Harmonic motion) :→

→ Simple harmonic motion is an oscillatory motion in which displacement of the object from mean position is a function of cosine. (ω)

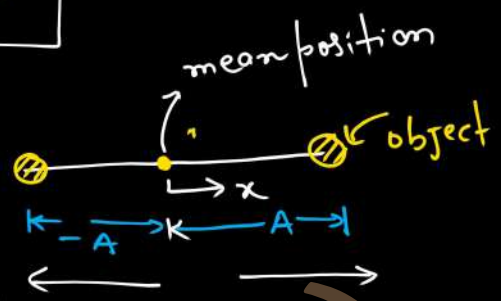
i.e $\boxed{x = A\cos(\omega t)}$ **

$x \rightarrow$ displacement of object from mean position.

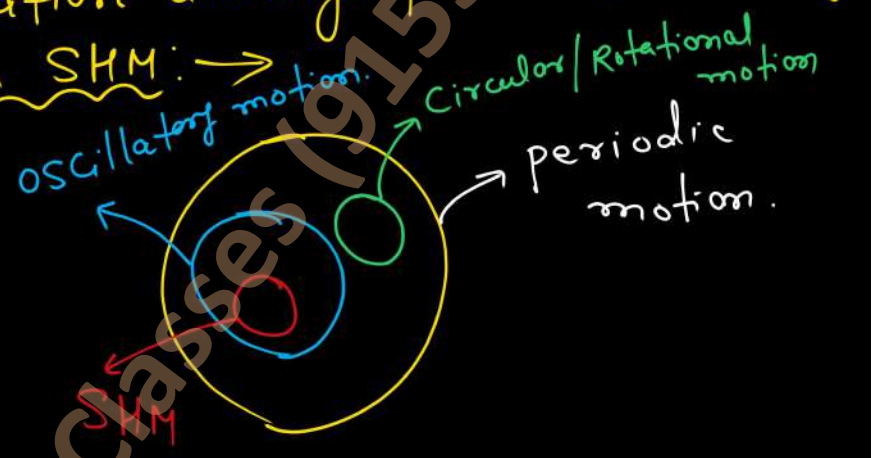
$A \rightarrow$ Amplitude.

$\omega \rightarrow$ Angular frequency $= \frac{2\pi}{T}$

$t \rightarrow$ time.



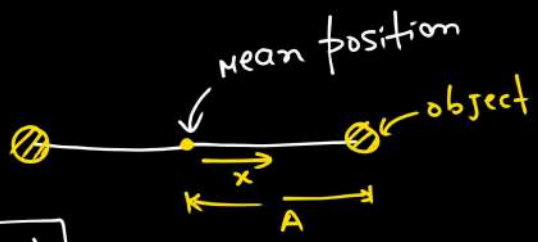
Relation among periodic, oscillatory, and SHM: →



∴

APPLIED Physics-B

∵ Displacement (x) of SHM is given by:—



** $\boxed{x = A\cos(\omega t)}$

∴ # velocity (V) $= \frac{\text{displacement}}{\text{time}} = \frac{dx}{dt}$ → differentiation of 'x' with respect to time (t)

$$\therefore \quad V = \frac{dx}{dt} = \frac{d\left(A\cos(\omega t)\right)}{dt}$$

**

$$\boxed{V = -A\omega \sin(\omega t)}$$

↓ velocity of SHM.

Acceleration (a) of SHM :—

$$\text{acceleration}(a) = \frac{dV}{dt}$$

→ differential of velocity (V) with respect to time (t)

$$\therefore \quad \text{acceleration}(a) = \frac{d\left(-A\omega \sin(\omega t)\right)}{dt}$$

**

$$\boxed{a = -A\omega^2 \cos(\omega t)}$$

→ acceleration of SHM.

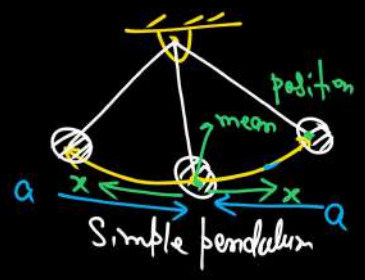
$$\therefore \quad a = -A\omega^2 \cos(\omega t)$$

***

$$\boxed{a = -\omega^2 x}$$

→ In above equation of acceleration negative sign(−) indicates that, direction of acceleration is always opposite to direction of displacement of object in SHM.

∵ example :—



∵ In SHM

$x = A\cos(\omega t)$

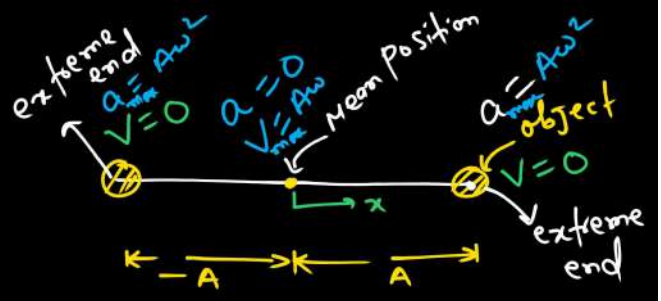
* at extreme end,

$x = A$

$\Rightarrow \cancel{A}\cos\omega t = \cancel{A}$

$\cos(\omega t) = 1$

$\therefore \boxed{\omega t = 0^\circ}$



∵ $\cos\theta = 1$

$\boxed{\theta = 0^\circ}$

∴ velocity (V) at extreme end :—

∵ at extreme end, $\boxed{\omega t = 0^\circ}$

∵ $V = -A\omega\sin(\omega t)$

$= -A\omega\sin(0^\circ)$

$V = -A\omega \times 0$

$\boxed{V = 0}$ → at extreme end.

Again acceleration (a) at extreme end :—

∵ $a = -A\omega^2\cos(\omega t)$

at extreme end $\omega t = 0^\circ$

∴ acceleration (a) $= -A\omega^2\cos(0^\circ)$

$a = -A\omega^2 \times 1$

$\boxed{a = -A\omega^2}$ → at extrement end.

↳ maximum acceleration.

At mean position :→

Displacement $(x) = 0$

velocity = maximum $(V_{max}) = A\omega$

and acceleration $(a) = 0$

∴ By N's 2nd law, $F_{net} = ma$

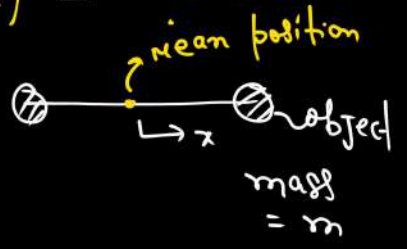
∴ At mean position, $\boxed{F_{net} = m \times 0 = 0}$

APPLIED Physics-B.

Force law of SHM :→

we know,

acceleration of SHM $(a) = -\omega^2 x$



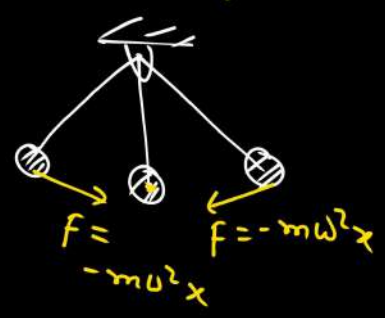
∴ By Newton's 2nd law.

total force $(F) = ma$

∴ $\boxed{F = -m\omega^2 x}$ → force law of SHM.

This force is known as restoring force.

** → when total force acts on an object is opposite to direction of displacement of object then object must always be in SHM.



$\because \quad F = -\underbrace{m\omega^2}\, x$

$$\boxed{F = -Kx}$$

where K = constant $= m\omega^2$

= Force constant

= spring constant. *

$\because \quad K = m\omega^2$

$\Rightarrow \quad \omega^2 = \dfrac{K}{m}$

$$\boxed{\omega = \sqrt{\frac{K}{m}}}$$

→ ** SI unit of 'K' is $\dfrac{\text{newton}(N)}{\text{meter}(m)}$.

$\because$ Angular frequency $(\omega) = \sqrt{\dfrac{K}{m}}$ —— (I)

$\because$ we know,

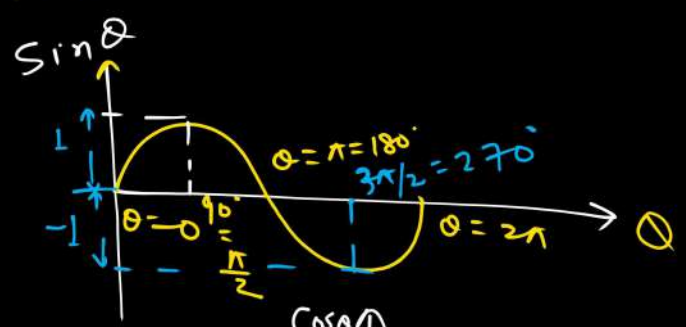
$$\boxed{\omega = \frac{2\pi}{T} = 2\pi\nu} \quad \text{—— (II)}$$

Equating eqn (I) and (II) we get,

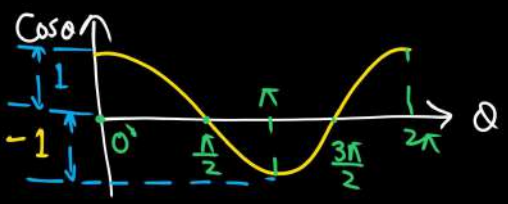
** $2\pi\nu = \sqrt{\dfrac{K}{m}}$

$$\boxed{\nu = \frac{1}{2\pi} \times \sqrt{K/m}} \rightarrow \sec^{-1} \text{ or } Hz$$

Sinθ :-

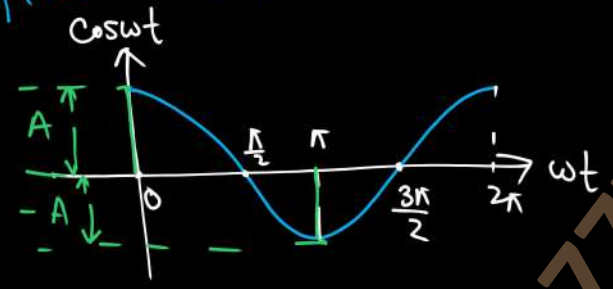


Cosθ

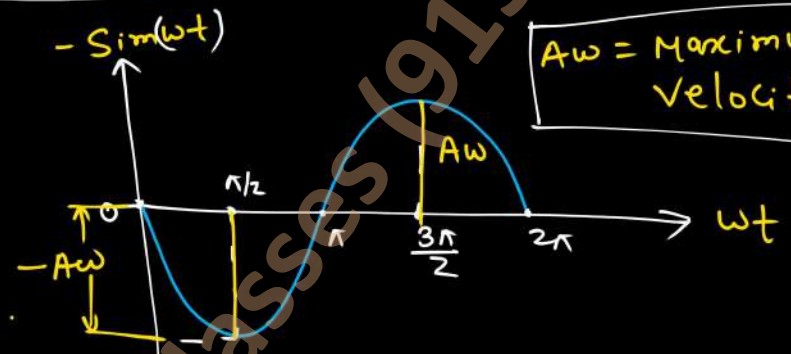


Graph of 'displacement', "velocity" and acceleration of SHM :→

∵ Displacement$(x) = A\cos(\omega t)$.

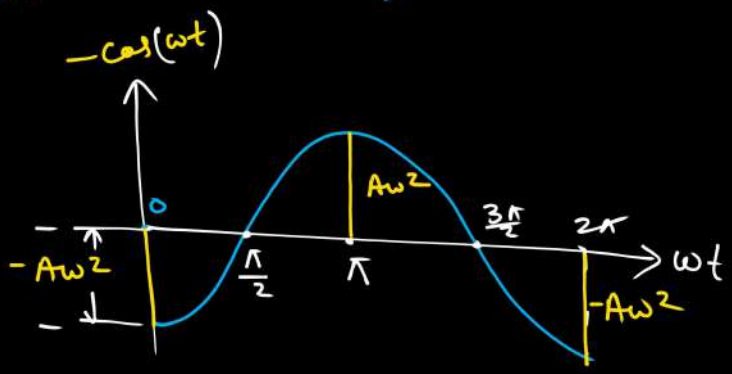


∵ velocity$(V) = -A\omega\sin(\omega t)$



$\boxed{A\omega = \text{Maximum Velocity}}$

Acceleration$(a) = -A\omega^2\cos(\omega t)$



APPLIED Physics-B

Q. Which of the followings not represents the unit of frequency?

(a) Hertz (Hz) (sec^{-1})

(b) sec^{-1}

(c) $meter^{-1}$

(d) both (a) and (b)

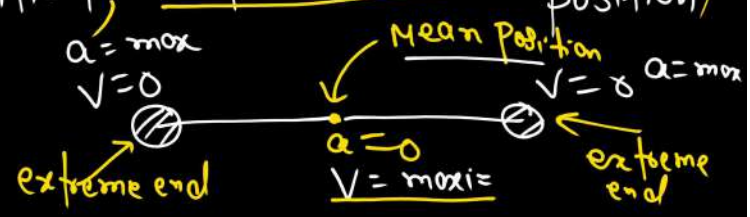
$\nu = \frac{1}{T}$

unit SI sec^{-1} = Hz.

Q. A body executing SHM has maximum acceleration at the

_ _ _ _ _ _

(Mean position, extreme position, any position)



Q: $\xrightarrow{2}$

Ans:— extreme position.

Note:→ $V_{max} = A\omega$ (ω → angular frequency, A → amplitude.)

$a_{max} = A\omega^2$

Q. which of the following is maximum at mean position for the particle executing SHM.

(a) Kinetic energy → $K.E = \frac{1}{2}mV^2$ ($K.E$ → kinetic energy, m → mass)

(b) Potential energy

(c) Acceleration

(d) None.

∵ At Mean position → total force is zero.

By Newton's 2nd law.

$F_{net} = ma$

at mean posi.

$\boxed{a = 0}$

$F_{net} = m \times 0 = 0$

Q. Which of the following relation between acceleration and displacement represents SHM.

(a) $a = 0.7x$ ✗

(b) $a = -200x$ (2)

(c) $a = -10x$

(d) $a = 100x$ (3).

explation

SHM

$$\boxed{a = -\omega^2 x}$$

$$a = -10x$$

$$\boxed{\omega^2 = 10}$$

APPLIED Physics-B

Q. A body oscillates with SHM according to the equation

$$x = 5\cos\left(2\pi t + \frac{\pi}{4}\right)$$

At 't = 2 sec Calculate

(a) displacement (b) Speed (c) acceleration (d) time period and frequency.

Solution Given equation of Displacement,

$$x = 5\cos\left(2\pi t + \frac{\pi}{4}\right) \quad \text{—— (I)}$$

we know, $x = A\cos(\omega t)$ —— (II)

Comparing equation (I) and equation (II) we get

$\boxed{A = 5\,m}$, $\boxed{\omega = 2\pi}$

(a) Displacement at $t = 2\,sec$

$$\because \; x = 5\cos\left(2\pi t + \frac{\pi}{4}\right)$$

$$= 5\cos\left(2\pi \times 2 + \frac{\pi}{4}\right)$$

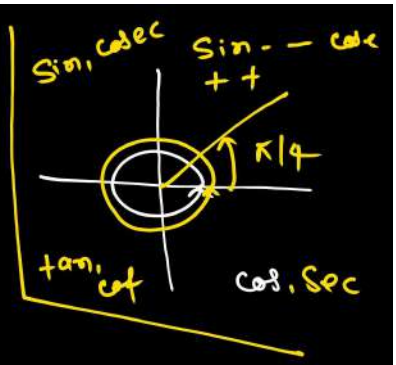
$$= 5\cos\left(4\pi + \frac{\pi}{4}\right)$$

$$= 5\cos\frac{\pi}{4}$$

$$= 5 \times \frac{1}{\sqrt{2}}\,m \quad \text{Ans//}$$

$$= 3.54\,m$$

(b) Speed at $t = 2\,sec$



$$V = \frac{dx}{dt}$$

$$= \frac{d\left(5\cos\left(2\pi t + \frac{\pi}{4}\right)\right)}{dt}$$

$$V = -A\omega\sin(\omega t)$$

$$= -5 \times 2\pi \sin\left(2\pi t + \frac{\pi}{4}\right)$$

$$V = -10\pi \sin\left(2\pi \times 2 + \frac{\pi}{4}\right)$$

$$= -10\pi \sin\left(4\pi + \frac{\pi}{4}\right)$$

$$= -10\pi \sin\frac{\pi}{4}$$

$$= -10\pi \frac{1}{\sqrt{2}}$$

$$V = \left|-\frac{10\pi}{\sqrt{2}}\right|$$

Speed $= \frac{10\pi}{\sqrt{2}}$ m/sec

(c) Acceleration at $t = 2$ sec.

$\because$ acceleration $(a) = \frac{dv}{dt}$

$$= \frac{d\left(-10\pi \sin(2\pi t + \pi/4)\right)}{dt}$$

$$= -10\pi \times 2\pi \cos\left(2\pi t + \frac{\pi}{4}\right)$$

$$a = -20\pi^2 \cos\left(2\pi t + \frac{\pi}{4}\right)$$

$\therefore$ at $t = 2$ sec

$$a = -20\pi^2 \cos\left(2\pi \times 2 + \frac{\pi}{4}\right)$$

$$= -20\pi^2 \cos\frac{\pi}{4}$$

$$a = -20\pi^2 \times \frac{1}{\sqrt{2}} = -10\sqrt{2}\pi^2 \text{ m/sec}^2$$

$$|a| = 10\sqrt{2}\pi^2 \text{ m/sec}^2$$

$$= 139.57 \text{ m/sec}^2 \text{ Ans}$$

(d) Time period (T) :→

∵ Given 'ω' = 2π

∵ we know,

$$\omega = \frac{2\pi}{T} = 2\pi$$

$$\boxed{T = 1\,Sec}$$ Ans))

frequency (ν) = $\frac{1}{T}$

$$= \frac{1}{1\,Sec} = 1\ Sec^{-1}$$

$$= 1\ Hz$$

Ans))

Q. On an average a human heart is found to beat 75 times in a minute.

find

(a) Time period (b) frequency in Hz

(c) angular frequency.

Solution :- Given :—

75 times heart beat in 1 min.

1 times " " $= \frac{1 \text{ min.}}{75}$

$\therefore$ Time period $= \frac{1}{75}$ minute

$= \frac{1}{\cancel{75}_{5}} \times \cancel{60}^{4}$ sec

$\boxed{T = \frac{4}{5} \text{ sec} = 0.8 \text{ sec}}$

Ans)

(b) frequency :—

$\because \quad \nu = \frac{1}{T} = \frac{1}{\frac{4}{5} \text{ sec}} = \frac{5}{4}$ Hz

$= 1.25$ Hz Ans)

(c) Angular frequency (ω) :—

$\because \quad \underline{2\pi\nu = \omega} = \frac{2\pi}{T}$

$\omega = 2\pi \times 1.25 \ \frac{\text{rad}}{\text{sec}}$

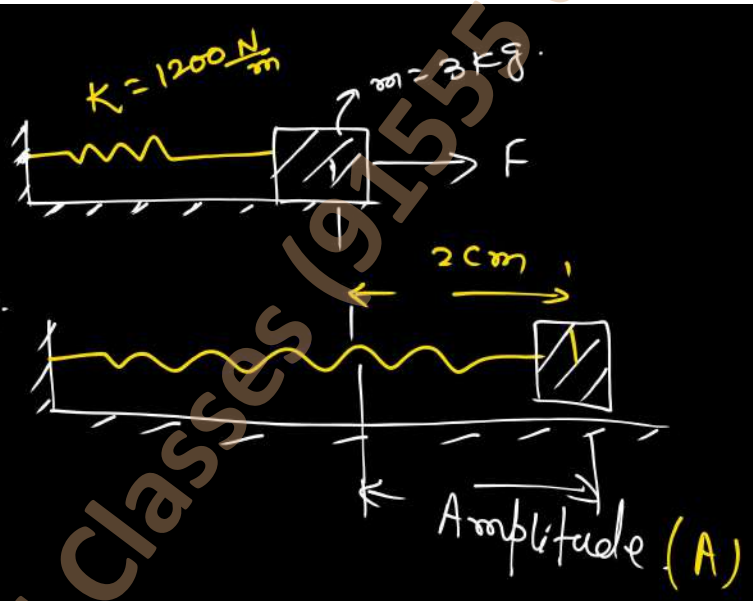
$= 2.5\pi$ rad/sec Ans)

$=$

Q. A spring has spring constant (K) is $1200 \frac{N}{m}$ is mounted on horizontal table as shown in fig. A mass of 3 kg is attached to free end of spring, then mass is pulled to a distance 2 cm and release, calculate

(a) frequency in Hz (b) Maximum acceleration
(c) Maximum speed.

Solution:



Amplitude (A) = 2 cm

$= 2 \times 10^{-2}$ m

$= 0.02$ m

$\because$ Angular frequency $(\omega) = \sqrt{\frac{K}{m}}$

$= \sqrt{\frac{1200 \text{ N/m}}{3}}$

$= 20$ rad/sec

$\because \quad 2\pi\nu = \omega$

$\therefore \quad \nu = \frac{\omega}{2\pi} = \frac{\cancel{20}^{10}}{\cancel{2\pi}}$ rad/sec

$$\boxed{\nu = \frac{10}{\pi}\ Hz}$$

(b) Maximum acceleration $(a)_{max}$:— Ans//

$a_{max} = A\omega^2 = 0.02m(20)^2$

$= 8\ m/sec^2.$

(c) Maximum speed :→

$V_{max} = A\omega$

$= 0.02\ m \times 20\ \frac{rad}{sec}$

$= 0.4\ \frac{m}{sec}$ Ans//

WAVE :→

→ wave is the movement (flow) of pattern of disturbances produced by external source of energy.

example, Sound wave, light wave, water wave, Seismic wave, String wave etc.,

Types of wave :—

There are following three types of wave.

I Mechanical wave.

II Electromagnetic wave

III Matter wave.

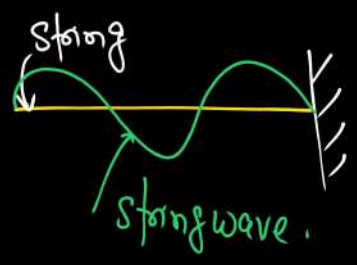
APPLIED Physics-B.

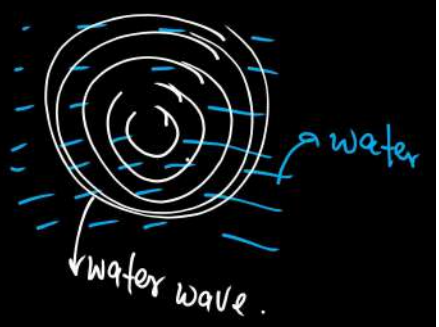
→ In wave propagation, energy is transfer from one place to another.

I Mechanical wave :→

→ Those waves which required a medium (Solid, liquid, gas) to its propagation are called mechanical waves.

Example, Sound wave, string wave, water wave, Seismic wave, etc.





** → In mechanical wave constituent of medium do not move from one place to another but oscillates at their own position.

example:

⇒ Mechanical waves have two types:→

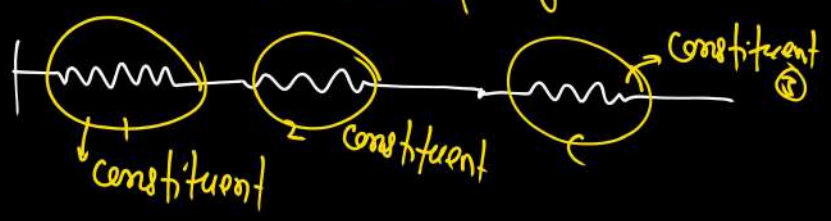
I longitudinal mechanical wave.

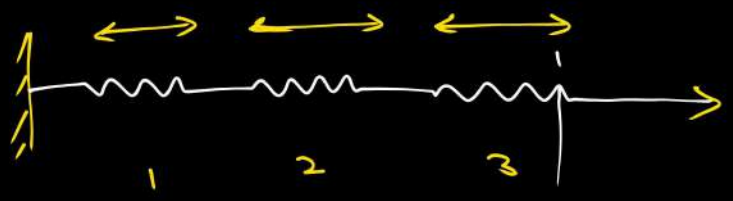
II Transverse wave.

I longitudinal wave:→

Mechanical waves in which constituent of medium oscillates in a direction same as the direction of wave propagation are called longitudinal mechanical waves.

example:— Sound is an example of longitudinal mechanical, spring waves.





→ Sound propagate in air by the combined phenomenon of compression and rarefaction.

→ Sound travels/propagate in solid by the vibration of solid constituent

APPLIED Physics–B

→ Sound has higher speed in solid material than in liquid and gas.

$$(V)_{Solid} > (V)_{liquid} > (V)_{gas}$$

V → Speed of sound wave.

** → speed of sound Maximum is in Aluminium = 6400 m/min.

** → speed of sound in air = 335 m/min

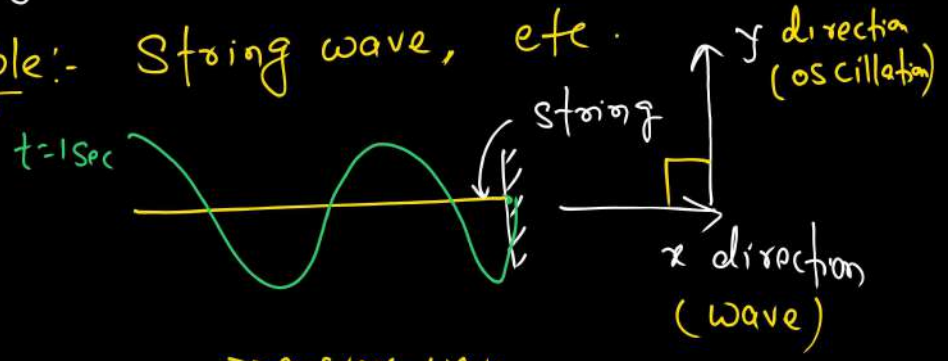
** → Sound wave traveled in gases due to change in density of gases.

NOTE :→ Mechanical waves can't travel or propage in vacuum.

(b) Transverse wave :→

→ Mechanical waves in which oscillation of constituent of medium takes place in a direction perpendicular to direction of wave propagation are called transverse waves.

example :- String wave, etc.



Transverse wave

→ Transverse mechanical waves can't supported by fluid (liquid gas)

Difference between longitudinal waves and transverse waves:

Longitudinal waves	Transverse waves
(i) In longitudinal waves oscillation of constituent of medium takes place in same direction as the direction of wave propagation.	(i) In this wave oscillation of constituent of medium takes place in a direction perpendicular to direction of wave propagation.
(ii) Longitudinal waves are supported by, solid, liquid and gas as well.	(ii) Transverse mechanical waves can only be supported by solid.
(iii) Speed of longitudinal wave in fluid is given by $V_{fluid} = \sqrt{\frac{\Delta P}{\Delta \rho}}$	(iii) Speed of transverse mechanical wave is given by, $V = \sqrt{\frac{T}{\mu}}$

ΔP = change in pressure

$\Delta \rho$ = change in density

and in solid, speed:-

$$V_{solid} = \sqrt{\frac{Y}{P}}$$

$Y \rightarrow$ Young's modulus (property)

$P \rightarrow$ pressure.

where

T = Tensile force

μ = mass per unit length (Kg/m).

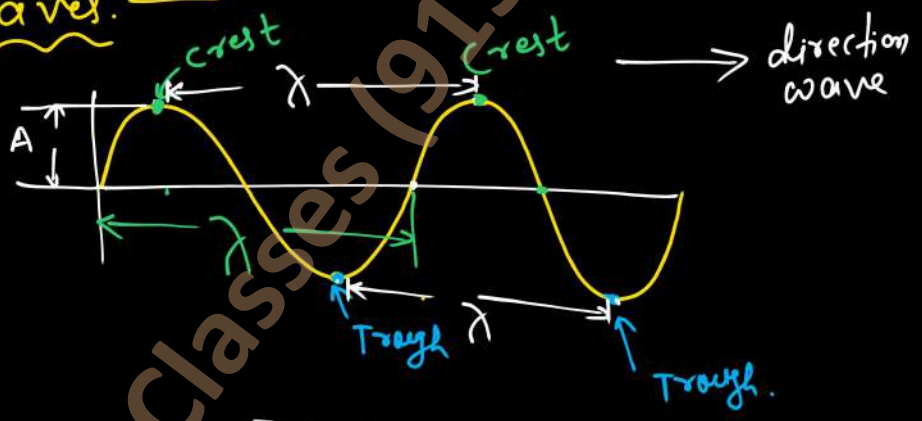
(iv) Sound wave is a longitudinal mechanical wave.

(v) longitudinal wave can chang the proper-ty fluid medium like its density.

(iv) string wave is a transverse mechanical wave.

(v) There no any change in property of solid during propagation of transverse wave in solid.

Important terminology related to mechanical waves:—



Transverse wave

(a) Amplitude (A) :→

→ It is maximum positive displacement from mean position of oscillation of Constituent of medium.

(b) Timeperiod (T).

→ it is the total time required to complete one cycle of wave.

(iii) frequency (ν) :→

→ Number of cycle completed in one sec is called frequency of wave.

$$\therefore \boxed{\text{frequency}(\nu) = \frac{1}{T}}$$

where T = Time period (sec)

→ SI unit of frequency (ν) = sec^{-1} or Hz.

(iv) Crest :→

→ The point of maximum positive displacement is called crest.

(v) Trough :→

→ The point of minimum negative displacement of oscillation of constituent of medium is called trough.

(vi) wave length (λ)

→ The distance travelled by wave during completion of one cycle is called wave length.

→ SI unit of wave length is meter (m).

→ The distance between two consecutive crest/trough is also takes as wave length (λ).

(vii) Speed of wave (v) :→

→ Distance travelled by wave per unit time is called speed of wave.

Relation between, speed, wavelength and frequency of wave :→

∵ T → Time period. (Time to complete one cycle)

λ → distance travelled by wave in one cycle.

∴ speed (v) of wave = $\frac{\text{wavelength}(\lambda)}{\text{Time period}(T)}$

∵ speed (v) = $\frac{\lambda}{T}$

⇒ $v = \left(\frac{1}{T}\right) \times \lambda$

⇒ ** $\boxed{v = \nu \lambda}$ → wave length.

v → Speed, ν → frequency

Q// Calculate the wave length (λ) of a Sound wave whose frequency (ν) = 220 Hz and Speed is 440 m/sec in a given medium.

Solution:→ Given

frequency (ν) = 220 Hz

Speed (v) = 440 m/sec

∵ We know,

$$v = \nu\lambda$$

$$\Rightarrow \lambda = \frac{v}{\nu} = \frac{440}{220} \; 2m$$

$$\Rightarrow \lambda = 2 \text{ meter Ans//}$$

Q// A sound wave has frequency (ν) = 2 KHz and wave length (λ) is 35 cm. How much time it will take to cover 1.5 Km.

Solution:- Given

frequency (ν) = 2 KHz = 2×10^3 Hz

wave length (λ) = 35 cm = 35×10^{-2} m

Distance to Cover (S) = 1.5 km = 1.5×10^3 m

$\because$ speed of wave $(v) = \nu\lambda$

$= 2\times10^{\cancel{8}} \times 35\times\cancel{10^{-2}} \frac{m}{sec}$

$= 700 \frac{m}{sec}$

$\therefore$ Time taken to cover (1.5 km),

$$time(t) = \frac{1.5\times\cancel{10^{3}}\ \cancel{m}}{\cancel{700}\ \frac{\cancel{m}}{sec}}$$

$$t = \frac{15}{7} \text{ sec}$$ Ans//

APPLIED Physics-B

Electromagnetic wave :→

→ Those waves which do not require a medium to propagate, but can travel in vacuum also are called electromagnetic waves.

example :- light wave, x-ray, γ-ray, ultraviolet ray etc.

Distinguise or Difference between Mechanical waves and electromagnetic waves :→

Mechanical waves	Electromagnetic waves
(i) Mechanical waves require a medium to propagate.	(i) Electromagnetic waves do not require a medium to propagate.

(i) These waves can't propagate in vacuum.	(ii) These waves can travels in vacuum.
(iii) Generally mechanical waves have lower speed.	(iii) Electromagnetic wave have higher speed.

(iv) These waves have larger wave length (λ).	(iv) Electromagnetic waves have smaller wave length (λ).
(v) Mechanical waves travels in a medium due to vibration and compression of molecules of medium	(v) Electromagnetic waves travels due to combination of electric and magnetic phenomena.

(vi) Mechanical waves can be longitudinal type and transverse type.	(vi) Electromagnetic waves in a medium can only be transverse type.
(vii) Sound wave, string wave, spring wave, Seismic wave etc are example of Mechanical waves.	(vii) light waves, x-ray, γ-ray, Solar radiation etc are the example of electro-magnetic waves.

Difference between Sound wave and light wave :→

Sound wave	light wave
(i) It is a mechanical wave.	(i) It is a electromagnetic wave.
(ii) Sound wave can travel in a medium only.	(ii) It does not neccessarily required a medium to propagate.
(iii) Sound wave can't travel in vacuum.	(iii) Light wave can propagate in vacuum also.
(iv) Sound wave has maximum speed in Solid (Al, 6400 $\frac{m}{sec}$)	(iv) light wave has maximum speed in vacuum ($3\times10^8 \frac{m}{sec}$)
(v) Sound has minimum speed in gases.	(v) light wave has minimum speed in Solid
(vi) Sound travels in medium due to vibration and compression of molecules of medium.	(vi) light wave travels in medium due to combination electric and magnetic phenomena.

APPLIED Physics-B.

③ Matter wave :→

→ wave of electrons inside any substance or matters is consider in the form of wave which is called matter wave.

