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{MHT-CET-2022 (PHYSICS 11^{th} And 12^{th})}

[Complete Concept] BY AJAY DUBE SIR

(Rotational Dynamics)

* Angular Velocity : (ω)

(i) $\omega = \frac{v}{r}$ (ii) $\omega = \frac{2\pi}{T}$ (iii) $\omega = 2\pi n$ (iv) $\omega = \frac{\theta}{t}$

* Angular displacement : (θ)

(i) $\theta = \omega t$ (ii) $\theta = \frac{2\pi t}{T}$ (iii) $\theta = 2\pi n t$

* Angular acceleration:(α)

(i) $\alpha = \frac{d\omega}{t}$ (ii) $\alpha = \frac{2\pi}{t}(n_2 - n_1)$

* Linear Velocity:(v)

(i) $v = r\omega$ (ii) $v = 2\pi n r$

* Centripetal acceleration:(a)

$$a = \frac{v^2}{r} = \omega^2 r$$

* Centripetal force: (F_{cp})

$$F_{cp} = \frac{mv^2}{r}$$

* centrifugal force (F_{CF}):

$$F_{CF} = -\frac{mv^2}{r}$$

* Inclined banked road (θ)

i.e $\theta = \tan^{-1}\left(\frac{v^2}{rg}\right)$

* Maximum Velocity on curved Horizontal Road.

i.e $V_{max} = \sqrt{\mu r g}$

* Banked road :
  - Upper limit (speed limit) $V_{max} = \sqrt{rg\left[\frac{\mu_s + \tan\theta}{1-\mu_s \tan\theta}\right]}$
  - Lower limit (speed limit) $V_{min} = \sqrt{rg\left[\frac{\tan\theta - \mu_s}{1+\mu_s \tan\theta}\right]}$

* Conical pendulum (Time Period)

i.e $T = 2\pi\sqrt{\frac{L\cos\theta}{g}}$

* Velocity at different-different Point (V.C.M)

i) $V_H = \sqrt{rg}$

ii) $V_L = \sqrt{5rg}$

iii) $V_M = \sqrt{3rg}$

* Tension in Diff-2 Point :

1) $T_H = \frac{mv^2}{r} - mg$

ii) $T_L = \frac{mv^2}{r} + mg$

iii) $T_M = \frac{mv^2}{r}$

Note: Difference between

$$T_H - T_L = 6mg$$

* Moment of Inertia :

$$I = Mr^2$$

* Radius of Gyration :

$$K = \sqrt{\frac{I}{M}}$$

* Kinetic Energy :

(i) $K.E_{ROT} = \frac{1}{2} I\omega^2$

(ii) $K.E_{TRA} = \frac{1}{2} mv^2$

(iii) $K.E_{ROL} = \frac{1}{2}\left[I\omega^2 + mv^2\right]$

* Principle of Parallel axes :

$$I_o = I_c + Mh^2$$

* Principle of Perpendicular axes :

$$I_z = I_x + I_y$$

* Angular momentum = ($L = I\omega$)

* Torque acting on a body :

$(\tau = I\alpha)$

MECHANICAL PROPERTIES OF FLUIDS

$T = \frac{F}{l}$ (surface Tension)

Pressure (P) = $\frac{F}{A}$

Pressure difference $(P_i - P_o) = h\rho g$

Pressure inside drop (P) = $\frac{2T}{r}$

Pressure inside soap bubble (P) = $\frac{4T}{r}$

Rise or Fall of capillary

$$h = \frac{2T\cos\theta}{\rho r g}$$

Velocity gradient

$$V_g = \frac{dv}{dx}$$

Viscous Force (F) = $\eta A \frac{dv}{dx}$

stoke's formula $F = 6\pi\eta r v$

KTG AND RADIATION

Ideal gas equation:

$\{PV = nRT\}$ $\{PV = N_A K_B T\}$

Pressure exerted by Gas:

$$P = \frac{1}{3}\frac{mNv^2}{V}$$

By Using this formula you can make many formula

Note: $\{$K.E, V_{rms} And ρ Everything can be calculated$\}$

Root mean square speed:

$$V_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3P}{\rho}}$$

Kinetic Energy of gas molecule:

