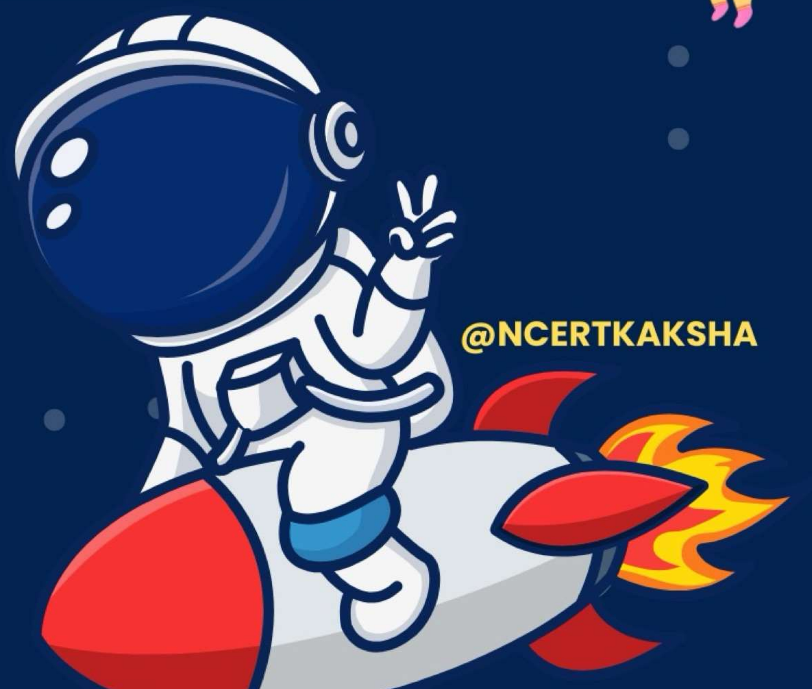
2025 - 2026

PHYSICS FORMULA SHEET

CLASS - 12



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WARNING

Class XII (2025 - 2026)

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CHAPTER-1

UNIT-1 (ELECTROSTATICS)

Electric charges and field

BOOSTER SHOT → Charges
- Positive (+)
- Negative (−)

Like charges (+, +) repel each other
unlike charges (+, −) attract each other

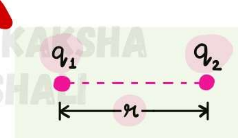
→ **Additivity of charges** $\boxed{q_1 + q_2 + q_3 + \dots + q_n}$

→ **Quantisation of charge** $\boxed{q = \pm ne}$

n = integer (positive or Negative)
e = basic unit of charge = 1.6×10^{-19} C
$q_1, q_2, q_3 \dots q_n$ = charges

→ $\boxed{q = i \times t}$ i = Electric current , t = time

→ **Coulomb's law** $\boxed{F = k\dfrac{|q_1 q_2|}{r^2}}$ $\boxed{F = \dfrac{1}{4\pi\varepsilon_0}\dfrac{|q_1 q_2|}{r^2}}$ $\left[k = \dfrac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ N\text{-}m^2/C^2\right]$



→ $\boxed{K = \dfrac{\varepsilon}{\varepsilon_0}}$ ε_0 = Permittivity of free space = $8.854 \times 10^{-12}\ C^2N^{-1}m^{-2}$, ε = Permittivity of dielectric

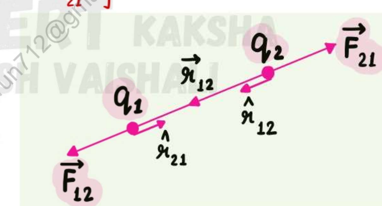
→ **Coulomb's law in vector form**

$$\boxed{F_{21} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{21}^2}\hat{r}_{21}}$$

$$\boxed{F_{12} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12}}$$

$$\boxed{\vec{F}_{12} = -\vec{F}_{21}}$$

$\left[\hat{r}_{21} = \dfrac{\vec{r}_{21}}{r_{21}}\right]$ $\left[\vec{r}_{12} = \vec{r}_1 - \vec{r}_2 = -\vec{r}_{21}\right]$



→ **Force between multiple charges**

$$\boxed{\vec{F}_1 = \vec{F}_{12} + \vec{F}_{13} + \dots + \vec{F}_{1n} = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12} + \frac{q_1 q_3}{r_{13}^2}\hat{r}_{13} + \dots + \frac{q_1 q_n}{r_{1n}^2}\hat{r}_{1n}\right] = \frac{q_1}{4\pi\varepsilon_0}\sum_{i=2}^{n}\frac{q_i}{r_{1i}^2}\hat{r}_{1i}}$$

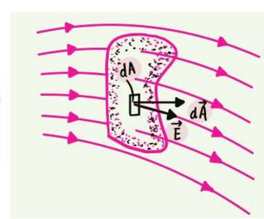
→ **Electric field** $\boxed{\vec{E} = \dfrac{\vec{F}}{q_0}}$

→ **Electric field due to a point charge** $\boxed{\vec{E} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{q}{r^2}}$

→ **Force on a charged particle due to an electric field** $\boxed{\vec{F} = q\vec{E}}$

→ **Electric flux** $\boxed{\phi_E = \int_A \vec{E}\cdot\vec{dA} = EA\cos\theta}$ OR $\boxed{\Delta\phi = \vec{E}\cdot\vec{dA}}$

dA = area element
θ = angle between E and ΔS

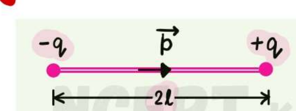


→ **Electric dipole moment** $\boxed{p = q \times 2l = 2ql}$

direction (−q) to (+q)

$2l$ = distance between charges

→ **Electric field due to an electric dipole**



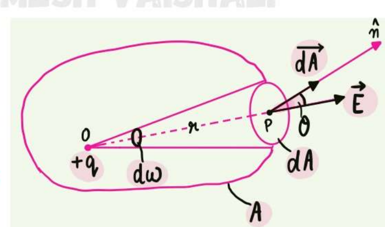
1. At a point on the dipole axis $\boxed{\vec{E} = \dfrac{2\vec{p}}{4\pi\varepsilon_0 r^3}}$ (in $\hat{p}$ direction)

2. At a point on equatorial plane $\boxed{\vec{E} = \dfrac{-\vec{p}}{4\pi\varepsilon_0 r^3}}$ (in $-\hat{p}$ direction)

→ **Dipole in a uniform external field** $\boxed{\vec{\tau} = \vec{p} \times \vec{E}}$ $\boxed{\tau = pE\sin\theta}$

τ = Torque

→ **Gauss law** $\boxed{\phi_E = \oint \vec{E}\cdot\vec{dA} = \dfrac{q}{\varepsilon_0}}$



Applications of gauss law

1. Field due to an infinitely long straight uniformly charged wire $\boxed{\vec{E} = \frac{\lambda}{2\pi\varepsilon_0 r}\hat{n}}$ $\hat{n}$ = unit vector

2. Field due to a uniformly charged infinite plane sheet $\boxed{\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}}$

3. Field due to a uniformly charged thin spherical shell

(a) Outside the shell $\boxed{\vec{E} = \frac{q}{4\pi\varepsilon_0 r^2}\hat{r}}$ $(r \geq R)$

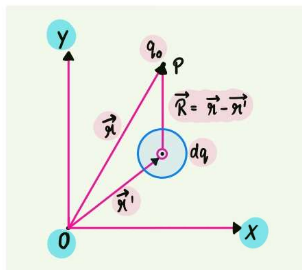
(b) inside the shell $\boxed{E = 0}$ $(r < R)$

Continuous charge density

Surface charge density $\boxed{\sigma = \frac{\Delta Q}{\Delta S}}$

Linear charge density $\boxed{\lambda = \frac{\Delta Q}{\Delta l}}$

Volume charge density $\boxed{\rho = \frac{\Delta Q}{\Delta V}}$

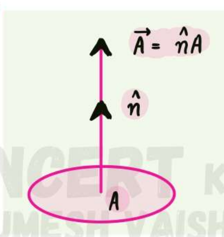


BOOSTER SHOT → Coulomb's law agree with the Newton's third law.