WAVE Equation :→

→ The mathematical form of a wave is called wave equation.

→ wave Equation is given by :→

$$\boxed{y(x,t) = a \sin(\underline{kx - \omega t + \phi})}$$

↳ general equation of wave.

where :—

$y(x,t)$ → Displacement of consititueent which is function of x, time (t)

a → amplitude of wave.

K → wave number $= \frac{2\pi}{\lambda}$ → wave length.

ω → Angular frequency $= \frac{2\pi}{T}$ → Time interv.

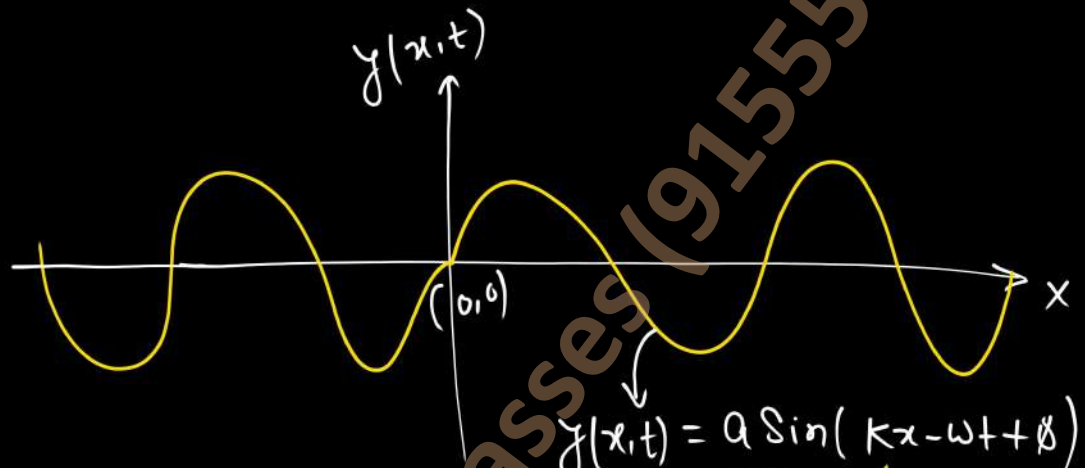
t → time.

ϕ → initial phase.

$kx - \omega t + \phi \longrightarrow$ Phase.

→ If $kx - \omega t + \phi \longrightarrow$ Then waves moves in + x-direction.

→ If $kx + \omega t + \phi \longrightarrow$ Then wave moves in − x-direction.



$$y(x,t) = a\sin(kx - \omega t + \phi)$$

∴ Wave Equation:—

$$y(x,t) = a\sin(kx + \omega t + \phi)$$

if $x = 0$ and $\phi = 0$

Then $\boxed{y(t) = a\sin(\omega t)}$ → phase

↳ Simplified wave equation

Phase difference :→

→ The difference between phases of two waves is called phase difference.

let a wave, $y_1(t) = a\sin(\omega t)$ —— (I)

another wave $y_2(t) = a\sin(\omega t + \phi)$ —— (II)

→ The above equations of two waves are of Same amplitude (a) and Same angular frequency (ω) but different phase.

$\therefore$ phase difference $= \cancel{\omega t} + \phi - \cancel{\omega t}$

$$\boxed{\text{Phase difference} = \phi}$$

** If phase difference (ϕ) between two wave is zero (0), then waves are called same phase wave.

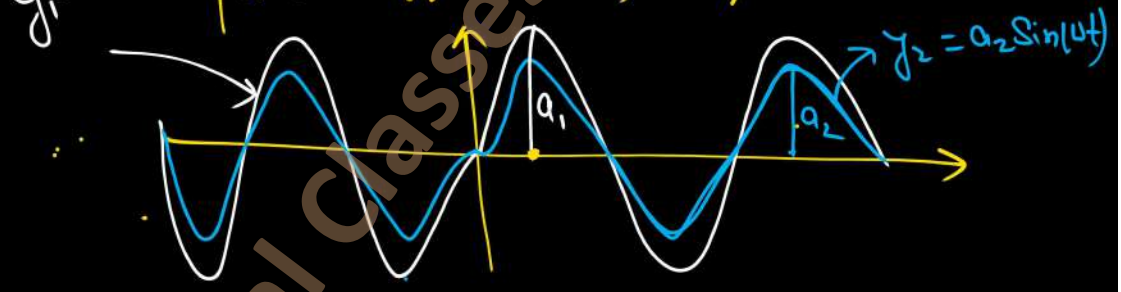
i.e $\boxed{\text{Phase difference}(\phi) = 0}$

→ wave are in same phase.

let $y_1(t) = a_1 \sin(\omega t)$ $\boxed{a_1 > a_2}$

$y_2(t) = a_2 \sin(\omega t)$

phase difference (ϕ) $= \cancel{\omega t} - \cancel{\omega t} = 0$



** If phase difference between two waves is π (180°), then two waves are called in opposite phase.

i.e $\boxed{\text{Phase difference} = \pi}$

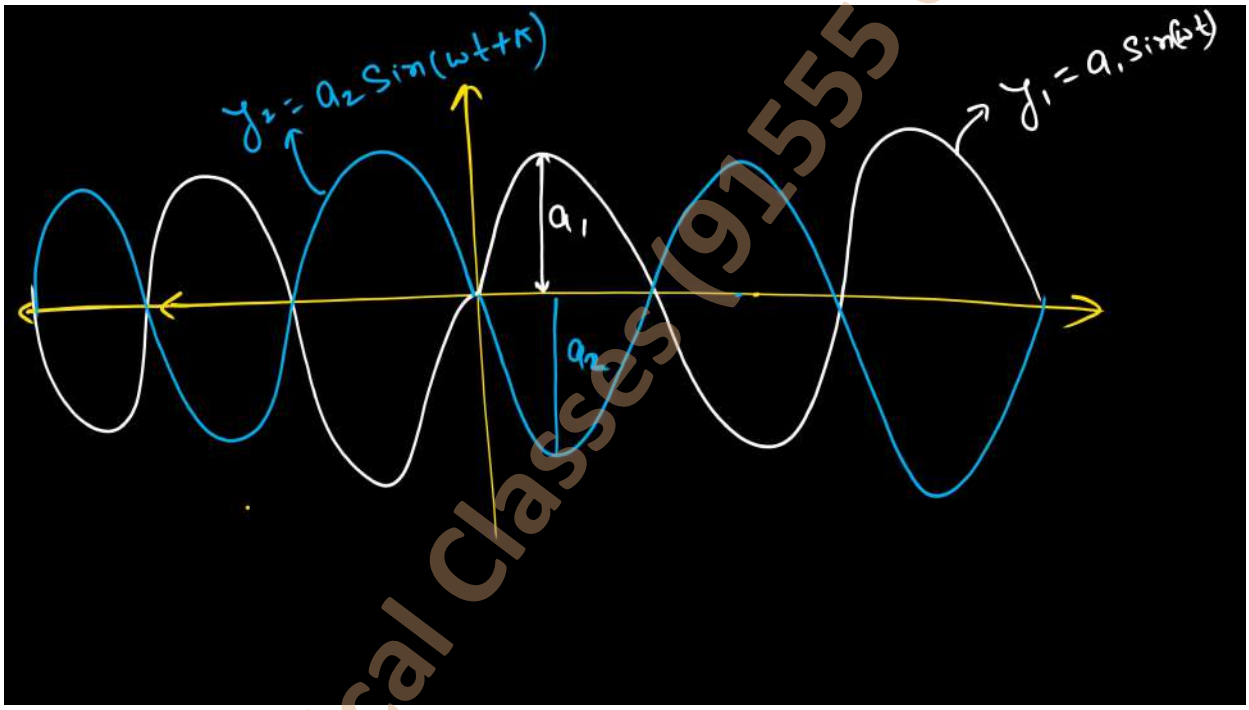
→ waves are in opposite phase.

let, $y_1(t) = a_1 \sin(\omega t)$ —— (I)

$\boxed{a_1 > a_2}$ $y_2(t) = a_2 \sin(\omega t + \pi)$ —— (II)

→ phase difference $= \cancel{\omega t} + \pi - \cancel{\omega t} = \pi$

wave $y_1(t)$ and wave $y_2(t)$ are called waves of opposite phase.



APPLIED Physics- B

Superposition of waves :→

→ when two or more than two waves overlaps on each other then the total displacement of resulting wave will be algebraic summation of individual waves.

let $y_1 = a_1 \sin(\omega_1 t)$ —— (i)

$y_2 = a_2 \sin(\omega_2 t)$ —— (ii)

$y_3 = a_3 \sin(\omega_3 t)$ —— (iii)

- - - - - -

∴ when above waves overlaps then according to superposition of waves:→

$$y(x,t) = y_1 + y_2 + y_3 + \cdots$$

$$y(x,t) = a_1 \sin(\omega_1 t) + a_2 \sin(\omega_2 t) + a_3 \sin(\omega_3 t) + \cdots$$

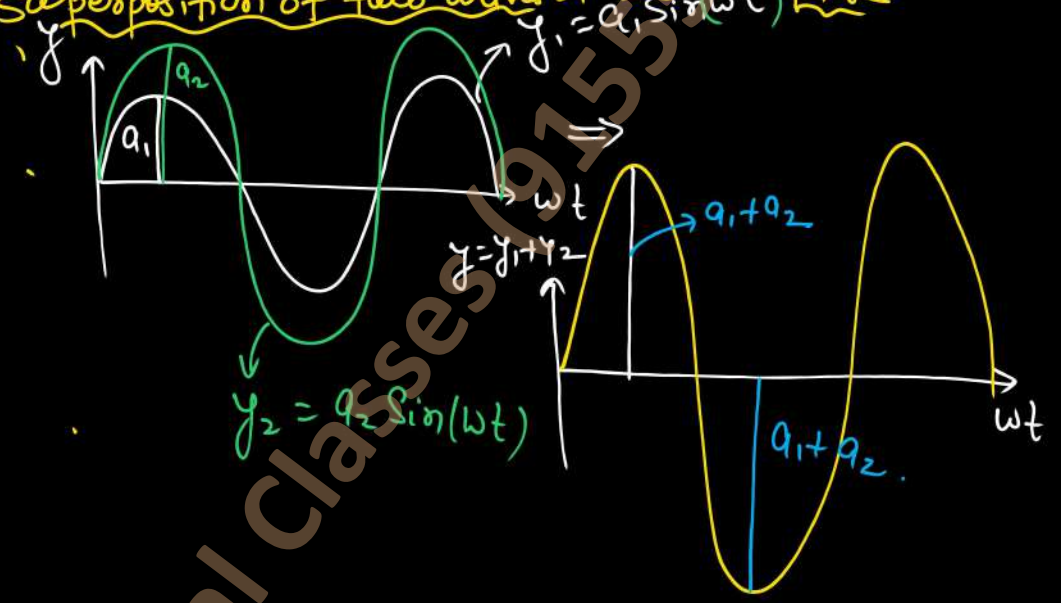
Note:→

(a) Phenomenon of interference of light takes place due to superposition of wave.

(b) When two waves of same phase superimpose then constructive interference takes place.

(c) when two waves of opposite phase superimpose, the destructive interference takes place.

Superposition of two waves of same phase



$$y = y_1 + y_2$$

$$= a_1 \sin(\omega t) + a_2 \sin(\omega t)$$

$$y = (a_1 + a_2) \sin \omega t$$

Superposition of two waves of opposite phase: ⟶

let $y_1 = a_1 \sin(\omega t)$

$y_2 = a_2 \sin(\omega t + \pi)$

$y_2 = -a_2 \sin(\omega t)$

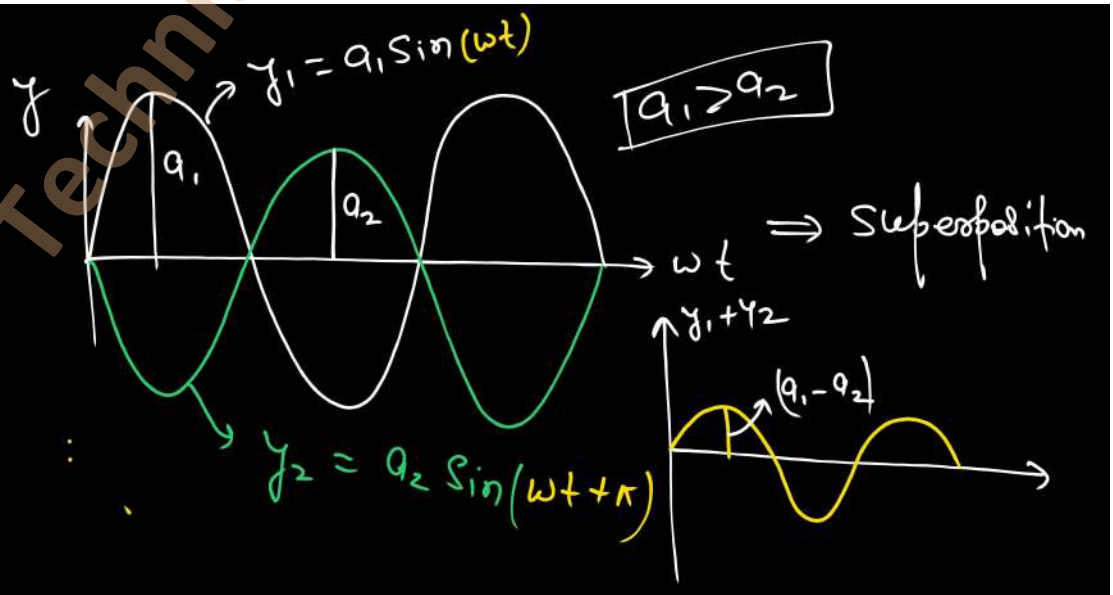
let $\boxed{a_1 > a_2}$

∴ By superposition waves

$$y = y_1 + y_2$$
$$= a_1 \sin(\omega t) - a_2 \sin(\omega t)$$
$$= (a_1 - a_2) \sin(\omega t)$$

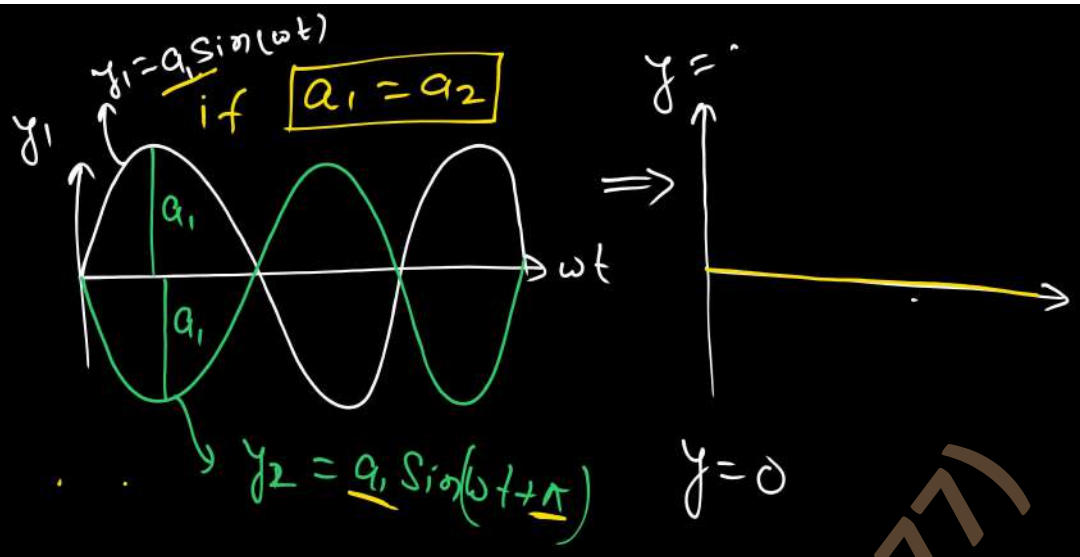
if $= a_1 = a_2$

∴ $\boxed{y = 0}$



$\boxed{a_1 > a_2}$

⟹ Superposition



** Note:→

** (a) Amplitude of sound wave related to loudness of sound.

(b) frequency of sound wave related to pitch of sound.

APPLIED Physics-B.

Q Correct relation between frequency (m), wave speed (V) and wavelength (λ).

(a) $V = m\lambda$ (b) $V = \frac{m}{\lambda}$ (c) $V = \frac{\lambda}{m}$

(d) $V = \frac{1}{m}$.

$V = V\lambda$ $V = m\lambda$

Q. loudness of sound is measured by

(a) Joule (b) Candela (c) Decible (db)

(d) Manometer.

loudness → amplitude
pitch → frequency.

Q. speed of sound is maximum in

(a) Air
(b) water
(c) vacuum
(d) steel.

$V_{solid} > V_{liquid} > V_{gas}$

New pattern

(Air, water, Steel)

Q. Sound wave in air are

(a) Longitudinal wave
(b) Transverse wave.
(c) Both (a) and (b)
(d) None of these.

Q. Which of the following wave can't travel through vacuum

(a) light wave
(b) X-rays
(c) γ-ray.
(d) Sound wave.

Q. Differentiate between Sound wave and light waves.

Q-1 The term for the distance between two consecutive crests or trough of wave ?

Q:-1 frequency, Amplitude, wavelength.

Ans → wavelength.

APPLIED Physics.

UNIT-03 - ELECTROSTATE, ELECTRO - MAGNETISM, ELECTRIC CURRENT

Electrostate :→ Electrostate deals with the electric charge at rest and its effects on its nearby surrounding space.

electric charge. at rest

Electric charge (q or Q) →

→ charge is an entity or an object / body which shows excess or defficiency of electrons on the body.

→ if excess electrons on the body then negative charge will be on the body

→ If there is defficiency of electrons on a body then positive charge will be on the body

→ SI unit of charge is coloumb (C).

→ charge on an electron (e) = -1.6021×10^{-19} C

→ " " " proton (P) = $+1.6021 \times 10^{-19}$ C.

→ Mass of an electron (m_e) = 9.1×10^{-31} kg.

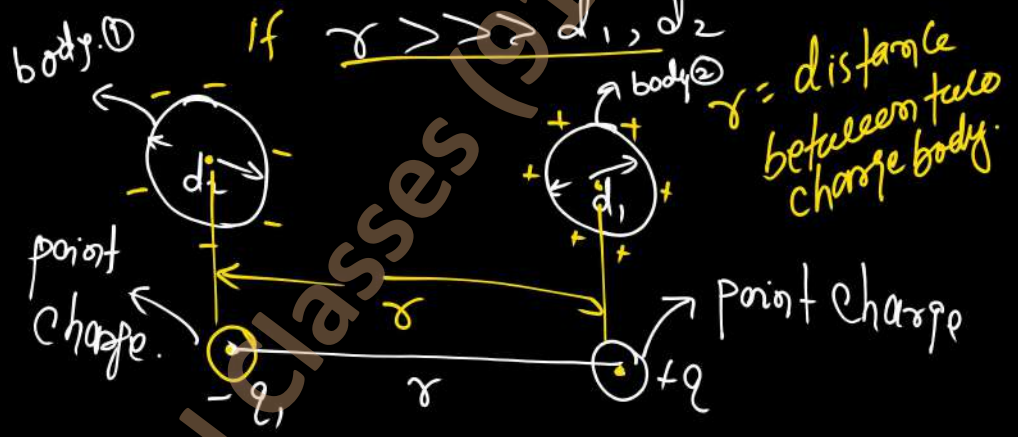
→ Mass of a proton (m_p) = 1.67×10^{-27} kg.

** → Gold leaf electroscope device is use to detect charge on a body.

→ Point charge :→

d_2, d_1 = diameter

If $r >>> d_1, d_2$



r = distance between two charge body.

→ If the distance (r) between two charged bodies is very large as compare to their size, then charge on two bodies are consider as point charge.

→ $-q$ = total negative charge on body
$+q$ = total positive charge on body

Method of charging :→

→ There are three-method of Charging.

I By Rubbing or By friction.

II By contact.

III Induction method.

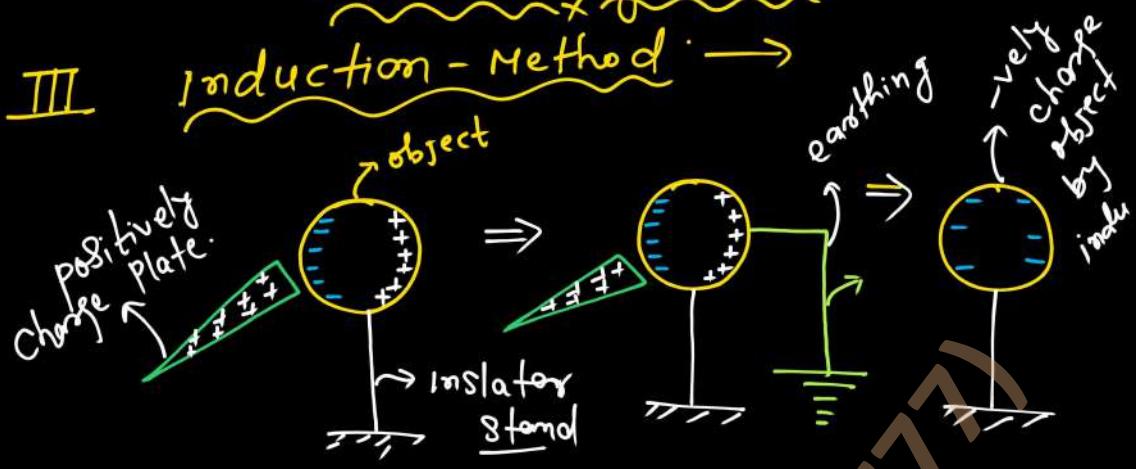
I By Rubbing or friction :→

→ If Surface of one object rubbed with Surface of another, the transfer of charge between two bodies takes place.

II By contact :→ If a neutral conductor body comes into contact with charge body, then transfer of charge from charge body to neutral body takes place. Thus neutral body gets charge.

APPLIED Physics-B

III Induction - Method →



→ Induction method of charging of a body in which no transfer of charge takes place like rubbing and contact - method.

→ In this of charging, a charge plate is to bring very close to a neutral body shown in above fig.

→ Then charge plate attract the opposite charge of the body and charges developed on otherside of body if earthed then a charges is uniformally distributed over neutral body, this method of charging is called induction method.

properties of electric charge:→

followings are properties of charge:—

I Conservative property:→

→ Total charge of the universe remains constant that is charge can neither be created nor destroyed.

II Additive property:→

→ This property states since charge is a scalar quantity, so total charge can found out by adding algebraic-cally (with sign) of all charges.

example:— let $q_1, -q_2, -q_3, q_4, q_5$ charges

∴ we can write

$$\text{Total charge } (Q_{total}) = q_1 + (-q_2) + (-q_3) + q_4 + q_5$$

III Quantization of charge:→

→ This property states that charge is always a integral multiple of a basic unit of charge.

i.e $\boxed{Q = ne}$

$Q \rightarrow$ Charge

where, n = integer = $\pm 1, \pm 2, \pm 3 \ldots$

$e \rightarrow$ basic unit of charge

$\rightarrow 1.602 \times 10^{-19}\ C$

APPLIED Physics-B.

Q Find the total number of electrons present in $-1C$ charge.

Sol^n:- Total charge $(Q) = -1\ C$

number of electron $(n) = ?$

By quantization property of charge

$$Q = n \times (\bar{e})$$

$$\cancel{-}1\cancel{C} = n(\cancel{-}1.602 \times 10^{-19}\cancel{C})$$

$$n = \frac{1}{1.6021 \times 10^{-19}}$$

$$= 6.241807627 \times 10^{+18}$$ Ans//

Coloumb's law :→

→ This law states that the magnitude of electrostatics force between two point charges is directly proportional to product of magnitude of charges and inversely proportional to square of the distance between them!

$$F_e \propto |q_1||q_2|$$

$$\propto \frac{1}{r^2}$$

$$F_e \propto \frac{|q_1||q_2|}{r^2}$$

where,

$|q_1|$ = magnitude of point charge q_1

$|q_2|$ = " " " " q_2

r = distance between two point charges.

F_e = electrostatics force between two point charges.

$\because F_e \propto \frac{|q_1||q_2|}{r^2}$ ($\epsilon \rightarrow$ epsilon)

$$\boxed{F_e = K\frac{|q_1||q_2|}{r^2}}$$

where K = proportionality constant $= 9\times10^{+9}\ \frac{Nm^2}{C^2}$

$= \frac{1}{4\pi\epsilon_0}$

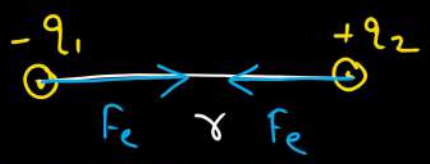
where ϵ_0 = electric permitivity of freespace/vacuum $= 8.854\times10^{-12}\ \frac{C^2}{Nm^2}$

→ Electric permitivity (ϵ) depends on medium between two point charges.

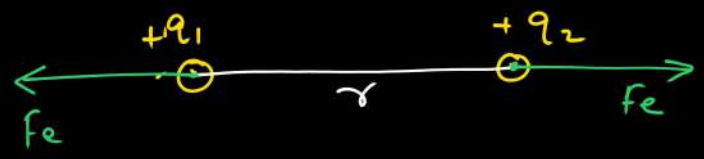
** → Electrostatic force between two point charges is always acts along the line joining two charges.

** → Electrostatic force between two point charges of opposite nature (+,−), is of attractive type

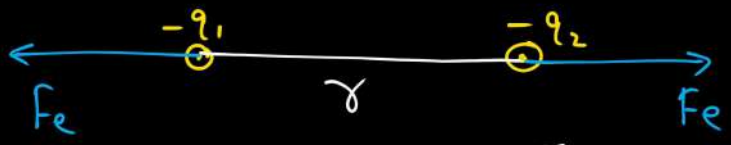
and between two point charges of same nature (++, −−) electrostatic force will be repulsive type.



$$\boxed{F_e = K\frac{|-q_1||+q_2|}{r^2}}$$



$$F_e = \frac{K|q_1||q_2|}{r^2}$$



$$\therefore \quad F_e = \frac{K|-q_1||-q_2|}{r^2}$$

Note :→ $[K] = [M L^3 T^{-4} A^{-2}]$

$K \rightarrow \frac{Nm^2}{C^2}$

$= \frac{kgm}{Sec^2} \times \frac{m^2}{(A\,Sec)^2}$

$= \frac{kgm^3}{Sec^4 A^2} =$

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

$Q = It$

$C = A \times Sec$

Q. What is the force between two small charge sphere having charges of 2×10^{-7} C and 3×10^{-7} C place at 30 cm apart in air.

Solⁿ :- Given $q_1 = 2\times10^{-7}$ C

$q_2 = 3\times10^{-7}$ C

Distance $(r) = 30$ cm $= 0.3$ m

By coloumb's law :—

$$F_e = \frac{K|q_1||q_2|}{r^2}$$

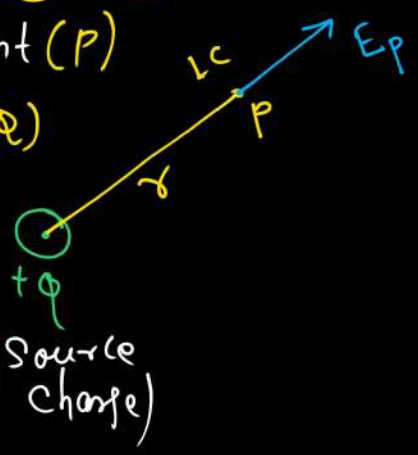
$$= \frac{9\times10^{+9}\,|2\times10^{-7}C|\,|3\times10^{-7}C|}{(0.3m)^2}\ N$$

$$F_e = \frac{9\times10^{+9}\times 6\times10^{-14}}{9\times10^{-2}}\ N$$

$$\boxed{F_e = 6\times10^{-3}\ N}$$ Ans//

Electric field ($\vec{E}$) :→

→ Electric field at a point (P) due to a source charge (Q) is the electrostatic force experience by a unit positive charge.



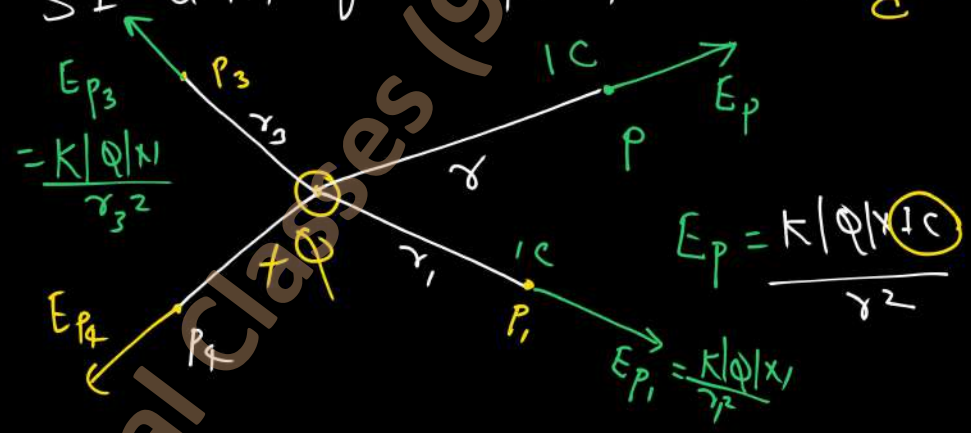
$$\boxed{\vec{E} = \frac{\vec{F}}{q}}$$

$$\boxed{E_p = \frac{K|Q|\times 1}{r^2} = \frac{K|Q|}{r^2}}$$

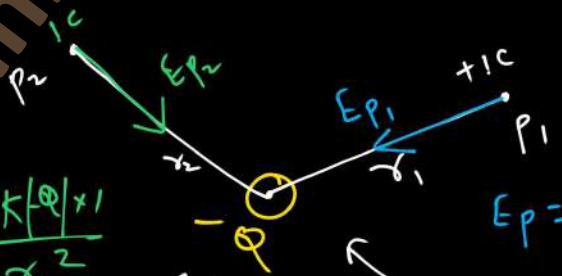
where Q = source charge due to which electric field (E_p) is required at point 'p' which is at distance 'r' from 'Q'.

→ Electric field is a vector quantity.

** → SI unit of electric field is $\frac{N}{C}$.



$$E_p = \frac{K|Q|\times 1C}{r^2}$$



$$E_{p_2} = \frac{K|-Q|\times 1}{r_2^2}$$

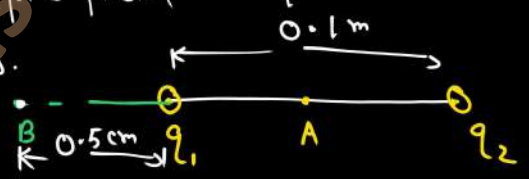
$$E_p = \frac{K|-Q|\times 1}{r_1^2}$$

*** # Direction of electric field due to a positive source charge (+Q) is always radially outward while due to negative source charge

$(-Q)$ is always radially inward.

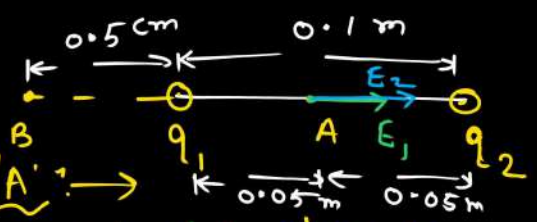
APPLIED physics-B :

Q Two point charges q_1 and q_2 of magnitude $+10^{-8}$ C and -10^{-8} C respectivelly are placed at 0.1 m apart. Calculate electric field at point 'A' and 'B' as shown below.