(i) K.E of gas molecules $= \frac{3}{2}PV$

(ii) K.E of gas per Unit mole $= \frac{3}{2}RT$

(iii) K.E per Unit mass $= \frac{3}{2}\frac{RT}{M}$

(iv) K.E per molecules $= \frac{3}{2}K_B T$

Mayer's Relation

1) $C_p - C_v = R$

ii) $\frac{C_p}{C_v} = \gamma$

emission

$$e = \frac{R}{R_B} \quad \text{Also} \quad a = \frac{R}{R_B}$$

Heat Radiation depends on

$$Q = RAt$$

Radiant Heat emitted by blackbody

$$Q = \sigma A T^4 t$$

Boltzmann Heat Radiation

(i) $Q \propto T^4$

$(Q = \sigma T^4)$

Also

(ii) $e \propto T^4$

$(e = \sigma T^4)$

Weins Displacement

$$\lambda_{max} = \frac{b}{T} \qquad (b = 2.898 \times 10^{-3} \text{ m-K})$$

REMEMBER It :

Note : $b = 2.898 \times 10^{-3}$

$\sigma = 1.17 \times 10^{-7}$

THERMODYNAMICS

Workdone ($dw = Pdv$)

First Law of thermodynamics

$$Q = U + W$$

or

$$\Delta Q = \Delta U + \Delta W$$

Ideal gas

$$(PV = nRT)$$

Isothermal (T constant)

$$\Delta T = 0$$

Adiabatic (Q constant)

$$\Delta Q = 0$$

Isobaric (P constant)

$$\Delta P = 0$$

Isochoric (V is constant)

$$\Delta V = 0$$

cyclic (U is constant)

$$\Delta U = 0$$

Reversible & Irreversible

Reversible	Irreversible
Slow Process	Fast Process
W_{min}	W_{max}
Reversed	Irreversed.

Workdone in Isothermal Process

i.e. $W = nRT\log_e\left(\frac{V_2}{V_1}\right)$

or

$W = nRT\log_e\left(\frac{P_1}{P_2}\right)$

Workdone in Adiabatic Process

$$W = \frac{nR}{(1-\gamma)}\left[T_2 - T_1\right]$$

Also

$PV^{\gamma} = \text{constant}$

$TV^{\gamma-1} = \text{constant}$

$\gamma = \frac{C_P}{C_V}$

Oscillations

Restoring Force

$F = -kx$

Spring Time period

$T = 2\pi\sqrt{\frac{m}{k}}$

Differential eqn

$$\frac{d^2x}{dt^2} + \omega^2 x = 0$$

accln in SHM

$a = -\omega^2 x$

Velocity in SHM

$v = \pm\omega\sqrt{A^2 - x^2}$

displacement

$x = A\sin(\omega t + \alpha)$

Frequency (F, n, f, ν)

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

Period in SHM

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

P.E = 0 (At MP)

$P.E = \frac{1}{2}kx^2 = \frac{1}{2}m\omega^2 x^2$ (At E.P)

K.E = 0 (At E.P)

$K.E = \frac{1}{2}k(A^2 - x^2)$ (At M.P)

$T.E = \frac{1}{2}kx^2 = \frac{1}{2}kA^2 = \frac{1}{2}m\omega^2A^2$

Composition of two SHM

i) Resultant Amplitude

$$R = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos(\phi_2 - \phi_1)}$$

ii) Resultant phase

$$\delta = \tan^{-1}\left[\frac{A_1\sin\phi_1 + A_2\sin\phi_2}{A_1\cos\phi_1 + A_2\cos\phi_2}\right]$$

Simple Pendulum

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

Note: Time for seconds Pendulum (2s) And length (100 cm ≈ 1m)

