All Chapters Formulas

Class 12 Physics


QUESTIONS


Class 12 Physics 2024
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One Shot
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Exam Time मे इसे follow करें
Chapter 1 : Electric Charges and field
Chapter 2 : Potential & Capacitance
Chapter 3 : Current Electricity
Chapter 4 : Moving Charges & Magnetism
Chapter 5 : Magnetism & Matter
Chapter 6 : Electromagnetic Induction
Chapter 9 : Ray optics
Chapter 10 : Wave Optics
Chapter 11 : Dual Nature of Radiation & Matter
Chapter 12 : Atoms
Chapter 13 : Nuclei
Chapter 14 : Semiconductors
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Chapter 1 : Electric Charges and field
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Chapter 5 : Magnetism & Matter
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Chapter 8 : Electromagnetic waves
Chapter 9 : Ray optics
Chapter 10 : Wave Optics
Chapter 11 : Dual Nature of Radiation & Matter
Coming Soon

QUESTIONS

For Presentations & Notes

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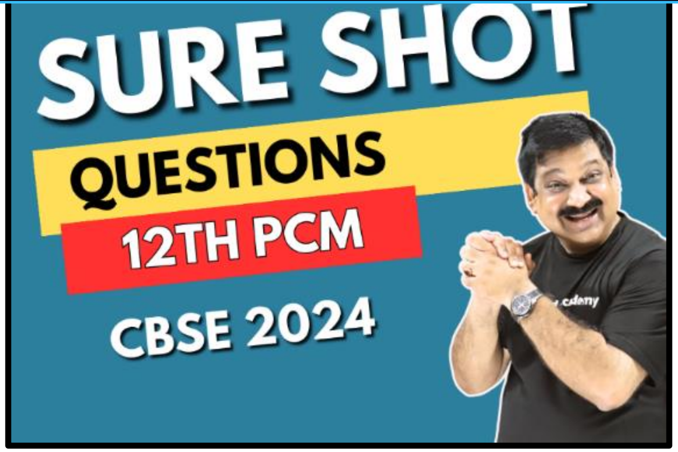

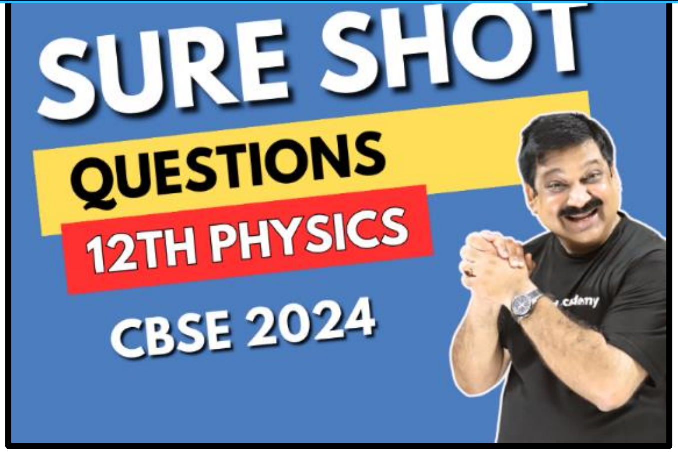

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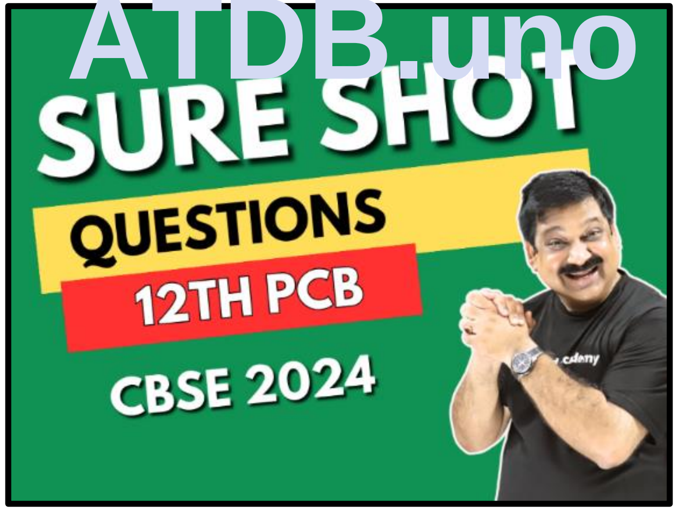

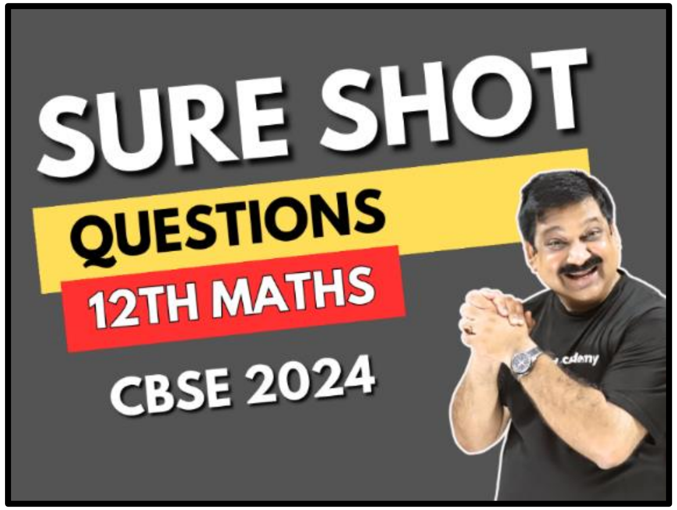

QUESTIONS

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QUESTIONS

Chap 1 Electric Charge & Field

⇒ continuous charge dist.

$$\boxed{\vec{F} = \frac{q_0}{4\pi\varepsilon_0}\int \frac{dq}{r^2}\cdot\hat{r}}$$

⇒ Volume charge distribution

$$\boxed{\vec{F}_V = \frac{q_0}{4\pi\varepsilon_0}\int_V \frac{\rho}{r^2}dv\,\hat{r}} \qquad \boxed{\rho = \frac{dq}{dv}}$$

$$\boxed{\vec{E}_V = \frac{\vec{F}_V}{q_0} = \frac{1}{4\pi\varepsilon_0}\int_V \frac{\rho}{r^2}dv\,\hat{r}}$$

⇒ Surface charge distribution

$$\boxed{\vec{F}_S = \frac{q_0}{4\pi\varepsilon_0}\int_S \frac{\sigma}{r^2}ds\,\hat{r}} \qquad \boxed{\sigma = \frac{dq}{ds}}$$

$$\boxed{\vec{E}_S = \frac{\vec{F}_S}{q_0} = \frac{1}{4\pi\varepsilon_0}\int_S \frac{\sigma}{r^2}ds\,\hat{r}}$$