Soln:- Given $q_1 \longrightarrow +10^{-8}$ C

$q_2 \longrightarrow -10^{-8}$ C



Electric field (E) at 'A' :→

$E_1 \rightarrow$ electric field at 'A' duto charge q_1

$\therefore$ $E_2 \rightarrow$ " " " " " " q_2

$$E_1 = \frac{K|q_1|}{r^2} = \frac{9\times10^{+9}\,|+10^{-8}C|}{(0.05)^2}\ \frac{N}{C}$$

$$= \frac{9\times10^{+9}\times10^{-8}}{25\times10^{-4}}$$

$$= \frac{9\times10^{1}\times10000}{25}$$

$$= 36000\ N/C$$

$$E_2 = \frac{K|q_2|}{(r)^2} = \frac{9\times10^{+9}\times|-10^{-8}C|}{(0.05\,m)^2}\ \frac{N}{C}$$

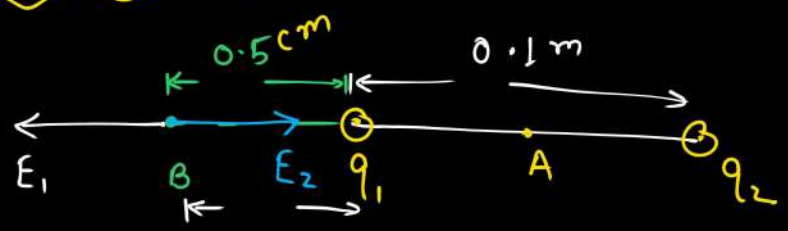
$$= 36000\ \frac{N}{C}$$

$\therefore$ Electric field at 'A' $= E_1 + E_2$

$$= 36000\ \frac{N}{C} + 36000\ \frac{N}{C}$$

$$E_A = 72000\ \frac{N}{C}$$ Ans//

Electric field at 'B' —



$\therefore$ Electric field at 'B' $(E_B = E_1 - E_2$

$$E_1 = \frac{K|q_1|}{(0.5\times10^{-2}m)^2} = \frac{9\times10^{+9}\times10^{-8}C}{25\times10^{-6}}\ \frac{N}{C}$$

$$= \frac{9\times10^{+7}}{25}$$

$$= \frac{9\times10^{2}\times10^{5}}{25}$$

$$= 36\times10^{5}\ N/C$$

$$E_2 = \frac{K|q_2|}{(0.1m+0.0005m)^2} = \frac{9\times10^{+9}|-10^{-8}C|}{(0.1005m)^2}$$

$$= \frac{9\times10^{+1}\times10^{-8}}{(0.1005m)^2}$$

$$= 8910.67\ \frac{N}{C}$$

$\therefore$ electric field at 'B'

$$= E_1 - E_2$$

$$= 36\times10^{+5} - 8910.67\ \frac{N}{C}$$

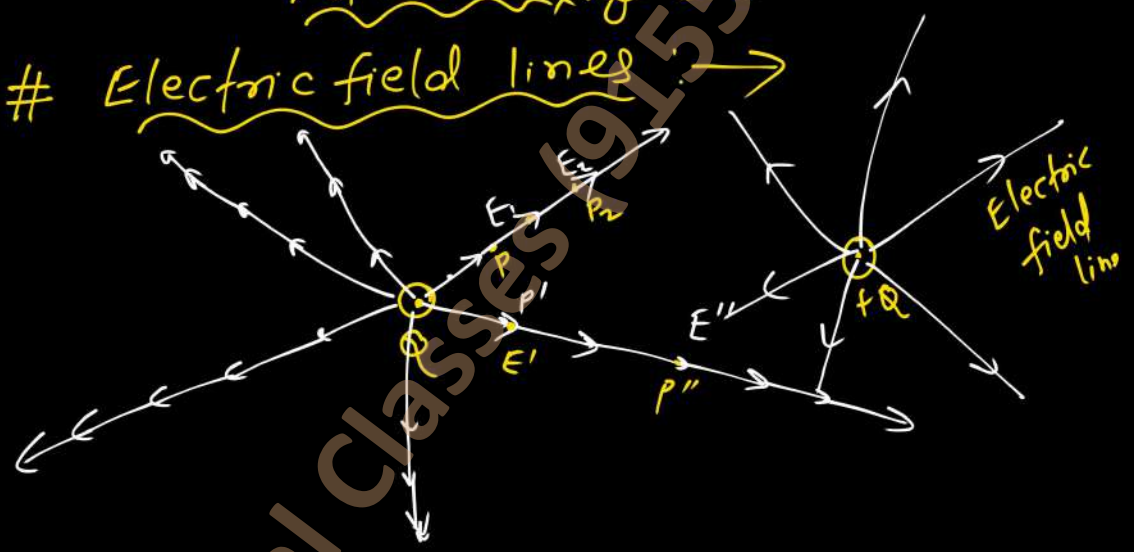
$$= 3600000 - 8910.67\ N/C$$

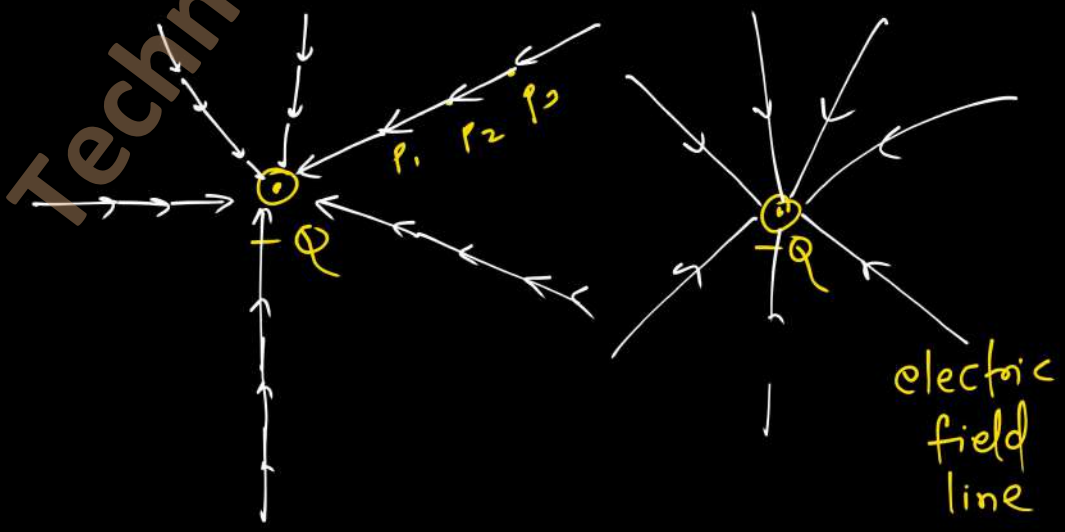
$$= 3591089.33\ \frac{N}{C}$$ Ans//

Electric field lines :→

APPLIED Physics-B.

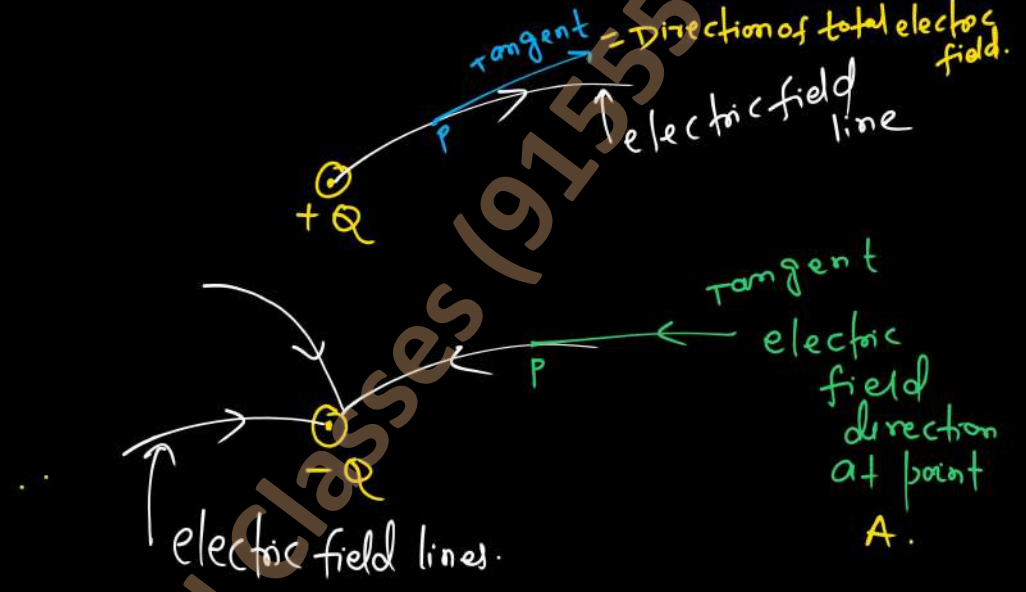
Electric field lines :→



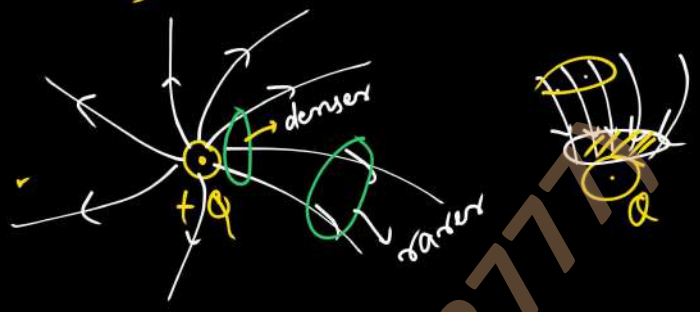


→ Electric fields lines are vector representation of electric field at each point in 3-Dimension space.

→ Electric field lines are continuous curve line such that tangent at any point on the electric field line gives the direction of total electric field at that point

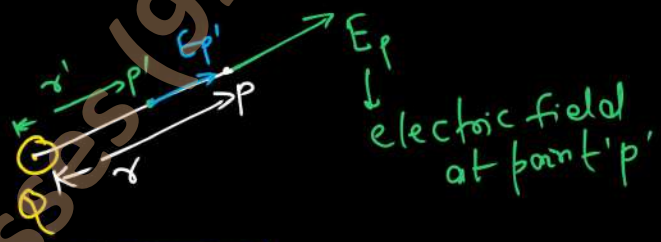


→ Denser the electric field lines in a region indicates high value of electric field and rarer the electric field lines shows smaller (weaker) value of electric field.



Note :→ ∵ $E_p = \frac{K|Q|}{r^2}$, Q → source charge.

$\boxed{r' < r}$

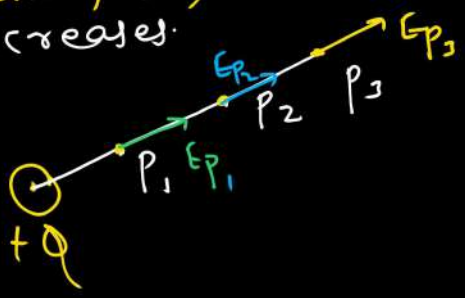


$E_{p'} = \frac{K|Q|}{r'^2}$

$\therefore \boxed{E_{p'} > E_p}$

→ As we move away from source charge (Q) value of electric field decreases and if we move towards or nearer the charge (Q) value of electric field increases.

$\boxed{E_{p_1} > E_{p_2} > E_{p_3}}$



E_p → electric field at P.

Properties of electric field lines :→

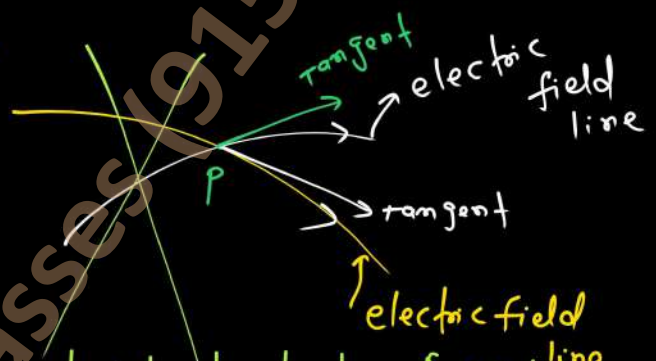
(i) Electric field lines are continuous curve line.

(ii) Electric field lines are uniformally distributed in a charge free region.

(iii) Electric field lines emerges or end at infinity for single point charge.

(iv) Two electric field lines never intersect each other.

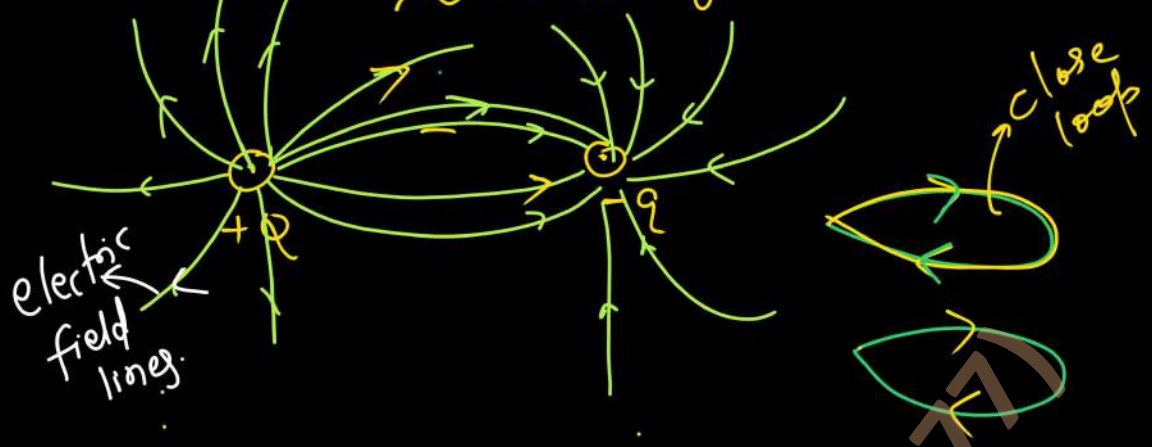
i.e



Because at intersecting point electric field line has two direction.

(v) Electric field lines never form close loop.

APPLIED Physics-B



Electric flux (ϕ) :

$$E = \frac{KQ}{r^2} = \frac{1}{4\pi\epsilon_0}\frac{Q}{r^2}$$

$$\boxed{\phi_1 > \phi_2}$$

$$\therefore \boxed{E_1 > E_2}$$

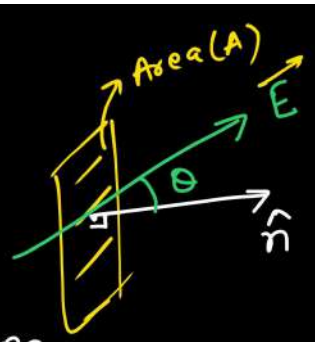
→ Electric flux is defined as the number of electric field lines passing through an area perpendicularly.

→ electric flux shows strength of electric field at a point.

→ More number of electric field lines passes through an area shows higher electric flux.

$A \rightarrow$ Area

$\hat{n} \rightarrow$ Area unit vector ($\perp^r$ to area)



$\vec{E}$ = Electric field.

θ = angle between area unit vector and electric field.

→ Electric flux (ϕ) :→ Electric flux (ϕ) through an area (A) is defined as the following

$$\boxed{\phi = \vec{E} \cdot A\hat{n}}$$

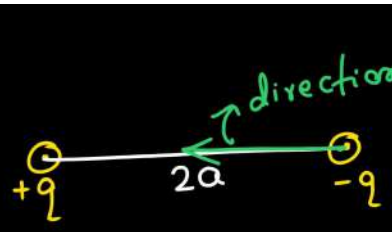
$$\boxed{\phi = EA\cos\theta}$$

→ Electric flux (ϕ) is a scalar physical quantity.

→ SI unit of electric flux (ϕ) is $\frac{N}{C} m^2$.

Electric dipole :→

→ When two charges of equal magnitude and opposite nature are placed at a '2a' distance apart, forms a electric dipole.



$|q| = |-q| = q$

$q \rightarrow$ electric charge

$2a \rightarrow$ Distance between two charge.

→ Electric dipole is a vector quantity which direction is given from negative charge towards positive charge.

Electric dipole moment ($\vec{P}$) →

→ Magnitude of electric dipole moment is defined as the product of magnitude of a charge multiplied by distance (2a) between two charge of a electric dipole.

∴ electric dipole moment $\boxed{(P) = q \times 2a}$

→ Electric dipole moment is a vector quantity.

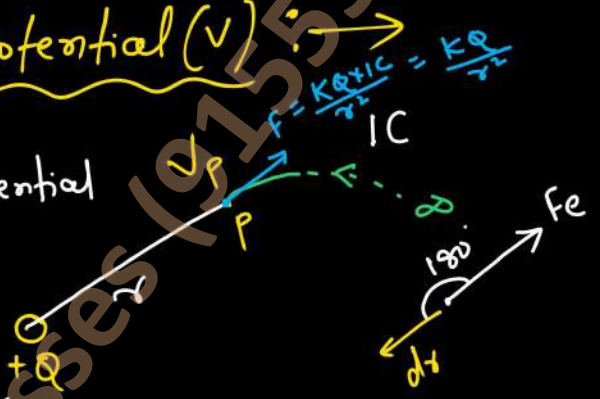
→ SI unit of electric dipole moment is Coulomb meter (cm)

Note:→ total charge in an electric dipole is zero.

Electric potential (V):→

V_p → electric potential at point 'p'

r → distance between source charge (Q) and point 'r'.



→ Electric potential at any point (P) at a distance (r) from source charge (Q) is defined as the work required to bring a unit positive charge (1C) from infinity to that point

$\because$ work $(dw) = -F_e \cdot dr$

$-$ve sign indicates force and displacement of '1c' charge are in opposite direction.

$\because dw = -F_e \times dr$

$dr \rightarrow$ small displacem

$$\underbrace{dw}_{\text{small work}} = -\frac{Kq}{r^2}dr$$

$dx = x_2 - x_1$

$x_f - x_i$

Total work

$$\because \int_0^W dw = \int_\infty^r \frac{-Kq}{r^2}dr$$

$$W = -Kq\left[\frac{r^{-2+1}}{-2+1}\right]$$

$$\boxed{W = +\frac{Kq}{r} = V_p}$$

i.e Electric potential at point 'P' :$\rightarrow$

$$\boxed{V_p = \frac{K|q|}{r}}$$

where $K \rightarrow \frac{1}{4\pi\epsilon_0} = 9\times10^9 \frac{Nm^2}{C^2}$

$|q| \rightarrow$ Magnitude of Source charge.

$r \rightarrow$ Distance b/w 'P' and source charge.

→ electric potential is a scalar quantity.

→ SI unit of electric potential is $\frac{\text{Joule}}{\text{Coulomb}}$ (J/C).

Change in Electric potential :—

Change in electric potential between point 'M' and 'P'

⊙ +Q (source charge)

$= V_M - V_P$

V_P → electric potential at point P.

V_M → electric potential at point M.

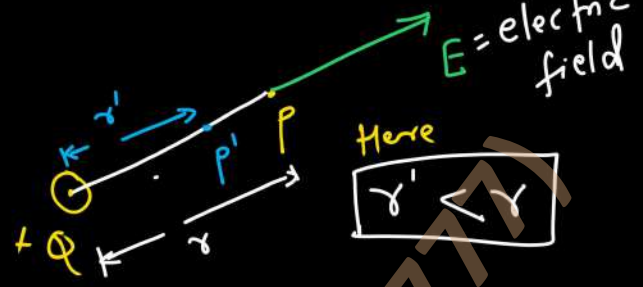
→ change in electric potential is called Voltage and its unit is Volt.

→ change in electric potential between two point does not depends on path but only depend initial and final point.

i.e change in potential b/w 'M' and 'P' is $= V_M - V_P$.

Note :→

** (a) value of electric potential always decreases in the direction of electric field.



Here $\boxed{r' < r}$

$\because V = \frac{K|Q|}{r}$

$\therefore$ at point 'p'

$V_{p'} = \frac{K|Q|}{r'}$

at point point 'p'

$V_p = \frac{K|Q|}{r}$

$\because \boxed{r' < r}$

$\therefore \boxed{V_{p'} > V_p}$

** (b) Electric field due to a source charge (Q) at a distance 'r'

$$E = \frac{K|Q|}{r^2}$$

and Electric potential (V) $= \frac{K|Q|}{r}$

$$\therefore \boxed{E \propto \frac{1}{r^2} \text{ and } V \propto \frac{1}{r}}$$

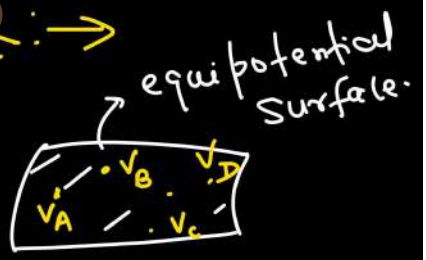
** → With the increase of distance of distance (r) electric field decreases more sharply than electric potential.

APPLIED Physics-B.

Equipotetial Surface :→

equal

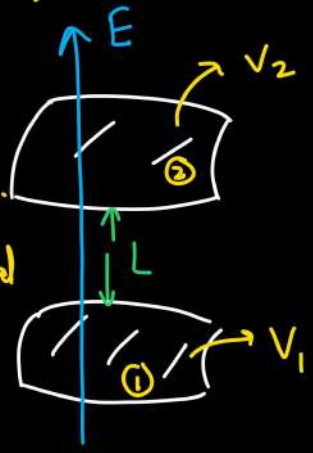
→ Those surface, over which value of electric potential is equal at every point on the surface is called equipotential surface.



$V_A = V_B = V_C = V_D$

V → electric potential.

Relation between electric field (E) and electric potential (V) :→



where V_1 = electric potential of equipotential surface ①.

V_2 = electric potential of equipotential surface ②

L = distance between two equipotential surface.

E = Direction of electric field.

$\because$ $\boxed{V_2 < V_1}$

$\therefore$ Relation between 'E' and 'v'

$$\boxed{E = -\frac{dv}{dL} = -\frac{V}{L}}$$

−ve sign indicates that value of electric potential decreases in the direction of electric field.

Different types of charge distribution and charge density :→

→ There are three types of charge distrib.

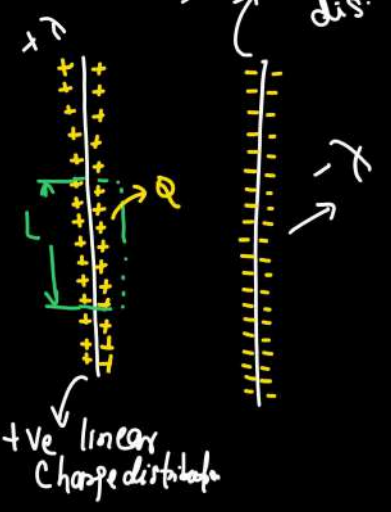
I linear charge distribution

II surface charge distribution

III volumetric charge distribution.

I linear charge distribution :→

→ when either positive or negative charges are uniformally distributed over a linear object, then this distribution of charge is called linear charge distribution.



→ linear charge density (λ) :→

→ It is defined as the ratio of total charge uniformally distributed to the length over which charge is distributed.

$$\therefore \boxed{\lambda = \frac{\text{Total charge}}{\text{length}} = \frac{Q}{L}}$$

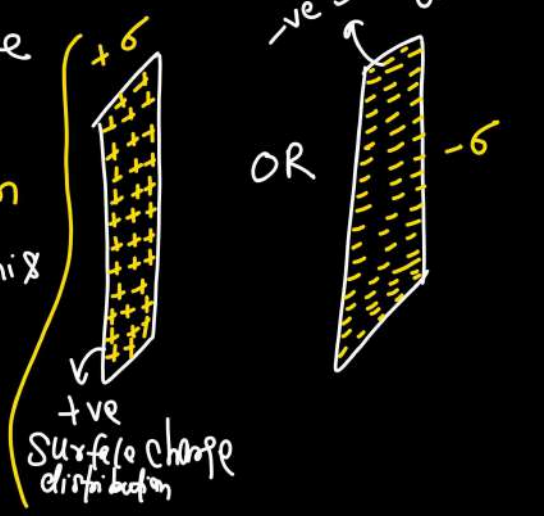
$\therefore$ Total charge (Q) = $\lambda \times L$

→ unit of linear charge density (λ) $\frac{\text{Coloumb}}{\text{meter}}$ $\left(\frac{C}{m}\right)$

** → linear charge density (λ) can be positive (+ve) or negative (-ve) depending on types of charge distributed over a length.

II Surface charge distribution :→

→ When either positive or negative charge are distributed over an area of a surface, then this type of distribution is called surface charge distribution.



→ **surface charge density (σ) :** →

→ it is defined as the ratio of total charge (Q) to the surface area (A) over which charge is uniformally distributed

$$\therefore \boxed{\text{Surface charge density}(\sigma) = \frac{\text{Total charge}}{\text{Surface Area}} = \frac{Q}{A}}$$

∴ Total charge on an area (Q) = $\sigma \times$ Area (A)

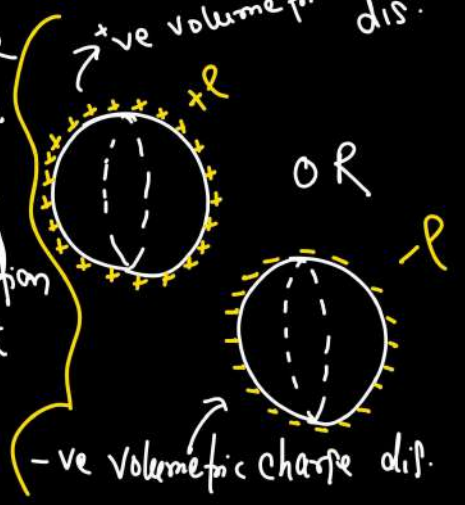
→ SI unit of surface charge density

$$\frac{\text{Coloumb}}{\text{meter}^2} \left(\frac{C}{m^2}\right)$$

→ value of surface charge density can be positive (+ve) or negative (-ve) depending on types of charge distributed over surface area.

III **volumetric charge distribution** :→

→ when either positive or negative charges are distributed over a volume of an object, this distribution of charge is called volumetric charge distribution.



→ volumetric charge density (ρ) :→

→ It is defined as the ratio of total charge to the volume over which this total charge is distributed.

i.e $\boxed{\text{Volumetric density}(\rho) = \frac{\text{Total charge}}{\text{Volume}} = \frac{Q}{V}}$

∴ Total charge (Q) = $\rho \times$ Volume (V)

→ SI unit of volumetric charge density (ρ) is $\frac{\text{Coloumb}}{\text{meter}^3}$ $\left(\frac{C}{m^3}\right)$

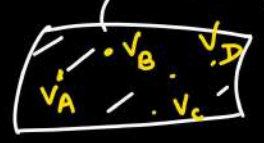
→ value of volumetric charge density can be positive (+ve) or negative (-ve) depending on types of charges distributed over a volume.

APPLIED Physics – B.

Equipotetial Surface :→

equal

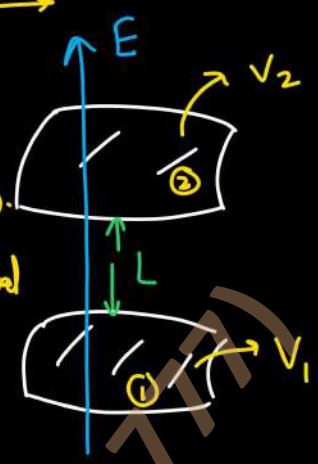
→ Those surface, over which value of electric potential is equal at every point on the surface is called equipotential surface.



$V_A = V_B = V_C = V_D$

V → electric potential.

Relation between electric field (E) and electric potential (V) :→



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L = distance between two equipotential surface.

E = Direction of electric field.

$\because$ $\boxed{V_2 < V_1}$

$\therefore$ Relation between 'E' and 'V'

$$\boxed{E = -\frac{dV}{dL} = -\frac{V}{L}}$$

−ve sign indicates that value of electric potential decreases in the direction of electric field.

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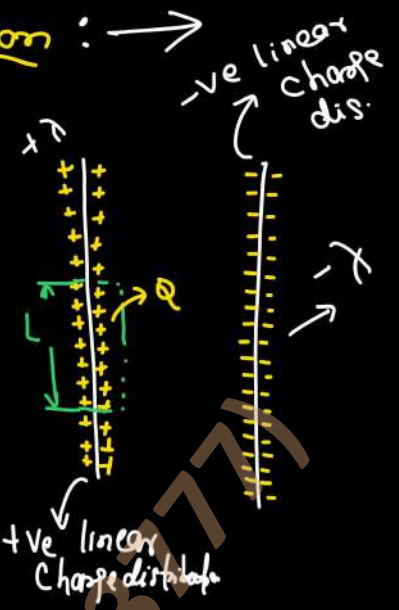
I linear charge distribution :→

→ when either positive or negative charges are uniformally distributed over a linear object, then this distribution of charge is called linear charge distribution.



→ linear charge density (λ) :→

→ It is defined as the ratio of total charge uniformally distributed to the length over which charge is distributed.

$$\therefore \quad \boxed{\lambda = \frac{\text{Total charge}}{\text{length}} = \frac{Q}{L}}$$

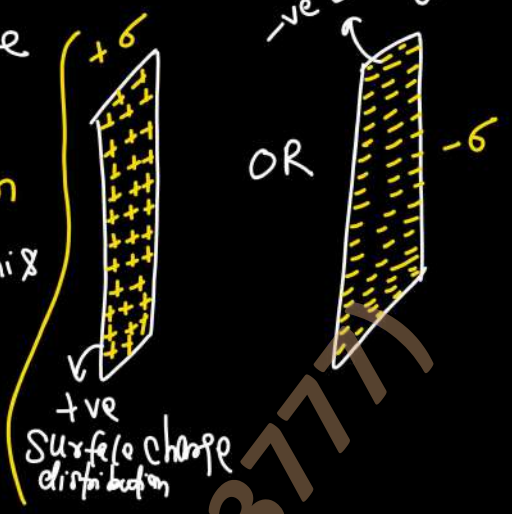
$\therefore$ Total charge $(Q) = \lambda \times L$

→ unit of linear charge density (λ) $\frac{\text{Coloumb}}{\text{meter}}$ $\left(\frac{C}{m}\right)$

** → linear charge density (λ) can be positive (+ve) or negative (-ve) depending on types of charge distributed over a length.

II Surface charge distribution : → surface charge dis.

→ When either positive or negative charge are distributed over an area of a surface, then this type of distribution is called surface charge distribution.



→ Surface charge density (σ) : →

→ It is defined as the ratio of total charge (Q) to the surface area (A) over which charge is uniformally distributed

$$\therefore \boxed{\text{Surface charge density}(\sigma) = \frac{\text{Total charge}}{\text{Surface Area}} = \frac{Q}{A}}$$

∴ Total charge on an area (Q) = σ × Area (A)

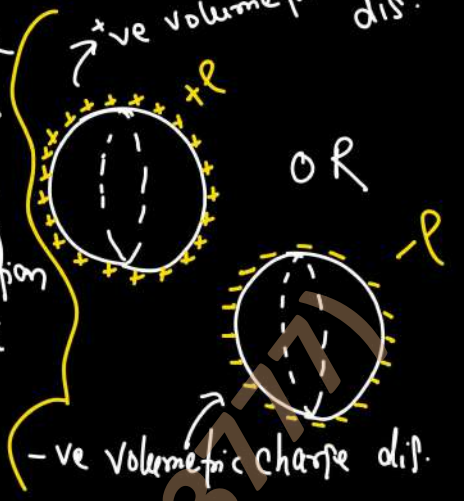
→ SI unit of surface charge density

$$\frac{\text{Coloumb}}{\text{meter}^2} \left(\frac{C}{m^2}\right)$$

→ value of surface charge density can be positive (+ve) or negative (-ve) depending on types of charge distributed over surface area.

III Volumetric charge distribution :→

→ when either positive or negative charges are distributed over a volume of an object, this distribution of charge is called volumetric charge distribution.



→ volumetric charge density (ρ) :→

→ It is defined as the ratio of total charge to the volume over which this total charge is distributed.

i.e $\boxed{\text{Volumetric density}(\rho) = \frac{\text{Total charge}}{\text{Volume}} = \frac{Q}{V}}$

∴ Total charge (Q) = ρ × Volume (V)

→ SI unit of volumetric charge density (ρ) is $\frac{\text{Coloumb}}{\text{meter}^3}$ $\left(\frac{C}{m^3}\right)$

→ value of volumetric charge density can be positive (+ve) or negative (-ve) depending on types of charges distributed over a volume.

APPLIED Physics-B.

V.V.I Gauss's law :→

→ Gauss's law states that the total electric flux (ϕ) through a close surface is equal to total charge inside the surface (q_{total}) divided by epsilon.

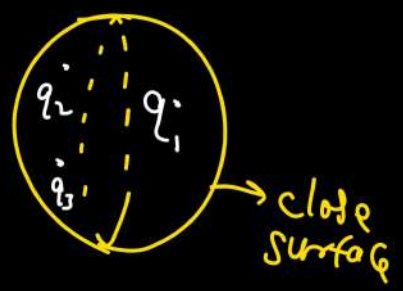
that Gauss's law

$$\text{total electric flux}(\phi) = \boxed{\frac{q_{total\,inside}}{\epsilon_0}}$$

$$q_{total\,inside} = q_1 + q_2 + q_3 + \cdots$$

ϵ_0 = epsilon not

$$= 8.854 \times 10^{-12} \frac{C^2}{Nm^2}$$



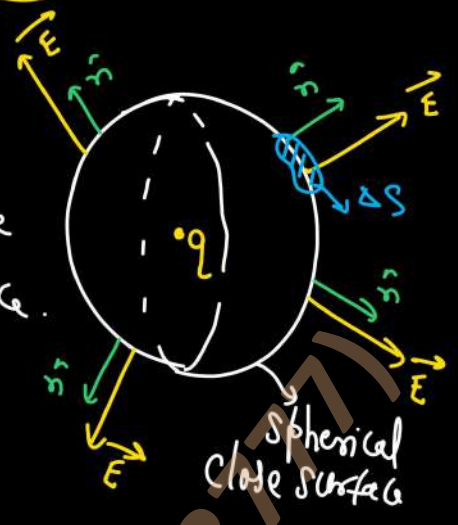
→ Illustration of Gauss's law :→

→ let a spherical close surface,

again let 'q' is a charge placed inside the surface.

$\vec{E}$ = electric field

$\hat{n}$ = Area unit vector of sphere.



ΔS → small surface area of sphere.

∴ small electric flux ($\Delta\phi$) through ΔS.

$$\Delta\phi = \vec{E} \cdot \Delta S\,\hat{n}$$

$$= |\vec{E}| \times (\Delta S) \cos 0^\circ$$

$$= E\,\Delta S \times 1 = E\,\Delta S$$

$$\left[\vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}| \cos\theta\right]$$

∴ total flux (ϕ) $= \Sigma\Delta\phi = \Sigma E\Delta S$

$$= E\,\Sigma\Delta S$$

$$\phi_{total} = E \times 4\pi R^2$$

where R = Radius of sphere.

∵ Electric field $(E) = \dfrac{Kq}{R^2}$

∴ $\phi_{total} = \dfrac{Kq}{R^2} \times 4\pi R^2$

$$= \frac{1}{\cancel{4\pi}\epsilon_0 \times \cancel{R^2}} \times q \times \cancel{4\pi R^2} = \frac{q}{\epsilon_0}$$ → Gauss's law.