Area Vector

$\boxed{\hat{n} = \frac{\vec{A}}{A}}$

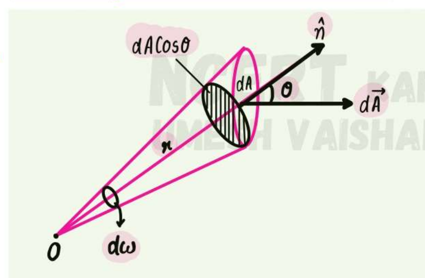
$\hat{n}$ = unit vector



Solid Angle

$\boxed{d\omega = \frac{dA}{r^2}}$ OR $\boxed{d\omega = \frac{dA\cos\theta}{r^2}}$

θ = Angle between $\hat{n}$ and $\vec{A}$



Best of luck for your Board Exams 2025-26

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CHAPTER-2

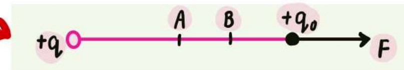
UNIT-1 (ELECTROSTATICS)

Electrostatic potential and capacitance

- **Electric Potential** $V = \frac{W}{q_0}$

  W = Work q_0 = positive test charge

- **Potential difference** $V_A - V_B = \frac{W}{q_0}$

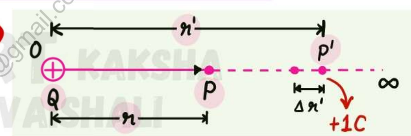


- **Work done in taking a charge between two points in an External field** $W = q \times \Delta V$

BOOSTER SHOT

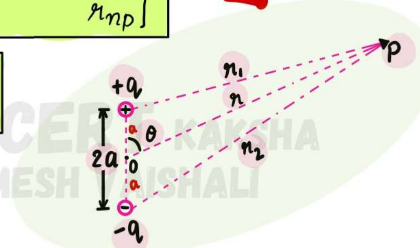
1 electron volt (eV) = 1.6×10^{-19} Joule
1 kiloelectron volt = 10^3 eV = 1.6×10^{-16} Joule
1 Millionelectron volt = 10^6 eV = 1.6×10^{-13} Joule
1 Billionelectron volt = 10^9 eV = 1.6×10^{-10} Joule

- **Potential due to point charge** $V(r) = \frac{Q}{4\pi\varepsilon_0 r}$



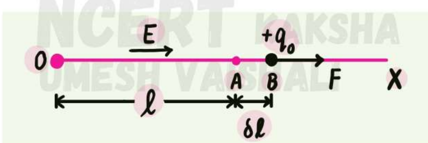
- **Potential due to an electric dipole** $V = \frac{1}{4\pi\varepsilon_0}\frac{\vec{p}\cdot\hat{r}}{r^2}$

- **Potential due to a system of charges** $V = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{r_{1P}} + \frac{q_2}{r_{2P}} + \cdots \frac{q_n}{r_{nP}}\right]$



- **Potential Energy of a system of charges** $U = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}}$

- **Relation between field and potential** $\vec{E} = -\frac{\delta V}{\delta l}$



- **Potential Energy in an external field** $U = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1 q_2}{r_{12}} + \frac{q_1 q_3}{r_{13}} + \frac{q_2 q_3}{r_{23}}\right]$

Potential Energy of a single charge = $qV(r)$

Potential Energy of a system of two charges in an external field = $q_1 V(r_1) + q_2 V(r_2) + \frac{q_1 q_2}{4\pi\varepsilon_0 r_{12}}$

Potential Energy of a dipole in an external field $q[V(r_1) - V(r_2)] = 0$

- **Electric field at the surface of a charged conductor** $\vec{E} = \frac{\sigma}{\varepsilon_0}\hat{n}$

  σ = surface charge density , $\hat{n}$ = unit vector normal to the surface in the outward direction

- **Work done in rotating Electric dipole** $W = pE(\cos\theta_0 - \cos\theta)$

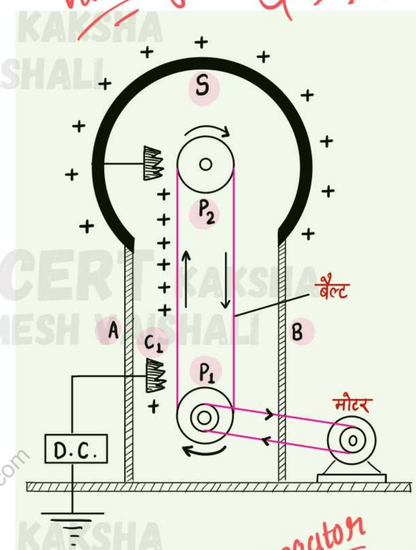
(a) $\theta_0 = 0°$ $W = pE(1 - \cos\theta)$ (b) $\theta = 90°$ $W = pE$ (c) $\theta = 180°$ $W = 2pE$

- **Potential Energy of electric dipole in an external field** $\boxed{U(\theta) = -pE\cos\theta = -\vec{p}\cdot\vec{E}}$

(a) $\theta = 0^\circ$ $\boxed{U = -pE}$ (b) $\theta = 90^\circ$ $\boxed{U = 0}$ (c) $\theta = 180^\circ$ $\boxed{U = pE}$

- **Potential difference** $\boxed{V = Ed}$
- **Capacitor in series** $\boxed{\dfrac{1}{C} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \dfrac{1}{C_3} + \dots + \dfrac{1}{C_n}}$
- **Capacitor in parallel** $\boxed{C = C_1 + C_2 + C_3 + C_4}$
- **Energy density of electric field** $\boxed{u = \dfrac{1}{2}\varepsilon_0 E^2}$
- **Van De Graff Generator** $\boxed{V(r) - V(R) = \dfrac{q}{4\pi\varepsilon_0}\left[\dfrac{1}{r} - \dfrac{1}{R}\right]}$

Vandegraff Generator

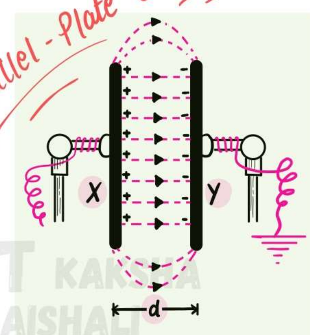


- **Polarization** (dipole moment per unit volume) $\boxed{\vec{P} = \chi_e \vec{E}}$

χ_e = electric susceptibility

- **Capacitance** $\boxed{C = \dfrac{Q}{V}}$
- **The Parallel Plate Capacitor** $\boxed{C = \dfrac{\varepsilon_0 A}{d}}$ d = Separation between plates

Parallel-Plate capacitor



- **Effect of dielectric on capacitance** $\boxed{K = \dfrac{C}{C_0}}$ K = dielectric constant
- **Electric Displacement** $\boxed{\vec{D} = \varepsilon_0\vec{E} + \vec{P}}$
- **Electric Susceptibility** $\boxed{\chi_e = \varepsilon_0(K-1)}$ and $\boxed{\vec{D} = \varepsilon_0 K\vec{E}}$
- **Force between the plates of a charged parallel-plate capacitor** $\boxed{F = \dfrac{1}{2}qE}$
- **Energy stored in capacitor** $\boxed{U = \dfrac{1}{2}\varepsilon_0 E^2 Ad}$ $\boxed{U = \dfrac{1}{2}\dfrac{Q^2}{C} = \dfrac{1}{2}CV^2 = \dfrac{1}{2}QV}$

CHAPTER-3

UNIT-II (CURRENT ELECTRICITY)

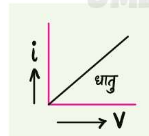
Current electricity

- **Electric current** $I = \frac{q}{t} = \frac{ne}{t}$ $(\because q = ne)$

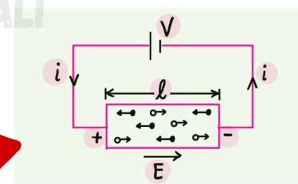
BOOSTER SHOT

1 Ampere = 1 coulomb/sec
1 Ampere = 6.25×10^{18} e/sec
1 ohm = 1 Volt/Ampere
1 Megaohm = 10^6 ohm (Ω)
1 microohm = 10^{-6} ohm

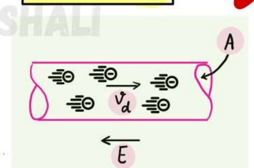
- **Ohm's law** $V = RI$ (R = Resistance)