⇒ Line charge distribution

$$\boxed{\vec{F}_L = \frac{q_0}{4\pi\varepsilon_0}\int_L \frac{\lambda}{r^2}dl\,\hat{r}} \qquad \boxed{\lambda = \frac{dq}{dl}}$$

$$\boxed{\vec{E}_L = \frac{\vec{F}_L}{q_0} = \frac{1}{4\pi\varepsilon_0}\int_L \frac{\lambda}{r^2}dl\,\hat{r}}$$

⇒ Dielectric Constant (K)
(Relative permittivity) → ε_r

$$\boxed{\varepsilon_r = K = \frac{\varepsilon}{\varepsilon_0} = \frac{F_{vac}}{F_{med}}}$$

K(vacuum) = 1
K (Air) = 1.00054
K(water) = 80

⇒ Superposition Principle

$$\boxed{\vec{F} = \frac{q}{4\pi\varepsilon_0}\sum_{\text{all pt charges}} q'\,\frac{\vec{r}-\vec{r}'}{|\vec{r}-\vec{r}'|^3}}$$

⇒ Electric field

$$\boxed{\vec{E} = \frac{\vec{F}}{q_0}} \qquad \vec{E} = \lim_{q_0\to 0}\frac{\vec{F}}{q_0}$$

$$\boxed{E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}} \leftarrow \text{due to Point charge}$$

⇒ charge on $e = 1.6\times10^{-19}$ C

⇒ $$\boxed{m = \frac{m_0}{\sqrt{1 - v^2/c^2}}}$$

m_0 = rest mass

⇒ Quantisation condⁿ of charge

$$\boxed{Q = ne}$$

⇒ Coulomb's law

$$\boxed{\vec{F}_{21} = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}\hat{r}_{12}} \leftarrow \text{Vector Form}$$

$$\boxed{F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}} \leftarrow \text{Scalar form}$$

$K = \frac{1}{4\pi\varepsilon_0} = 9\times10^9\ Nm^2C^{-2}$

⇒ ε_0 = permittivity of free space

$$\boxed{\varepsilon_0 = 8.85\times10^{-12}\ C^2N^{-1}m^{-2}}$$

QUESTIONS

Chap 1 Electric Charge & Field

⇒ E.F. Infinite Plane Sheet

$$\boxed{\vec{E} = \frac{\sigma}{2\varepsilon_0}\hat{n}}$$

$\hat{n}$ = unit vector normal to plane going away.

$$\boxed{E = \frac{\sigma}{2\varepsilon_0}}$$ free from r.

⇒ E.F. (thin spherical shell)

① outside (r>R)

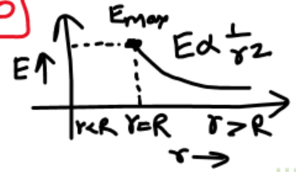
$$\boxed{E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}}$$

② on the surface (r=R)

$$\boxed{E = \frac{1}{4\pi\varepsilon_0}\frac{q}{R^2}}$$

③ Inside (r<R)

$$\boxed{E = 0}$$



⇒ E.F. Equatorial Pt. (Dipole)

$$\vec{E}_{eq} = -\frac{1}{4\pi\varepsilon_0}\frac{p}{(r^2+a^2)^{3/2}}\hat{p}$$

If r >> a

$$\boxed{\vec{E}_{eq} = -\frac{1}{4\pi\varepsilon_0}\frac{p}{r^3}\hat{p}}$$

⇒ Torque on Dipole

$$\boxed{\vec{\tau} = \vec{p} \times \vec{E}}$$ vector form

$$\boxed{\tau = pE\sin\theta}$$ only mag.

⇒ Electric Flux

(It is a Scalar Qty)

$$\boxed{\Delta\phi_E = \vec{E}\cdot\Delta\vec{S}}$$

$$\boxed{\phi_E = \oint_S \vec{E}\cdot d\vec{S}}$$

⇒ Gauss's Theorem

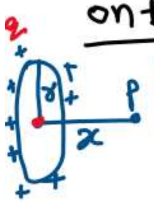
$$\boxed{\phi_E = \oint_S \vec{E}\cdot d\vec{S} = \frac{q_{in}}{\varepsilon_0}}$$

⇒ Electric field due to long thin wire

$$\boxed{E = \frac{\lambda}{2\pi\varepsilon_0 r}}$$

λ = Uniform Linear charge density

⇒ Electric field due to Ring on the axis of Ring



$$\boxed{E = \frac{1}{4\pi\varepsilon_0}\frac{qx}{(x^2+r^2)^{3/2}}}$$

⇒ Electric Dipole moment

$$\boxed{\vec{p} = q \times 2\vec{l}}$$ from (direction) $-q \rightarrow +q$

⇒ E.F. Axial Pt. (Dipole)

$$\vec{E}_{axial} = \frac{1}{4\pi\varepsilon_0}\frac{2pr}{(r^2-a^2)^2}\hat{p}$$

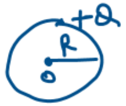
for r >> a

$$\boxed{\vec{E}_{axial} = \frac{1}{4\pi\varepsilon_0}\frac{2p}{r^3}\hat{p}}$$

QUESTIONS

Chap 2: Electrostatic Potential & Capacitance

⇒ Capacitance (Spherical Cond.)



$$\boxed{C = 4\pi\varepsilon_0 R}$$

⇒ V at P along the axis (Ring)

$$\boxed{V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{\sqrt{R^2+r^2}}}$$

* at Centre O, $\boxed{V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}}$

* $$\boxed{V_{BA} = V_B - V_A = -\int_A^B \vec{E}\cdot d\vec{r}}$$

$$d\vec{r} = dx\,\hat{i} + dy\,\hat{j} + dz\,\hat{k}$$

⇒ P.E. (Two point charges)

$$\boxed{U = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r}}$$

* q_1 & q_2 with sign

⇒ P.E. (Three point charges)

$$\boxed{U = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1 q_2}{r_{12}} + \frac{q_1 q_3}{r_{13}} + \frac{q_2 q_3}{r_{23}}\right]}$$

⇒ P.E. of a Dipole

$$\boxed{U = pE(\cos\theta_1 - \cos\theta_2)}$$

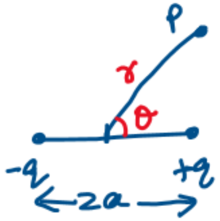
$$\boxed{U = -pE\cos\theta = -\vec{p}\cdot\vec{E}}$$

If initially $\theta_1 = 90°$
→ Considered $U_{\theta=90°} = 0$

CAPACITORS

⇒ Capacitance

⇒ Dipole Potential (General Pt.)



$$\boxed{V = \frac{1}{4\pi\varepsilon_0}\frac{p\cos\theta}{r^2}}$$

⇒ Potential due to uniformly charged thin spherical shell

① $r > R$ (outside)