Some important points related to Gauss's law: →

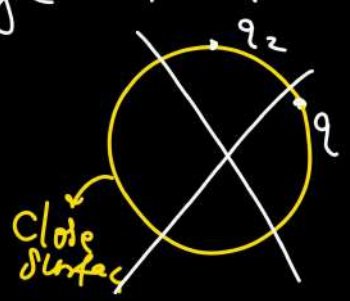
→ followings are important point related to Gauss's law

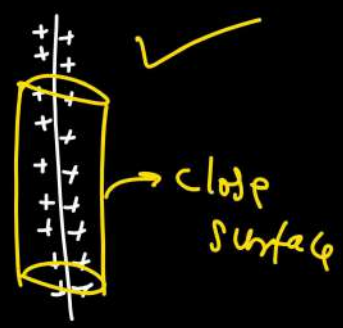
(i) Close surface choosen for Gauss's law can be of any shape and size.

(ii) Total charge inside the surface can be placed any where inside the surface.

(iii) Total flux through a close surface by Gauss's law gives flux due inside and outside charge both if present, though we take total charge inside only in the formula.

(iv) Close surface choosen for Gauss's law can't pass through descrete charge but it can pass through uniform charge distribution.

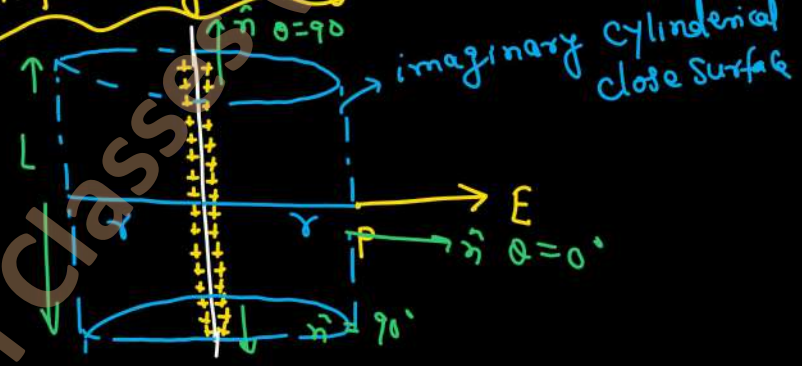




(v) Gauss's law is very much applicable for finding electric field (E) where symmetricity occure.

V.V.I Application of Gauss's law :→

I Electric field due to a infinitely long uniformally charge straight wire :→



let a uniformally positivelly charge straight wire.

λ → linear charge density.

r → Distance at which electric field (E) is required.

L → length of cylinderical close surface

let an imaginary cylinderical close surface of radius (r), charge wire passes axially through this cylinder.

→ ∴ Total flux (ϕ) through cylinder:—

$$\phi_{total} = E \times 2\pi r L \times \cos 0^\circ + E \times \pi r^2 \cos 90 + E \times \pi r^2 \times \cos 90$$

$$= E \times 2\pi r L \times 1 + 0 + 0$$

$$\boxed{\phi_{total} = E \times 2\pi r L} \quad \text{—— (I)}$$

Again total flux (ϕ_{total}) through cylinder:—

By Gauss's law,

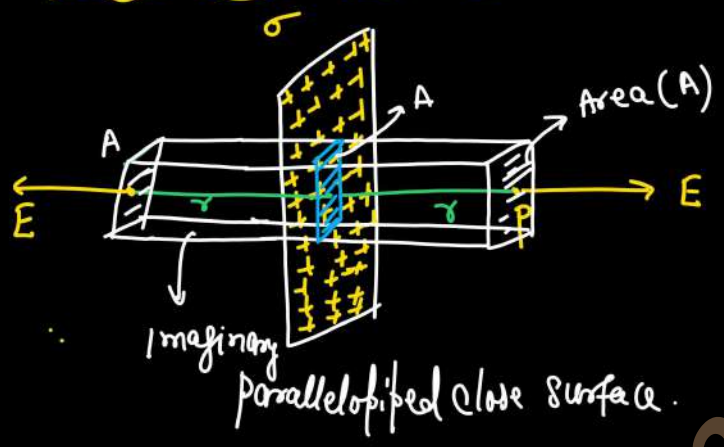
$$\phi_{total} = \frac{q_{inside}}{\epsilon_0} = \frac{\lambda \times L}{\epsilon_0} \quad \text{—— (II)}$$

∴ Equating equation (I) and (II) we get $\left[\because \lambda = \frac{q}{L}\right]$

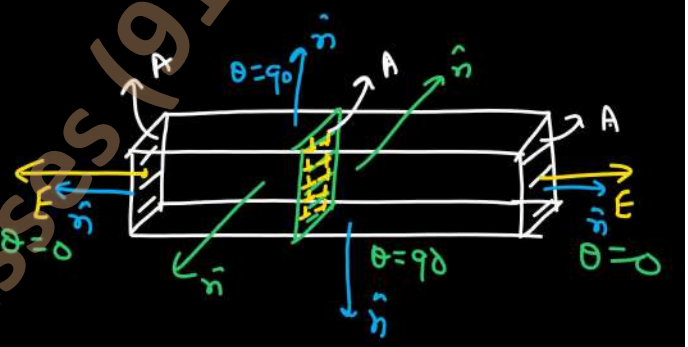
$$E \times 2\pi r \cancel{L} = \frac{\lambda \times \cancel{L}}{\epsilon_0}$$

$$\therefore \boxed{E = \frac{\lambda}{2\pi \epsilon_0 r}}$$

II Electric field due to a infinitelly uniformally charge plane sheet: →



→ let a parallelopiped imaginary close surface of length '2r' and point 'p' lies on its one surface



let A uniformally positive charged plane sheet

σ = surface charge density.

r = distance from sheet to point 'P' at which electric field (E) is required.

→ total electric flux (ϕ_{total}) through parallelopiped :—

$$\phi_{total} = EA\cos 0 + EA\cos 0 + 0 + 0 + 0 + 0$$

$$\boxed{\phi_{total} = 2EA} \quad \text{—— (I)}$$

Again total flux (ϕ_{total}) through parallelo-piped :—

By Gauss's law

$$\phi_{total} = \frac{q_{total\,inside}}{\epsilon_0} = \frac{\sigma \times A}{\epsilon_0} \quad \text{—— (II)}$$

Equating equation (I) and (II) we get

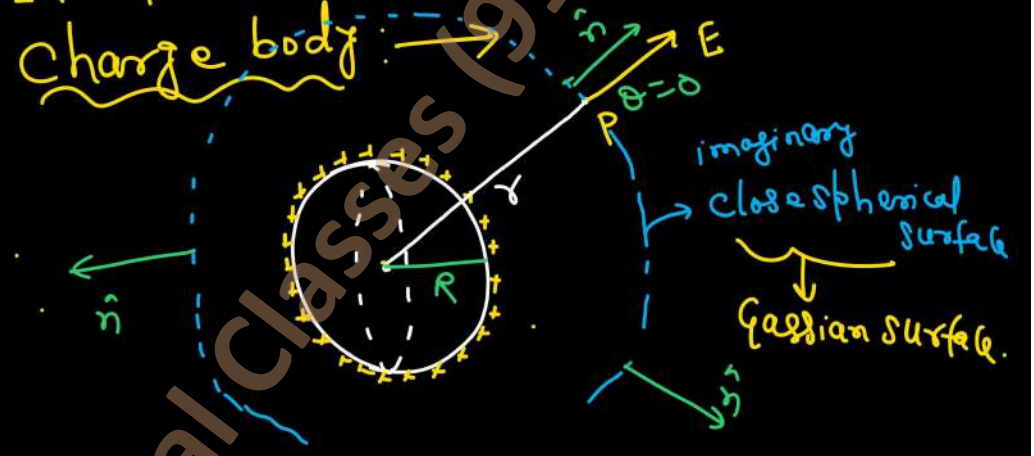
$$2E\cancel{A} = \frac{\sigma \times \cancel{A}}{\epsilon_0}$$

$$\boxed{E = \frac{\sigma}{2\epsilon_0}}$$

→ Electric field does not depend on distance r.

APPLIED Physics-B

III Electric field due to a thin spherical charge body :→



let a thin spherical body of radius 'R'.

ρ = volumetric charge density.

Case-a :-

let a point 'P' lies outside of the spherical body at a distance 'r' from the centre of the spherical body.

let a imaginary close spherical surface (Gaussian surf.) of radius 'r'

$\hat{n} \rightarrow$ Area unit vector of Gaussian surface.

$E \rightarrow$ electric field.

$\therefore$ Total flux (ϕ_{total}) through Gaussian surface.

$\vec{E} \cdot \vec{A} \cdot \hat{n}$

$$\phi_{total} = E \times \text{area} \times \cos\theta$$
$$= E \times 4\pi r^2 \cos 0$$

$$\therefore \phi_{total} = E \times 4\pi r^2 \quad \text{——— (I)}$$

Again total flux through Gaussian surface.

$$\phi_{total} = \frac{q_{total\,inside}}{\epsilon_0} = \frac{\rho \times \frac{4}{3}\pi R^3}{\epsilon_0} \quad \text{——— (II)}$$

Equating equation (I) and (II)

$$E \times \cancel{4\pi} r^2 = \rho \times \frac{\cancel{4}}{3} \frac{\cancel{\pi} R^3}{\epsilon_0}$$

$$\boxed{E = \frac{\rho R^3}{3\epsilon_0 r^2}}$$

Case-b :→ let point 'P' lies inside the spherical body.

Close spherical surface (Gaussian surf.)

→ let an imaginary close surface (Gaussian surface) of radius 'r'

∴ Total electric flux through Gaussian surface

$$\phi_{total} = E \times 4\pi r^2 \times \cos 0^\circ$$
$$= E \times 4\pi r^2 \quad \text{——— (I)}$$

Again total electric flux through Gaussian surface.

By Gauss's law :—

$$\phi_{total} = \frac{q_{inside}}{\epsilon_0} = \frac{0}{\epsilon_0} = 0 \quad \text{——— (II)}$$

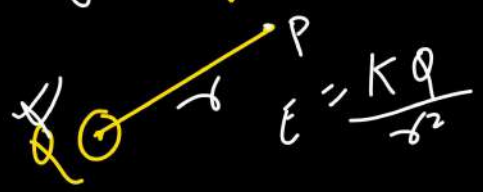
∴ Equating equation (I) and (II) we get

$$E \times 4\pi r^2 = 0$$

$$\boxed{E = 0}$$

Note :→

(a) Electric field inside of any charged body is zero.

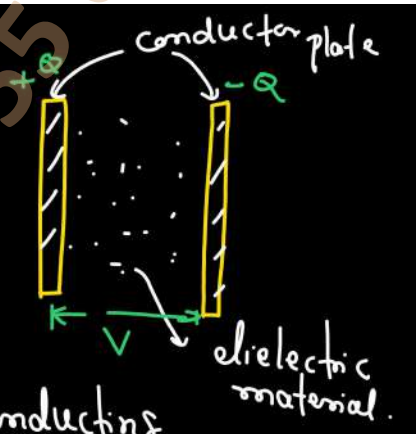


CAPACITOR :→

→ Capacitor is an electrical device use to store or acts as charge storing device.

→ A capacitor is basically consist of two plates made-up of conducting material and seperated a dielectric material between them.

→ Two conducting plates of capacitor has equal and opposite charges ($\pm Q$).



→ A potential difference (V) is develope between two conducting plates of capacitor.

→ Total charge on a capacitor is zero.

→ Capacitance (C) :→

→ Capacitance is defined as the ratio of charge (Q) on a plate of a capacitor to the potential difference (V) between two conducting plates of capacitor.

$$\therefore \text{Capacitance } (C) = \frac{Q}{V}$$

→ Capacitance of a capacitor express its charge storing capacity

→ unit of capacitance (C) is $\frac{\text{Coloumb}}{\text{Volt}}$.

$$\boxed{\frac{\text{Coloumb}}{\text{Volt}} = \text{Farad (F)}}$$

→ Capacitance (C) of a capacitor does not depend on charge and voltages, it depends on geometrical configration (Area of plate, distance between plate) and dielectric material between the plates of capacitor.

→ A capacitor of constant capacitance (C) is denoted by  and of variable capacitance (C)  .

Dielectric material :→

→ It is a non conducting material which conductivity can be change after application of external electric field.

example of dielectric material :→

Mica, Glass, dry air, distilled water etc.

→ Break down of dielectric :→

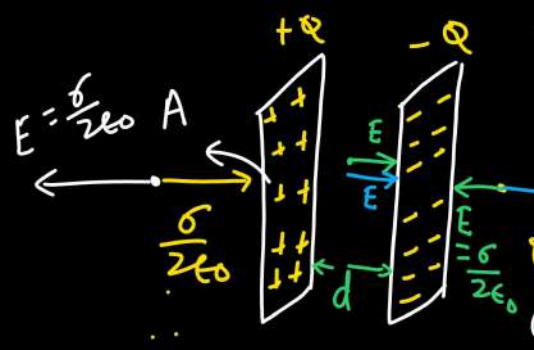
→ When a dielectric material lost its insulating properties due to externally applied electric field, then this is called break down of dielectric material.

→ Dielectric strength :→

→ The minimum value of externally applied electric field, at which break down of dielectric material takes place is called dielectric strength.

APPLIED Physics-B

Parallel plate capacitor :→

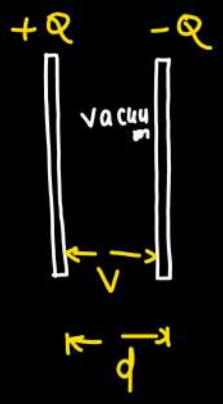


A parallel plate capacitor has two conducting plates placed paralle to each other

Q → charge on a plate

d → distance between two plates of capacitor.

A → Surface area of both plate.



V → Potential differce between two plates of capacitor

let σ = Surface charge density of plates

$$= \frac{Q}{A}$$

∴ Total electric field at any point outside of capacitor $= \frac{\sigma}{2\epsilon_0} - \frac{\sigma}{2\epsilon_0} = 0$

Again Total electric field inside a capacitor or between two plates :—

$$\boxed{E_{total} = 2E = 2 \times \frac{\sigma}{2\epsilon_0} = \frac{\sigma}{\epsilon_0}}$$

$\because$ we know,

$$E = \frac{V}{L}$$

$$\Rightarrow \frac{\sigma}{\epsilon_0} = \frac{V}{d}$$

$$\Rightarrow \frac{Q}{A\epsilon_0} = \frac{V}{d} \qquad \left[\because \sigma = \frac{Q}{A}\right]$$

$$\Rightarrow \frac{Q}{A\epsilon_0} = \frac{V}{d}$$

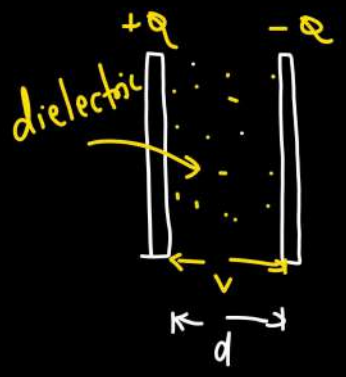
$$\Rightarrow \frac{Q}{V} = \frac{\epsilon_0 A}{d}$$

$$\Rightarrow \boxed{C = \frac{\epsilon_0 A}{d}} \qquad \left[\because C = \frac{Q}{V}\right]$$

Capacitance of parallel plate capacitor

→ from Above formula of Capacitance, it depends on area (A) of plate distance (d) between and permitivity (ϵ_0) of vacuum or free space between plates.

Effect of dielectric material between two plates of capacitor:



∵ when there is vacuum between plates, then

$$\text{Capacitance} = \frac{\epsilon_0 A}{d} = C$$

→ Relative permitivity (ϵ_r) :→ It is defined as the ratio of permitivity of medium to the permitivity free space or vacuum.

$$\because \text{Relative permitivity } (\epsilon_r) = \frac{\epsilon_{med.}}{\epsilon_0}$$

where $\boxed{\epsilon_r > 1}$

$$\because \epsilon_{med.} = \epsilon_r \times \epsilon_0$$

$$\because \boxed{\epsilon_{dielectric} = (\epsilon_r)_{dielectric} \times \epsilon_0}$$

∵ Now, if a dielectric medium placed between plates of capacitor.

then capacitance (C) $= \dfrac{\epsilon_{diel} \times A}{d}$

$\epsilon_{diel.} \rightarrow$ permitivity of dielectric medium

$\because \epsilon_{diel.} > \epsilon_0$

** $\rightarrow$ $\therefore$ Capacitance increases when dielectric is placed between two plates.

** $\rightarrow$ Higher the value of relative permitivity of dielectric medium between plates Higher the capacitance of capacitor.

** $\rightarrow$ Energy stored in capacitor =

$$\boxed{\text{Energy} = \frac{1}{2} CV^2}$$

where C = Capacitance
V = potential difference between two plates.

$\rightarrow$ Energy $= \frac{1}{2} CV^2 = \frac{1}{2} \frac{Q}{\cancel{V}} \times V^{\cancel{2}}$

$= \frac{1}{2} QV = \frac{1}{2} Q \times \frac{Q}{C}$

$= \frac{1}{2} \frac{Q^2}{C}$

**

$$\boxed{\text{Energy} = \frac{1}{2} CV^2 = \frac{1}{2} QV = \frac{1}{2} \frac{Q^2}{C}}$$

Combination or Connections of Capacitors :→

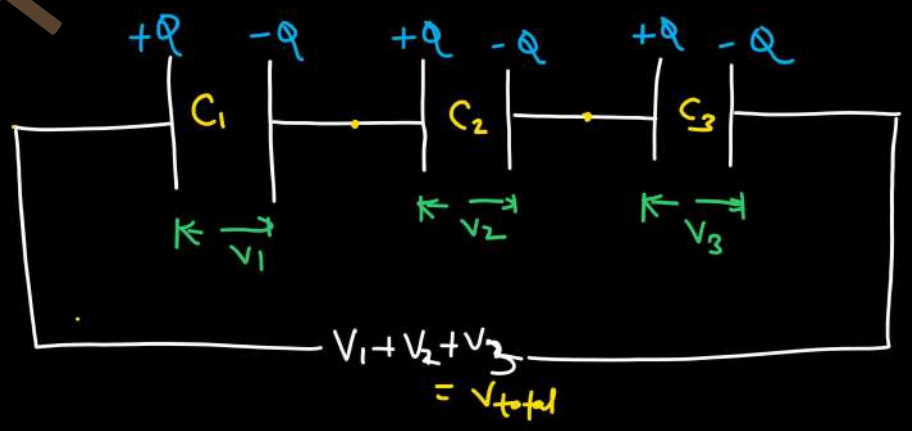
→ When two or more than two capacitor are connected to each other to get desired potential and charge then this is called combination of capacitor.

→ There are basically two types of combination of capacitors :→

ⓐ Series combination

ⓑ parallel combination.

Series Combination of Capacitors :→



→ When one end of a capacitor is connected to one end of another capacitor, and another end of this capacitor connected to one of a third capacitor and so on, then this combination is called Series combination

** → In series combination all capacitors have equal charge ($\pm Q$).

→ In series combination total potential difference across the combination will be sum of potential difference of individual capacitor

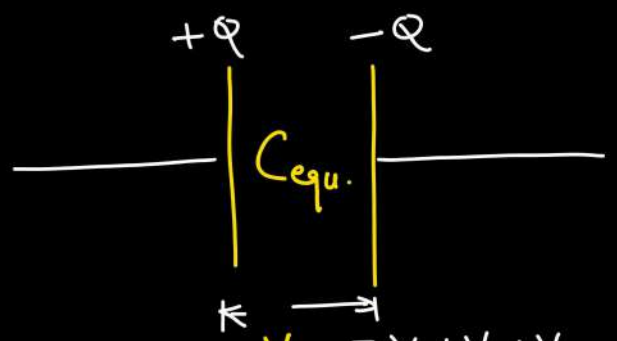
$$\boxed{V_{total} = V_1 + V_2 + V_3 + \cdots}$$

$V_1, V_2, V_3 \ldots$ are the potential difference across each capacitor.

V_{total} = total potential difference (voltage) across the combination.

Equivalent capacitance (C_{equ}) of Series Combination :→

→ Capacitance of a single capacitor across which potential difference is the total potential difference of series combination and charge equal each capacitor in series, is called equivalent capacitance.



$$V_{total} = V_1 + V_2 + V_3$$

$$\because \quad C_{equ.} = \frac{Q}{V_{total}} = \frac{Q}{V_1 + V_2 + V_3}$$

$$\Rightarrow \quad C_{equ.} = \frac{Q}{V_1 + V_2 + V_3}$$

$$\Rightarrow \quad V_1 + V_2 + V_3 = \frac{Q}{C_{equ.}}$$

$$\Rightarrow \quad \frac{\cancel{Q}}{C_1} + \frac{\cancel{Q}}{C_2} + \frac{\cancel{Q}}{C_3} = \frac{\cancel{Q}}{C_{equ.}}$$

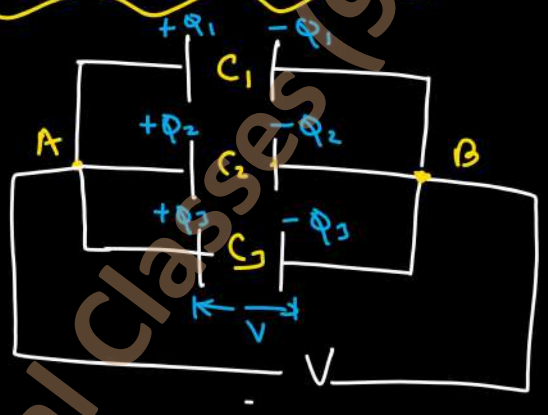
$$\boxed{\frac{1}{C_{equ.}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}} \rightarrow \text{series.}$$

for 'n' number capacitors in series :—

$$\boxed{\frac{1}{C_{equ.}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4} + \cdots + \frac{1}{C_n}}$$

APPLIED Physics-B.

parallel combination of capacitors :→



$C_1 = \frac{Q_1}{V}$

$\Rightarrow Q_1 = C_1 V$

→ In parallel combination of capacitors one ends of all capacitors are connected at one point(A) and another ends of all capacitor connected at another point(B).

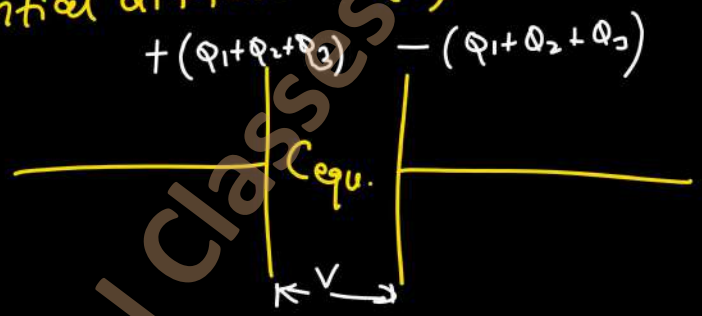
→ In parallel combination, potential difference between each capacitor

and whole combination must be same (V).

→ Charges on each capacitor may be different or same.

→ Equivalent Capacitance ($C_{equ.}$) :→

→ Equivalent capacitance in parallel combination is the capacitance of a single capacitor in which charge will be sum of all the charges of each capacitor in parallel and have same potential difference (V) as on each capacitor.



∴ Equivalent capacitance ($C_{equ.}$)

$$C_{equ.} = \frac{Q_1+Q_2+Q_3}{V}$$

$$\Rightarrow \quad Q_1+Q_2+Q_3 = V \times C_{equ.} \quad \text{—— (1)}$$

$$\because \quad Q_1 = C_1V, \quad Q_2 = C_2V, \quad Q_3 = C_3V$$

putting this value of Q_1, Q_2 and Q_3 in equation (1) we get

$$C_1V + C_2V + C_3V = C_{equ}V$$

$$\Rightarrow \cancel{V}(C_1 + C_2 + C_3) = C_{equ} \times \cancel{V}$$

$$\therefore \boxed{C_{equ} = C_1 + C_2 + C_3} \rightarrow \text{parallel combination}$$

for 'n' number of capacitors in parallel combination.

$$\boxed{C_{equ} = C_1 + C_2 + C_3 + \cdots + C_n}$$

Q. Three - capacitor of capacitance 9 μF each are connected in series.

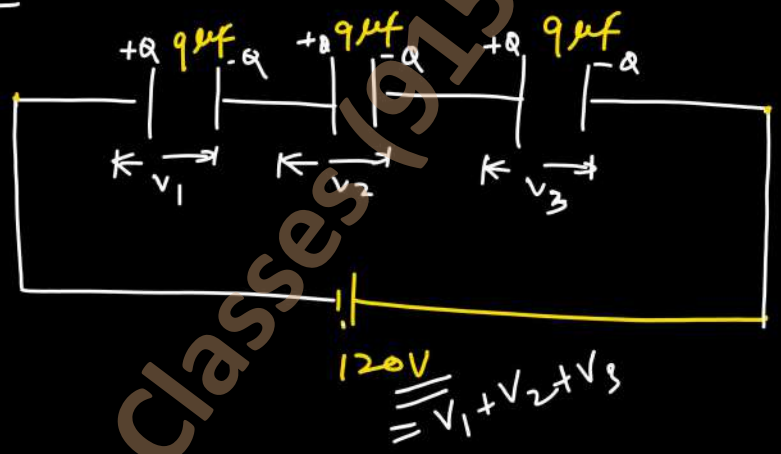
Find

(a) total capacitance or equivalent capacitance of combination.

(b) What is the potential difference across each capacitor, if combination is connected 120 V

(c) charge on each capacitor.

Solution:



(a) Equivalent capacitance or total capacitance:—

for series:—

$$\frac{1}{C_{equ}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} = \frac{1}{9\mu F} + \frac{1}{9\mu F} + \frac{1}{9\mu F}$$

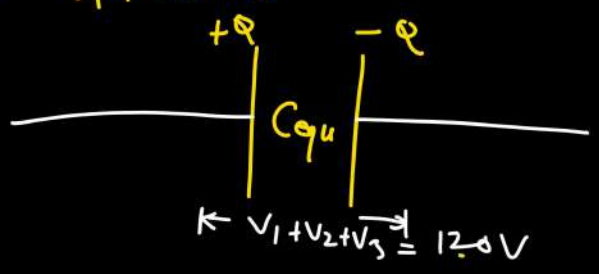
$$\Rightarrow \boxed{C_{equ} = \frac{9\mu F}{3} = 3\mu F}$$ Ans//

(b) let $V_1 \longrightarrow$ potential difference of capacitor 1

$V_2 \longrightarrow$ " " " " 2

$V_3 \longrightarrow$ " " " " 3

$\therefore \quad V_1 + V_2 + V_3 = 120\,V.$



$\because \quad C_{equ} = \dfrac{Q}{V_1+V_2+V_3}$ $\qquad F \rightarrow \dfrac{\text{Coulomb}}{\text{Volt}}$

$3\,\mu F = \dfrac{Q}{120\,V}$

$Q = 360\,\mu F\,V = 360\,\mu \times \dfrac{\text{Coulomb}}{\text{volt}} \times \text{volt}$

$= 360\,\mu C$ Ans//

$\therefore \quad V_1 = \dfrac{Q}{C_1} = \dfrac{Q}{9\,\mu F} = \dfrac{\overset{40}{\cancel{360}}\,\cancel{\mu} C}{\cancel{9}\,\cancel{\mu} F}$

$= 40\,V$ Ans//

$\therefore \quad V_2 = \dfrac{Q}{C_2} = \dfrac{360\,\mu F}{9\,C} = 40\,V$ Ans//

$\therefore \quad V_3 = 40\,V$ Ans//

Q. Three capacitors of capacitor of capacitance 2 μf, 3 μf, 4 μf are in parallel and whole combination is connected to 120 V Battery

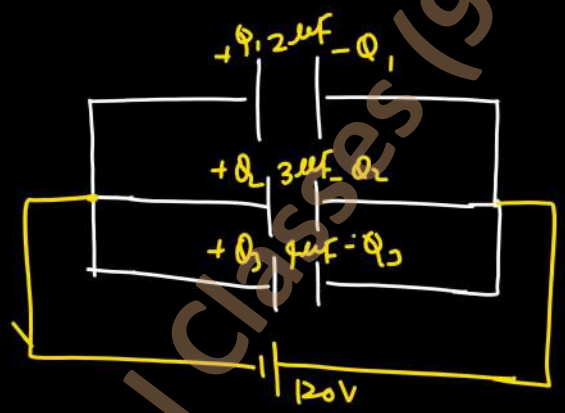
find.

(a) Total capacitance of combination

(b) charge on each capacitor.

APPLIED Physics-B.

Q. 2 μf, 3 μf, 4 μf



(a) Total capacitance ($C_{equ.}$) = $C_1 + C_2 + C_3$

$= 2\mu f + 3\mu f + 4\mu f$

$C_{equ.} = 9\mu f$ Ans

∴ Charge on capacitor having capacitance 2μ =

$Q_1 = 2\mu f \times 120V = 240\ \mu C$

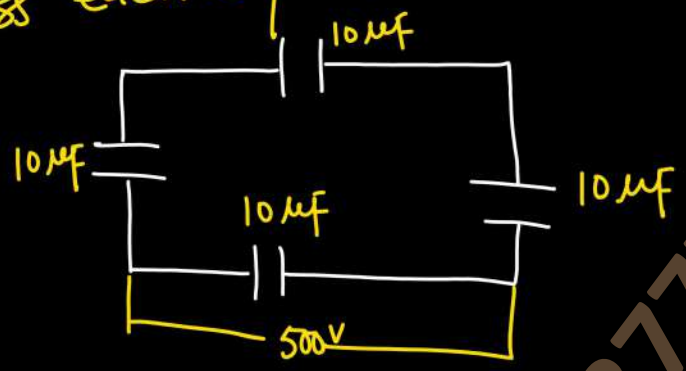
Similarly

$Q_2 = 3\mu f \times 120V = 360\ \mu C$

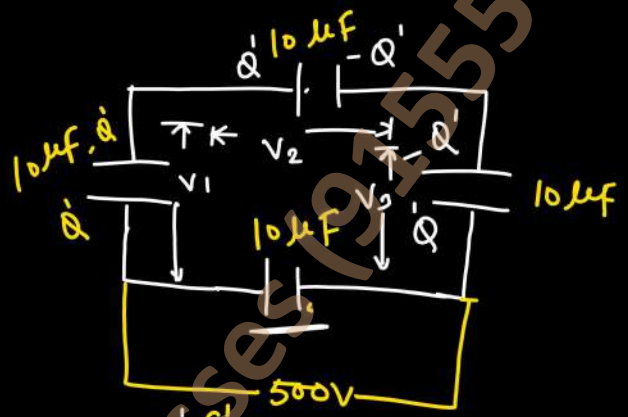
$Q_3 = 4\mu f \times 120V = 480\ \mu C$

Ans

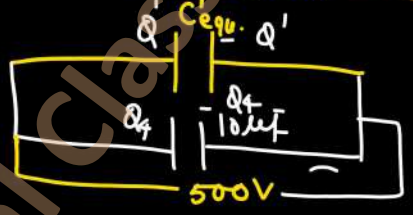
Q. Find the total capacitance, charge on each capacitor and potential difference across each capacitor shown below.