Differential eqn for Angular SHM

$$\left[\frac{Id^2\theta}{dt^2} + c\theta = 0\right]$$

Superposition of Waves

velocity of wave

(i) $v = n\lambda$

(ii) $v = \lambda/T$

Angular frequency

$$\omega = \frac{2\pi}{T} = 2\pi n \quad (\text{since } \tfrac{1}{T} = n)$$

Phase difference

$$\delta = \frac{2\pi x}{\lambda}$$

Path difference

$$x = \frac{\lambda}{2\pi}\delta$$

Simple Harmonic Progressive Wave
(Positive Direction)

$$y = A\sin\left(\omega t - \frac{2\pi x}{\lambda}\right)$$

Also

$$y = A\sin 2\pi\left(nt - \frac{x}{\lambda}\right)$$

Also

$$y = A\sin 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)$$

Period of Beat

$$T = \frac{1}{n_1 - n_2} \quad \text{if } n_1 > n_2$$

Also

$$T = \frac{1}{n_2 - n_1} \quad \text{if } n_2 > n_1$$

Distance betn (successive) Nodes And (successive) Antinodes $= \frac{\lambda}{2}$

Distance betn Nodes And Antinodes $= \frac{\lambda}{4}$

wave velocity $v = \sqrt{\frac{T}{m}}$

frequency in string

$$n = \frac{1}{2l}\sqrt{\frac{T}{m}}$$

frequency in open pipe

$$n = \frac{v}{2L}$$

WAVE OPTICS

Refractive Index

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} = \frac{v_1}{v_2}$$

Brewster's Law

$$\mu = \tan i_p$$

Path difference for Interference

$$\Delta x = n\lambda \quad \text{(Bright)}$$

$n = 0, 1, 2, 3 \ldots$

$$\Delta x = (2n-1)\frac{\lambda}{2} \quad \text{(Dark)}$$

$n = 1, 2, 3 \ldots$

Phase difference for Interference

$$\Delta\phi = 2n\pi \quad \text{(Bright)}$$

$n = 0, 1, 2, 3 \ldots$

$$\Delta\phi = (2n-1)\pi$$

$n = 1, 2, 3 \ldots$ (Dark)

Band width :

$$W = \frac{\lambda D}{d} \quad \text{(General)}$$

for Bright

$$W = \frac{\lambda D}{d} = \frac{n\lambda D}{d}$$

for Dark

$$W = \frac{(2n-1)\lambda D}{2d}$$

Wavelength $\lambda = \frac{Wd}{D}$

For Diffraction

Path difference $= a\sin\theta = n\lambda$ (secondary minimum)

$a\sin\theta = (2n+1)\frac{\lambda}{2}$ (secondary maximum)

Distance of nth (secondary) Minimum from Centre

$$y_{n_d} = \frac{nD\lambda}{a}$$

Distance of nth (secondary) maximum from centre

$$y_{n_b} = (2n+1)\frac{\lambda D}{2a}$$

8 # ELECTROSTATICS

charge $(q = It)$

Electric field $(E) = \frac{F}{q} = \frac{V}{d}$

Electric flux $(\phi) = E\,ds\cos\theta = EA$

Gauss Law $\phi = \frac{q}{\varepsilon_0}$

$$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F/m}$$

Linear charge Density $\lambda = \frac{q}{l}$

surface charge Density $\sigma = \frac{q}{A}$

Dielectric constant

$K = \frac{\varepsilon}{\varepsilon_0}$ Note $(K = 3)$

Electric Intensity (Sphere)

$$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2}$$

Electric Intensity

$$E = \frac{\lambda}{2\pi r \varepsilon_0} \quad \text{(cylindrical)}$$

$E_{inside} = 0$

Work done: $W = qV$

Torque: $\tau = PE\sin\theta$

Potential Energy (point charge)

$$U = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q q_0}{r}$$

Electrostatic Potential (Point charge)