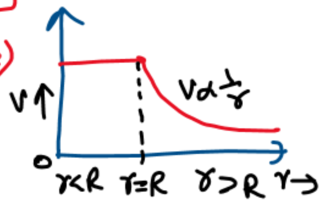
$$\boxed{V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}}$$

② $r = R$ (on the surface)

$$\boxed{V = \frac{1}{4\pi\varepsilon_0}\frac{q}{R}}$$

③ $r < R$ (Inside)

$$\boxed{V = \frac{1}{4\pi\varepsilon_0}\frac{q}{R}}$$



⇒ Relation b/w E.F. & Potential

$$\boxed{\vec{E} = -\left[\frac{\partial V}{\partial x}\hat{i} + \frac{\partial V}{\partial y}\hat{j} + \frac{\partial V}{\partial z}\hat{k}\right]}$$

$$\vec{E} = E_x\hat{i} + E_y\hat{j} + E_z\hat{k}$$

$\boxed{E = -\frac{dV}{dr}}$ –ve sign shows V decreases in the direction of

⇒ Potential difference

$$\boxed{V = V_B - V_A = \frac{W_{AB}}{q_0}}$$

⇒ Potential due to Point charge

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

⇒ Dipole Potential (Axial Point)

$$\boxed{V_{ax} = \frac{1}{4\pi\varepsilon_0}\frac{p}{(r^2 - a^2)}}$$

for short dipole $r^2 >> a^2$

$$\boxed{V_{ax} = \frac{1}{4\pi\varepsilon_0}\frac{p}{r^2}}$$

⇒ Dipole Potential (equatorial)

$$\boxed{V_{eq} = 0}$$

QUESTIONS

⇒ Electric Susceptibility (χ)

$$\boxed{\chi = \frac{\vec{P}}{\varepsilon_0 \vec{E}}}$$

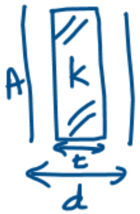
$\vec{P}$ = Polarisation
$\vec{E}$ = Resultant field

⇒ Relation b/w K & χ

$$\boxed{K = 1 + \chi}$$

K = dielectric constant

⇒ Capacitance with partially filled dielectric



$$\boxed{C = \frac{\varepsilon_0 A}{d - t + t/k}}$$

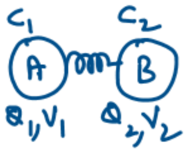
⇒ Capacitance with Conducting Slab

$$\boxed{C = \frac{d}{(d-t)} C_0}$$

C_0 = without slab

Conducting slab $K = \infty$

⇒ Redistribution of charges



Common Potential

$$\boxed{V = \frac{Q_1 + Q_2}{C_1 + C_2} = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}}$$

after redistribution charges Q_1' & Q_2'

$$\boxed{\frac{Q_1'}{Q_2'} = \frac{C_1}{C_2}}$$

⇒ Loss of energy (in Redistribution)

$$\boxed{\Delta U = \frac{1}{2} \frac{C_1C_2(V_1 - V_2)^2}{(C_1 + C_2)}}$$

⇒ In dielectric

$$\boxed{K = \varepsilon_r = \frac{\vec{E}_0}{\vec{E}} = \frac{\vec{E}_0}{\vec{E}_0 - \vec{E}_p}}$$

⇒ Polarisation density (P)

$$P = \frac{\text{dipole moment of dielectric}}{\text{Volume}} = \sigma_p$$

Here $\boxed{\sigma_p = \frac{Q_p}{A}}$

⇒ Parallel plate Capacitor

$$\boxed{C = \frac{K \varepsilon_0 A}{d}}$$

⇒ capacitors in Series

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

⇒ capacitors in Parallel

$$\boxed{C_p = C_1 + C_2 + \cdots + C_n}$$

⇒ Energy Stored in Capacitor

$$\boxed{U = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}QV}$$

⇒ Energy stored in Series & Parallel Combination is same

$$\boxed{U = U_1 + U_2 + \cdots + U_n}$$

⇒ Energy density of an E.F.

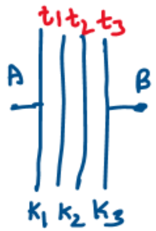
Total Energy $= U = \frac{1}{2}\varepsilon_0 E^2 A d$

$$\boxed{\text{Energy density} = u = \frac{U}{Ad} = \frac{1}{2}\varepsilon_0 E^2}$$

⇒ Effect of dielectric

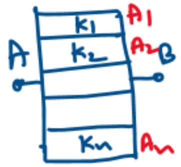
	Battery disconnected	Battery Kept Connected
①	$Q = Q_0$	$Q = KQ_0$
②	$V = V_0/K$	$V = V_0$
③	$E = E_0/K$	$E = E_0$
④	$C = KC_0$	$C = KC_0$
⑤	$U = U_0/K$	$U = KU_0$

⇒ Compound dielectric (Series)



$$\boxed{C = \frac{\varepsilon_0 A}{\frac{t_1}{K_1} + \frac{t_2}{K_2} + \cdots + \frac{t_n}{K_n}}}$$

⇒ Compound (Parallel)



$$\boxed{C = \frac{\varepsilon_0}{d}(K_1A_1 + \cdots + K_nA_n)}$$

If $A_1 = A_2 = A_n = A/n$

$$\boxed{C = \frac{\varepsilon_0}{d}\frac{A}{n}(K_1 + K_2 + \cdots + K_n)}$$

Chap 3: Current Electricity

QUESTIONS

⇒ Resistance in Series

$$R = R_1 + R_2 + R_3 + \dots + R_n$$

⇒ Resistance in Parallel

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n}$$

⇒ CELL ⇐

⇒ Discharging of cell

$$V = \varepsilon - Ir$$

$$r = \frac{\varepsilon - V}{I} = \frac{\varepsilon - V}{V/R} = \left(\frac{\varepsilon - V}{V}\right) R$$

⇒ Resistivity

$$\rho = \frac{m}{ne^2 \tau}$$

⇒ Relation b/w $\vec{j}$, σ & $\vec{E}$

$$\vec{j} = \sigma \vec{E} \quad \text{OR} \quad \vec{E} = \rho \vec{j}$$

⇒ Mobility of charge Carriers

$$\mu = \frac{v_d}{E}$$

⇒ Relation b/w I & μ

$$I = neA\mu_e E$$

⇒ Temp. dependence of Resistivity

$$\rho = \rho_0 [1 + \alpha (T - T_0)]$$

$$\alpha = \frac{\rho - \rho_0}{\rho_0 (T - T_0)} = \frac{1}{\rho_0} \frac{d\rho}{dT}$$

$$R_t = R_0 (1 + \alpha \Delta t)$$

⇒ conductivity

$$\sigma = \frac{1}{\rho}$$

SI unit
ohm^{-1}m^{-1} or mho m^{-1}
or Sm^{-1}

⇒ Vector form of OHM's LAW

$$\vec{E} = \rho \vec{j} \quad \text{OR} \quad \vec{j} = \sigma \vec{E}$$

⇒ Drift velocity

$$\vec{v}_d = -\frac{e\vec{E}}{m} \tau$$

⇒ Relation b/w I & v_d

$$I = neAv_d \qquad \vec{j} = ne\vec{v}_d$$

n = no. of e^- per unit Volume

⇒ Deduction of OHM's LAW

$$R = \frac{ml}{ne^2 \tau A}$$

⇒ Electric current

$$I_{av} = \frac{Q}{t} \qquad I_{inst.} = \frac{dQ}{dt}$$

⇒ OHM's LAW

$$V = IR$$

⇒ Resistivity (ρ)