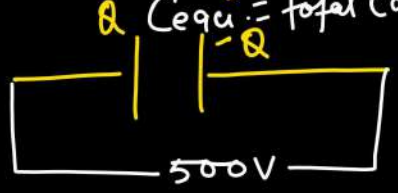


Solution :-



⇒





Cequ = total capacitance = equivalent capacitance of combination

$$\because \frac{1}{C'_{equ}} = \frac{1}{10\mu F} + \frac{1}{10\mu F} + \frac{1}{10\mu F}$$

$$\Rightarrow \boxed{C'_{equ} = \frac{10\mu F}{3}}$$

$\therefore$ Total capacitance $(C_{equ}) = C'_{equ} + 10\mu F$

$= \frac{10}{3}\mu F + 10\mu F$

$= \frac{40}{3}\mu F$ Ans//

Again charge on equivalent capacitor (Q) :⟶

$Q = C_{equ} \times 500\,V$

$= \frac{40}{3}\mu F \times 500\,V = \frac{20,000}{3}\mu C$

$\therefore$ $Q_4 = 10\mu F \times 500\,V = 5000\,\mu C$ Ans//

$\therefore$ Again $Q' = C'_{equ} \times 500\,V = \frac{10}{3}\mu F \times 500\,V$

$= \frac{5000}{3}\mu C$ Ans//

= Charge on all three capacitors

$\therefore$ potential across, three capacitors in series,

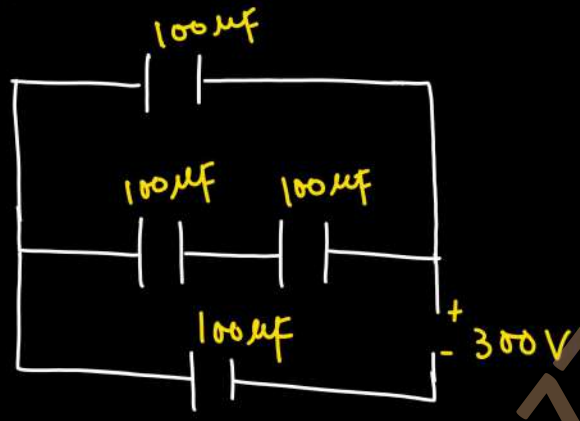
$V_1 = V_2 = V_3 = \frac{Q'}{C}$

$= \frac{5000\,\mu C}{3 \times 10\,\mu F}$

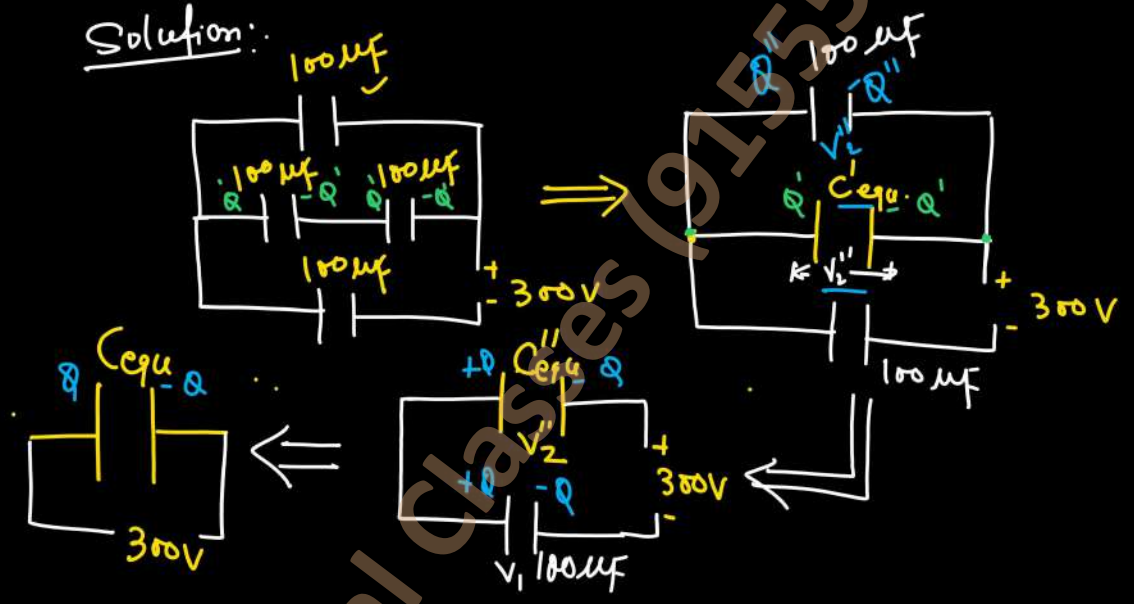
$= \frac{500}{3}\,V$

Potential difference across fourth capacitor $= 500\,V$ Ans//

Q// Find charge and voltage across each capacitor shown in fig. below



Solution:



let C_{equ} = equivalent or total capacitance of combination.

$$\therefore \frac{1}{C'_{equ}} = \frac{1}{100\mu F} + \frac{1}{100\mu F}$$

$$\boxed{C'_{equ} = \frac{100}{2}\mu F = 50\mu F}$$

$\therefore C''_{equ} = C'_{equ} + 100\mu F$

$= 50\mu F + 100\mu F = 150\mu F$

$$\boxed{C''_{equ} = 150\mu F}$$

$$\therefore \frac{1}{C_{equ}} = \frac{1}{C''_{equ}} + \frac{1}{100\mu F}$$

$$\Rightarrow \frac{1}{C_{equ}} = \frac{1}{150} + \frac{1}{100}$$

$$\Rightarrow \frac{1}{C_{equ}} = \frac{2+3}{300}$$

$$\Rightarrow C_{equ} = \frac{300}{5}$$

$$\Rightarrow \boxed{C_{equ} = 60\ \mu F}$$

$\therefore Q = C_{equ} \times 300V$

$= 60\mu F \times 300V = 18{,}000\ \mu C$

$$\therefore \boxed{V_1 + V_2'' = 300V} \quad (1)$$

Again $V_1 = \frac{Q}{100\mu F} = \frac{18000\ \mu C}{100\ \mu F}$

$$\boxed{V_1 = 180\ V}$$

$\therefore$ from eqn ①

$V_2'' = 300V - V_1 = 300V - 180V$

$\boxed{V_2'' = 120V}$ Ans//

$\therefore Q'' = V_2'' \times 100\mu F = 120V \times 100\mu F$

$= 12000\mu C$ Ans//

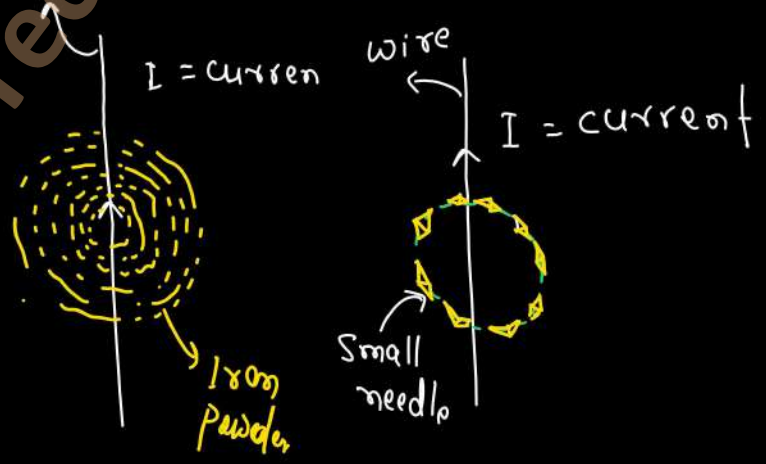
$\therefore Q' = C_{eq'} \times V_2'' = 50\mu F \times 120V$

$= 6000\mu C$ Ans//

$\therefore$ potential difference across two capacitors in series $= \frac{Q'}{100\mu F} = \frac{6000\mu C}{100\mu F}$

$= 60V$ Ans//

APPLIED Physics-B



→ First of all Danish physicist Oersted found that moving charge or current, produces magnetic effect (magnetic field) to its nearby space or surrounding space.

→ Oersted found that a small needle (made-up of magnetic material) near a current carrying wire is deflected and arranged in a circle of centre, passing through wire.

Sign Convention :→

(a) If current, and magnetic field are perpendicular to plane of paper and outward then it is represented by a sign ⊙.

(b) If current and magnetic field are perpendicular to plane of paper and inward, then it is represented by ⊗.

LORENTZ'S FORCE :→

→ Sum of electric force (F_e) and magnetic force (F_m) on a charge (q) moving in a electric field ($\vec{E}$) and magnetic field ($\vec{B}$) with velocity ($\vec{V}$) is called lorentz's force.

∴ Lorentz's force = Electric force (F_e) + Magnetic force (F_m)

$$\boxed{\text{Lorentz's force} = \underbrace{q\vec{E}}_{\text{electric force}} + \underbrace{q(\vec{V}\times\vec{B})}_{\text{Magnetic force}}}$$

Magnetic force (F_m) = $q(\vec{V}\times\vec{B})$

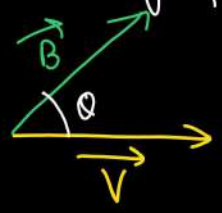
ⓐ Magnetic force on a charge will only act when charge is in motion. If charge is at rest then $\vec{V} = 0$

$$\therefore \boxed{F_m = q(0\times B) = 0}$$

(b) ∵ Magnetic Force (F_m) = $q(\vec{V} \times \vec{B})$

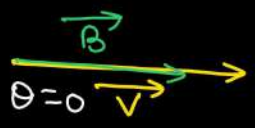
$F_m = qVB\sin\theta$

where θ = angle between velocity ($\vec{V}$) and magnetic field ($\vec{B}$)



Case-I, if $\theta = 0$

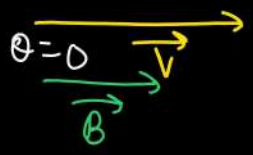
→ If Both velocity and magnetic field ($\vec{B}$) are parallel



Then magnetic force (F_m)

$= qVB\sin 0$

$\therefore = 0$



Case-II :- If $\theta = 180°$

It means $\vec{V}$ and $\vec{B}$ are anti parallel.

Then magnetic force (F_m)

$= qVB\sin 180°$

$= qVB \times 0 = 0$

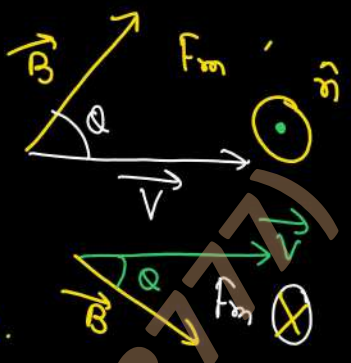
(c) Magnetic force ($\vec{F_m}$) = $q(\vec{V} \times \vec{B})$

$= qVB\sin\theta\ \hat{n}$

where $\hat{n}$ → unit vector perpendicular plane of $\vec{B}$ and $\vec{V}$.

→ $\hat{n}$ gives direction of magnetic force.

→ It is find out by Right hand thum rule.



Unit of Magnetic field ($\vec{B}$) :→

∵ Magnetic force (F_m) = $q(\vec{V} \times \vec{B})$

$F_m = qVB\sin\theta$

newton = Coulomb × $\frac{m}{sec}$ × Unit of B

→ SI Unit of Magnetic field (B) = $\frac{\text{newton sec}}{\text{Coulomb} \times \text{meter}}$

→ $\boxed{1\ \frac{\text{newton sec}}{\text{meter Coulomb}} = 1\ \text{tesla (T)}}$

↓

SI unit of magnetic field.

→ gauss is also a unit of magnetic field which is use to represent small value of magnetic field

** $\boxed{1\ \text{gauss} = 10^{-4}\ T}$

→ Dimension of magnetic field (B):

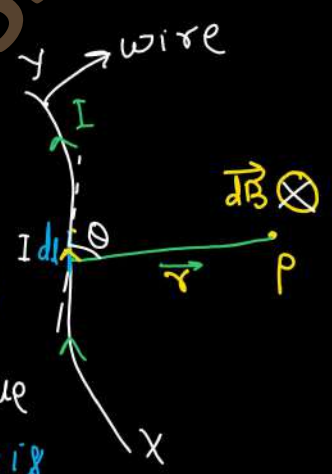
$$[\vec{B}] = \left[\frac{F_m}{qV}\right] = \left[\frac{M\cancel{L}T^{-2}}{A\cancel{T}\cancel{L}\cancel{T^{-1}}}\right]$$

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

BIOT-SAVAR'S LAW :→

→ let a current (I) carrying wire (xy),

$\vec{r}$ = position vector of point 'p' at which magnetic field due to small element (dl) of wire is required.



θ = angle between small current element (I dl) and position vector ($\vec{r}$)

Then BIOT-SAVART'S law states that magnetic field at point 'P' due to current element (I dl) is directly proportional to current element (I dl) and inversely proportional to square of the distance (r) between point and current element

$$dB \propto \frac{I\,dl}{r^2}$$

$$\boxed{\vec{dB} = \frac{\mu_0}{4\pi}\frac{I\vec{dl}\times\vec{r}}{r^3}}$$

Small magnetic field due to small current element Idl.

where $\mu_0 \rightarrow$ Magnetic susceptibility of free space or vacuum.

where

$$\boxed{\mu_0 = 4\pi\times10^{-7}\ \frac{Tm}{A}}$$

→ Magnetic field is a vector quantity.

→ Direction of current element is taken as same direction as the direction of current.

APPLIED Physics-B.

Note:-

$$[\mu_0] = \left[\frac{BL}{I}\right] = \left[\frac{MT^{-2}A^{-1}\times L}{A}\right]$$

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

Relation between μ_0 and ϵ_0 :→

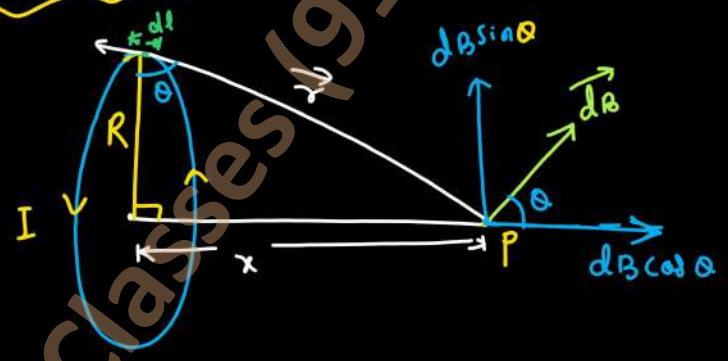
$\because \mu_0 \rightarrow 4\pi \times 10^{-7} \frac{Tm}{A}$

$\because \epsilon_0 \rightarrow 8.854 \times 10^{-12} \frac{C^2}{Nm^2}$

$\therefore \boxed{\mu_0 \times \epsilon_0 = \frac{1}{c^2}}$ **

where c = Speed of light in Vacuum $= 3 \times 10^8 \frac{m}{sec}$.

Magnetic field due to a Circular current Carrying Loop :→



→ let a Circular loop of radius (R) through current (I) is flowing.

→ let a point (P) at a distance 'x' from the centre of Circular current carrying loop, at which total magnetic field (B) is required due to this loop.

Again let a small current element (Idl) on the circumference of circular loop. Due to this loop, the magnetic field (dB) is given by:→

$$\vec{dB} = \frac{\mu_0}{4\pi} \frac{I\vec{dl} \times \vec{r}}{r^3}$$

$$|d\vec{B}| = \frac{\mu_0}{4\pi} \frac{I\,dl\,\cancel{r}\sin 90^\circ}{r^{\cancel{3}\,2}}$$

Magnitude of magnetic field due current element (Idl)

$$dB = \frac{\mu_0}{4\pi} \frac{I\,dl}{r^2}$$

$\because$ $r^2 = R^2 + x^2$, $\boxed{r = \sqrt{R^2 + x^2}}$

$$\therefore \boxed{dB = \frac{\mu_0}{4\pi} \times \frac{I\,dl}{(R^2 + x^2)}}$$

Since, there are always a apposite current element for each element on the circumference of current hence, the vertical component of magnetic field are cancel out due to each element.

Hence total magnetic field at point 'P' due to small current element (Idl)

$$= dB\cos\theta$$

$$\because \cos\theta = \frac{R}{\sqrt{R^2+x^2}}$$

$\therefore$ Total Magnetic field due to Idl :→

$$= dB\cos\theta$$

$$= \frac{\mu_0}{4\pi}\frac{Idl}{(R^2+x^2)} \times \frac{R}{\sqrt{R^2+x^2}}$$

$$dB = \frac{\mu_0}{4\pi}\frac{RIdl}{(R^2+x^2)^{3/2}}$$

Hence total magnetic field (B) due to Circular loop,

$$B = \frac{\mu_0}{2\cancel{4\pi}} \times \frac{R \times I \times \cancel{2\pi R}}{(R^2+x^2)^{3/2}}$$

$$** \quad \boxed{B = \frac{\mu_0}{2}\frac{IR^2}{(R^2+x^2)^{3/2}}}$$

** ⇒ Total magnetic field at centre of Circular loop :→

For, $\boxed{x = 0}$

$\therefore$ Magnetic field (B_0) at the centre :→

$$B_0 = \frac{\mu_0}{2} \times \frac{IR^2}{(R^2+0)^{3/2}}$$

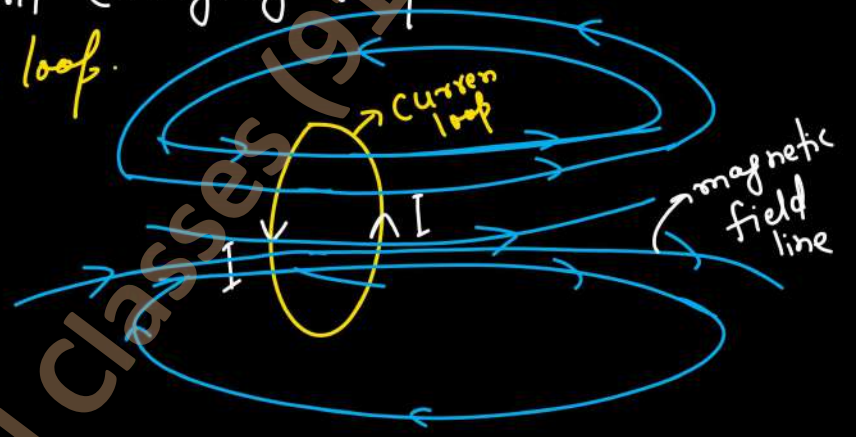
$$= \frac{\mu_0}{2} \times \frac{I\cancel{R^2}}{R^{\cancel{3}}}$$

∴ At centre, Magnetic field.

$$B_0 = \frac{\mu_0 I}{2R}$$

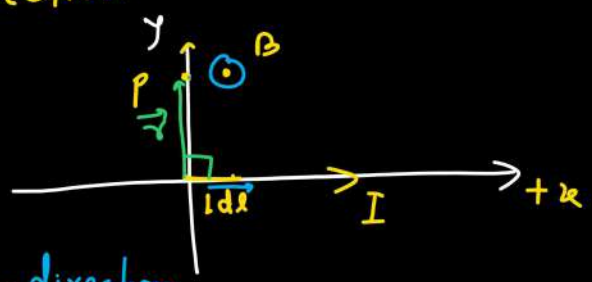
→ Direction of magnetic field due to a Circular current carrying loop is find out by right hand thumb rule.

→ Magnetic field lines due to a Circular current carrying loop are formed close loop.



Q. If a current along + x-axis the magnetic field at point on + y-axis will along which direction.

$\vec{I}d\vec{l} \times \vec{r}$

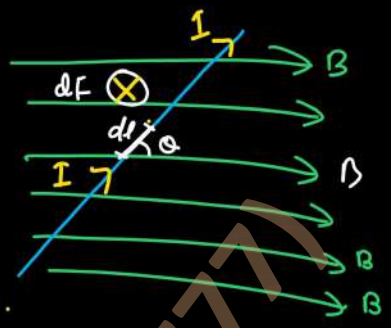


Direction of Mag. field, +ve z-direction

APPLIED Physics-B

Force on a current carrying wire in a magnetic field :→

let a wire through which a current (I) is flowing and it is placed in a magnetic field (B)



∵ Magnetic force on a moving charge (q) moving with velocity (v) is given by,

$$\vec{F_m} = q(\vec{v} \times \vec{B})$$

let a small current element of wire (Idl) which makes an angle (θ) with magnetic field (B).

Again ∵ $f_m = q(\vec{v} \times \vec{B})$ $\left[\because \vec{v} = \frac{dl}{dt}\right]$

$$df_m = q\left(\frac{\vec{dl}}{dt} \times \vec{B}\right)$$

$$= \frac{q}{dt}(\vec{dl} \times \vec{B}) \quad \left[\because \frac{q}{t} = I\right]$$

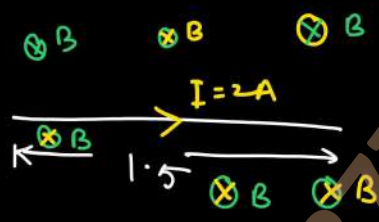
$$\boxed{df_m = I\,\vec{dl} \times \vec{B}}$$

∴ Total force on wire $(\vec{F}) = I\vec{L} \times \vec{B}$

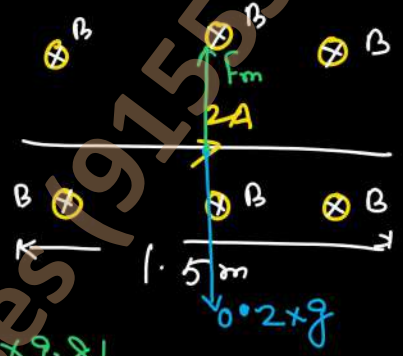
$$\boxed{F = ILB\sin\theta}$$

Q A straight wire of mass 200 g and length 1.5 m carries a current of 2A is suspended in air, by a horizontal magnetic field 'B' as shown in fig. What is the magnitude of 'B'.

mass of wire
= 200 gram
= 0.2 kg



Solution



$\therefore F_m = 0.2g$

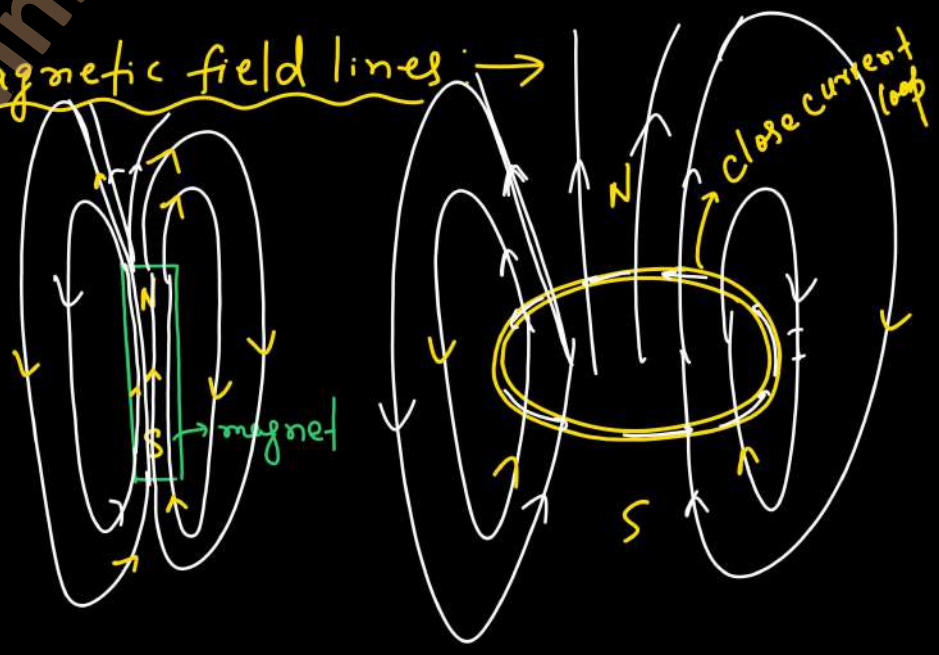
$ILB\sin 90 = 0.2g$

$\Rightarrow 2 \times 1.5 \times B \times 1 = 0.2 \times 9.81$

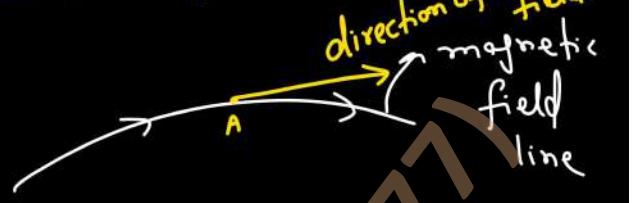
$\therefore B = \dfrac{0.2 \times 9.81}{2 \times 1.5}$ T

$= 0.654$ T Ans//

Magnetic field lines :→



→ Magnetic field lines are continuous curve lines such that tangent at any point on the lines gives direction of total magnetic field at that point.

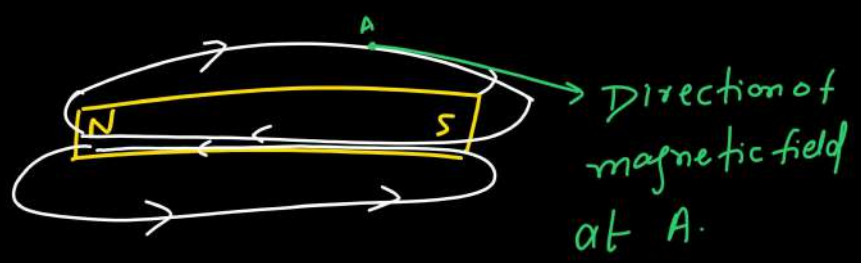


→ Magnetic field lines are vectorally pictorial representation of magnetic field in 3-dimension

properties of magnetic field lines :→

following are the important properties of magnetic field lines.

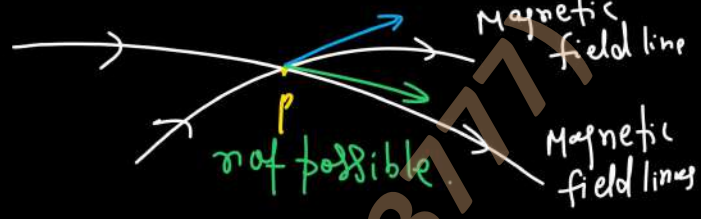
I. Tangent at any point on the magnetic field lines gives the direction of total magnetic field at that point.



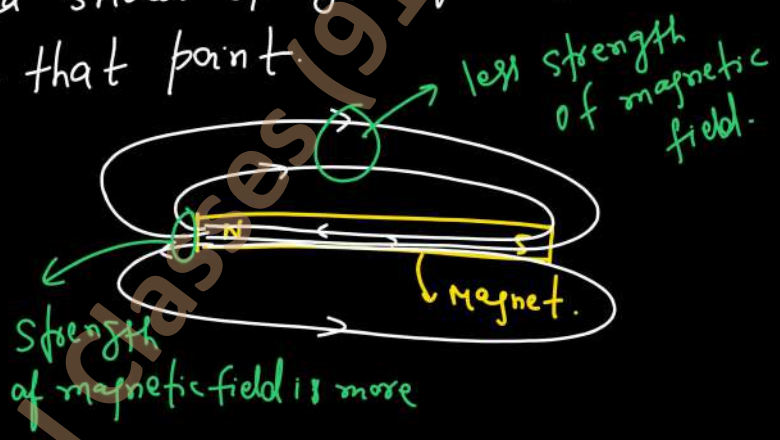
II Magnetic field lines form close loop unlike to electric field lines.

III Two magnetic field lines never intersec each other, because at a single point total magnetic field can't have two direction.

∴



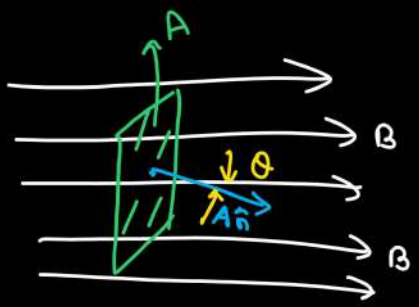
(iv) Density of magnetic field lines over an area shows strength of magnetic field at that point.



APPLIED Physics-B.

Magnetic flux (ϕ_B) :→

→ Magnetic flux is defined as the total number of magnetic field lines passes perpendicularly through an area.



→ Magnetic flux (ϕ_B) through an area (A) in a magnetic field (B) is given by.

$$\boxed{\phi_B = \vec{B} \cdot A\hat{n}}$$

$$\Rightarrow \boxed{\phi_B = BA\cos\theta}$$

where $\hat{n}$ → unit area vector (perpendicular to area (A))
B → magnetic field
θ → angle between $\hat{n}$ and $\vec{B}$.

→ Magnetic flux is a scalar quantity.

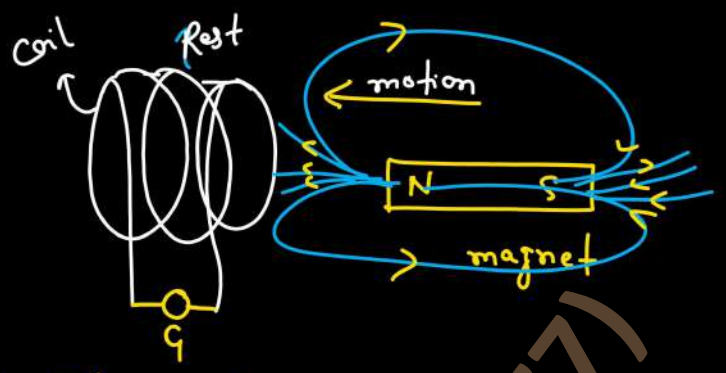
→ SI unit of magnetic flux is tesla meter^2 (Tm^2)

$$\therefore \boxed{1\ Tm^2 = \text{Weber}}$$

Electromagnetic Induction :→

→ The phenomenon of generation of electric current by changing value of magnetic field is called electromagnetic induction.

→ Faraday's Experiment :→

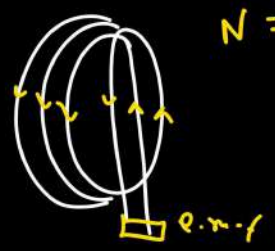


G → Galvenometer → Current or Voltage measure

→ When there is relative motion between Coil and a magnet, then also, phenomenon of electromagnetic induction takes place.

Faraday's law of Electromagnetic induction :→

→ Faraday's state that, the e.m.f induced in a circuit is equal to change in time rate of magnetic flux through the Circuit.



N = number of turn in Circuit

$$\boxed{e.m.f(\varepsilon) = -N\frac{d(\phi_B)}{dt}}$$

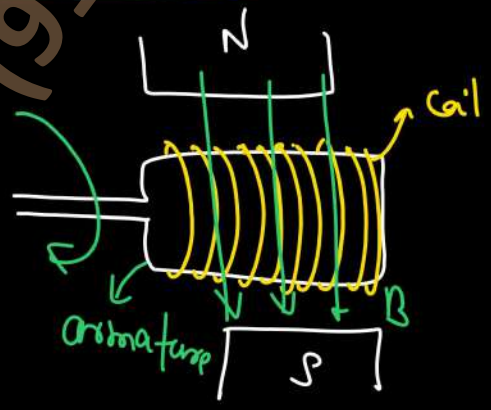
where $-$ve sign indicates direction of polarity of induced emf

ϕ_B = magnetic flux.

$= BA\cos\theta$

t = time.

$$\therefore \boxed{e.m.f(\varepsilon) = -N\frac{d(BA\cos\theta)}{dt}}$$



→ From above expression it is clear that magnetic flux in a coil or circuit can be change, by varying value of followings

(a) Magnetic field (B)

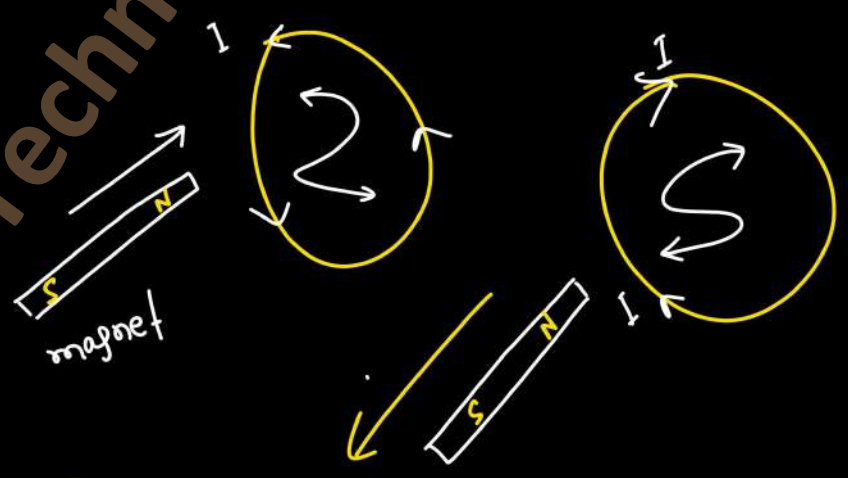
(b) Area under coil (A)

and (c) Angle (θ) between area unit vector and magnetic field.

→ In Electric generator, due to rotation of armature, angle(θ) between area of Coils and magnetic field (B) change and electric current generator in the Coils on the armature.

LENZ LAW :→

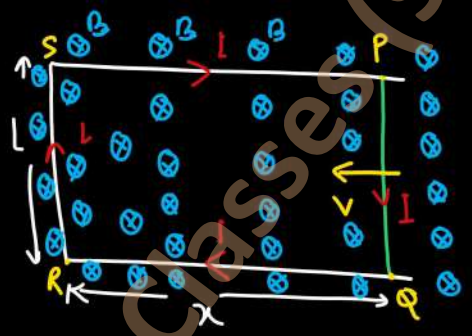
→ This law states that the induced e.m.f generated in the Circuit in Such a way that current develope in the Circuit which opposes the change in magnetic flux that produce it.



→ lenz law is basically based on conservation of energy.

APPLIED Physics-B

Motional electromotive force :→



I = Induced current due to motion e.m.f

→ let a rectangular coil PQRS which is placed in a constant magnetic field (B) which perpendicular to plane of coil and in inward direction.

→ let a member 'PQ' of coil PQRS is in motion with velocity (V).

→ Due to motion of member PQ, the area under coil changes continuously with respect to time which changes the magnetic flux (ϕ_B)

through, hence an e.m.f is generated through the coil which motional electromotive force.

→ According to Faraday's law of electromagnetic induction

$$e.m.f\ (\varepsilon) = -\frac{d(\phi_B)}{dt} \quad \text{—— (1)}$$

$$\because \phi_B = \vec{B} \cdot \vec{A_n}$$

$$= B \times A \times \cos 180^\circ$$

$$= -BLx$$

∴ putting the above value of magnetic flux in equation (1) we get,

$$\varepsilon = -\frac{d(-BLx)}{dt}$$

$$= +BL\frac{dx}{dt}$$

$$\boxed{\varepsilon = BLV} \Rightarrow \text{motion e.m.f}(\varepsilon)$$

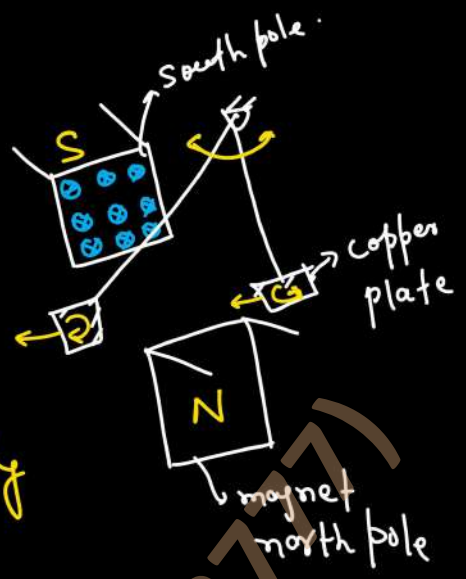
where B = magnetic field,

L = width of coil

V = velocity of member 'pq' of coil.

Eddy Current :→

→ Current of Swirl nature produced in a piece of Conductor due to electromagnetic induction is called eddy current.



→ Eddy currents are undesirable in electrical machines like motor and transformer due to loss of electrical energy into Heat energy by eddy current.

→ To minimise eddy current loss in machines we use insulation between Coil and armature.

→ Eddy current is desirable in following cases :→

(a) Trains electric brake

(b) Induction furnace.

(c) power meters.

APPLIED Physics-B.