- **Electrical Resistance** $R = \frac{V}{i}$
- **Resistivity** OR **Specific Resistance** (ρ) $\rho = R\frac{A}{l}$ $\rho = \frac{m}{ne^2\tau}$
- **Specific conductance** OR **Conductivity** (σ) $\sigma = \frac{1}{\rho}$ $\sigma = \frac{ne^2\tau}{m}$ $\sigma = e(\mu_e n_e + \mu_h n_h)$
- **Relation between Specific Conductance and Current density (j)** $\vec{j} = \sigma\vec{E}$
- **Drift velocity on the basis of ohm's law** $v_d = \left(\frac{eV}{ml}\right)\tau$ (drift velocity)
- **Mobility (μ)** $\mu = \frac{v_d}{E} = \frac{e\tau}{m}$



- **Relation between drift velocity of free electrons and electric current** $i = neAv_d$

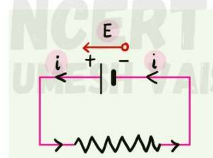


- **Current density** $j = nev_d$
- **Temperature dependence of Resistivity** $\rho_T = \rho_0[1 + \alpha(T - T_0)]$
- **Dynamic Resistance** $= \frac{\Delta V}{\Delta i}$
- **Electric Energy** $H = \frac{W}{4.2} = \frac{Vit}{4.2} = \frac{i^2Rt}{4.2} = \frac{V^2t}{4.2R}$ Calorie
- **Electric Power** $P = \frac{W}{t} = i^2R = \frac{V^2}{R}$

BOOSTER SHOT

1 Watt = 1 Joule/sec
1 Kilowatt-hour = 3.6×10^6 Watt-sec = 3.6×10^6 Joule

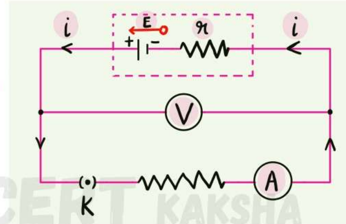
- **Resistors in Series** $R = R_1 + R_2 + R_3$
- **Resistors in parallel** $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
- **EMF of a cell** $E = \frac{W}{q}$



- **Terminal Potential difference** $E = V_1 + V_2 + V_3 + \ldots$

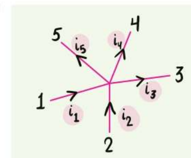
Relation among Terminal Potential difference, EMF and internel resistance of a cell

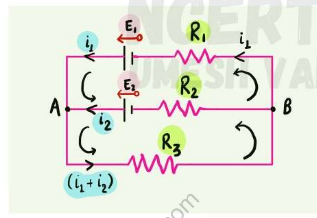
$\boxed{V = E - ir}$ $\quad$ $\boxed{r = R\left[\frac{E}{V} - 1\right]}$ $\quad$ $\boxed{i = \frac{E}{R+r}}$



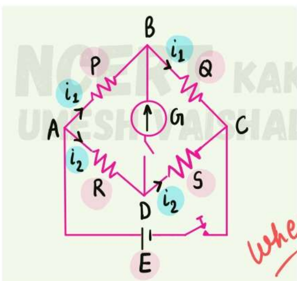
Kirchhoff's law

1. First law or Junction Rule $\quad \boxed{\Sigma i = 0}$
2. Second law or loop Rule $\quad \boxed{\Sigma iR = \Sigma E}$





Wheatstone bridge $\quad \boxed{\frac{P}{Q} = \frac{R}{S}}$



Wheatstone Bridge

Meter bridge $\quad \boxed{S = R\left(\frac{100-l}{l}\right)}$

l = length
R = standard known Resistance
S = unknown Resistance

Potentiometer $\quad \boxed{\frac{E_1}{E_2} = \frac{l_1}{l_2}}$ $\quad \boxed{V = E = \phi l}$ $\quad \boxed{r = R\left[\frac{l_1}{l_2} - 1\right]}$

Electric Energy or dissipated Energy $\quad \boxed{W = Vq = Vit = \frac{V^2 t}{R} = i^2RT}$

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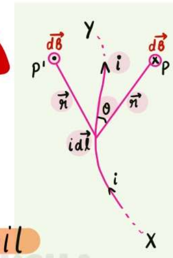
UNIT-III (MAGNETIC EFFECTS OF CURRENT AND MAGNETISM)

CHAPTER-4

Moving charges and Magnetism

➡ **Bio Savart law** $\boxed{dB = \frac{\mu_0}{4\pi}\frac{idl\sin\theta}{r^2}}$ $\boxed{\vec{dB} = \frac{\mu_0}{4\pi}\frac{i(\vec{dl}\times\vec{r})}{r^3}}$

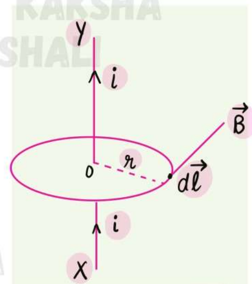


➡ **Relation between μ_0 and ε_0** $\boxed{c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}}$ $\frac{\mu_0}{4\pi} = 10^{-7}\ N/Amp^2$

➡ **Magnetic field along the axis of a current-carrying circular coil**

$\boxed{B = \frac{\mu_0 N i a^2}{2(a^2+x^2)^{3/2}}}$

a = radius of loop
μ_0 = Permiability of free space
N = No. of rounds in coil
ε_0 = Permitivity of free space



➡ **At centre of circular loop, $x = 0$** $\boxed{B = \frac{\mu_0 i}{2R}}$ $\boxed{B = \frac{\mu_0 N i}{2R}}$

➡ **Ampere's Circuital law** $\boxed{\oint \vec{B}\cdot\vec{dl} = \mu_0 i}$

➡ **Magnetic field due to an infinitely long straight current-carrying wire** $\boxed{B = \frac{\mu_0 i}{2\pi r}}$

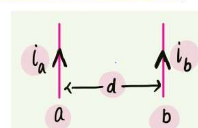
➡ **Magnetic field inside a long solenoid** $\boxed{B = \mu_0 n i_0}$

➡ **Magnetic field due to a toroid (Endless) Solenoid** $\boxed{B = \mu_0 n i}$

➡ **Magnetic field outside the toroid** $\boxed{B = 0}$

➡ **Motion in combined electric and Magnetic field** $\boxed{\vec{F} = q(\vec{E} + \vec{v}\times\vec{B}) = \vec{F}_B + \vec{F}_m}$

➡ **Force between two parallel currents** $\boxed{F_{ba} = \frac{\mu_0 i_a i_b L}{2\pi d}}$



➡ **Torque on a current loop** $\boxed{\tau = iAB\sin\theta}$ L = length of conductive wire

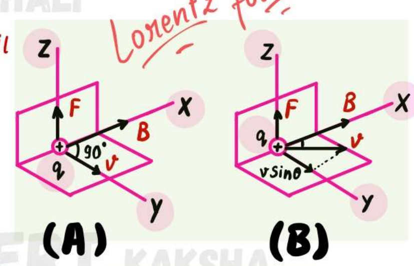
If loop N turns $\boxed{\tau = NiAB\sin\theta}$ A = Area of loop

If $\theta = 90^\circ$ $\boxed{\tau = NiAB}$ θ = Angle between field & Normal to the coil

If $\theta = 0^\circ$ $\boxed{\vec{\tau} = 0}$ i.e forces are collinear.