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

⇒ Current density

$$j = \frac{I}{A} \qquad I = \vec{j} \cdot \vec{A}$$

j = vector qty
dir ⇒ motion of +ve charge

⇒ Conductance

$$G = \frac{1}{R}$$

SI unit
ohm^{-1} or mho or
Siemens (S)

Chap 3: Current Electricity

QUESTIONS

⇒ Power in Parallel Comb.

$$\boxed{P = P_1 + P_2 + P_3}$$

⇒ Efficiency of a Source of emf

$$\boxed{\eta = \frac{\text{output Power}}{\text{Input Power}} = \frac{R}{R+r}}$$

⇒ Max Power theorem

max output power of a source of emf

$$\boxed{P_{Max} = \frac{\varepsilon^2}{4r}}$$ when $R = r$

⇒ Kirchhoff's LAWS

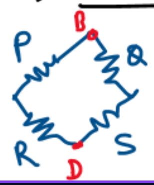
① 1^{st} Law/Junction Rule (KCL)

$$\boxed{\Sigma I = 0}$$

② 2^{nd} Law/Loop Rule (KVL)

$$\boxed{\Sigma \Delta V = 0}$$

⇒ Wheatstone Bridge



$$\boxed{\frac{P}{Q} = \frac{R}{S}}$$

Balanced W.B

⇒ Condⁿ max I (Parallel Comb)

$$\boxed{I = \frac{\varepsilon}{R + r/m} = \frac{m\varepsilon}{mR + r}}$$

$$\boxed{I_{Max} = \frac{m\varepsilon}{r}}$$ when $R << r/m$

⇒ Mixed grouping of cells

$$\boxed{I = \frac{mn\varepsilon}{mR + nr}}$$ n cells in Series, m rows

I_{Max} when $\boxed{R = \frac{nr}{m}}$

⇒ Electric Power

$$\boxed{P = \frac{W}{t} = VI = I^2R = \frac{V^2}{R}}$$

⇒ Electrical Energy

$$\boxed{W = P.t = VIt = I^2Rt}$$

$$\boxed{1\,\text{Kwh} = 3.6 \times 10^6\,J}$$

⇒ Power in Series Comb.

$$\boxed{\frac{1}{P} = \frac{1}{P_1} + \frac{1}{P_2} + \frac{1}{P_3}}$$

⇒ charging of a cell

$$\boxed{V = \varepsilon + Ir}$$

⇒ Cells in Series

$$\boxed{\varepsilon_{eq} = \varepsilon_1 + \varepsilon_2} \quad \boxed{r_{eq} = r_1 + r_2}$$

⇒ Cells in Parallel

For 2 cells ⇐

$$\boxed{\varepsilon_{eq} = \frac{\varepsilon_1 r_2 + \varepsilon_2 r_1}{r_1 + r_2}} \quad \boxed{r_{eq} = \frac{r_1 r_2}{r_1 + r_2}}$$

⇒ n cells in Parallel

$$\boxed{\frac{\varepsilon_{eq}}{r_{eq}} = \frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2} + \dots + \frac{\varepsilon_n}{r_n}}$$

$$\boxed{\frac{1}{r_{eq}} = \frac{1}{r_1} + \frac{1}{r_2} + \dots + \frac{1}{r_n}}$$

⇒ Condⁿ max I (series Comb.)

$$\boxed{I = \frac{n\varepsilon}{R + nr}}$$

$$\boxed{I_{max} = \frac{n\varepsilon}{R}}$$ when $R >> nr$

Chap 4: Moving Charges & Magnetism

QUESTIONS

→ Force on a moving charge

$\boxed{\vec{F} = q(\vec{v} \times \vec{B})}$

$F = qvB\sin\theta$

(i) If $v = 0$, $F = 0$

(ii) If $\theta = 0°$ or $180°$, $F = 0$

(iii) If $\theta = 90°$, $F_{max} = qvB$

→ Force on c.c. conductor in a mag. field.

$\boxed{\vec{F} = I(\vec{l} \times \vec{B})}$

$\boxed{F = IlB\sin\theta}$

$\boxed{\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{net}}$

Simplified form when $d\vec{l} \parallel d\vec{B}$ & dB constant along dl

$\boxed{BL = \mu_0 I_{net}}$

→ $\vec{B}$ due to solenoid (Near about Axis)

$\boxed{B = \mu_0 n I}$ $n = \frac{N}{l}$

$\vec{B}$ at one end

$\boxed{B = \frac{1}{2}\mu_0 n I}$

→ $\vec{B}$ due to c.c. thick wire Inside/outside

① $r > R$ (outside)

$\boxed{B = \frac{\mu_0}{2\pi}\frac{I}{r}, B \propto \frac{1}{r}}$

② $r = R$ (surface)

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

long wire

③ $r < R$ (Inside)

$\boxed{B = \frac{\mu_0}{2\pi}\frac{I}{R^2}\times r, B \propto r}$

B, $B \propto r$, $B \propto \frac{1}{r}$

→ Mag. field (Infinite wire) at one end

$\boxed{B = \frac{\mu_0}{4\pi}\frac{I}{r}}$

→ $\vec{B}$ at centre of c.c. loop

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

→ $\vec{B}$ on the axis of loop

$\boxed{B = \frac{\mu_0 I r^2}{2(r^2+x^2)^{3/2}}}$

P far away ($x >> r$)

$\boxed{B = \frac{\mu_0}{2}\frac{I r^2}{x^3}}$

→ $\vec{B}$ at centre, circular segment (arc l)

$\boxed{B_0 = \frac{\mu_0}{4\pi}\frac{I}{r^2}l}$

$\boxed{B_0 = \frac{\mu_0}{4\pi}\frac{I}{r}\times\theta}$

→ Bio-Savart's Law

$\boxed{d\vec{B} = \frac{\mu_0}{4\pi}\frac{I\,d\vec{l}\times\vec{r}}{r^3}}$

$dB = \frac{\mu_0}{4\pi}\frac{I\,dl\sin\theta}{r^2}$

where $\frac{\mu_0}{4\pi} = 10^{-7}\,T A^{-1} m$

→ Relation b/w μ_0, ε_0 & c

$c = \frac{1}{\sqrt{\mu_0\varepsilon_0}} \Rightarrow \mu_0\varepsilon_0 = \frac{1}{c^2}$