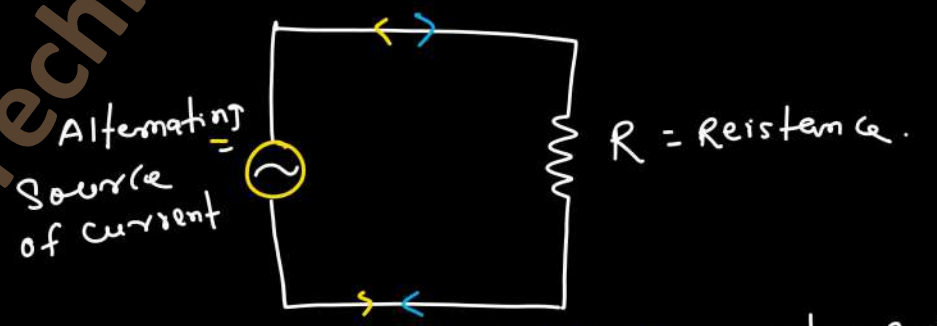
Direct Current (DC) :→

→ The current obtained from a fixed polarity voltage, which has constant magnitude and direction is called direct current (DC).

example:- Electric current obtained from Battery, electric generator is a Direct current (DC).

ALTERNATING CURRENT (AC) :→

→ Current of changing direction obtained from a source which polarity is changes continuously is called alter-nating current.



→ Voltage of Alternating Source is changes with respect to time and is Sinusoidal function, which is given by,

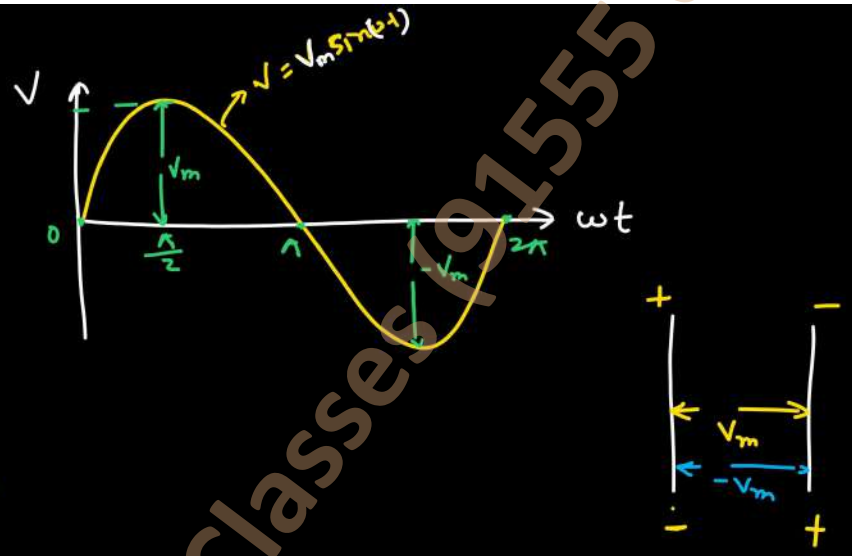
$$\boxed{V = V_m \sin(\omega t)}$$

$V \rightarrow$ voltage of Alternate Source

$V_m \rightarrow$ Maximum voltage or peak voltage.

$\omega \rightarrow$ Angular frequency of alternating voltage source

$t \rightarrow$ time.



$\therefore$ By ohm's law.

$$I = \frac{V}{R}$$

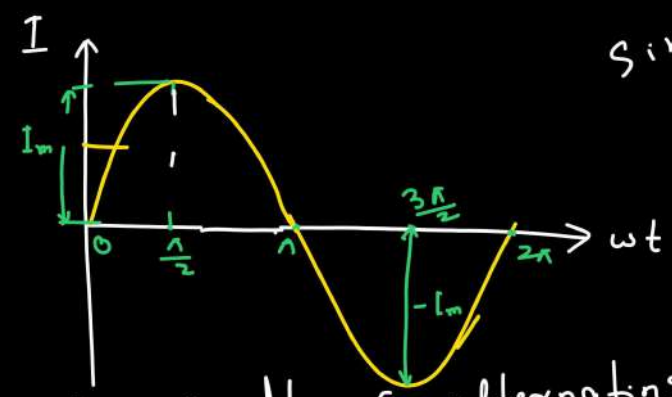
$\therefore$ Alternating current,

$$I = \frac{V}{R} = \frac{V_m \sin(\omega t)}{R}$$

$$\therefore \boxed{I = I_m \sin(\omega t)}$$

where $\left[\frac{V_m}{R} = I_m\right]$

where I_m = Maximum or peak alternating current



$\sin(\omega t)$
since $= 2\pi$

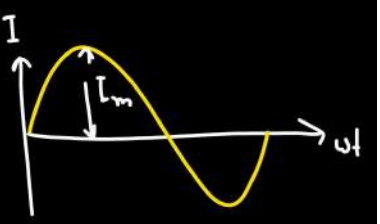
** from above graph of alternating source voltage and alternating current it is clear that both are in same phase.

→ Phase difference between alternating voltage and alternating current is zero.

Peak current (I_m) :→ Maximum value of alternating current is called peak current

$\therefore$ $I = I_m \sin(\omega t)$

where I_m = peak current.



Average current ($I_{av.}$) :→

$\therefore$ $$I_{av.} = \frac{1}{T}\int_0^T I_m \sin(\omega t)\, dt$$ ∫ → Integration

where T = Time period = 2π

$$I_{av.} = \frac{1}{T} I_m \left[\frac{\cos(\omega t)}{\omega}\right]_0^{T=2\pi}$$

$$I_{av.} = \frac{1 \times I_m}{2\pi \times \omega}\left[\cos(2\pi) - \cos(0)\right]$$

$$= \frac{I_m}{2\pi \times \omega}\left[\cancel{+1} \cancel{-1}\right]$$

$$= \frac{I_m}{2\pi\omega} \times 0 = 0$$

**

$$\boxed{I_{av.} = 0}$$

Electric power of A.C. →

$$\text{power}(P) = I^2 R$$

$$= \left\{I_m \sin(\omega t)\right\}^2 \times R$$

$$= I_m^2 \sin^2(\omega t) \times R$$

$$\boxed{P = I_m^2 R \sin^2(\omega t)}$$

Average power ($P_{av.}$) $= \frac{1}{T}\int_0^T I_m^2 R \sin^2(\omega t)\, dt$

where, T = Time period $= 2\pi$

$$P_{av.} = \frac{1}{T}\int_0^T I_m^2 R \sin^2(\omega t)\, dt$$

$$= \frac{I_m^2 R}{T}\int \sin^2(\omega t)\, dt$$

$$= \frac{I_m^2 R}{T} \int_0^T \left(\frac{1-\cos(2\omega t)}{2}\right) dt \qquad \left[\because \sin^2\theta = \frac{1-\cos 2\theta}{2}\right]$$

$$= \frac{I_m^2 R}{T}\left[\int_0^T \frac{1}{2}\, dt - \int_0^T \frac{\cos(2\omega t)}{2}\, dt\right]$$

$$= \frac{I_m^2 R}{2T}\int_0^T dt - \frac{I_m^2 R}{T}\int_0^T \frac{\cos(2\omega t)}{2}\, dt$$

$$= \frac{I_m^2 R}{2T}\left[t\right]_0^{T=2\pi} - \frac{I_m^2 R}{2T}\left[\frac{\sin(2\omega t)}{2\omega}\right]_0^{T=2\pi}$$

$$= \frac{I_m^2 R}{2\times 2\pi}\left[2\pi\right] - \frac{I_m^2 R}{2\times 2\pi}\left[\frac{\sin(4\pi\omega)-\sin 0}{2\omega}\right]$$

$$= \frac{I_m^2 R}{2} - 0$$

**

$$\boxed{P_{av.} = \frac{I_m^2 R}{2}}$$

$\rightarrow \because$ In case of D.C current (I), and resistance (R) :$\longrightarrow$

power $= I^2 R$

$$\because \frac{I_m^2 \cancel{R}}{2} = I^2 \cancel{R}$$

$$\boxed{I = \frac{I_m}{\sqrt{2}} = 0.707\, I_m}$$

$\hookrightarrow$ Root mean square current (r.m.s current)

$$I_{r.m.s} = \frac{I_m}{\sqrt{2}}$$

∴ → Root mean square current is the value of a DC current which make loss with same value equal to that AC current

APPLIED Physics-B

UNIT-04 - SEMICONDUCTOR PHYSICS

Max^m — 2 object × 2 = 4 no.

Subj - 2 Que × 4 no. = 8 no.

Whole - Theoretical unit

preparing - 3 times readings.

Semiconductor :→

→ Those materials which properties (conductivity and resistivity) lies between insulator and conductors are called Semiconductor materials.

properties	Conductors (Metals)	Semiconductors	Insulator
Resistivity (Ωm) (ρ)	$10^{-2} - 10^{-8}$	$10^{-5} - 10^{8}$	$10^{11} - 10^{19}$
Conductivity ($S m^{-1}$) $(\sigma) = \frac{1}{\rho}$	$10^{2} - 10^{8}$	$10^{+5} - 10^{-8}$	$10^{-11} - 10^{-19}$

Semi conductors :→

→ Those materials in which flow of electrons can be controlled by externally supply of heat (thermal energy), light and voltage.

example, Ge, Si, CdS, GaAs, polypyrole (→ organic semi conductor)

etc.

Advantage of semiconductors :—

Followings are the major advantage of Semiconductors :—

(i) value of current flowing through semi conductors can be controlled.

(ii) Small power loss through Semiconductor.

(iii) Require low voltage supply.

(iv) long life and Reliable.

Energy Band :→

→ The uniform distribution of energy of electrons inside a material is called Energy Band.

Valence Band :→ The energy distribution of all electrons of outermost orbit in a atoms of mater is called valence band.

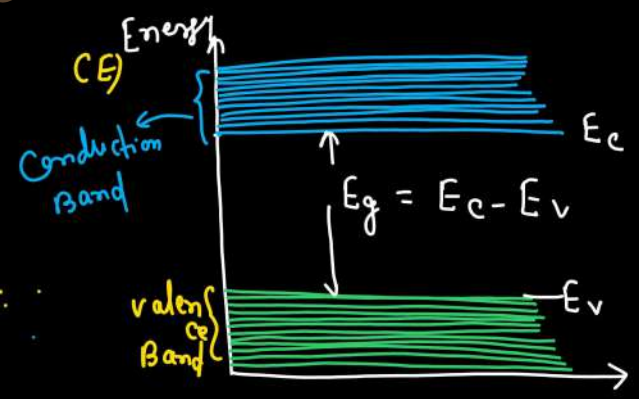
Conduction Band :→

→ The energy distribution of all excited electrons which are ready to flow is called Conduction Band.

Energy gap (E_g) :→

It is difference between lower energy level of Conduction Band (E_c) and higher energy level of valance Band.

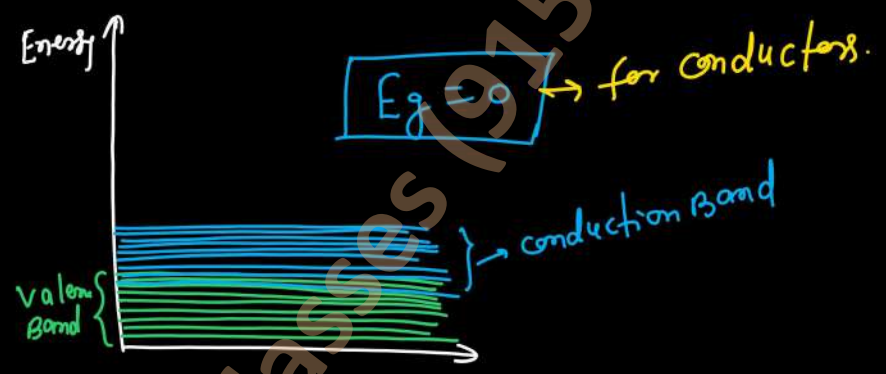
i.e $\boxed{E_g = E_c - E_v}$



→ To carry current through a materials maximum number of electrons should be in conduction Band.

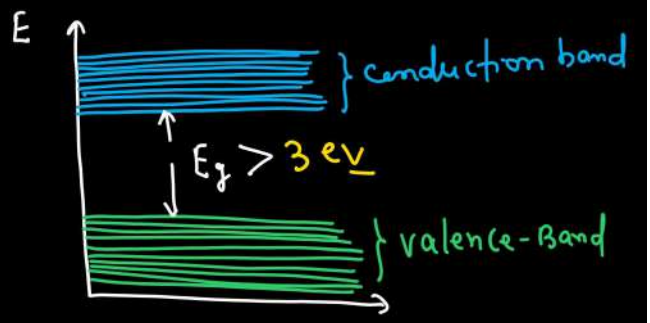
Types of material on the basis of Energy gap (E_g) :→

ⓐ **Conductors** :→ When conduction band and valance band overlap that energy gap (E_g) be comes zero for a material that material is called conductors.



ⓑ **Insulator** :→ When energy gap between conduction band and valence band is more than 3 eV for a material then that material behaves as insulator.

$E_g > 3\,eV$

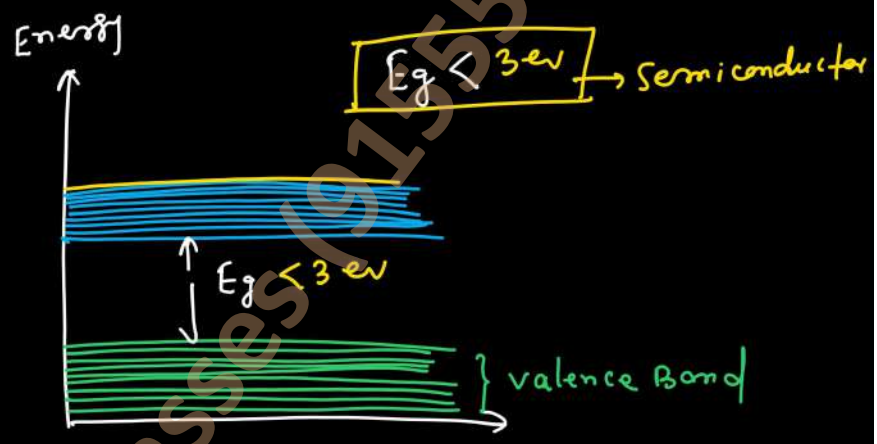


Note:- Electron volt is unit of energy.

$$1\,eV = 1.6 \times 10^{-19}\ \text{Joule}$$

(c) Semiconductor:→

Those materials for which energy gap between Conduction band and valence band is less than 3 eV are behave as Semiconductors.



Types of semiconductors:→

There are two types of semiconductors:→

I Intrinsic or pure semiconductor

II Extrinsic or impure or dopant semiconductors.

I Intrinsic Semiconductors :→

→ Intrinsic semiconductors are also called pure semiconductors.

→ This type of semiconductor is also known as elemental semiconductor.

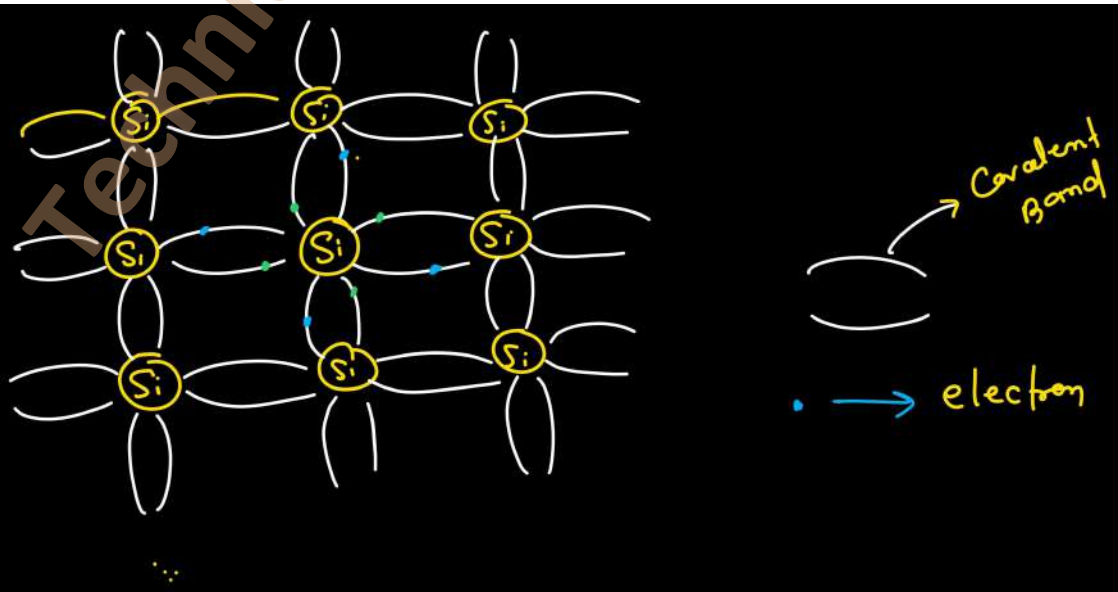
Example:- Si, Ge,

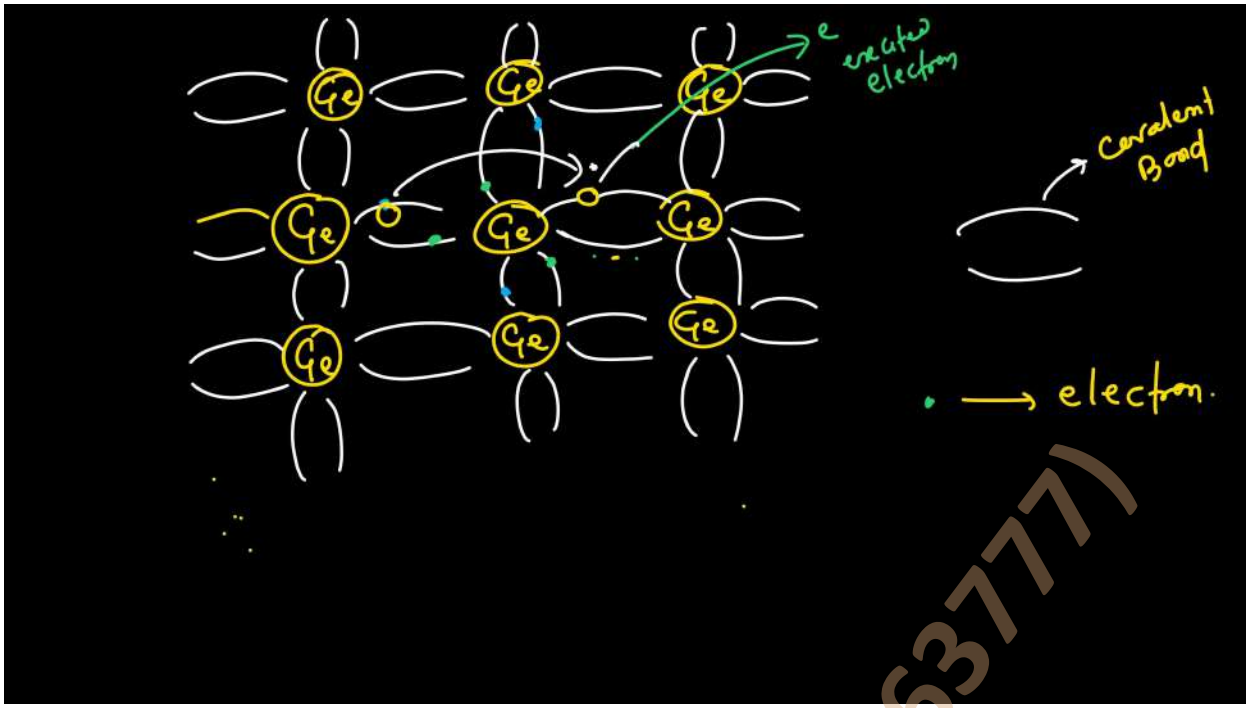
→ It is called pure semi conductor because of no any foreign material (impurities) are added to this semiconductors.

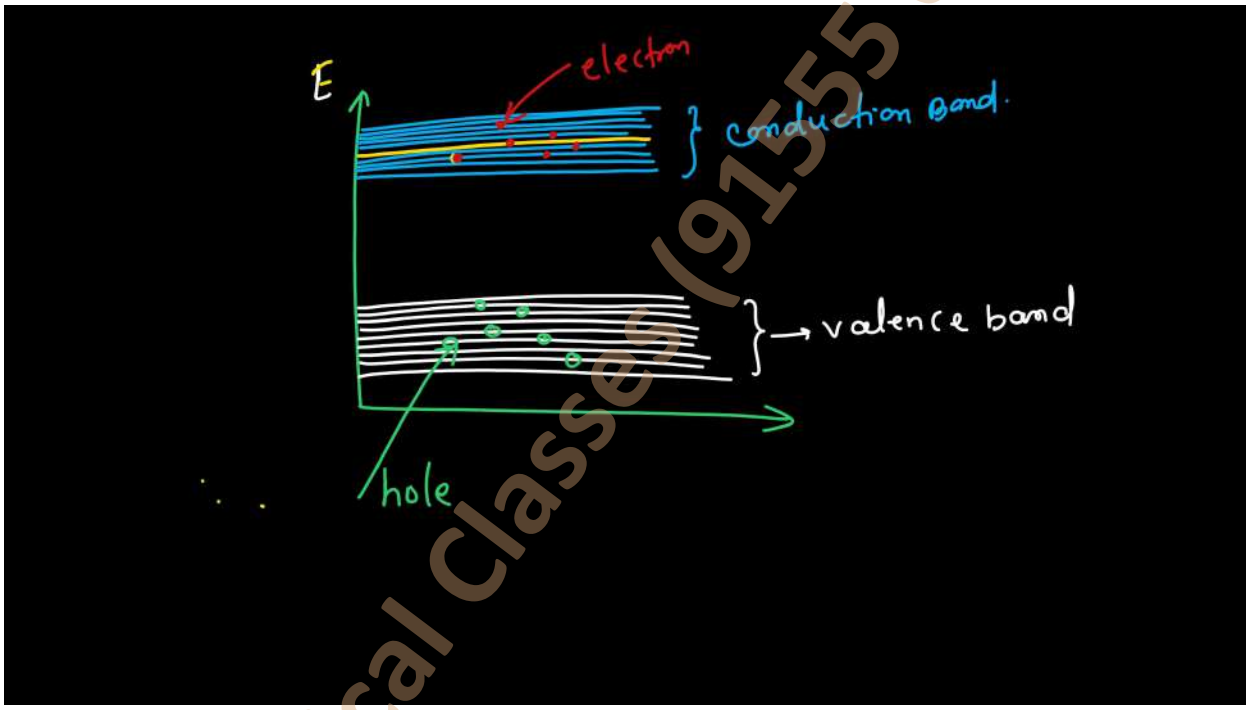
→ Si → 14 → — 4 valance electron

Ge → 32 → — — 4 valance electrons

→ Bond between atoms of Si and Germenium is a Covalent Bond.







→ hole :→ Hole is a apparantly free particle having positive charge.

→ In case of intrinsic semiconductor

$$\boxed{n_h = n_e = n_i}$$

where n_h → number of holes
n_e → number of charge carrier electron
n_i → number of intrinsic charge carrier.

→ In case of intrinsic semiconductor, the total current in semiconductor will sum of current due to hole and electrons.

$$\boxed{\text{total current}(I) = I_e + I_h}$$ → Intrinsic semiconductor

where I_e → current due to electrons
I_h → current due to holes

→ Due to very small conductivity of intrinsic semiconductor at room temperature (25°c) no any practical electronics device can be made with intrinsic semiconductor.

II Extrinsic semiconductor :→

→ To increase conductivity of intrinsic semiconductor, other materials (impurities) are added to it, then the semiconductor form are called extrinsic semiconductor.

→ The process of adding impurities to intrinsic semiconductor to form extrinsic semiconductor is called dopping.

→ The impurities added to intrinsic semicon-ductor are called dopant.

→ Extrinsic semiconductor are also called doped semiconductor.

** → To add impurities (dopant) to intrinsic semiconductor, size of atom of impurities and size of atom of intrinsic semiconductor (Si, Ge) should be approximately same.

III rd	IV th	V th
B	Si	P
Al	Ge	As
In		Sb

Trivalent element

pentalvalent element.

There are two types of extrinsic semiconductor →

(a) n-type extrinsic semiconductor

(b) p-type extrinsic semiconductor.

APPLIED Physics-B

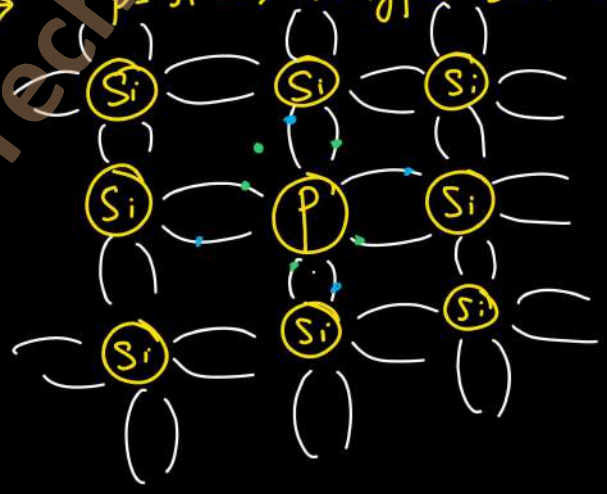
n-type Semiconductor :→

→ when a pentavalent element like Phosphorous, Arsenic, Antimony etc added to intrinsic semiconductor then n-type extrinsic semiconductor is formed.

→ A pentavalent impurities, or dopant, like, P, As, Sb has five number of valance electron in their outermost orbit.

→ in n-type semiconductor, Si or Ge form, covalent bond with 4 electron of pentavalent element and one electrons remains freely for conduction.

→ P-Si → n-type semiconductor.



• → valence electron phosphorous

• → valence electron of silicon

→ In n-type semiconductor, the pentavalent impurities (P, As, Sb) are called as donor impurities because they provide extra electrons in the semiconductor for conduction.

** → In n-type semiconductor number of electrons are greater than number of holes. So, electrons in n-type semiconductor is called majority carrier and holes are called minority carrier

→ $\boxed{n_e > n_h}$ → for n-type semiconductor.

where n_e → number of electrons.

n_h → number of holes.

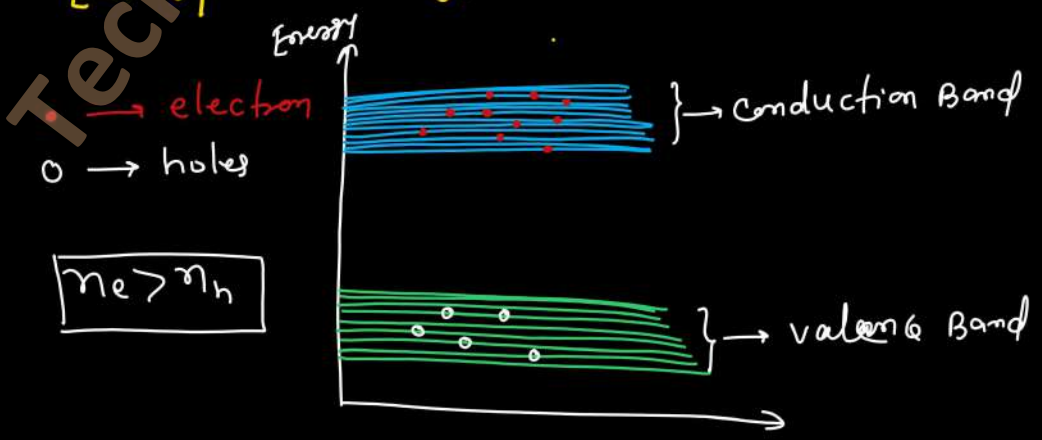
Note :- (a) Si → $E_g = 1.1$ eV

or Ge → $E_g = 0.72$ eV

(b) Extrinsic (n type or p type) Si - base extrinsic semi → $E_g = 0.05$ eV

Ge " " " → $E_g = 0.01$ eV

Energy Band - n-type Semi Conductor :→



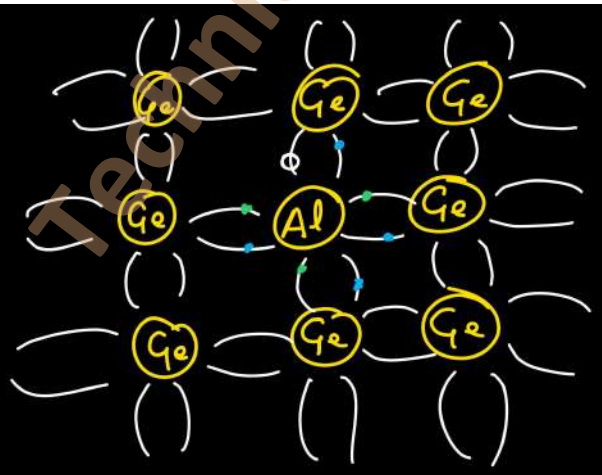
P-type semiconductor :→

→ When a trivalent element like, Boron(B) Aluminium(Al), indium(In) is added to a intrinsic semiconductor, then p-type extrinsic semiconductor is formed.

→ A trivalent element or impurities or dopant has three valence electrons in their outermost orbit.

→ A trivalent impurities can share only three electrons with Si or Ge, hence one place remains a vaccant (hole) place in the the semiconductor

→ In p-type semiconductors, numbers of holes are greater than number of electrons that is holes are called majority carrier and electrons are called minority carrier in p-type semiconductor



• → electron of Al.

• → valence electrons of Germanium

o → hole → vacant place for electr

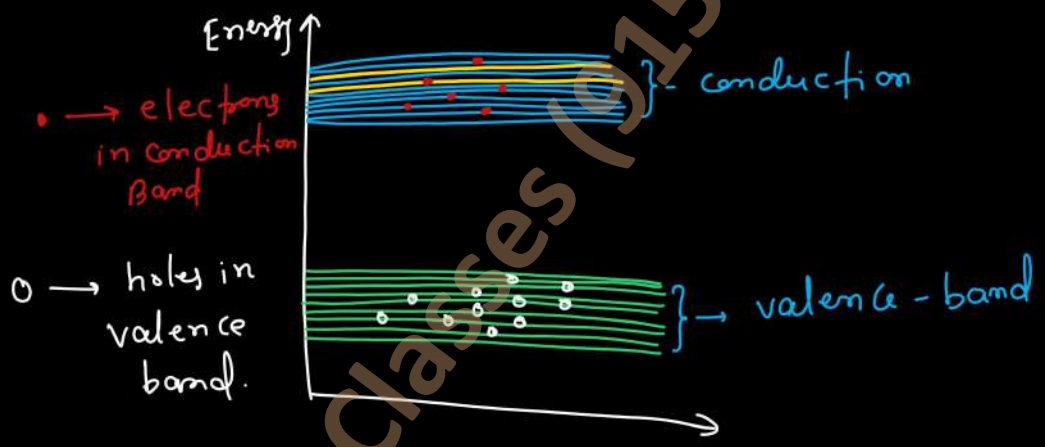
For p-type semiconductor:—

$$\boxed{n_h > n_e}$$

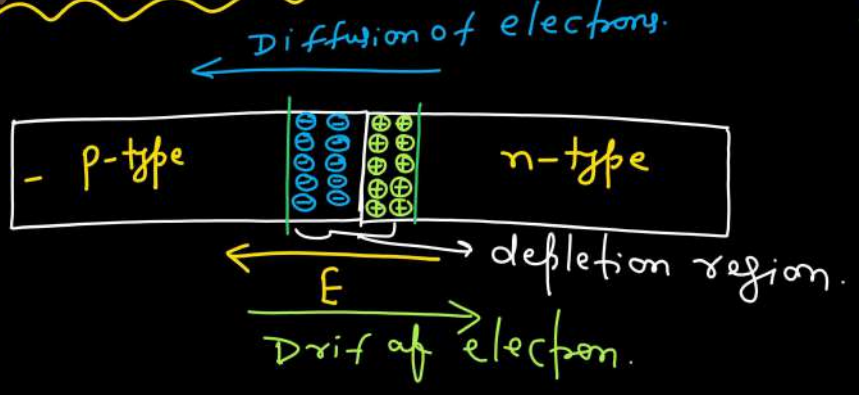
Where n_h = number of holes

n_e = number of electrons.

⇒ Energy band for p-type semiconductor:-



p-n junction :→



→ A p-n junction is fabricated when a p-type semiconductor, is attached with n-type semiconductor.

→ There are two processes takes place while forming of p-n junction.

I Diffusion of electrons.

II Drift of electrons.

I Diffusion of electrons: → When flow/movement of electrons takes place from higher concentration (n-type semiconductor) to lower concentration (p-type semiconductor), then it is called Diffusion of electrons.

→ At the junction of p-type of n-type semiconductor a region of positive charge and negative charge is develope which is called depletion region.

→ Due to formation of depletion region, an electric field is set-up from positive charge toward negative of the region.

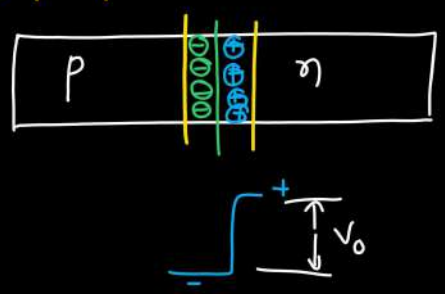
→ Drift of electron: → The flow of electrons from p-side to n-side of semiconductor due to electric field set-up by depletion region is called

Drift of electrons.

→ When equilibrium is reached between Diffusion of electrons and drift of electrons then complete formation of p-n Junction takes place.