If $NiA = m$ (magnetic moment) $\boxed{\tau = mB\sin\theta}$ OR $\boxed{\vec{\tau} = \vec{m}\times\vec{B}}$

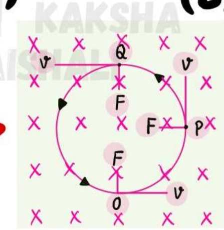
Lorentz force



➡ **Lorentz force** $\boxed{F = qvB}$ $\boxed{F = qvB\sin\theta}$

➡ **Motion of a charged Particle in a uniform Electric field**

$\boxed{y = \frac{qE}{2mv^2}x^2}$ $\boxed{y = \frac{qEl^2}{2mv^2}}$ $\boxed{y = \frac{qEl^2}{4K}}$ $\because K = \frac{1}{2}mv^2$



1. Parallel to the field $\boxed{F = 0}$

2. Perpendicular to the field

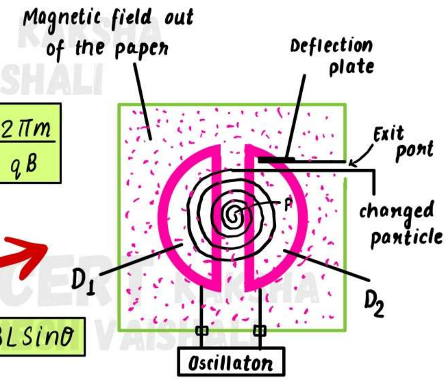
Radius of circle $r = \dfrac{mv}{qB}$ $\quad r = \dfrac{\sqrt{2mk}}{qB}$ $\quad \because v = \sqrt{\dfrac{2K}{m}}$ $\quad r = \dfrac{1}{B}\sqrt{\dfrac{2mV}{q}}$ $\quad \because K = qB$

Time period $T = \dfrac{2\pi r}{v} = \dfrac{2\pi m}{qB}$ $\quad$ frequency $\nu_0 = \dfrac{qB}{2\pi m}$

Relative frequency $\nu_0 = \dfrac{qB\sqrt{1-\frac{v^2}{c^2}}}{2m_0}$

3. Diagonal to the field $P = v\cos\theta \times \dfrac{2\pi m}{qB}$ $\quad r = \dfrac{mv\sin\theta}{qB}$ $\quad T = \dfrac{2\pi m}{qB}$

➡ Cyclotron $K_{max} = \dfrac{q^2B^2R^2}{2m}$



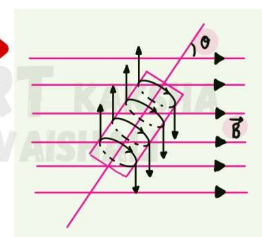
➡ Force on a current carrying conductor $F = iBL\sin\theta$

➡ Magnetic field at the centre of a current-carrying circular loop or coil $B = \dfrac{\mu_0 i}{2a}$ $\quad B = \dfrac{\mu_0 Ni}{2a}$

➡ Magnetic field due to a straight current carrying conductor to finite length $B = \dfrac{\mu_0}{4\pi}\dfrac{i}{r}(\sin\phi_1 + \sin\phi_2)$

➡ Potential Energy of a Magnetic Dipole in an external field

$U_\theta = -MB\cos\theta$



➡ Torque on a Bar Magnet $M = NiA$ $\quad \tau = MB\sin\theta$

➡ Magnetic field Intensity due to Magnetic dipoles

(a) End on position $B = \dfrac{\mu_0}{4\pi}\dfrac{2M}{r^3}$

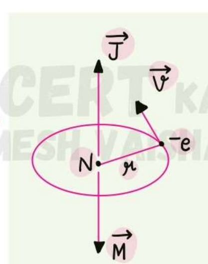
(b) Broad side on position $B = \dfrac{\mu_0}{4\pi}\dfrac{M}{r^3}$

➡ Moving coil Galvanometer

Deflection formula $\phi = \left(\dfrac{NAB}{K}\right)I$ $\quad$ Current sensitivity $= \dfrac{\phi}{I}$ $\quad$ Voltage sensitivity $= \dfrac{\phi}{V}$

➡ Magnetic dipole moment of revolving electron

$\vec{m}$ OR $\mu_e = \dfrac{-e}{2m_e}\vec{l}$ $\quad \left\{ \vec{l} \text{ OR } \vec{J} = \dfrac{nh}{2\pi} \text{ \& } n=1 \text{ for min} \right\}$



➡ Bohr Magneton $(\mu_e)_{min} = \dfrac{-eh}{4\pi m_e} = 9.27 \times 10^{-24}\ Am^2$

➡ Magnetic field at centre of long solenoid $B = \dfrac{\mu_0 ni}{2}[\cos\theta_1 - \cos\theta_2]$

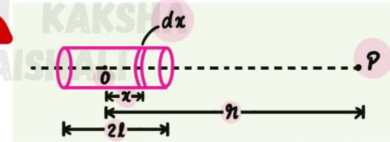
UNIT- III (MAGNETIC EFFECTS OF CURRENT AND MAGNETISM)

CHAPTER-5

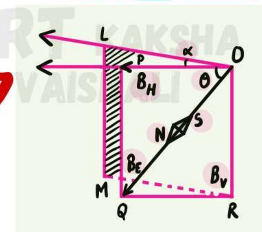
Magnetism and matter

➡ Bar Magnet as equivalent solenoid $B = \frac{\mu_0}{4\pi}\frac{2m}{r^3}$

m = magnetic moment



➡ Horizontal component of Earth's Magnetic field (B_E) $B_E = \sqrt{B_H^2 + B_V^2}$ $\theta = \tan^{-1}\left(\frac{B_V}{B_H}\right)$



➡ Intensity of Magnetisation ($\vec{M}$) OR ($\vec{I}$) $\vec{M} = \frac{\vec{m}_{net}}{V}$

➡ Magnetic Intensity ($\vec{H}$) $\vec{H} = \frac{\vec{B}}{\mu_0} - \vec{M}$

➡ Relative Magnetic Permeability (μ_r) $\mu_r = \frac{\mu}{\mu_0}$ $\mu_r = \frac{B}{B_0}$

flux density

$\mu_r < 1$ Diamagnetic $\mu_r > 1$ Paramagnetic $\mu_r >> 1$ Ferromagnetic

➡ Magnetic Susceptibility (χ_m) $\chi_m = \frac{\vec{M}}{\vec{H}}$ ➡ $\vec{B} = \mu_0 \vec{H}$

➡ Relation between μ_r and χ_m $\mu_r = I + \chi_m$

➡ Curie law $\chi = C\left(\frac{\mu_0}{T}\right)$ In Paramagnetic Phase $\chi = \frac{C}{T - T_c}$, $T > T_c$

➡ Dipole in uniform magnetic field $B = \frac{4\pi^2 I}{MT^2}$ I = Moment of Inertia

➡ Gauss law for magnetism for any closed surface $\phi_B = \oint \vec{B} \cdot d\vec{A} = 0$

MAGNETIC SUSCEPTIBILITY OF SOME ELEMENTS AT 300K

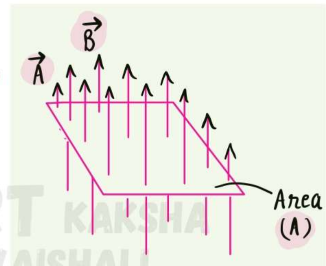
Diamagnetic substance	χ	Paramagnetic substance	χ
Bismuth	-1.66×10^{-5}	Aluminium	-2.3×10^{-5}
Copper	-9.8×10^{-6}	Calcium	-1.9×10^{-5}
Diamond	-2.2×10^{-5}	Chromium	-2.7×10^{-4}
Gold	-3.6×10^{-5}	Lithium	-2.1×10^{-5}
Lead	-1.7×10^{-5}	Magnesium	-1.2×10^{-5}
Mercury	-2.9×10^{-5}	Niobium	-2.6×10^{-5}
Nitrogen (STP)	-5.0×10^{-9}	Oxygen (STP)	-2.1×10^{-6}
Silver	-2.6×10^{-5}	Platinum	-2.9×10^{-4}
Silicon	-4.2×10^{-6}	Tungsten	-6.8×10^{-5}

UNIT-IV (ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENTS)

CHAPTER-6

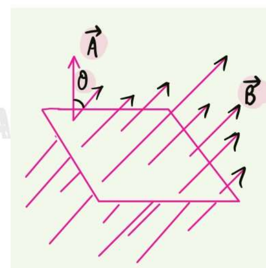
Electromagnetic induction

- **Magnetic flux** — $\phi_B = \vec{B}\cdot\vec{A} = BA\cos\theta$



[A] $\phi_B = BA$

- **Induced current** — $i = \frac{e}{r} = \frac{N}{R}\frac{d\phi_B}{dt}$ $\frac{d\phi_B}{dt} \propto \frac{di}{dt}$ & $N\phi_B \propto i$
- **Induced EMF** — $e = \frac{-d\phi_B}{dt}$ $e = -N\frac{d\phi_B}{dt}$
- **Induced charge** — $q = \frac{N}{R}\, d\phi_B$
- **Induced EMF cross the Ends of straight conductor** — $e = Bvl$