$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r}$$

$E = \frac{-dv}{dx}$ { Rel^n bet^n Electric field And Electric Potential }

Workdone (external field)

$$(W = qV)$$

Potential due to dipole

$$V = \frac{P}{4\pi\varepsilon_0 r^2}$$

Potential energy due to electric dipole (external)

$$U = PE(\cos\phi_2 - \cos\phi_1)$$

Capacity (c)

$$c = \frac{Q}{V}$$

Capacitance in series

$$\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \cdots \frac{1}{C_n}$$

Capacitance in parallel

$$C_p = C_1 + C_2 + C_3 \cdots + C_n$$

Capacitance in Parallel Plate

$$c = \frac{A\varepsilon_0 k}{d} = \frac{A\varepsilon}{d}$$

Energy stored in Capacitor

$$U = \frac{1}{2}cV^2 = \frac{1}{2}QV$$

Current Electricity

Resistance of wire

$$R = \frac{\rho L}{A}$$

Current: $Q = It$

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

Potential (Voltage) across external Resistance

$$V = \frac{ER}{(R+r)}$$

Junction Law:

$$\sum I = 0$$

Voltage Law

$$\sum IR + \sum E = 0$$

Meter Bridge

$$X = R\left(\frac{l_x}{100-l_x}\right)$$

Galvanometer of Resistance

$$G = R\left(\frac{l_g}{100-l_g}\right)$$

Potentiometer

$$V = Kl$$

Potential gradient (K)

$$K = \frac{V}{l}$$

Comparison betn Emf :

cell Individulal method

$$\frac{E_1}{E_2} = \frac{Kl_1}{Kl_2}$$

cell combinationmethod

$$\frac{E_1}{E_2} = \frac{l_1+l_2}{l_1-l_2}$$ {sum And Diff method)

Internal Resistance

$$r = R\left(\frac{l_1}{l_2}-1\right) \quad \text{or} \quad r = R\left(\frac{E}{V}-1\right)$$

Galvanometer As Ammeter

i) $I = I_s + I_g$

ii) $I_s S = I_g G$

iii) $S = \frac{G I_g}{I_s}$

iv) $I_s = \left(\frac{G}{S+G}\right) I$

Voltmeter :

$$x = \frac{V}{I_g} - G$$

Magnetic fields due to electric Current

Force $(F) = BIl\sin\theta = BIl$

Force on moving charge

$$F = qvB\sin\theta = qvB$$

Torque on a current loop

$$\tau = NAIB\sin\theta$$

$$\tau = NAIB \quad (\text{for } N \text{ turns})$$

Magnetic moment

$$M = IA$$

or

$$M = nIA$$

Deflection of Torque in (M.C.G)

$$\tau = NIAB\sin\theta \quad (\text{perpendicular})$$

or

$$\tau = NIAB\cos\theta \quad (\text{Horizontal})$$

Biot - Savart's Law (To find magnetic field)

$$dB = \frac{\mu_0}{4\pi} \cdot \frac{Idl\sin\theta}{r^2}$$

Magnetic Induction at a point perpendicular distance (R)

$$B = \frac{\mu_0 I}{2\pi R}$$

Magnetic Force betn two parallel wire

$$F = \frac{\mu_0 I_1 I_2 l}{2\pi d}$$

Magnetic length due to current carrying arc.
(field)

$$B = \frac{\mu_0 I}{4\pi R} \times \theta$$

Magnetic field At centre of Circular coil.

$$B = \frac{\mu_0 I}{2r} = \frac{\mu_0 n I}{2r}$$

Magnetic Induction at a point along the Axis of a coil carrying current.

$$B = \frac{\mu_0 I R^2}{2(z^2+R^2)^{3/2}}$$

for n turns

$$B = \frac{\mu_0 n I R^2}{2(z^2+R^2)^{3/2}}$$

Magnetic Induction at a point inside the solenoid

$$B = \mu_0 n i$$

$$\left(n = \frac{N}{l}\right)$$

Magnetic Induction along the Axis of Toroid.

$$B = \mu_0 n i$$

$$\left(n = \frac{N}{2\pi r}\right)$$

Magnetic Materials

Torque acting on magnetic dipole.

$$\tau = MB\sin\theta$$

Time Period of angular oscillations of a bar magnet.

$$T = 2\pi\sqrt{\frac{I}{MB}}$$

For Revolving electron

- Magnetic moment $= \frac{evr}{2} = \frac{eL}{2m_e}$

Gyromagnetic Ratio : $\frac{M_{orb}}{L} = \frac{e}{2m_e}$

Magnetic Intensity : $H = \frac{B_0}{\mu_0}$

Magnetization $(M_z) = \frac{M_{net}}{V}$

Magnetic field Due to Iron Core.(Toroid)