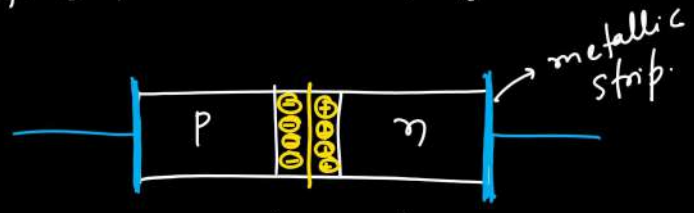
Barrier Potential (V_0) :→

The potential develope across depletion region of p-n Junction which apposes the flow of electrons from n-side to p-side is called Barrier potential.



Diode :→

→ Diode is a p-n Junction has metallic strip at its both side to apply external voltage.



→ A Diode is denoted

Bias :→ External supply of voltage to a diode is called bias.

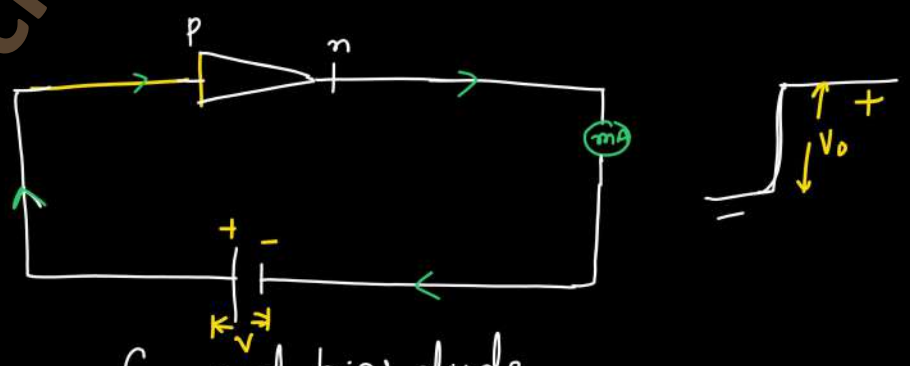
→ There are two types of bias in diode :→

I- Forward bias diode

II Reverse-bias diode.

I **Forward Bias diode** :→

when p-side of a diode is connected to the +ve terminal of battery and n-side of diode is connected to -ve terminal of battery, then this condition of diode is called forward bias diode.



forward bias diode

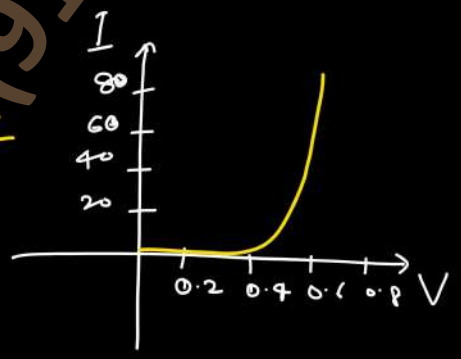
→ when forward bias condition when external voltage (V) increases, Barrier potential decreases that is net potential across depletion region is given by $\boxed{V_0 - V}$

where V_0 → Barrier potential
V → external voltage supply.

** → when barrier potential decreases, width of depletion region also decreases.

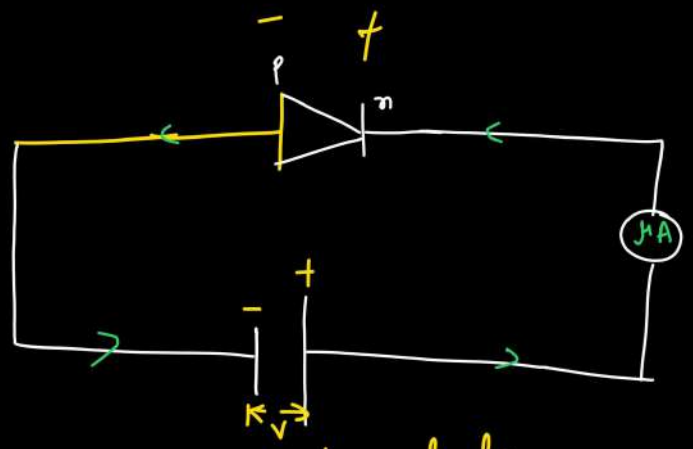
→ In forward bias a small current in milli ampere (mA) is flowing through the diode.

** → V-I - characteristic



II Reverse-bias diode :→

When p-side of a diode is connected to -ve terminal of battery and n-side of diode is connected to +ve terminal of battery, then this condition of diode is called reverse bias diode.



$\mu \to 10^{-6}$

Reverse bias diode.

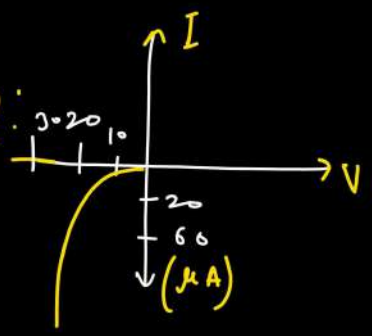
→ With the increase of external voltage barrier potential increases across the diode and becomes $V_0 + V$

where $V_0 \to$ barrier potential
$V \to$ external supply voltage.

→ With the increase of barrier potential width of depletion region also increases.

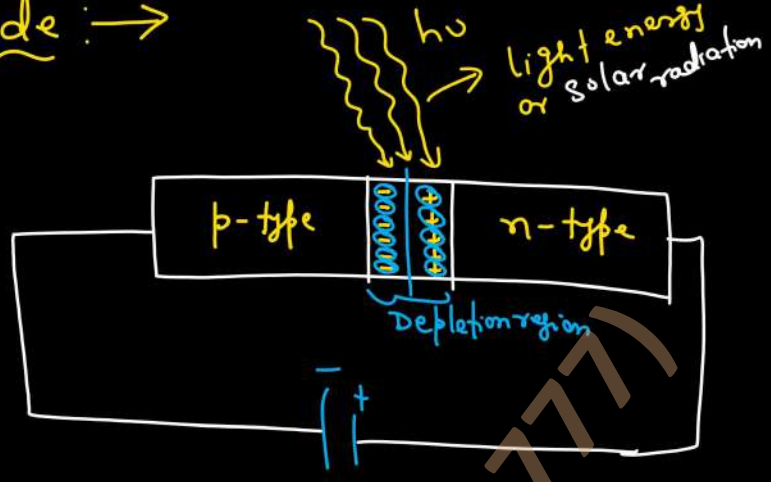
→ In Reverse bias diode very less or negligible Current in microampere (μA) is flowing through diode.

→ V-I characteristics:



APPLIED Physics-B.

Photo diode :→



→ A photodiode is a p-n junction diode which works in reverse bias condition.

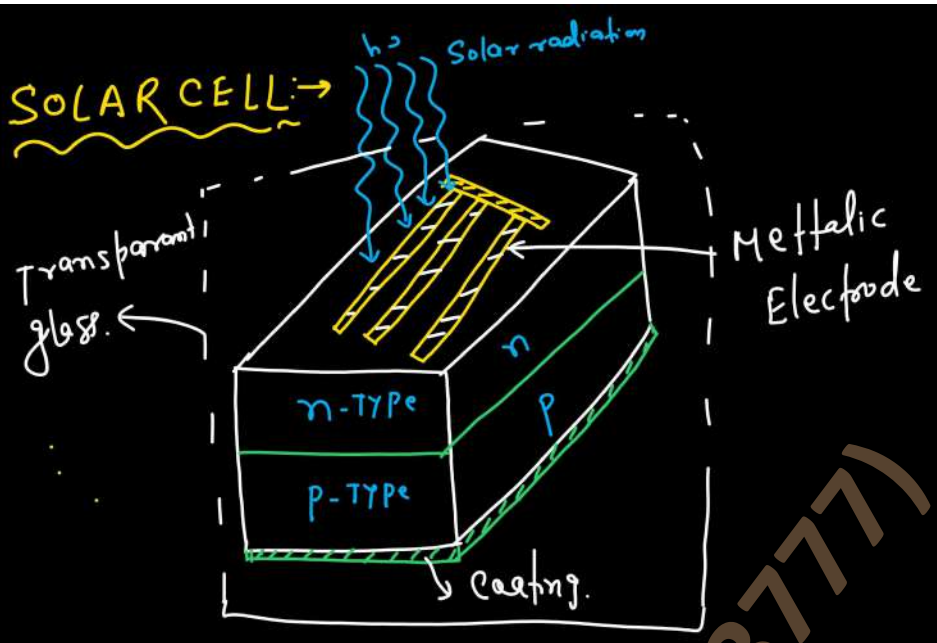
→ When light energy or photonic energy falls on the diode, electrons from n-side of diode get excited by absorbing the light energy and starts seperating from n-side and moving toward p-side of diode.

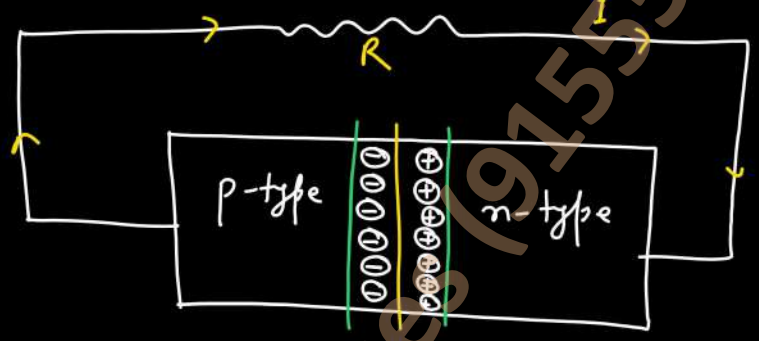
→ A very small e.m.f is develope between p-side and n-side of diode due to flow of electrons.

→ The small e.m.f shows a small current at the presence of optical energy.

Application :→ This photodiode is use to detect optical sign in the Cables.

SOLAR CELL →





APPLIED Physics-B.

Solar Cell : →

→ Solar cell is a p-n Junction diode which generates a photovoltage or emf when Solar radiation or light falls on it.

→ Solar cell almost work same principle

as photo diode. but there is no any biasing is provided like in photodiode.

→ To falls maximum amount of solar radiation, the junction area of solar cell diode is kept large, so that large value of photovoltage generated.

→ In solar cell photovoltage (emf) is generated by following three process: →

I Generation

II Seperation

III Collection.

I Generation: →

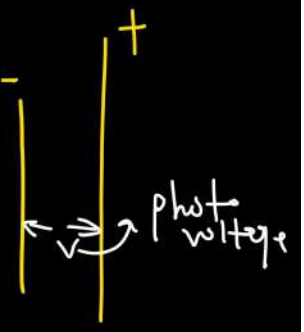
→ when solar radiation energy or photon energy falls on p-n junction, electrons gets excited by absorbing this energy and comes out from inside the diode, this is called generation of electrons.

II Seperation:→

→ The process ejection or seperating out electrons from one side and going to another side of diode is called Seperation of electrons.

III Collection:→ The set of electrons accumulated at one side and number of holes accumulated at another side of diode is called collection.

→ The place where electrons are collected produce lower potential and place where holes are collected produce higher potential. Thus a potential differce (voltage) is produced which is called photo voltage.



→ If we connects a conductor through photovoltage, a current starts to flow, this current is called photocurrent.

→ In general Silicon (Si) based p-type and n-type extrinsic semiconductor is use to manufacture solar cell.

→ following properties of material are required for manufacturing of solar cell.

I Semiconductor material should have energy gap (E_g) less than 1.1 eV.

II Material has high solar energy absorbtion capacity.

III Material should have high electrical conductivity.

(iv) Material should be easily available.

(v) Material should be of lower cost.

Application of Solar Cell :→

Following are the important application of Solar Cell :→

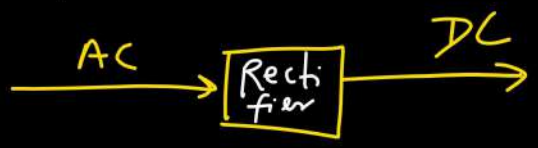
(i) powering of satellites in space.

(ii) powering of electric devices of spacevehicles

(iii) For Running other devices like Calculators, etc.

Diode as a Rectifier :→

Rectifier :→ Rectifier is a device which Converts alternating current (AC) in to Direct current (DC).



Invertor :→ This is a device use to Convert Direct current (DC) in Alternating Current (AC)

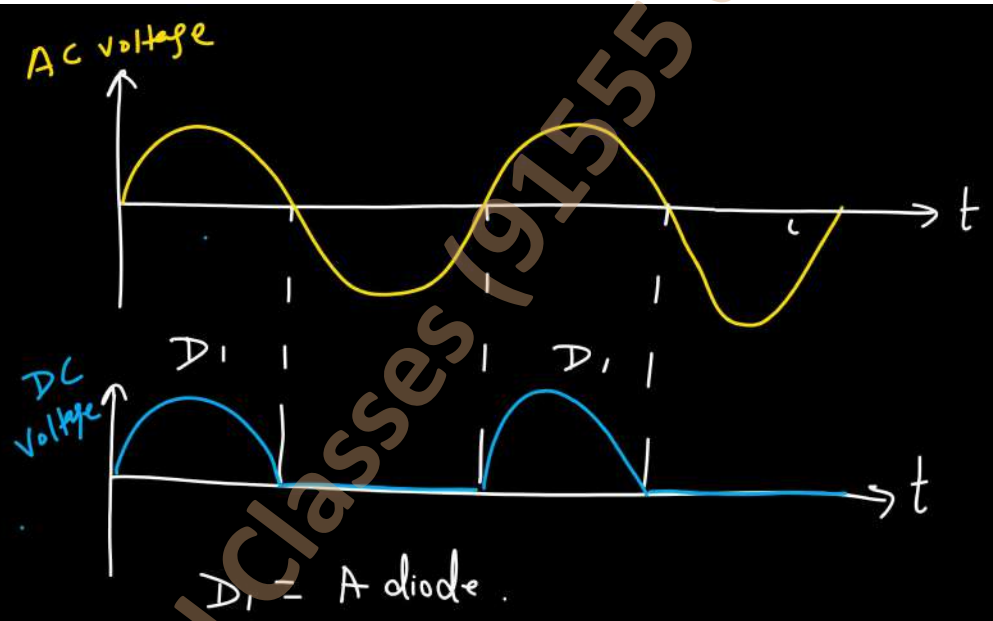
(a) Diode as a Half wave Rectifier :→

→ An AC voltage is a pulsating voltage whose magnitude and polarity is continuously changes with respect to time.

→ To fix the polarity of AC voltage we use diode because diode can only pass through current in

forward bias, and in Reverse bias, there is negligible current through diode, Hence if one polarity of AC acts as a forward bias for diode then other polarity of AC will acts as Reverse bias of diode, that is no current in this case.

→ if a diode is Convert half cycle of AC voltage into DC, then it is called half wave rectifier.



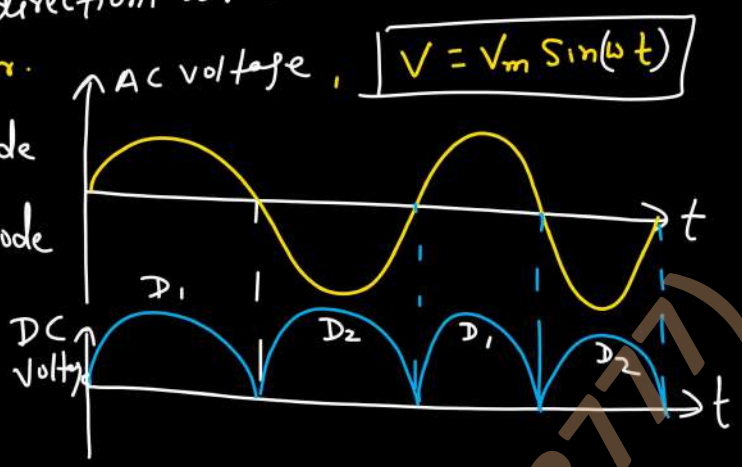
(b) Diode as a full wave Rectifier :→

→ when two diodes are added in the circuit. Such one half cycle of AC voltage acts as forward bias of one diode and reverse bias of another and similarly another one half of AC voltage acts as forward bias of another and reverse bias of one diode, the full AC voltage

cycle is converted to one direction or rectify to one direction, which is called full wave rectifier.

$D_1 \rightarrow$ 1st diode

$D_2 \rightarrow$ 2nd diode



Q what is the term for the process of adding impurities to a semiconductor to alter its conductivity.

(Mixing / Doping)

Ans:- Doping.

Q what is the term for region formed at the at the junction of p-type and n-type semiconductor.

(Conduction region / Depletion region)

Ans:- Depletion region.

Q. Describe the difference between intrinsic and extrinsemi semiconductor and explain how doping affects the conductivity of semiconductor.

APPLIED PHYSICS - B

Steps:—

I → Main Notes

II → Memorise the notes.

III → 2 time Notedown in rough copy

IV Book :- NCERT - PHYSICS — XI th and XII th

Vol.-I Vol.-II Vol. I & II

Short Notes
→ formulae
→ important

UNIT-05

MODERN PHYSICS.

→ photoelectric EffECT.

→ LASER

→ OPTICAL fiber.

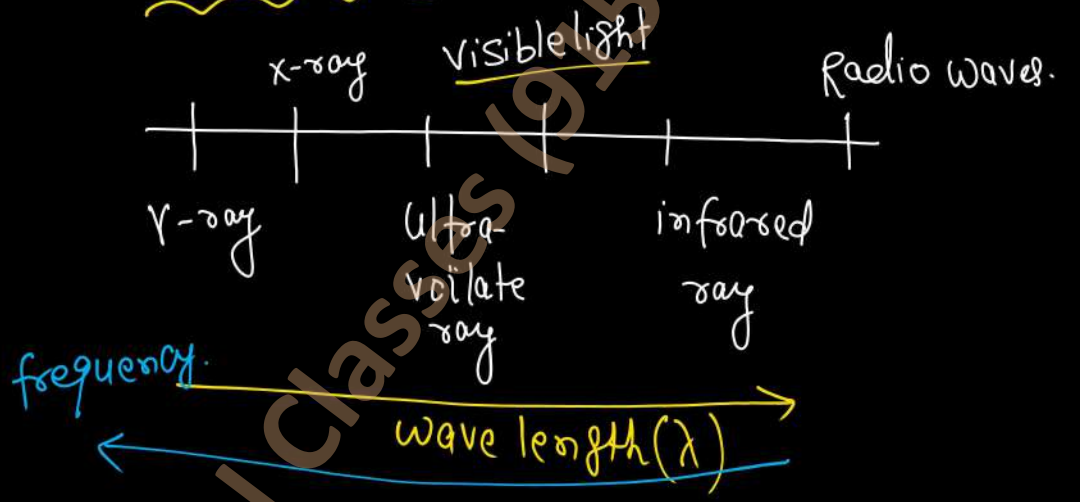
→ Nanotechnology.

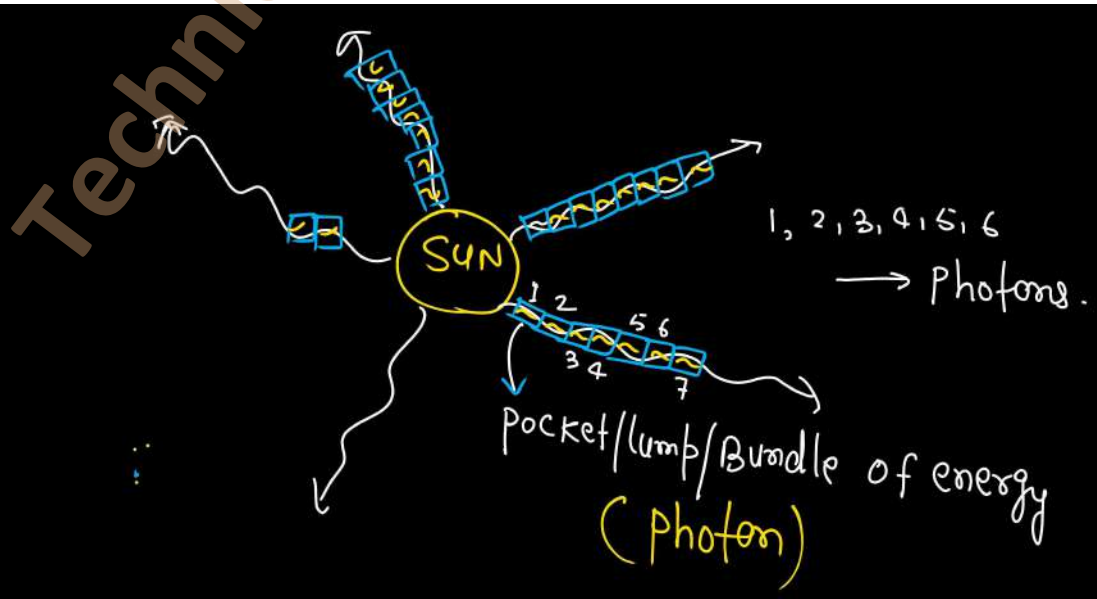
Photo Electricity :→

Photon :→

light :→ It is a form of energy which comes from Solar radiation.

Solar radiation :→





Photon: → A pocket or lump or Bundle of energy of solar radiation is called photon.

→ It is also called quantisation of ligh energy.

Energy stored in a photon: →

$$E = h\nu$$

E = Energy of a Photon.

h = Plank's Constant

$= 6.63 \times 10^{-34}$ J Sec.

ν = frequency of Solar radiation wave.

UNIT-05-MODERN Physics

Energy of a photon:—

$$E = h\nu$$

Energy of radiation:—

$$E_{rad} = nh\nu$$

where $n = 1, 2, 3, 4, ----$

E_{rad} = Energy of radiation

→ unit of energy of radiation Joule (J)

→ In generally the energy of radiation is measured in electron volt (eV).

$\because$ $\boxed{1.602 \times 10^{-19}\ eV = 1\ J}$

** → Energy can't be fractional multiple of $h\nu$.

$E = 0.3\cancel{h}\nu$ or $0.\cancel{8}h\nu$ or $\cancel{0.7}h\nu$

Some Important properties of photon :→

(i) Photons moves with a speed (c) 3×10^{8} m/sec in vacuume.

$\because$ $\boxed{C = \nu\lambda}$ → unit $\frac{m}{sec}$

where C = speed of photons of the radiation

ν = frequency of waves of radiation. (sec^{-1} or Hz)

λ = wave length of wave of radiation (meter)

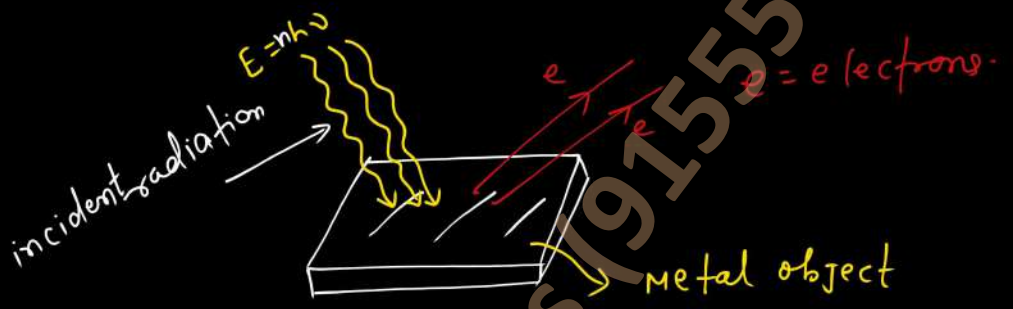
(ii) Photons have no charge that is electrically neutral.

(iii) Number of photons in a radiation increases with the increase of Intensity of radiation.

$\boxed{\text{Intensity}(I) = \frac{\text{Energy}}{\text{Area}}}$ → unit $\frac{\text{Joule}}{\text{meter}^2}$

Photoelectric effect :→

→ Photoelectric effect is the phenomenon in which electrons are ejected/emitted from a metal or non metals when radiation (Energy) of suitable wave length and frequency falls on it.



Photoelectric effect

** → Metals like Cesium, Pottasium, Sodium show photoelectric effect when visible light falls on it.

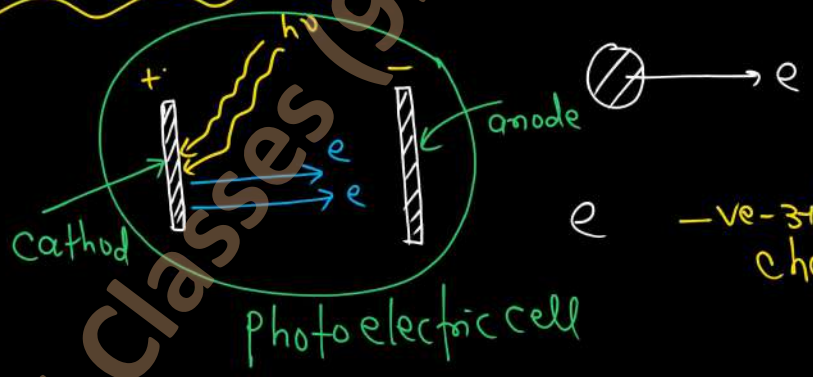
** → Metals like Zinc, Cadium shows photo-electric effect when ultraviolet rays falls on it.

** → Electrons emitted during photoelectric

effect are called Phot electrons.

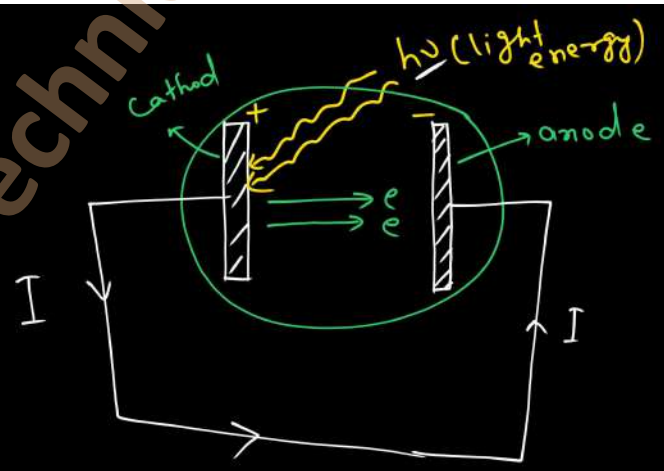
MODERN PHYSICS.

Photo electric cell :→



e → e

e —ve-आवेश charge



e → electrons

I → electric current

→ current(I) is called Photo electric current.

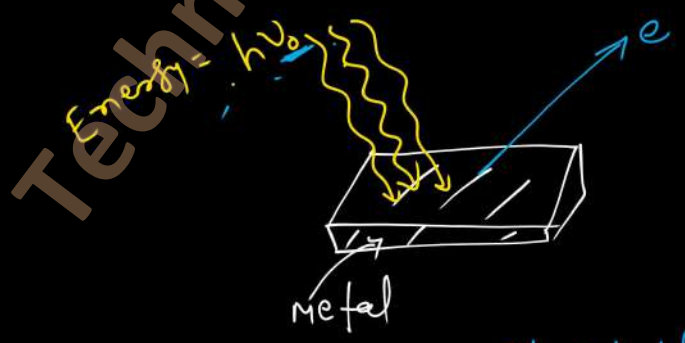
Some Important definitions :→

(i) Threshold frequency (ν_0) :→

→ Threshold frequency is the minimum value of frequency (ν_0), with which when incident light falls on the metal electrons just started to emit.

→ In other words, threshold frequency is the minimum value of frequency of light energy required to detach electron from a metal.

** → Threshold frequency (ν_0) depends on metals of object at which light energy falls. for different metals, threshold frequency (ν_0) will be different.



e = electron

ν_0 → Threshold frequency of Metal

** → If energy of incident light falls on metal has greater frequency than threshold frequency (ν_0)

then photoelectric effect that photo electrons emitted from metals.

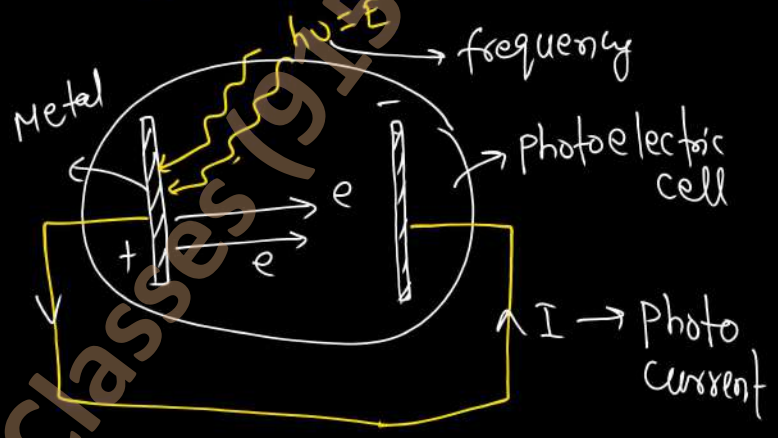
→ If light energy has frequency less than threshold frequency then photoelectric effect does not takes place.

MODERN Physics.

Threshold frequency (ν_0)

$\boxed{\nu \geq \nu_0}$

↓ frequency



Threshold wave length (λ_0) :→

λ → lambda

→ Threshold wave length is the maximum value of wavelength of light that falls on a metal surface and electrons just ejected/emitted.

∵ we know that $\boxed{c = \nu\lambda}$

c = speed of light in vacuume (3×10^8 m/sec)

ν = frequency, λ = wavelength.

Again for threshold frequency (ν_0)

$\therefore C = \nu_0 \lambda_0$

$\boxed{\frac{c}{\lambda_0} = \nu_0} \Rightarrow \boxed{\lambda_0 = \frac{c}{\nu_0}}$

c → speed of light

λ_0 → Threshold wavelength

ν_0 → Threshold frequency.

Work function (W_0) :→

→ The minimum value of energy required to eject an electron from a metal surface is called work function of that metal surface.

$\therefore$ Work function (W_0) = Minimum Energy (E_{min})

$$\therefore \boxed{W_0 = E_{min} = h\nu_0 = \frac{hc}{\lambda_0}}$$

$\because \boxed{c = \nu_0 \lambda_0}$

λ_0 = Threshold wavelength

where W_0 → Work function

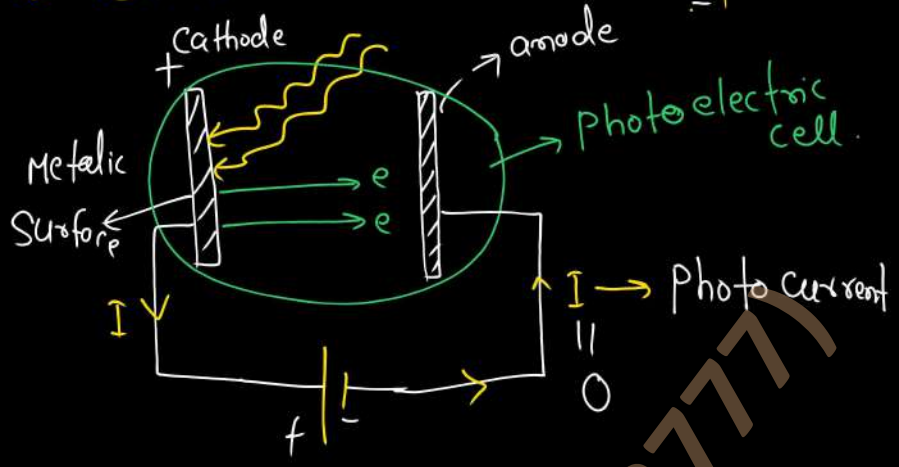
E_{min} → Minimum energy of a photon.

h → Plank's constant = 6.63×10^{-34} J sec.

c → speed of light in vacuume → 3×10^8 m/sec

ν_0 → Threshold frequency.

Stopping Potential (V_0) :—



→ The minimum negative potential provided to anode that stops the electrons coming at anode and photo-current becomes zero, is called stopping potential.

Einstein's Photoelectric Equation :→

→ When light energy falls on a metallic surface then electrons are ejected, the kinetic energy of a ejected electron (photo electron) is given by.

$$\boxed{\frac{1}{2} m V_{max}^2 = h\nu - W_0}$$

above equation is called Einstein's photo electric equation.

→ where

m = mass of a electron = 9.31×10^{-31} kg.

V_{max} = Maximum velocity of a electron.

$h\nu$ = energy of a photon.

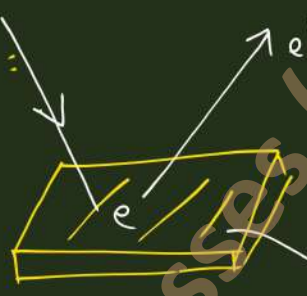
h = Plank's constant, = 6.63×10^{-34} JS

ν = frequency (Sec^{-1} or Hz)

W_0 = work function.

$E = h\nu$

10 J



2 J

8 J

$$h\nu = W_0 + \frac{1}{2} m V_{max}^2$$

$$\Rightarrow \boxed{h\nu - W_0 = \frac{1}{2} m V_{max}^2}$$

2 − 3 = −1

$$\Rightarrow h\nu - h\nu_0 = \frac{1}{2} m V_{max}^2$$

$$\Rightarrow \boxed{\frac{1}{2} m V_{max}^2 = h(\nu - \nu_0)}$$

ν_0 = Threshold frequency.

NOTE :- for photoelectric effect,

$$h(\nu - \nu_0) > 0$$

$$\Rightarrow \boxed{\nu > \nu_0}$$

ν → frequency of photon or light energy

ν_0 → Threshold frequency.

welcome

To

Technical classes

APPLIED PHY-B.

NITESH SIR

- Unit-02- Simple H. Motion
- Unit-03- electrostate-
- Unit-04 - Semi conductor PHY.
- Unit-05- MODERN Physic.

GAUTAM SIR

- Unit-01 Units and Measurement

Sub.

100 Marks

- 70 Marks (end semester examination)
- 30 MARKS (College)
  - 20 Marks (Class test)
  - 10 Marks (Teacher)

FOR B.Tech.

LEET EXAM

- Sub
- MATH
- Engg. Mechanics
- English.