[B] $\phi_B = BA\cos\theta$

- **Self inductance** — $L = \frac{N\phi_B}{i}$ $e = -L\frac{di}{dt}$
- **Self inductance of a plane coil** — $L = \frac{\mu_0}{2}\pi N^2 r$
- **Self inductance of a long solenoid** — $L = \frac{\mu N^2 A}{l}$
- **Energy stored in a coil** OR **Energy required to build up the current i in coil** — $U = \frac{1}{2} L i_0^2$
- **Inductors in Series** — $L = L_1 + L_2$
- **Inductors in Parallel** — $\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2}$
- **Mutual inductance** — $M = \frac{N_2\phi_2}{i_1}$ $M = \frac{-e_2}{\Delta i_1/\Delta t}$
- **Mutual inductance of two coaxial Solenoids** — $M = \mu_r \mu_0 n_1 n_2 \pi r_1^2 l$
- **Energy consideration** — $P = \frac{B^2 l^2 v^2}{r}$ $\Delta Q = \frac{\Delta\phi_B}{r}$ P = Power
- **Inductance when current flowing in both coil** — $e = -L_1\frac{di_1}{dt} - M_{21}\frac{di_2}{dt}$

OR

EMF = Self inductance + Mutual inductance

Never Give up

UNIT- IV (ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENTS)

CHAPTER-7

Alternating current

- Alternating voltage $e_0 = NBA\omega$ $e = e_m \sin\omega t$, $i = i_m \sin\omega t$, $V = V_m \sin\omega t$

i_m and v_m are maximum values of current & voltage respectively.

- Mean value of Alternating voltage $i_{mean} = \frac{2}{\pi} i_{max} = 0.637\, i_{max}$
- Root mean square value of alternating current $i_{rms} = \sqrt{\bar{i^2}} = \frac{i_m}{\sqrt{2}} = 0.707\, i_m$
- Periodic Time $T = \frac{2\pi}{\omega}$
- Frequency $f = \frac{1}{T} = \frac{\omega}{2\pi}$
- $P = i^2 R$ $i_{virtual} = i_{rms} = \frac{i_m}{\sqrt{2}}$ $V_{virtual} = V_{rms} = \frac{V_m}{\sqrt{2}}$
- Average of $\langle \sin^2\omega t \rangle = \frac{1}{2}$
- Average value of power over a cycle $\bar{P} = \frac{1}{2} i_m^2 R$ & $\bar{P} = (i_{rms})^2 R$
- The average value of a function F(t) over a period T $\langle F(t) \rangle \frac{1}{T} \int_0^T F(t)\,dt$
- AC voltage applied to inductor

Current $i = i_m \sin\left(\omega t - \frac{\pi}{2}\right)$

Inductive Reactance $X_L = \omega L = 2\pi f L$

Power $P_L = \frac{-i_m v_m}{2} \sin 2\omega t$

- AC voltage applied to capacitor

Current $i = i_m \sin\left(\omega t + \frac{\pi}{2}\right)$

Capacitive Reactance $X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

Power $P_C = \frac{i_m v_m}{2} \sin 2\omega t$

Average power over a cycle $\bar{P_C} = \bar{P_L} = 0$

- When L and R in series

Impedance $Z = \sqrt{R^2 + (\omega L)^2}$ Phase angle $\tan\phi = \frac{\omega L}{R}$

- When C and R in series

Impedance $Z = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$ Phase angle $\tan\phi = \frac{1}{\omega C R}$

- When L and C in series

Resonance frequency $f = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}$

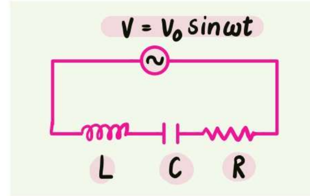
L = Inductance
C = Capacitance
R = Resistance

- When L, C, R in series

Impedance $Z = \sqrt{R^2 + (X_C - X_L)^2}$ Phase angle $\tan\phi = \frac{X_C - X_L}{R}$

- Max current $i_m = \frac{v_m}{\sqrt{R^2 + (X_C - X_L)^2}}$

→ **Series L-C-R Resonance circuit** $f = \frac{\omega}{2\pi} = \frac{1}{2\pi\sqrt{LC}}$

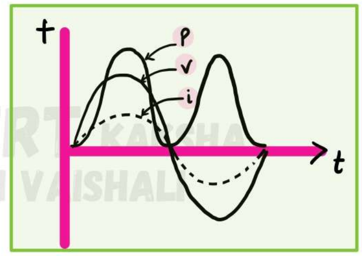


→ **Power in AC circuit**

1) When circuit contains pure resistance only $\bar{P} = V_{rms} \times i_{rms}$

2) When circuit contains L and R both $\bar{P} = V_{rms} \times i_{rms} \times \cos\phi$ $\cos\phi = \frac{R}{\sqrt{R^2+\omega^2L^2}} = \frac{R}{Z}$

$P = i^2_{rms} \cos\phi$ $P = \frac{v_m}{\sqrt{2}} \frac{i_m}{\sqrt{2}} \cos\phi$



→ **Watless Current** $\bar{P} = v_{rms} \times i_{rms} \times \cos 90° = 0$

→ **Band width** $\Delta\omega = \omega_2 - \omega_1 = \frac{R}{L}$

→ **Quality factor** $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

→ **Transformer Efficiency** $\eta = \frac{V_s \times i_s}{V_p \times i_p}$ $\bar{P} = (i_{rms})^2 \times R$ $\bar{P} = \frac{1}{2} i_0^2 R$

$\frac{V_s}{V_p} = \frac{e_s}{e_p} = \frac{N_s}{N_p} = r$ $\frac{i_p}{i_s} = \frac{V_s}{V_p} = \frac{N_s}{N_p} = r$

→ **L-C oscillations**

(i) $\frac{d^2q}{dt^2} + \omega_0^2 q = 0$

(ii) $\omega_0 = \frac{1}{\sqrt{LC}}$

(iii) $q = q_m \cos(\omega_0 t + \phi)$

(iv) Total energy of L-C circuit $U_E = \frac{1}{2}\frac{q_m^2}{C}$

Work hard ❤

CHAPTER-8

UNIT- V (ELECTROMAGNETIC WAVES)

Electromagnetic Waves

- **Displace current** $\boxed{i_d = \varepsilon_0 \dfrac{d\phi_E}{dt}}$ $\boxed{i = i_c + i_d}$

- **Maxwell Equations**

1. Gauss law of Electricity $\boxed{\oint \vec{E}\cdot d\vec{A} = \dfrac{q}{\varepsilon_0}}$
2. Gauss law of Magnetism $\boxed{\oint \vec{B}\cdot d\vec{A} = 0}$
3. Faraday's law of Electromagnetic induction $\boxed{e = -\dfrac{d\phi_B}{dt}}$ $\boxed{\oint \vec{E}\cdot d\vec{l} = -\dfrac{d\phi_B}{dt}}$
4. Ampere's Maxwell circuital law $\boxed{\oint \vec{B}\cdot d\vec{l} = \mu_0 (i + i_d)}$

- **Energy density of Electromagnetic waves** $\boxed{\bar{u} = \dfrac{1}{2}\varepsilon_0 E^2 + \dfrac{1}{2}\dfrac{B^2}{\mu_0}}$

$\boxed{u_e = \dfrac{1}{2}\varepsilon_0 E^2}$ $\boxed{u_m = \dfrac{1}{2}\dfrac{B^2}{\mu_0}}$

u_e = Electrical Energy density
u_m = Magnetic Energy density

$\boxed{\dfrac{E}{B} = \dfrac{1}{\sqrt{\mu_0 \varepsilon_0}} = c}$ $\boxed{B_0 = \dfrac{E_0}{c}}$

Your only limit is your mind

CHAPTER - 9

UNIT- VI (OPTICS)

Ray optics and optical instruments

➡ **focal length of Spherical mirror** $f = \frac{r}{2}$

f = focal length
r = radius of curvature

➡ **Mirror equation** $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ for both concave and convex mirror.