→ Mag. field due to a finite c.c. wire

$\boxed{B = \frac{\mu_0}{4\pi}\frac{I}{r}[\sin\phi_1 + \sin\phi_2]}$

→ Mag. field due to Infinite c.c. wire (appx in the middle)

$\boxed{B = \frac{\mu_0}{2\pi}\frac{I}{r}}$

QUESTIONS

Chap 4: Moving Charges & Magnetism

→ Galvanometer → Voltmeter

R(High) in series

$$\boxed{R = \frac{V}{I_g} - G}$$

$$\boxed{R_V = R + G}$$

R_V = Resistance of Voltmeter

→ Current sensitivity

$$\boxed{I_s = \frac{\alpha}{I} = \frac{NBA}{K}}$$

→ Voltage sensitivity

$$\boxed{V_s = \frac{\alpha}{V} = \frac{\alpha}{IR} = \frac{NBA}{KR}}$$

$$\boxed{V_s = \frac{I_s}{R}} \ \#$$

$$\text{Vol. sens} = \frac{\text{current sensitivity}}{R}$$

→ Conversion

Galvanometer → Ammeter

$$\boxed{S = \frac{I_g}{I - I_g} \times G}$$

S = Shunt Resistance

G = Galvanomt. Resistance

$$\boxed{I_g = \frac{S}{G+S} \times I}$$

I_g = Full scale deflection current

$$\boxed{R_A = \frac{GS}{G+S} < S}$$

I = desired current Range.

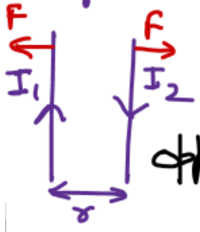
S in Parallel

R_A = Resistance of Ammeter

→ force b/w two parallel C.C. Conductors

$$\boxed{f = \frac{F}{l} = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{r}}$$

Same dir. Current
ATTRACTION



$$\boxed{f = \frac{F}{l} = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{r}}$$

Opposite dir current
REPULSION

→ Torque on c.c. loop in $\vec{B}$

$$\boxed{\vec{\tau} = \vec{m} \times \vec{B}}$$

$\tau = NIAB\sin\theta$ — θ is b/w $\vec{m}$ & $\vec{B}$

$m = NIA$

GALVANOMETER

→ $\boxed{\alpha = \frac{NBA}{K} I}$ $\quad \alpha \propto I$

α = deflecting angle

K = Torsion Constant of Spring

A = Area of Coil

→ $\boxed{G = \frac{I}{\alpha} = \frac{K}{NBA}}$

G = Galvanometer constant

G = Figure of merit also

QUESTIONS

$\boxed{\vec{m} = I\vec{A} = IA\hat{n}}$

If Coil has N turns

$\boxed{\vec{m} = NI\vec{A}}$

⇒ Gauss's law in Magnetism

$\boxed{\oint \vec{B} \cdot d\vec{s} = 0}$ ⇒ Monopoles do not exist

⇒ Magnetising field

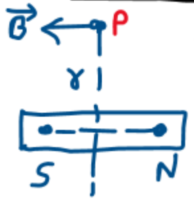
$\boxed{B_0 = \mu_0 n I}$ for Solenoid

⇒ Magnetic Induction

$\boxed{B_M = \mu_0 n I_M}$ I_M = Magnetisation Surface Current

$\boxed{B_M = \mu_0 M}$

⇒ $\vec{B}$ (equatorial point) Bar Magnet

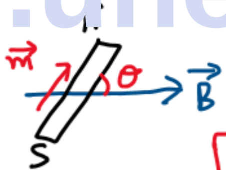


$$\boxed{B_{eq} = \frac{\mu_0}{4\pi} \frac{m}{(r^2+l^2)^{3/2}}}$$

For short dipole, $l << r$

$$\boxed{\vec{B}_{eq} = -\frac{\mu_0}{4\pi} \frac{\vec{m}}{r^3}}$$ equatorial Point.

⇒ Torque on mag. Dipole



$\boxed{\vec{\tau} = \vec{m} \times \vec{B}}$

$\boxed{\tau = mB\sin\theta}$

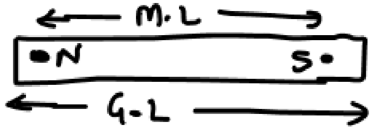
⇒ P.E. of magnetic Dipole

$\boxed{U = mB(\cos\theta_1 - \cos\theta_2)}$

$\boxed{U = 0 \text{ at } \vec{m} \perp \vec{B}}$

$\boxed{U = -\vec{m} \cdot \vec{B}}$

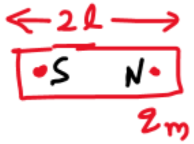
⇒ $\dfrac{\text{Magnetic length}}{\text{Geometrical length}} = 0.84$



⇒ Coulomb's law of mag. force

$$\boxed{F = \frac{\mu_0}{4\pi} \frac{q_{m_1} q_{m_2}}{r^2}}$$

⇒ Magnetic Dipole moment



$\boxed{\vec{m} = q_m \times 2\vec{l}}$

Vector Qty
S→N

⇒ $\vec{B}$ (Axial Point) Bar Magnet

$$\boxed{B_{axi} = \frac{\mu_0}{4\pi} \frac{2mr}{(r^2-l^2)^2}}$$

For short magnet $l << r$

$$\boxed{\vec{B}_{axi} = \frac{\mu_0}{4\pi} \frac{2\vec{m}}{r^3}}$$ Axial Point

QUESTIONS

Chap 5: Magnetism & Matter

⇒ **Modified Curie's Law (Curie-Weiss Law)** (for Ferromagnetic substances)

$$\boxed{\chi_m = \frac{C'}{T - T_c}}$$

T_c = Curie Temp or Curie Point
↳ above this temp Ferro. becomes Para.