Hollywood — English

Newpaper - English

THE HINDU NEWPAPER

APPLIED PHYSICS-B

UNIT-05 = MODERN PHYSICS

LASER :→

→ Light amplification by stimulated emission of Radiation.

→ Laser is a device which produces a special light of high power, coherant and monochromatic light.

Properties of laser light :→

→ followings are the important properties of laserlight that made it a special light.

I Coherance :→

→ laser light is a Coherant beam of light which means waves of laser light are in same phase.

→ Phase difference between waves of laser light is zero.

II Monochromocity :→

→ laser light is a monochromatic light beam. in which all light waves are nearly (approximately) of same wave length.

Monochromocity :→ it is the ratio of change in frequency to the original frequency.

$$\boxed{c = \frac{\Delta \nu}{\nu}}$$

where c = Monochromocity
$\Delta \nu$ = change in frequency of waves
ν = frequency.

** → for a perfectly monochromatic light beam monochromocity is zero.

→ laser light has highest degree of monochromocity than ordinary light.

III Directionability :→

→ laser light has high directionability because its wavefront are planar and it is a non diversing light.

→ Due to high directionability, laser light travels very long distance.

→ laser light has very small focus area.

IV Intensity :→

→ intensity is the Energy per unit area.

$$\boxed{\text{intensity}(I) = \frac{\text{Energy}}{\text{Area}}}$$

→ laser light has very small focus area hence laser light is very high intensity light and highly powerful light

V Polarisation :→

→ laser light has plane wave front unlike to ordinary light which have spherical wave front hence laser light polarised in a plane.

Interaction of energy with atoms of substance :→

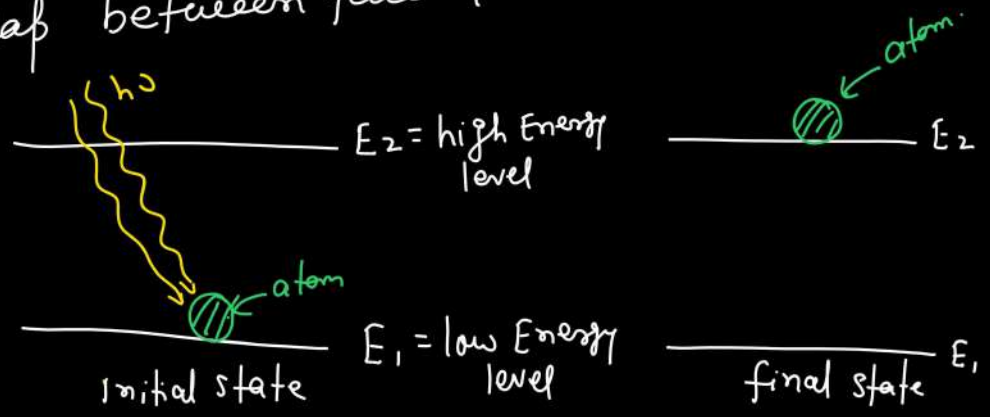
→ when atoms gets energy externally the emits differents emissions which are as follows:—

I Stimulated absorption.
✓II Spontaneous emission
✓III Stimulated emission.

I Stimulated absorption :→

→ when atoms of substance gets radiation energy or photonic energy (light energy) they gets excited and jumps to higher energy level, this phenomenon of atoms are called stimulated emission.

→ To jump atom from lower energy level to higher energy level, photonic energy falls on atom must be equal to energy gap between two levels.



II Spontaneous emission :→

→ when excited atom at high energy level jumps to lower energy level then a radiation is emitted which is called spontaneous emission.

→ spontaneous emission is can't controlled from outside.

→ Emission radiated by spontaneous emission are non coherant and not mono chromatic emission.

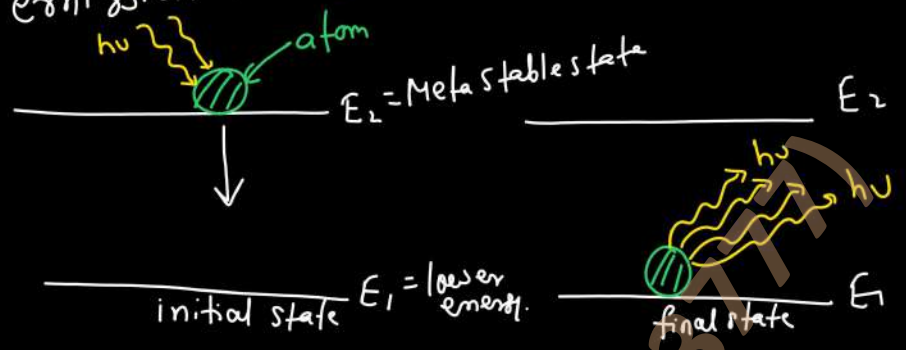
III Stimulated emission :→

→ laser light is formed by stimulated emission.

→ In this type of emission atoms at metastable state when get external photonic energy and falls at lower energy level emits double amount of radiation which is called stimulated emission.

→ Stimulated emission can be controlled externally.

→ Emissions radiated by this stimulated emission are coherent and monochromatic



Difference between spontaneous emission and stimulated emission →

Spontaneous emission	Stimulated emission
(i) Spontaneous emission occure between any two energy level.	(i) Stimulated emission occure between a metastable state and a low energy level.
(ii) Metastable state does not require	(ii) Metastable state is required.
(iii) light emitted by this radiation is not monochromatic	(iii) light emitted by this emission is monochromatic

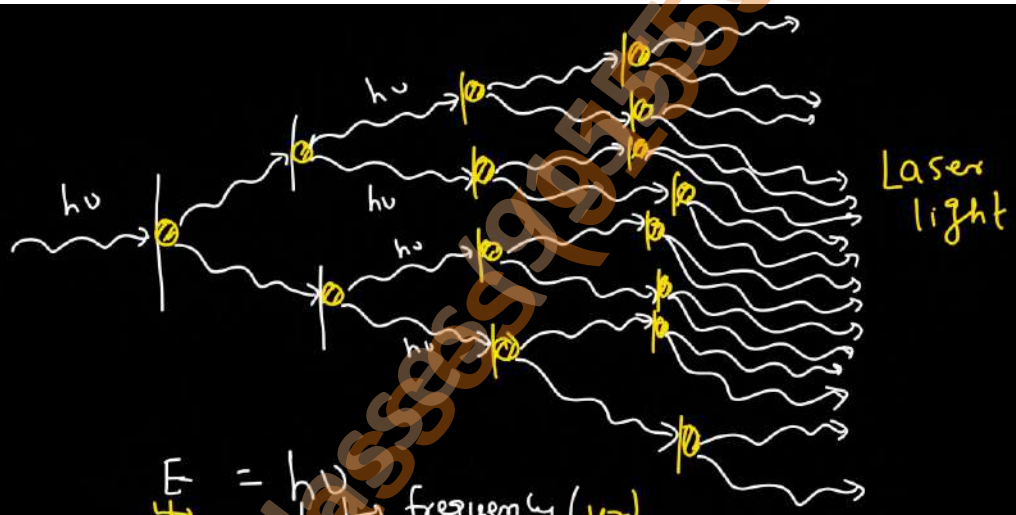
(iv) light emitted by this radiation is incoherant.	(iv) light emitted by this radiation is coherant.
(v) light emitted by this radiation has no directionably.	(v) light emitted by this radiation is directionable.
(vi) ordinary light is example of spontaneous emission	(vi) Laser light is emitted by this emission.

APPLIED Physics-B

principle of laser light :→

→ laser light formed by the principle of stimulated emission.

→ By stimulated emission very high power ful, coherant, and monochromatic beam of laser light can be produced as follow.



$E = h\nu$

E → Photonic Energy.

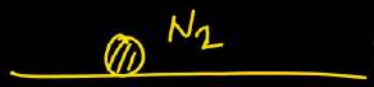
h → plank Const

ν → frequency (Hz)

population :→

→ The total number of atoms at higher energy level is called popoulation of that energy level.

→ For stimulated emission to produce laser light maximum number of atoms required at high energy level.



E_2 = higher energy level

E_1 = lower energy level

N_2 = population at energy level E_2

N_1 = population at energy level E_1

Population inversion :→

→ The condition of achieving higher number of atoms at higher energy level than the atoms at lower energy level is called population inversion.

E_2 = higher energy

N_2 = population at E_2

N_1 = " " E

If $\boxed{N_2 > N_1}$ then population inversion.

E_1 = lower energy

Pumping :→

→ The external supply of energy to achieve population inversion is called pumping.

Methods of pumping :→

There are following methods of pumping.

(a) Optical-Method :→

→ In this method external energy is supplied to the medium in the form of light or solar energy.

→ This method of pumping is ofently used in the formation of laser.

(b) Electric discharge Method :→ In this method external energy is supplied in the form of electricity of battery.

(c) atom to atom collision method :→

→ In this method initial external energy is supplied in the form of electric energy and then excited atoms transfer energy to others atom.

(d) Direct recombination method :→

→ In this electrons combines with holes and emits photonic energy, which excited or increases the recombination of electrons and holes.

→ This method of pumping is used in semiconductor laser.

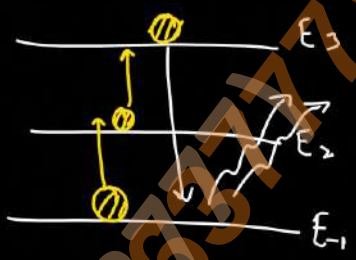
Pumping scheme :→

I Three-level pumping.

II Four level pumping.

I Three level pumping :→

E_3 → Metalstable state
E_2 → intermediate energy level
E_1 → lower energy level.

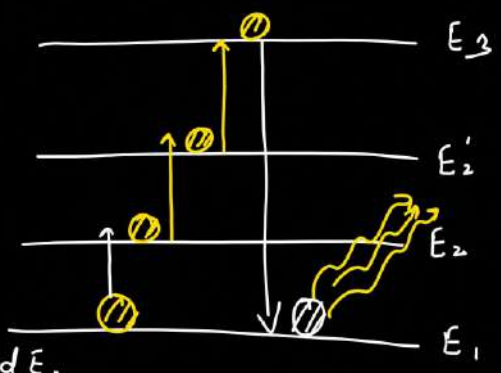


→ In this scheme of pumping, atoms are raised upto metastable state between Three energy level and then atoms falls directly from metastable state to lower energy state which emits radiation produces laser light

** → Three level pumping is used in ruby laser

II Four level pumping :→

E_3 → Metastable state
E_2 = intermediate energy level
E_2' → Energy level between metal stable state (E_3) and E_2
E_1 = lower Energy level.



→ In this scheme of pumping an atom is raised to metastable state between four energy level and atom from metastable state falls directly to lower energy level and emits very large radiation.

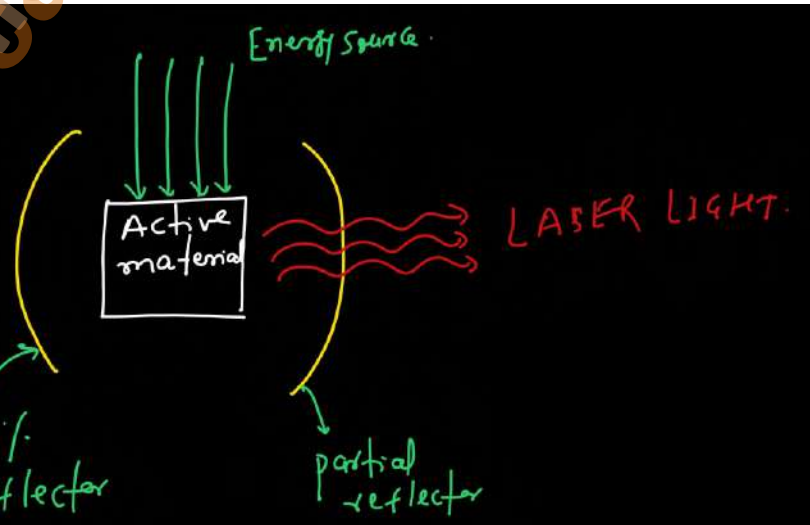
** → This four level pumping method is used in He-Ne laser.

He → Helium
Ne → Neon.

Major Components/parts of laser :→

following are the major or important Components of a laser device :—

I Active medium (substance/material)
II Energy source
III optical resonator/reflector.



I Active material :→

→ This the main component of a laser device in which stimulated emission by atoms of the medium takes place, by external supply of energy.

II Source of energy :→

→ This source of energy supplies external energy to medium for pumping inside the medium.

III optical Resonator/Reflector :→

→ This is the components of the laser device which makes body of the device and reflected all the light striking to these surface and can only allow to pass the laser through a passage, and laser comes out from the device.

Types of LASER :→

followings are the types of laser :→

I Solid state laser :→

example :- Ruby laser, Semiconductor (p-n junction diode laser)

II Gaseous laser :→

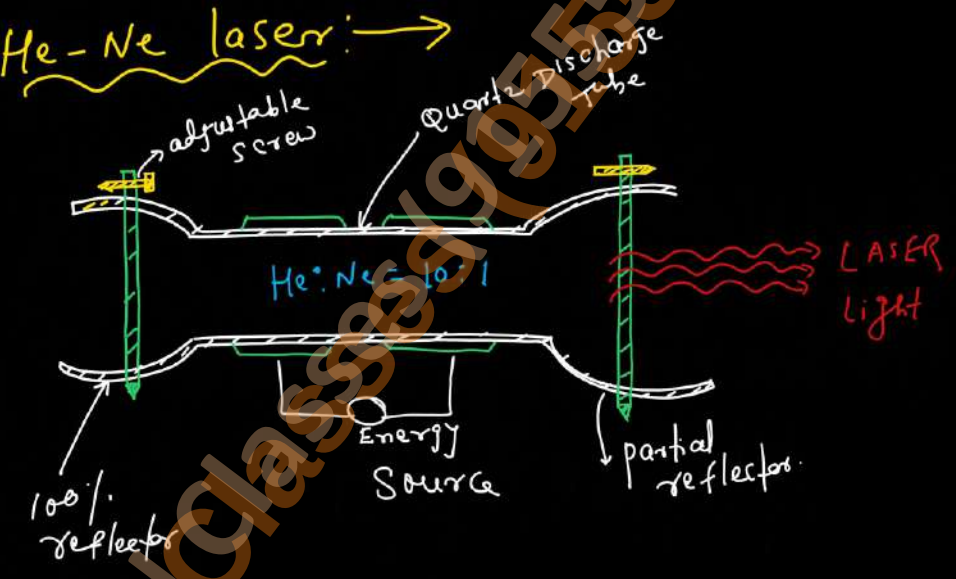
→ example :→ He – Ne laser.

He → Helium gas

Ne → Neon gas.

III chemical Reaction :→

He – Ne laser :→



→ He – Ne laser is a gaseous laser in which Helium and Neon gas are kept in a discharge tube in the ratio of 10:1.

→ He – Ne laser is used to produce generally red colour laser light.

→ He – Ne mixture of gases are kept in a discharge tube at the pressure of 1mm of Hg of Neon and 10mm of Hg of Helium.

→ Discharge tube of He-Ne laser is made-up of quartz of dimension approx 80 cm in length and 10 cm in diameter.

** → He-Ne laser can uses followings types of pumping method.

(a) Electrical discharge method.
(b) atom to atom collision method.
etc

** → He-Ne laser uses four level pumping scheme.

Advantages of He-Ne laser :→

followings are the important advantage of He-Ne laser.

(i) It is continuous laser
(ii) it produces laser light of high intensity, mon - onchromatic and coherant beam of light
(iii) it has high degree of directionability.

(iv) low cost of production.
(v) its frequency is stable.

Application of He-Ne laser :→

followings are the important application of He-Ne laser:—

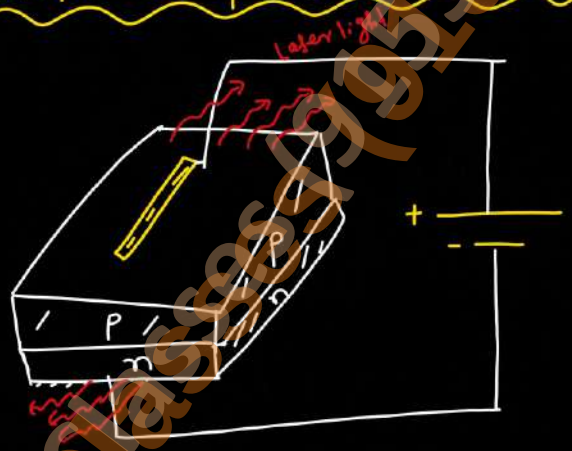
(i) It is used in experimental lab and for the production of hologram in industry.

(ii) It is use to align ruby laser.

(iii) It is used in optical communication.

(iv) It is used in the field of Opthalmology
↓
(Medical field related eye)

Semiconductor or p-n junction diode laser :→



forwarding Biasing.

→ A p-n junction diode laser is Solid state laser.

→ It works in forward bias condition.

→ This laser uses GaAs based laser.

→ This Semiconductor laser produces laser light in the range of infrared radiation.

→ This laser uses Direction recombination method of pumping.

→ This semiconductor laser works in forward bias condition hence electrons from n-side of diode gets excited and travels towards p-side and recombine with holes of p-side of diode.

→ During recombination of electrons with holes photonic radiations emits, which produces laser light of the diode.

Application p-n Junction diode laser :→

following are important application of diode laser.

(i) It is used in optical communication purpose.

(ii) It is used for barcode reader devices.

(iii) It is also used in laser based printer.

(iv) For other security purposes, like biometric etc Diode laser is being used.

General application of laser :→

(a) use of laser in medical field :→

→ for the treatment of detached retina.

→ for bloodless surgery.

→ for treatment of cancer and skin tumors.

(b) use of laser in the field of industry :→

→ laser is being used for welding.

→ for cutting and drilling of holes in the metallic object.

→ for testing of quality of finish product

→ for Heat treatment of metallic and non metallic materials.

(c) use of laser in the field of science and technology :→

→ in fiber optical communication.

→ for inter planet communication.

→ for under water communication in submarine.

→ To drills holes in cell of body, without affecting it.

(d) Use of laser for Millitary purposes :→

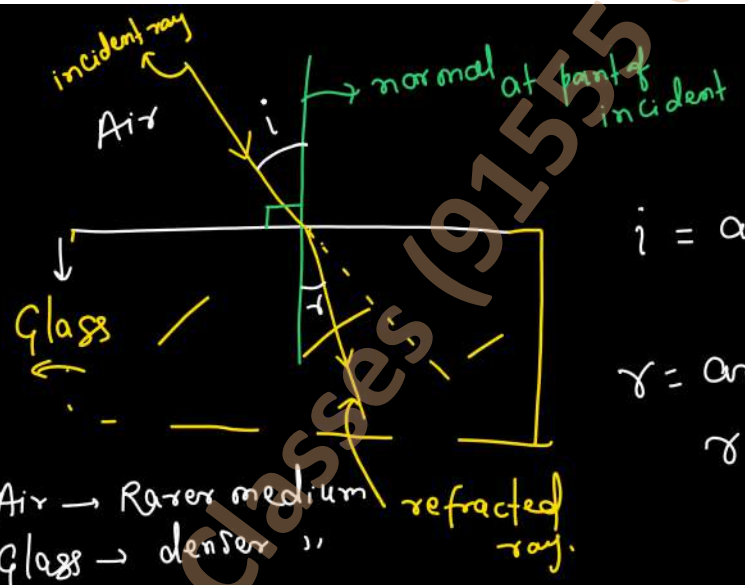
→ laser light is use to destroy heavy and distant object, so laser beam is called death ray.

→ LIDAR (Light detection and ranging) technology to identify enemy distant aircraft is based on laser only.

APPLIED Physics-B

Total internal Reflection (TIR) :→

Refraction :→ when light travels from one medium to another medium it deviates from its original path. this phenomenon of light is called refraction of light.

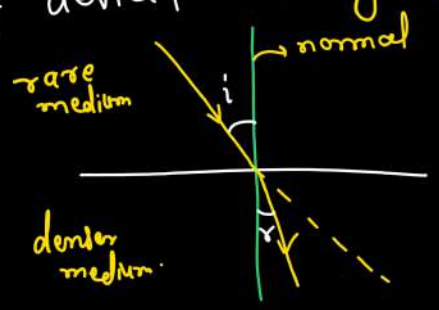


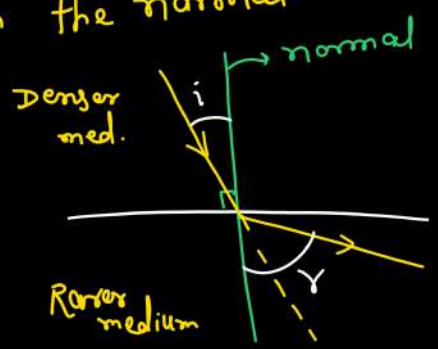
i = angle of incidence

r = angle of refraction.

Air → Rarer medium
Glass → denser "

→ when light travels from rarer to denser medium, it deviates towards normal and if light travels from denser to rarer medium it deviates away from the normal.

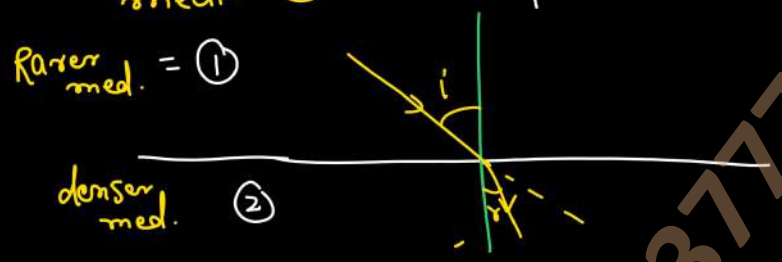




→ Snell's law :→

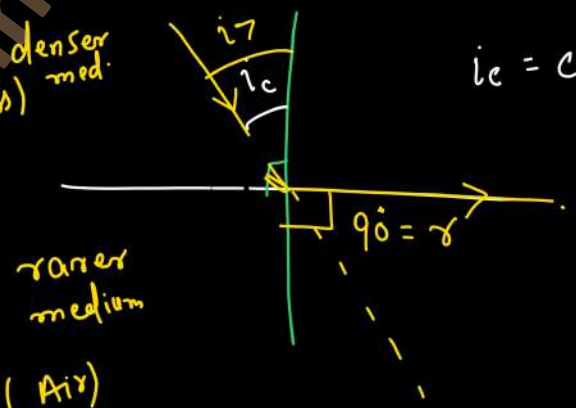
$$\boxed{\frac{\sin i}{\sin r} = n_{21} = \left(\frac{1}{n_{12}}\right)}$$

Where n_{21} → refractive index of denser medium ② with respect to rarer med (1).



Critical angle (i_c)

→ When light travels from denser medium to rarer medium at such an angle of incidence corresponding to which angle of refraction becomes 90°, then that angle of incidence is called critical angle.

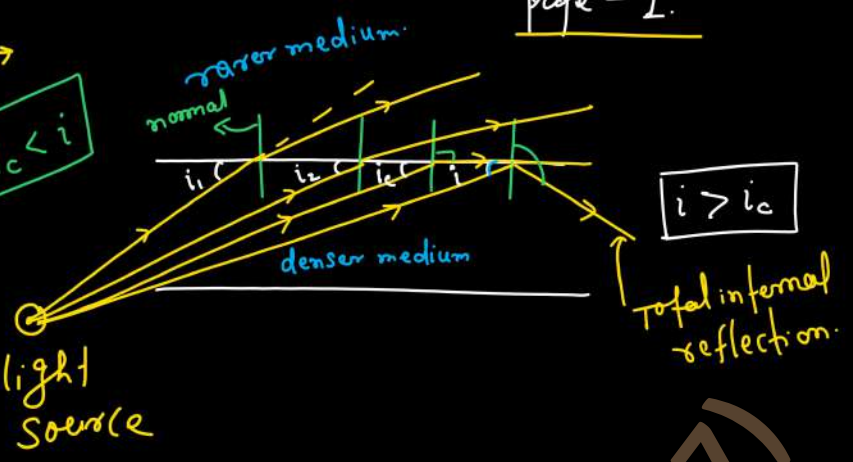


i_c = critical angle

page – 1.

TIR :→

$i_1 < i_2 < i_c < i$



$i > i_c$

∴ By Snells law,

$$\frac{\sin i_c}{\sin 90} = \eta_{air\,glass} = \left(\frac{1}{\eta_{glass\,air}}\right)$$

$$\Rightarrow \boxed{\frac{\sin i_c}{1} = \left(\frac{1}{\eta_{denser,\,rarer}}\right)}$$

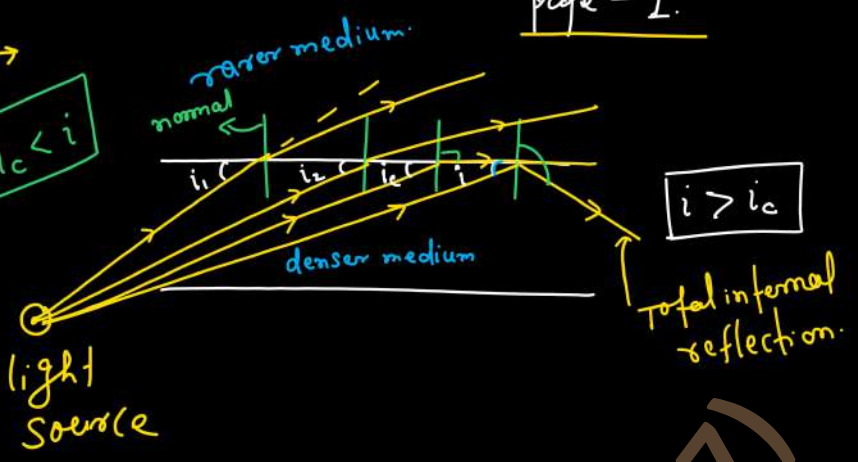
$$\Rightarrow \boxed{i_c = \sin^{-1}\left(\frac{1}{\eta_{denser\,rarer}}\right)}$$

Note: (a) $\boxed{\eta_{glass\,air} = 1.5}$

(b) $\boxed{\eta_{water\,air} = 1.33}$

TIR :→

$i_1 < i_2 < i_c < i$



TIR :- when light travels from denser medium to rarer medium at angle of incidence which is greater than the critical angle then refracted beam of light completely reflected back to same medium, this phenomenon of light is called total internal reflection (TIR).

Required condition of TIR :→

followings are the two required condition for TIR.

I- light must travels from denser medium to rarer medium

II incident angle of light beam must be greater than critical angle.

Advantage of TIR :→

following are the important advantages of TIR.

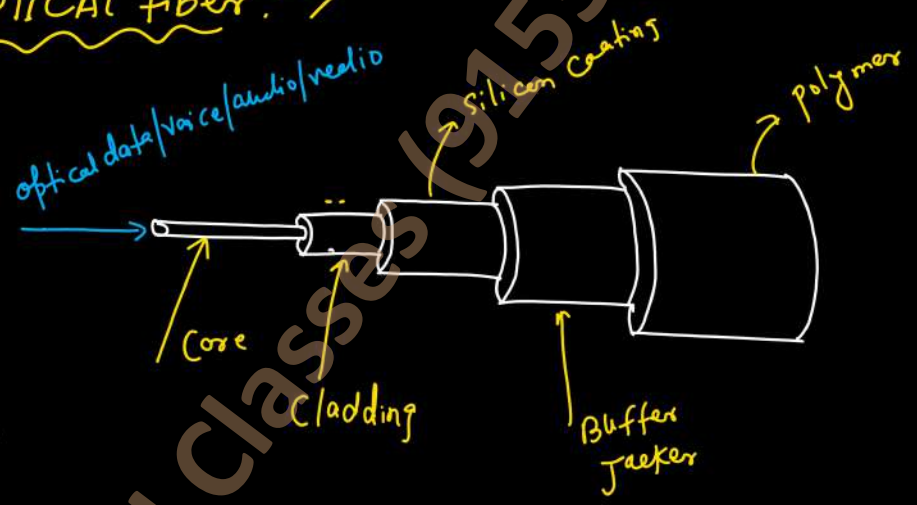
(a) In optical fiber Communication is based on TIR.

(b) Brightness/Brilliance of diamond because of TIR

(c) Phenomena like mirage, upright roof of tree in desert are are due to TIR.

OPTICAL fiber :→

→



→ optical fiber :→

→ It is thin cylinderical glass fiber use transmist data in the form of light by the principle of total internal reflection.

Core :- It is made from glass fiber, and its diameter is in micrometer.

Cladding:— Core is surrounded by a material which refractive index is less than the refractive index core material that is glass.

Outer jacket:→ It is made from polymers to provide its strength against bending and stretching.

FIBER OPTICS classification:→

I Single step optical fiber

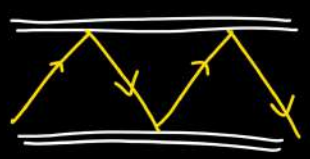
II Graded step optical fiber.

I **Single step optical fiber**:—

→ For this optical fiber

→ Numerical aperture is more

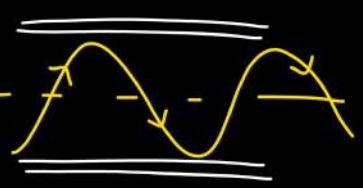
→ attenuation more.



II **Graded step**:→

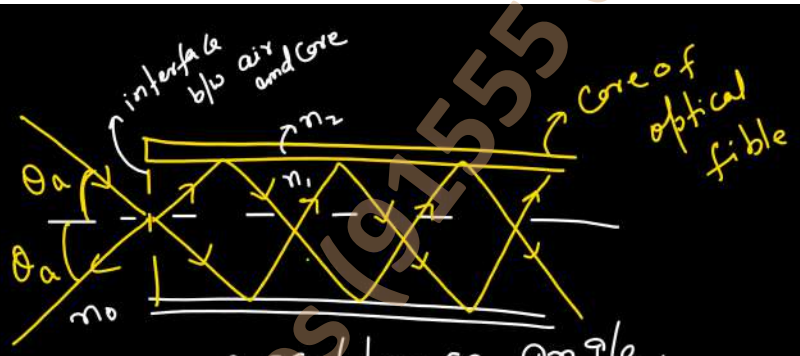
→ less numerical aperture

→ Attenuation is also less.



*** Acceptance angle :→

→ it is the maximum angle of incidence at the interface of air medium and core material for which total internal reflection takes place in the cable/fiber.



θ_a = Acceptance angle.

$$\theta_a = \sin^{-1}\left[\frac{\sqrt{n_1^2 - n_2^2}}{n_0}\right],$$

where n = refractive index

where
n_0 → ref. index air
n_1 → " core
n_2 → " cladding

** Numerical Aperture (N.A) :→

→ light gathering power of optical fiber is called its numerical aperture.

→ it is proportional to acceptance angle (θ_a)

→ Numerical it is equal, $\sin\theta_a$.

$$\boxed{N.A = \sin\theta_a = \frac{\sqrt{n_1^2 - n_2^2}}{n_0}}$$

Application of fiber optics/optical fiber/cable :→

following are the important application of optical fibers :—

(i) It is use to exchange information between two computers.

(ii) It is used in field of space vehicle, Submarine system, security system, industrial engg. etc

(iii) optical fiber is very useful in communication system.

(iv) various types sensor uses optical fiber for showing their input and output data. example, pressure sensor, Temperature sensor etc.

(v) It is widely used in the field of medicine like endoscopy, Gastology, orthoscopy etc

Nano science :→

$\boxed{\text{nano} \rightarrow 10^{-9}}$

→ The branch of science which deals with the study of properties of material at their atomic level, is called nanoscience

→ properties of material at atomic level are found quit different from their macrolevel properties.

Nanoscale :→

1 nm — 100 nm

↳ nanoscale.

nm → nano meter → 10^{-9} meter.

Nanomaterial :→ Those materials of which at least one dimension falls under nanoscale is called nano materials.

example

object	Dimension (nanoscale)	Name
① Nano shells, nanodots, nano rings	All Dimension	3-D nanomaterial.
② Nanotubes, fiber, Graphene, Carbon nanotube (CNT)	Two dimension in nano scale	2-D nanomaterial.
③ Thin film, Coating	One dimension in nano scale	1-D nanomaterials.

→ Some naturally occuring nanoparticles :→

ⓐ Virus

ⓑ protein

ⓒ Glucose.

	Size
→ Bacterial →	1000 nm
→ Cance cell →	10,000 nm
→ Human hair →	80,000 nm

→ Not a nano material.

Nano technology :→

→ nano technology is the process of manufacture electronic devices, that are very smaller in size more effective by the use of nano science.

Application of Nanotechnology :→

following are the some important application of nano technology :→

(i) In medical field nano technology is use to treatment of cance and enhancement of antibacterial properties.

→ sun lotion cream are manufacture by using nano technology.

→ CNT, Graphene properties are use to manufacturing flexible touch screen.

→ In the field of energy, specially in solar cell to enhance its light energy absorbing capacity.

→ Nanotechnology is used in Air purifier, water treatement.

→ in food industry it is use to detect pathogens in food by nanobio sensor.

→ it is also in food packaging.

Q. what is the term for the property of an optical fiber that determines ability to accept light from a given angle.

(Critical angle / Acceptance angle)

Ans:- Acceptance angle.

Q. What is the term for the process of increasing the population of atom in higher energy level than lower ones.

(population inversion / population centration)

Ans:- population inversion.

Q. In formation of half wave rectifier we use

(a) one P-N diode
(b) Two P-N diode
(c) Three P-N diode
(d) Four P-N diode

Q. Nanometer is equal to

(a) 10^{-9} m
(b) 10^{-16} m
(c) 10^{-12} m
(d) 10^{-5} m

THANK YOU ALL

GOOD LUCK