➡ **Linear Magnification for mirror** $m = \frac{h'}{h} = -\frac{v}{u}$

Note : Sign convention : According to cartesian sign convention

➡ **Snell's law** $\frac{\sin i}{\sin r} = {}_1n_2$ OR $n_{21} = \frac{n_2}{n_1}$

i = angle of incident
r = angle of reflection

➡ $n_{12} = \frac{1}{n_{21}}$ $\qquad n_{32} = \frac{n_{31}}{n_{21}}$

➡ **Relation between critical angle and refractive index** $n_{21} = \frac{1}{\sin c}$ $\qquad n_{g_a} = \frac{1}{\sin c}$

1 = rare medium $\qquad$ 2 = denser medium

$v = \frac{c}{n}$ $\qquad n_{g_w} = \frac{n_{g_a}}{n_{w_a}}$

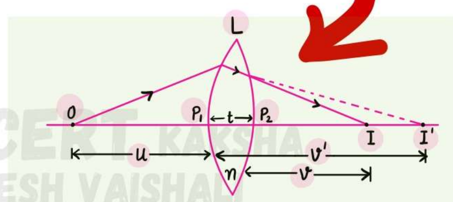
➡ **Thin lens formula** $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

➡ **Magnification for lens** $m = \frac{y_2}{y_1} = \frac{v}{u}$

+ve for lens

➡ **Power of lens** $P = \frac{1}{f}$

➡ **focal length of convex lens by displacement method** $f = \frac{a^2 - \alpha^2}{4a}$



➡ **For combination of lenses**

focal length $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} + \cdots$

Power $P = P_1 + P_2 + P_3 + \cdots$

Magnification $m = m_1 \cdot m_2 \cdot m_3 \cdots$

➡ **Refraction at a spherical surface** $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$

➡ **Deviation by a thin prism** $\delta_m = (n-1)A$ & $D_m = n_{21} - A$

➡ **Refractive index of the prism** $n = \frac{\sin\left[\frac{A + \delta_m}{2}\right]}{\sin \frac{A}{2}}$

➡ **Rayleigh's scattering law** $I \propto \frac{1}{\lambda^4}$

Dispersive power of prism $\omega = \frac{n_V - n_R}{n_Y - 1}$

n_V = refractive index of prism for violet colour
n_R = refractive index of prism for red colour
n_Y = refractive index of prism for yellow colour

Magnification power of simple microscope $m = \left(1 + \frac{D}{f}\right)$

when image is at infinity, then angular magnification $m = \frac{\theta_i}{\theta_0} = \frac{D}{f}$

where $\theta_0 = \frac{h}{D}$, $\theta_e = \frac{h}{f}$

Magnification power of compound microscope

$$m = m_0 m_e = \left(\frac{L}{f_0}\right)\left(\frac{D}{f_e}\right)$$

m_0 = magnification power of objective lens
m_e = magnification power of eyepiece
L = distance b/w second focus of objective & first focus of eyepiece
D = distance of final image from eyepiece

Magnification power of telescope

$$m = \frac{\beta}{\alpha} = \frac{f_0}{f_e}$$

β = Angle subtented at eye by image
α = Angle subtented at eye by object
f_0 = focal length of objective
f_e = focal length of eyepiece

lens maker formula $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Refraction at Spherical surface $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$

If $\frac{n_2}{n_1} = n$ $\quad \frac{n}{v} - \frac{1}{u} = \frac{n-1}{R}$

Principal foci of Spherical surface

(a) First Principal foci $f' = -\frac{R}{n-1}$

(b) Second Principal foci $f = \frac{nR}{n-1}$

(c) $f = -nf'$

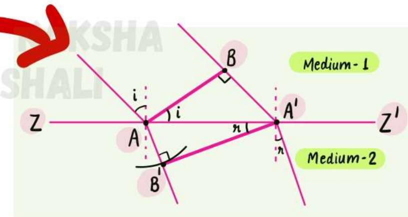
Take the Risk
OR
Loose the chance

CHAPTER - 10

UNIT- VI (OPTICS)

Wave optics

Huygen's Principal of secondary waves $i = r$



$$\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \text{constant}$$

$$n_{21} = \frac{v_1}{v_2} = \frac{\text{velocity of light in first medium}}{\text{velocity of light in second medium}}$$

$$v = \frac{c}{n}$$

n = refractive index
c = velocity of light

$$\frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2} = n_{21}$$

Optical path $c \times t = nd$

Dopplen Effect

$$\underbrace{\frac{\Delta\nu}{\nu}}_{\text{change in frequency}} = \frac{-v_{radical}}{c}$$

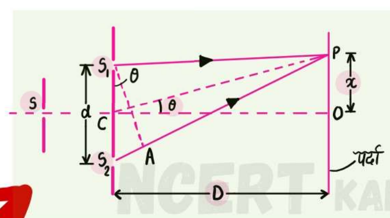
velocity

Refractive index of water relative to air $n = \frac{\lambda}{\lambda_W}$ OR $\lambda_W = \frac{\lambda}{n}$

Interference $I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$

Position of bright fringes $x = n\frac{D\lambda}{d}$

Position of dark fringes $x = \left[n - \frac{1}{2}\right]\frac{D\lambda}{d}$



Displacement of fringe $x_0 = \frac{D}{d}(n-1)t$

fringe width $\beta = \frac{D\lambda}{d}$

Angular fringe width OR **Angular Path difference** $\theta = \frac{\lambda}{d}$

Thickness of Plate $t = \frac{x_0\lambda}{W(n-1)}$

Diffraction of light due to a single slit $e\sin\theta = \pm m\lambda$ $e\sin\theta = (2m+1)\frac{\lambda}{2}$

Angular width of central maximum $2\theta = \frac{2\lambda}{e}$

Linear width of central maximum $2x = \frac{2\lambda}{e} \times f$

Resolving power of telescope $\frac{1.22\lambda}{d}$

Resolving power of microscope $\frac{1.22\lambda}{2n\sin\alpha}$

Fresnel distance $Z_F = \frac{e^2}{\lambda}$

Brewster's law $\mu = \tan i_B$

Coherent and non-coherent additional of waves $\boxed{I \propto a^2}$

I = Intensity
a = amplitude

Coherent Waves : No phase difference

Displacement $\boxed{y = 2a\cos\omega t}$

Amplitude $\boxed{2a}$

Intensity $\boxed{I = 4I_0}$ where $I_0 \propto a^2$

Incoherent waves : having phase difference

Displacement $\boxed{y = 2a\cos\frac{\phi}{2}\cos(\omega t + \phi)}$

Amplitude $\boxed{2a\cos\frac{\phi}{2}}$

Intensity $\boxed{I = 4I_0\cos^2\frac{\phi}{2}}$ where $I_0 \propto a^2$

Average intensity $\boxed{\langle I \rangle = 2I_0}$ $\because \langle\cos^2\phi/2\rangle = \frac{1}{2}$

In coherent Addition

1. Path difference for constructive interference $\boxed{S_1P \sim S_2P = n\lambda}$ where $n = 0, 1, 2, 3 \ldots$
2. Path difference for inconstructive interference $\boxed{S_1P \sim S_2P = \left(n + \frac{1}{2}\right)\lambda}$

Young's Experiment

Path difference $\boxed{S_2P - S_1P = n\lambda \approx \frac{xd}{D}}$

x = position of fringe on screen
d = distance between two slits
D = distance between slits & screen

Polarization (Malus law)

$\boxed{I = I_0\cos^2\theta}$

I_0 = Intensity of polarized light after passing through polaroid.