⇒ **Important Table**

Diamagnetic	Paramagnetic	Ferromagnetic
$-1 \leq \chi < 0$	$0 < \chi < \varepsilon$	$\chi >> 1$
$0 \leq \mu_r < 1$	$1 < \mu_r < 1 + \varepsilon$	$\mu_r >> 1$
$\mu < \mu_0$	$\mu > \mu_0$	$\mu >> \mu_0$

⇒ **Relative permeability**

$$\boxed{\mu_r = \frac{\mu}{\mu_0}}$$

⇒ **Magnetic Susceptibility (χ_m)**

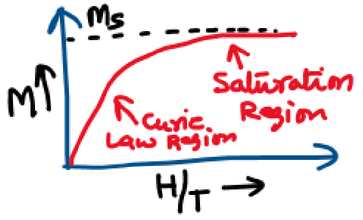
$$\boxed{\chi_m = \frac{M}{H}}$$

⇒ **Relation b/w μ_r & χ_m**

$$\boxed{\mu_r = 1 + \chi_m}$$

⇒ **Curie's Law** (For Paramagnetic)

$$\boxed{\chi_m = \frac{C}{T}}$$



$\chi_m = \frac{M}{H} = \frac{C}{T}$

T = absolute Temp.
C = Curie Constant

⇒ **Magnetising field Intensity**

$\boxed{H = nI}$ nI = no. of ampere-turns

$B_0 = \mu_0 nI = \mu_0 H \Rightarrow \boxed{H = \frac{B_0}{\mu_0}}$

⇒ **Intensity of magnetisation**

$\boxed{\vec{M} = \frac{\vec{m}}{V}}$ $\vec{m}$ = mag. moment per unit volume

If Interior of solenoid is filled with material with non-zero magnetisation

Net field in solenoid
$B = B_0 + B_M = \mu_0 H + \mu_0 M$

$\boxed{B = \mu_0 (H + M)} \Rightarrow \boxed{H = \frac{B}{\mu_0} - M}$

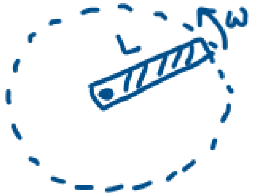
⇒ **Magnetic permeability**

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

QUESTIONS

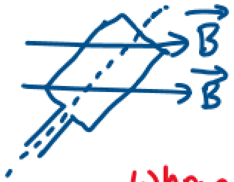
Chap 6: Electromagnetic Induction

⇒ emf in rotating Rod



$$\boxed{e = \frac{1}{2} B L^2 \omega}$$

⇒ Coil rotating in Uniform $\vec{B}$

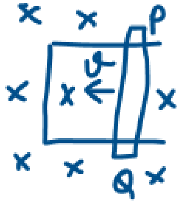


$$\boxed{e = NBA\omega \sin\omega t}$$

$$\boxed{e = e_0 \sin\omega t}$$

where $\boxed{e_0 = NBA\omega}$

⇒ Current Induced in the loop



$$\boxed{I = \frac{e}{R} = \frac{Blv}{R}}$$

⇒ Force on movable arm PQ

$$\boxed{F = \frac{B^2 l^2 v}{R}}$$

⇒ Powered delivered by the external force

$$\boxed{P = Fv = \frac{B^2 l^2 v^2}{R}}$$

⇒ Relation b/w Induced charge & change in mag. flux

$$\boxed{\Delta q = \frac{\Delta \phi}{R}}$$

⇒ Magnetic flux

$$\boxed{\phi = \vec{B} \cdot \vec{A}} \qquad \boxed{\phi = \int_A \vec{B} \cdot d\vec{A}}$$

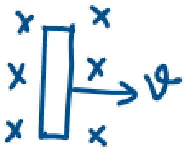
Scalar Qty
SI unit weber (Wb)
CGS unit maxwell (Mx)

$$\boxed{1\,\text{Wb} = 10^8\ \text{maxwell}}$$

⇒ Faraday's Law

$$\boxed{e = -N \frac{d\phi}{dt}} \qquad \boxed{e = -\frac{N(\phi_2 - \phi_1)}{t}}$$

⇒ Motional emf



$$\boxed{e = Blv}$$

QUESTIONS

Chap 6: Electromagnetic Induction

⇒ Mutual Induction

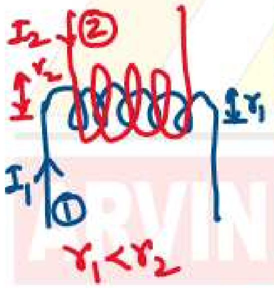
$$\boxed{\phi = MI}$$

M = Coeff. of mutual Inductance or mutual Inductance

$$\boxed{e = -M\frac{dI}{dt}}$$

⇒ Mutual Inductance of two long solenoids

$A = \pi r_1^2$

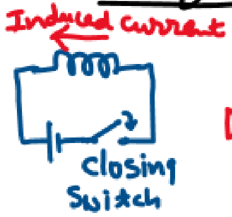


$$\boxed{M = \frac{\mu_0 N_1 N_2 A}{l}}$$

A = area of inner solenoid (common area)

$$\boxed{M = \mu_0 n_1 n_2 A l = \mu_0 n_1 n_2 \pi r_1^2 l}$$

⇒ Self Induction



$$\boxed{\phi = LI}$$

L = Coeff. of Self Induction or Self-Inductance or Inductance

$$\boxed{e = -L\frac{dI}{dt}}$$

⇒ Self-Inductance of a Solenoid

$$\boxed{L = \mu_0 n^2 l A} \quad \boxed{L = \frac{\mu_0 N^2 A}{l}}$$

• If coil is wound over a material μ_r

$$\boxed{L = \mu_r \mu_0 n^2 l A = \frac{\mu_r \mu_0 N^2 A}{l}}$$

Chap 7: Alternating Current

QUESTIONS

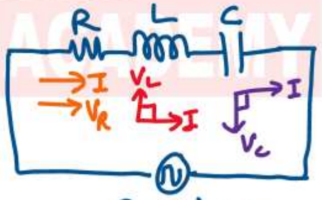
⇒ Series LCR circuit

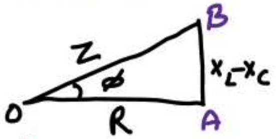
$e = e_0 \sin\omega t$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

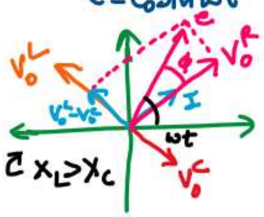
$$\boxed{\tan\phi = \frac{X_L - X_C}{R}}$$