- $B = B_0 + B_m$
- $B = \mu_0 (H + M)$

Magnetic susceptibility (χ)

$$\therefore \chi = \frac{M}{H}$$

magnetic permeability (μ)

$$\therefore \mu = \frac{B}{H}$$

Relation betn Permeability And susceptibility

i.e $\mu = \mu_0 (1 + \chi)$

Also

$(\mu = \mu_0 \mu_r)$

#ElectroMagneticInduction

Magnetic flux :

$$\phi = BA\cos\theta$$

Magnitude of Induced emf.

$$e = \frac{d\phi}{dt}$$

$$e = \frac{nd\phi}{dt} \text{ (for turns)}$$

emf induced in straight Conductor

i.e $e = Blv$

Induced current

$$I = \frac{e}{R} = \frac{e_0 \sin\omega t}{R} = I_0 \sin\omega t$$

Instantaneous emf.

$$e = e_0 \sin\omega t$$

Induced emf in self(Inductor)

$$e = \frac{Ld\phi}{dt} \Rightarrow e = \frac{LdI}{dt}$$

Induced emf in mutual(Inductor)

$$e = M\frac{d\phi}{dt} \Rightarrow e = \frac{MdI}{dt}$$

Transformer

$$e_s = N_s \frac{d\phi}{dt}$$

$$e_p = N_p \frac{d\phi}{dt}$$

for an Ideal Transformer

$$\frac{e_s}{e_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$$

AC Circuit

Alternating emf : $e = e_0 \sin\omega t$

Alternating current $I = I_0 \sin\omega t$

Average Value :

$$i_{av} = 0.637\, i_0$$

$$e_{av} = 0.637\, e_0$$

R.M.S value of Induced emf And current

$$e_{rms} = \frac{e_0}{\sqrt{2}}$$

$$i_{rms} = \frac{i_0}{\sqrt{2}}$$

Inductive reactance :

$$X_L = \frac{e_{rms}}{i_{rms}} = \omega L = 2\pi f = 2\pi n L$$

Capacitive reactance :

$$X_C = \frac{e_{rms}}{i_{rms}}$$

Impedance :

$$z = \frac{e_{rms}}{i_{rms}} = \sqrt{R^2 + (X_L - X_C)^2}$$

Impedance in LR circuit

$$z = \sqrt{R^2 + X_L^2}$$

in CR circuit

$$z = \sqrt{R^2 + X_C^2}$$

Resonance frequency

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

Dual Nature of Light

photon Energy

i) $E = h\nu = \frac{hc}{\lambda}$

Work function

$$W_0 = \phi_0 = h\nu_0 = \frac{hc}{\lambda_0}$$

Maximum Energy of photoelectron.

$$K.E_{max} = \frac{1}{2}mv^2$$

$$K.E_{max} = eV_0$$

Relation betn momentum And K.E

$$P = \sqrt{2mE}$$

De-Broglie's Wavelength :

$$\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$$

Structure of Atoms And Nuclei

Angular momentum

$$L = mvr = \frac{nh}{2\pi}$$

Radius in nth Bohr orbit

$$r_n = \frac{\varepsilon_0 n^2 h^2}{\pi m_e Z e^2} \qquad r_n \propto n^2$$

$$\frac{r_1}{r_2} = \left(\frac{n_1}{n_2}\right)^2$$

Velocity of electron in nth Orbit

$$v_n = \frac{Ze^2}{2\varepsilon_0 nh} \quad \text{i.e} \quad v_n \propto \frac{1}{n}$$

Energy diff.

$$\Delta E = E_2 - E_1$$

Energy of nth orbit

$$E_n = \frac{-13.6 Z^2}{n^2} = \frac{-13.6}{n^2} \text{ eV}$$

Decay Law :

$$N(t) = N_0 e^{-\lambda t}$$

Half Life Period $T_{1/2} = \dfrac{0.693}{\lambda}$

Average Life $\tau = \dfrac{T_{1/2}}{0.693}$

Semi Conductor Devices.