Failure is Success in Progress

UNIT- VII (DUAL NATURE OF RADIATION AND MATTER)

CHAPTER - 11

Dual nature of radiation and matter

- **Maximum kinetic energy of Photoelectrons** $\boxed{E_K = eV_0}$ $\boxed{E_K = K_{max} = eV_0}$
- **Threshold frequency** $\boxed{\lambda_0 = \frac{c}{\nu_0}}$ $\boxed{\lambda = \frac{c}{\nu}}$

  Threshold frequency
- **Einstein's Photoelectric Equation**

  W = Work function $\hbar$ = Plancks constant

  $\boxed{W = \phi = h\nu_0}$ $\boxed{K_{max} = h(\nu - \nu_0)}$ $\boxed{\nu_0 = \left(\frac{h}{e}\right)\nu - \frac{\phi_e}{e}}$ $\boxed{\frac{1}{2} m v^2_{max} = h(\nu - \nu_0)}$
- **Energy of Photon** $\boxed{E = h\nu = \frac{hc}{\lambda}}$
- **Momentum of Photon** $\boxed{P = mc = \frac{h}{\lambda}}$ OR $\boxed{\lambda = \frac{h}{P}}$
- **Wave nature of particle** $\boxed{\lambda = \frac{h}{mv}}$ $\boxed{\lambda = \frac{h}{\sqrt{2mk}}}$ $\boxed{\lambda = \frac{h}{\sqrt{2meV}}}$ $\boxed{\lambda = \frac{12.27}{\sqrt{V}} \text{Å}}$

$h = 6.63 \times 10^{-34}$ Joule/sec
$m = 9.31 \times 10^{-31}$ Kg

$e = 1.6 \times 10^{-19}$ C
$1 eV = 1.6 \times 10^{-19}$ Joule

$\boxed{V_0 = \left[\frac{h}{e}\right]\nu - \left[\frac{h}{e}\right]\nu_0}$

- **Bragg Equation** $\boxed{\lambda = 2d \sin\theta}$
- **Heisenberg's Uncertainty principle** $\boxed{\Delta x \cdot \Delta p \approx \hbar}$ OR $\boxed{\Delta x \cdot \Delta p \geq \hbar}$ $\left[\hbar = \frac{h}{2\pi}\right]$

Good things take time

UNIT- VIII (ATOMS AND NUCLEI)

CHAPTER - 12

Atoms

➡ Electrostatic force of Repulsion b/w alpha particle and positively charged nucleas

$$F = \frac{1}{4\pi\varepsilon_0}\frac{(2e)(Ze)}{r^2}$$

➡ Relation between orbit radius and electron velocity for hydrogen atom

$$r = \frac{e^2}{4\pi\varepsilon_0 m v^2}$$

➡ Kinetic Energy for Hydrogen atom

$$K = \frac{e^2}{8\pi\varepsilon_0 r}$$

➡ Potential Energy for Hydrogen atom

$$U = \frac{-e^2}{4\pi\varepsilon_0 r}$$

➡ Total Energy

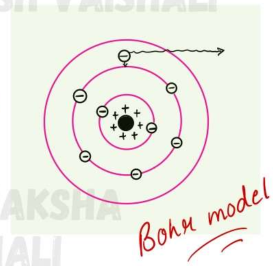
$$E = K + U$$

$$E = \frac{-e^2}{8\pi\varepsilon_0 r}$$

➡ Bohr's atomic Model

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

$$h\nu = E_2 - E_1$$



➡ Radius of stationary orbit

$$r = n^2\frac{h^2\varepsilon_0}{\pi m Z e^2}$$

➡ Bohr radius

$(n = 1 \;,\; z = 1)$

$$r_0 = \frac{h^2\varepsilon_0}{\pi m e^2}$$

➡ Velocity of Electron in stationary orbits

$$v = \left[\frac{Ze^2}{2h\varepsilon_0}\right]\frac{1}{n}$$

➡ Energy of Electron in stationary orbits

$$E_n = -\left[\frac{mZ^2e^4}{8\varepsilon_0^2h^2}\right]\frac{1}{n^2} = -Z^2\,\frac{13.6}{n^2}\,eV$$

➡ Ionization Energy

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

$$E_n = \frac{-Rhc}{n^2}\,eV$$

➡ Wavelength in Emission and absorption transitions

$$\lambda = \frac{12375}{\Delta E}\,\text{Å}$$

$R = 1.03 \times 10^7\ m^{-1}$ = Rydberg constant

n = quantum number

$$R = \frac{me^4}{8\varepsilon_0^2h^3c}$$

Wave number
$$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

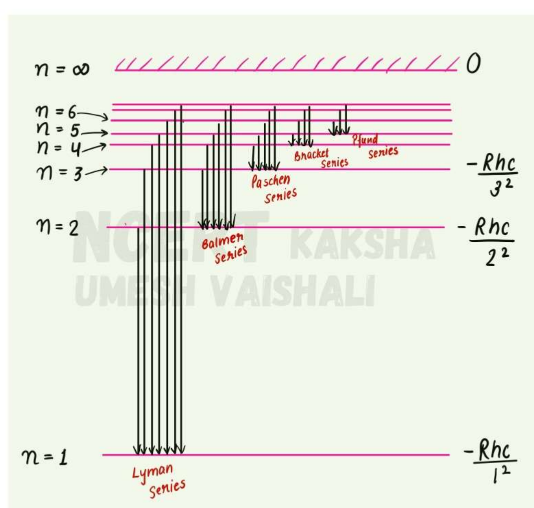
Lyman Series
$$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{n_2^2}\right]$$
$n_2 = 2, 3, 4 \ldots\ldots$

Balmer Series
$$\frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{n_2^2}\right]$$
$n_2 = 3, 4, 5 \ldots\ldots$

Paschen Series
$$\frac{1}{\lambda} = R\left[\frac{1}{3^2} - \frac{1}{n_2^2}\right]$$
$n_2 = 4, 5, 6 \ldots\ldots$

Bracket Series
$$\frac{1}{\lambda} = R\left[\frac{1}{4^2} - \frac{1}{n_2^2}\right]$$
$n_2 = 5, 6, 7 \ldots\ldots$

Pfund Series
$$\frac{1}{\lambda} = R\left[\frac{1}{5^2} - \frac{1}{n_2^2}\right]$$
$n_2 = 6, 7, 8 \ldots\ldots$



➡ Frequency

$$\nu = RC\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\nu = \frac{c}{\lambda}$$

UNIT-VIII (ATOMS AND NUCLEI)

CHAPTER-13

Nuclei

- **Size of nucleus** $R = R_0 A^{1/3}$ $R_0 = 1.2 \times 10^{-15}\,m$ Note :- 1 Fermi = $10^{-15}\,m$

$1\,amu = 1.66 \times 10^{-27}\,kg$ $1u \times c^2 = 931\,MeV$ u = atomic mass unit

- **Mass Energy** $E = mc^2$
- **Nuclear Binding Energy** $\Delta m = [Zm_p + (A-Z)m_n] - M$
- **Binding Energy** $E_b = \Delta M c^2$ ΔM = Mass defect
- **Binding Energy per Nucleon** $E_{bn} = \dfrac{E_b}{A}$
- **Theory of Relativity** $m = \dfrac{m_0}{\sqrt{1 - \dfrac{v^2}{c^2}}}$

Note :- ${}^{A}_{Z}X$

Z = Atomic no. = no. of protons

N = Neutron no. = no. of neutrons

A = mass no. = Z + N = no. of neutrons and protons

- **Rutherford and Soddy law** $N = N_0 e^{-\lambda t}$
- **Half life** $T_{1/2} = \dfrac{\log_e 2}{\lambda} = \dfrac{0.6931}{\lambda}$
- **Average life** $\tau = \dfrac{1}{\lambda}$ $T = 0.6931\,\tau$
- **Rate of decay** $R = -\dfrac{dN}{dt}$ $R = R_0 e^{-\lambda t}$

$\dfrac{\Delta N}{\Delta t} \propto N \Rightarrow \dfrac{dN}{dt} = -\lambda N$

N = Number of Nuclei

λ = Radioactive decay constant

- **α - decay** ${}^{A}_{Z}X \longrightarrow {}^{A-4}_{Z-2}X + {}^{4}_{2}He$
- **Destination Energy OR Q value for α - decay** $Q = (m_x - m_y - m_{He})c^2$
- **β - decay** $n \longrightarrow p + e^- + \bar{\nu}$
- **β⁺ decay** $p \longrightarrow n + e^+ + \nu$
- **Activity of Radioactive substance** $R = R_0\left(\dfrac{1}{2}\right)^n$ $N = N_0\left(\dfrac{1}{2}\right)^n$

Semiconductor electronics : Materials , Devices and Simple circuits

➡ $\sigma = \frac{1}{\rho}$ — σ = Electrical conductivity, ρ = Resistivity

➡ $i_E = i_B + i_C$ — i_E = Emitter current, i_B = Base current, i_C = Collector current