If $X_L > X_C$





Impedence Triangle



If $X_L > X_C$

⇒ Capacitive Reactance

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

① For A.C. $X_C \propto \frac{1}{f}$

② For D.C., $f = 0 \Rightarrow \boxed{X_C = \infty}$

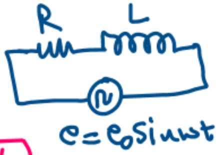
⇒ LR Circuit

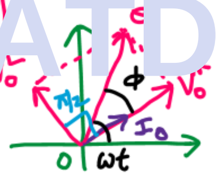
$e = e_0 \sin\omega t$

$I = I_0 \sin(\omega t - \phi)$

$\boxed{\text{e leads the I by } \phi \text{ or I lags the } \varepsilon \text{ by } \phi}$

$$\boxed{\tan\phi = \frac{X_L}{R} = \frac{\omega L}{R}}$$





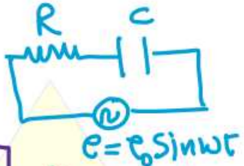
⇒ CR-Circuit

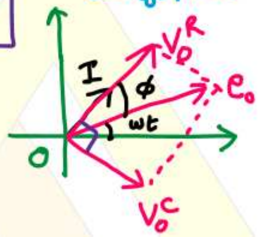
$e = e_0 \sin\omega t$

$I = I_0 \sin(\omega t + \phi)$

$\boxed{\text{I leads the } \varepsilon \text{ by } \phi}$

$$\boxed{\tan\phi = \frac{X_C}{R} = \frac{1/\omega C}{R}}$$





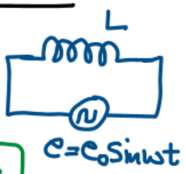
⇒ Pure Inductor Circuit

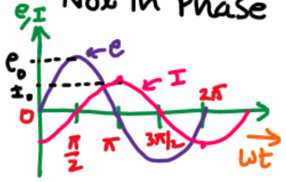
$e = e_0 \sin\omega t$

$I = I_0 \sin(\omega t - \pi/2)$

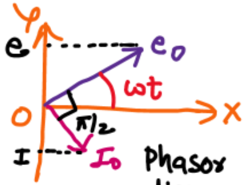
$\boxed{\text{I lags behind e by } \pi/2}$

Not in Phase





Graph e & I Vs ωt



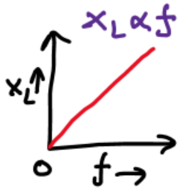
Phasor diagram

⇒ Inductive Reactance

$\boxed{X_L = \omega L = 2\pi f L}$

① For A.C., $X_L \propto f$

② For D.C., $f = 0 \Rightarrow \boxed{X_L = 0}$

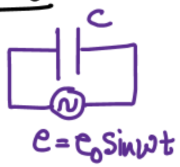


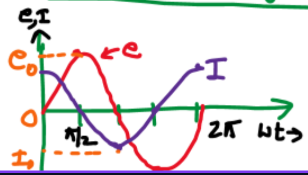
⇒ only capacitor circuit

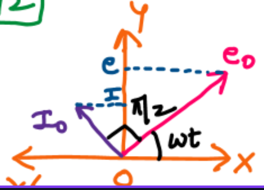
$e = e_0 \sin\omega t$

$I = I_0 \sin(\omega t + \pi/2)$

$\boxed{\text{I leads the e by } \pi/2}$







⇒ AC voltage & current eqn

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

⇒ 3 Values of A.C.

$I_{av(\text{one cycle})} = 0 = e_{av(1\text{ cycle})}$

$I_{av(\text{half cycle})} = \frac{2}{\pi} I_0 = 0.637 I_0$

$e_{av(\text{half cycle})} = \frac{2}{\pi} e_0 = 0.637 e_0$

$I_{rms} = I_{eff} = I_V$

$$\boxed{I_{rms} = \frac{I_0}{\sqrt{2}} = 0.707 I_0}$$

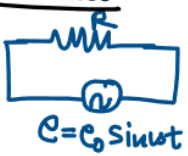
$$\boxed{e_{rms} = \frac{e_0}{\sqrt{2}} = 0.707 e_0}$$

⇒ Pure Resistor circuit

$e = e_0 \sin\omega t$

$I = I_0 \sin\omega t$

$\boxed{\text{Same Phase}}$



Graph e & I Vs ωt

Phasor Diagram

QUESTIONS

$$\boxed{\text{Power factor} = \cos\phi = \frac{R}{Z}}$$

→ For Pure Inductive/Capacitive $\cos\phi = 0$

→ Purely Resistive $\boxed{\cos\phi = 1}$

→ At Resonance $\boxed{\cos\phi = 1}$

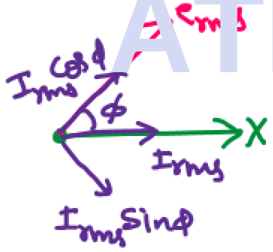
⇒ Wattless Current

I in a.c. circuit, if avg. power consumed in the circuit is zero.

example:-

① Purely Inductive
$\phi = \pi/2$, $P_{av} = 0$

② Purely Capacitive
$\phi = -\pi/2$, $P_{av} = 0$



⇒ Transformer

$$\boxed{\frac{I_1}{I_2} = \frac{e_2}{e_1} = \frac{N_2}{N_1}}$$

$I_1 = I_p$
$I_2 = I_s$

$$\eta = \frac{\text{Power output}}{\text{Power Input}} \times 100\%$$

⇒ Resonance condition

→ max I in series LCR

Cond^n $\boxed{X_L = X_C}$

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

Quality factor Q

$$\boxed{Q = \frac{1}{R}\sqrt{\frac{L}{C}}}$$

⇒ POWER ⇐

$$\boxed{P_{av} = e_{rms} I_{rms} \cos\phi}$$

① Pure Resistive circuit ($\phi = 0$)
$P_{av} = e_{rms} I_{rms}$

② Pure Inductive ($\phi = \pi/2$) ⇒ $\boxed{P_{av} = 0}$

③ Pure Capacitive ($\phi = -\pi/2$) ⇒ $\boxed{P_{av} = 0}$

④ Series LCR
$P_{av} = e_{rms} I_{rms} \cos\phi$ $\quad \cos\phi = \frac{R}{Z}$

⑤ At Resonance ($X_L = X_C$) ($\phi = 0$)
$\boxed{P_{av} = e_{rms} \times I_{rms}}$

⇒ Special Cases

① When $X_L > X_C$ or $V_L > V_C$ (Inductive Circuit)
$e = e_0 \sin\omega t$
$I = I_0 \sin(\omega t - \phi)$
Here $\tan\phi = \frac{X_L - X_C}{R}$
or $\cos\phi = \frac{R}{Z}$

② When $X_L < X_C$ OR $V_L < V_C$ (Capacitive circuit)
$e = e_0 \sin\omega t$
$I = I_0 \sin(\omega t + \phi)$
Here $\tan\phi = \frac{X_C - X_L}{R}$
OR $\cos\phi = \frac{R}{Z}$

③ When $X_L = X_C$ OR $V_L = V_C$ (Resistive circuit)
$e = e_0 \sin\omega t$
$I = I_0 \sin\omega t$
Here $\tan\phi = \frac{X_L - X_C}{R} = 0$
$\boxed{\phi = 0}$
$\boxed{\text{Same Phase}}$

QUESTIONS

Chap 8: Electromagnetic Waves

⇒ Electromagnetic Spectrum

λ		freq.
> 0·1 m	① Radio Waves	$10^4 - 10^8$ Hz
0·1 m – 1 mm	② Microwave	$10^9 - 10^{12}$ Hz
1 mm – 700 nm	③ Infrared	$10^{11} - 5\times10^{14}$
700 nm – 400 nm	④ Visible light	$4\times10^{14} - 7\times10^{14}$
400 nm – 1 nm	⑤ Ultraviolet	$10^{16} - 10^{17}$
1 nm – 10^{-3} nm	⑥ X-Ray	$10^{16} - 10^{19}$
< 10^{-3} nm	⑦ γ- Rays	$10^{18} - 10^{22}$

⇒ ① Radio Waves

Uses: Radio Communication
Radioastronomy

Production: Accelerated motion of charges in Conducting wires or oscillating circuits.