Current in Transistor

$$I_E = I_B + I_C$$

Current Gain of Transistor

$$\alpha_{DC} = \frac{I_C}{I_E}$$

$$\beta_{DC} = \frac{I_C}{I_B}$$

$$\beta_{AC} = \frac{I_C}{I_B}$$

Resistance of Transistor :

Input dynamic Resistance

$$r_i = \frac{\Delta V_{BE}}{\Delta I_B}$$

output

$$r_o = \frac{\Delta V_{CE}}{\Delta I_C}$$

#MotionInAPlane

Average speed $= \dfrac{\text{Path length}}{\text{time}}$

Average velocity $= \dfrac{\text{distance}}{\text{time}}$

Instantaneous velocity $= \dfrac{dr}{dt}$

Instantaneous acceleration $= \dfrac{dv}{dt}$

#
$$\left.\begin{aligned} v &= u + at \\ v^2 &= u^2 + 2as \\ s &= ut + \tfrac{1}{2}at^2 \end{aligned}\right\} \text{Eq}^n \text{ of motion}$$

Motion Under gravity

$v = u - at$, $v = u - gt$

$s = ut - \frac{1}{2}gt^2$

$v^2 = u^2 - 2gs$

Projectile Motion

$u_x = v_x = u\cos\theta$

Distance betn projection and the Position at 't'

$v = \sqrt{v_x^2 + v_y^2}$

Time of flight

$$T = \frac{2u\sin\theta}{g}$$

Maximum Height

$$H = \frac{u^2\sin^2\theta}{2g}$$

Horizontal Range

$$R = \frac{u^2\sin 2\theta}{g}, \quad R_{max} = \frac{u^2}{g}$$

at
$\theta = 90°$
$\theta = 45°$

Uniform Circular Motion

$$T = \frac{2\pi r}{v} \quad ,(v = r\omega)$$

For Conical Pendulum (T)

$$T = 2\pi\sqrt{\frac{L\cos\theta}{g}} = 2\pi\sqrt{\frac{h}{g}}$$

Gravitation

Newton's Law of Gravitation

$$F = \frac{GM_1M_2}{r^2}$$

Gravitational P.E

$$U = -\frac{GMm}{r}$$

Acceleration due to gravity

- on Earth Surface

$$g = \frac{GM}{R^2}$$

- At certain Height

$$g_h = \frac{GM}{(R+h)^2}$$

- At centre of Earth

$$g_{cent} = 0$$

Critical velocity

$$V_c = \sqrt{\frac{GM}{r}}$$

Angular velocity of satellite

$$\omega = \sqrt{\frac{GM}{r^3}} = \sqrt{\frac{GM}{(R+h)^3}}$$

Time Period of satellite

$$T = \frac{2\pi r}{V_c}$$

escape velocity

$$V_e = \sqrt{\frac{2GM}{R}} = \sqrt{2}\, V_c$$

Optics

velocity of light

1) $c = \nu\lambda$

2) ${}^1n_2 = \frac{c_1}{c_2}$

Real And Apparent

$${}^1n_2 = \frac{\text{real Depth}}{\text{Apparent Depth}}$$

Refractive Index

- $${}^1n_2 = \frac{\sin i}{\sin r} = \frac{\sin e}{\sin r_2}$$
- $A = r_1 + r_2$
- $i + e = A + \delta$

For thin Prism

$$\delta = A(n-1)$$

Mean value

$$\omega = \frac{\delta_V - \delta_R}{\delta_y}$$

Simple Microscope

$$M = \frac{D}{u} = \frac{D}{f}$$
at ∞

Also $M = 1 + \frac{D}{f}$ at Distinct Vision

Compound Microscope

$M = m_o \times m_e$

Power (P) $= \frac{1}{f}$

Electrostatics 11th
&
semiConductor 11th

} same 12th

THANK You

~ By AjayDube Sir.

*———— Good Luck ———— *

★ May the Luck Always With You

Love & Regards
Ajay Sir

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for Any Information____.