➡ **Energy band gap for**

Metals	$E_g \simeq 0$
Semiconductor	$E_g < 3eV$
Insulator	$E_g > 3eV$

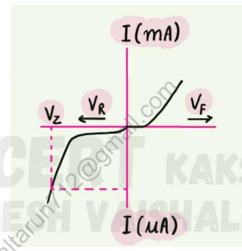
➡ **Zener diode** $R = \frac{V_{in} - V_z}{i_z + i_L}$ $f = \frac{1}{2\pi\sqrt{LC}}$

(A)

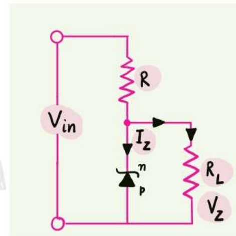
➡ **Characteristics of transistor**

Input Resistance $R_1 = \left[\frac{\Delta V_{BE}}{\Delta i_B}\right]_{V_{CE}}$

Output Resistance $R_2 = \left[\frac{\Delta V_{CE}}{\Delta i_C}\right]_{i_B}$



(B)



(C)

Current gain in common emitter configuration $\beta = \left[\frac{\Delta i_C}{\Delta i_B}\right]_{V_{CE}}$

➡ **AC current gain** $\beta(ac) = \left[\frac{\Delta i_C}{\Delta i_B}\right]_{V_{CE}}$

➡ **AC voltage gain** $A_v = \frac{\Delta i_C}{\Delta i_B} \times \frac{R_{out}}{R_{in}}$

$\frac{R_{out}}{R_{in}}$ = Resistance gain

➡ **AC Power gain** = $\beta^2(ac) \times$ Resistance

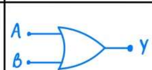
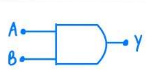
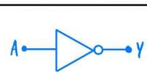
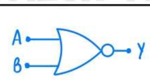
➡ **Collector-to-emitter voltage** $V_{CE} = V_{CC} - i_C R_L$

➡ **Current transfer Ratio** $\alpha = \frac{i_C}{i_E}$ $\alpha = \frac{\beta}{1+\beta}$

➡ **Current Amplifier factor** $\beta = \frac{i_C}{i_B}$

➡ $n_e n_h = n_i^2$ — n_e = no. of electrons, n_h = no. of holes, n_i = Intrinsic carrier concentration

➡ **Table summary of devices**

Gate	Logic symbol	Logic variables	Truth table Input (A)	(B)	Output (Y)
OR		$A + B = Y$	0 0 1 1	0 1 0 1	0 1 1 1
AND		$A \cdot B = Y$	0 0 1 1	0 1 0 1	0 0 0 1
NOT		$\bar{A} = Y$	0 1		1 0
NAND		$\overline{A \cdot B} = Y$	0 0 1 1	0 1 0 1	1 1 1 0
NOR		$\overline{A + B} = Y$	0 0 1 1	0 1 0 1	1 0 0 0

- $I = I_e + I_h$ — I_e = current due to electrons, I_h = current due to holes
- For intrinsic semi conductor $n_e = n_h = n_i$
- For n-type extrinsic semi conductor $n_e >> n_h$
- For p-type extrinsic semi conductor $n_e << n_h$
- dynamic Resistance $r_d = \frac{\Delta V}{\Delta I}$

PHYSICAL QUANTITIES	FORMULAS	DIMENSION FORMULA	SI UNIT
Electric current (I)	Fundamental unit	$[M^0L^0T^0A]$	A (ampere)
Electric current density (j)	$\frac{\text{current}}{\text{area}}$	$[M^0L^{-2}T^0A]$	$A\,m^{-2}$
Electric charge (q)	current × time	$[M^0L^0T\,A]$	C (coulomb)
Electric potential (V)	$\frac{\text{work}}{\text{charge}}$	$[ML^2T^{-3}A^{-1}]$	V (volt)
Electric field intensity (E)	$\frac{\text{force}}{\text{charge}}$	$[MLT^{-3}A^{-1}]$	NC^{-1}
Permittivity of free space (ε_0)	$\frac{\text{charge} \times \text{charge}}{\text{force} \times \text{distance}^2}$	$[M^{-1}L^{-3}T^4A^2]$	C^2Nm^{-2}
Electric flux (ϕ_E)	electric field × area	$[ML^3T^{-3}A^{-1}]$	Nm^2C^{-1}
Electric capacitance (C)	$\frac{\text{charge}}{\text{potential difference}}$	$[M^{-1}L^{-2}T^4A^2]$	F (farad)
Surface charge density (σ)	$\frac{\text{charge}}{\text{area}}$	$[M^0L^{-2}TA]$	$C\,m^{-2}$
Volume charge density (ρ)	$\frac{\text{charge}}{\text{volume}}$	$[M^0L^{-3}TA]$	$C\,m^{-3}$
Electric dipole moment (P_e)	charge × length	$[M^0LTA]$	$C\,m$
Electric resistance (R)	$\frac{\text{potential difference}}{\text{current}}$	$[ML^2T^{-3}A^{-2}]$	Ω (ohm)
Resistivity (ρ)	$\frac{\text{resistance} \times \text{area}}{\text{length}}$	$[ML^3T^{-3}A^{-2}]$	$\Omega\,m$
Electric conductance (G)	$\frac{1}{\text{resistance}}$	$[M^{-1}L^{-2}T^3A^2]$	S(siemen) or Ω^{-1} (mho)
Conductivity (σ)	$\frac{1}{\text{resistivity}}$	$[M^{-1}L^{-3}T^3A^2]$	Sm^{-1} or $\Omega^{-1}m^{-1}$
Coefficient of self induction (L) or mutual induction (M)	$\frac{\text{e.m.f.} \times \text{time}}{\text{current}}$	$[ML^2T^{-2}A^{-2}]$	H (henry)
Inductive reactance (X_L)	ωL	$[ML^2T^{-2}A^{-2}]$	Ω

Capacitive reactance (X_C)	$\frac{1}{\omega C}$	$[ML^2T^{-3}A^{-2}]$	Ω
Power factor ($\cos\phi$)	Trigonometric ratio	Dimensionless	No unit
Resonant angular frequency (ω_0)	$\frac{1}{\sqrt{LC}}$	$[M^0L^0T^{-1}]$	Hz
Quality factor (Q)	$\frac{\omega_0 L}{R}$	$[M^0L^0T^0]$	No unit
Permeability of free space (μ_0)	$\frac{2\pi \times \text{force} \times \text{distance}}{\text{current}^2 \times \text{length}}$	$[MLT^{-2}A^{-2}]$	NA^{-2} or $Wb\,A^{-1}m^{-1}$
Magnetic pole strength (m)	$\frac{4\pi \times \text{force} \times \text{distance}^2}{\mu_0}$	$[M^0LT^0A]$	A m
Magnetic dipole moment (P_m)	pole strength $\times$ distance	$[M^0L^2T^0A]$	$A\,m^2$
Magnetic induction (B)	$\frac{\mu_0 \times \text{current}}{2\pi \times \text{distance}}$	$[ML^0T^{-2}A^{-1}]$	$Nm^{-1}A^{-1}$ or tesla (T)
Magnetic flux (ϕ_B)	B $\times$ area	$[ML^2T^{-2}A^{-1}]$	NmA^{-1} or weber (Wb)
Coefficient of self induction (L) or mutual induction (M)	$\frac{\text{magnetic flux}}{\text{current}}$	$[ML^2T^{-2}A^{-2}]$	H (henry)
Magnetic intensity (H)	$\frac{\text{magnetic induction}}{\mu_0}$	$[M^0L^{-1}T^0A]$	Am^{-1} or $Nm^{-2}T^{-1}$
Intensity of magnetisation (I)	$\frac{\text{magnetic moment}}{\text{volume}}$	$[M^0L^{-1}T^0A]$	Am^{-1} or $Nm^{-2}T^{-1}$
Coercivity	H (opposing)	$[M^0L^{-1}T^0A]$	Am^{-1} or $Nm^{-2}T^{-1}$
Retentivity	I (residual)	$[M^0L^{-1}T^0A]$	Am^{-1} or $Nm^{-2}T^{-1}$

Thank You