⇒ Momentum of em Wave

$$\boxed{p = \frac{U}{c}}$$

U = Total Energy
c = Speed of light in Vacuum/Air

⇒ Radiation Pressure

$$\boxed{P_r = \frac{I}{c}}$$

I = Intensity

⇒ E & B Relation

$$\boxed{\frac{E}{B} = c} \text{ or } \boxed{\frac{E_0}{B_0} = c}$$

⇒ Relation b/w c, μ & ε

$$\boxed{c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}} \qquad \boxed{v = \frac{1}{\sqrt{\mu\varepsilon}} = \frac{c}{\sqrt{K\mu_r}}}$$

⇒ Equation of em wave

$$\vec{E} = E_0 \sin(kx - \omega t)\,\hat{j}$$
$$\vec{B} = B_0 \sin(kx - \omega t)\,\hat{k}$$

$\vec{E}$ & $\vec{B}$ Are in Same Phase

⇒ Electromagnetic Waves

① direction of em wave = $\vec{E}\times\vec{B}$

② Source = accelerated charge

⇒ Energy density of em Wave

→ Energy per unit Volume

$$u_E = \frac{1}{2}\varepsilon_0 E_{rms}^2, \quad u_B = \frac{1}{2}\frac{B_{rms}^2}{\mu_0}$$

→ Imp. $\boxed{u_E = u_B}$

$E_{rms} = \frac{E_0}{\sqrt{2}}$

$B_{rms} = \frac{B_0}{\sqrt{2}}$

$$\boxed{u(\text{Total}) = u_E + u_B = \varepsilon_0 E_{rms}^2 = \frac{B_{rms}^2}{\mu_0}}$$

⇒ Intensity of em wave

Energy Crossing per unit area per unit time perpendicular to the propagation of the wave.

$$\boxed{I = \varepsilon_0 E_{rms}^2 c = \frac{B_{rms}^2}{\mu_0}\times c}$$

⇒ Displacement Current

$$\boxed{I_d = \varepsilon_0 \frac{d\phi_E}{dt}}$$

⇒ Modified Ampere's Law

$$\oint \vec{B}\cdot d\vec{l} = \mu_0 [I_C + I_D]$$

Here $I_D = \varepsilon_0 \frac{d\phi_E}{dt}$, I_C = Conduction Current

⇒ Maxwell 4 eqn Electromagnetism

① $\oint \vec{E}\cdot d\vec{s} = \frac{q}{\varepsilon_0}$ (Gauss Law)

② $\oint \vec{B}\cdot d\vec{s} = 0$ (Gauss Law for magnetism)

③ $e = -\frac{d\phi_B}{dt}$ (Faraday's Law)

④ $\oint \vec{B}\cdot d\vec{l} = \mu_0 [I_c + I_D]$ (Modified Ampere's law)

QUESTIONS

Chap 8: Electromagnetic Waves

⇒ 7 Gamma Rays

Uses: In Radiotherapy for malignant tumors, initiate nuclear reactions, study of structure of atomic nuclei etc.

Production: Radioactive decay of the nucleus, Co-60 is a pure γ-Ray source.

⇒ 5 Ultraviolet light

Uses: In food preservation, Invisible writings, fingerprints, molecular structure.

Production: Sun, High voltage gas discharge tubes etc.

⇒ 6 X-Rays

Uses: Medical diagnosis, In the study of crystal structure, detecting cracks, In Radiotherapy to cure malignant growths.

Production: Sudden deceleration of fast moving electrons by metal target.

⇒ 2 Microwaves

Uses: Radar System, AirCraft navigation, Geostationary Satellites.

Production: through Klystron Valve or magnetron valve.

⇒ 3 Infrared Waves (Heat waves)

Uses: Remote Control TV, VCR.
In Green houses, Infrared Lamps in treatment of muscular complaints, Study of molecular structure, Secret writings.

Production: Vibration of atoms and molecules.

⇒ 4 Visible light

Uses: We Can see, initiate chemical reactions.

Production: Radiated by excited atoms in ionised gas & incandescent bodies.

QUESTIONS

Chap 9: Ray optics & Optical Instruments

⇒ Thin Lens Formula

→ $\boxed{\frac{1}{v} - \frac{1}{u} = \frac{1}{f}}$

→ $\boxed{m = \frac{v}{u}}$

→ $\boxed{m = \frac{f}{f+u} = \frac{f-v}{f}}$

m = Linear magnification

⇒ Power of Lens

→ $\boxed{P = \frac{1}{f}}$

⇒ Refraction at spherical surfaces

① Rarer → Denser

$$\boxed{\frac{\mu_D}{v} - \frac{\mu_R}{u} = \frac{\mu_D - \mu_R}{R}}$$

② Denser → Rarer

$$\boxed{\frac{\mu_R}{v} - \frac{\mu_D}{u} = \frac{\mu_R - \mu_D}{R}}$$

$\boxed{\frac{\mu_D - \mu_R}{R}}$ → is called Power factor of the Spherical surface

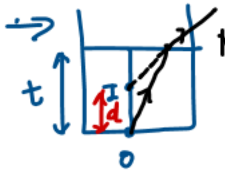
⇒ Lens Maker's Formula

$$\boxed{\frac{1}{f} = \left(\frac{\mu_D - \mu_R}{\mu_R}\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]}$$

⇒ When Lens is placed in AIR $\mu_R = 1$

$$\boxed{\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]}$$

→ $\boxed{\text{Refractive Index} = \frac{\text{Real depth}}{\text{Apparent depth}}}$

→ 

Normal shift = d

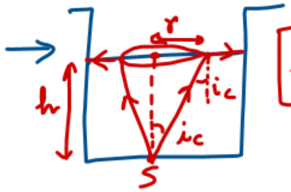
$$\boxed{d = t\left(1 - \frac{1}{\mu}\right)}$$

→ Total Normal shift for Compound media

$$\boxed{d = t_1\left(1 - \frac{1}{\mu_1}\right) + t_2\left(1 - \frac{1}{\mu_2}\right) + ---}$$

⇒ Total Internal Reflection (TIR)

→ $\boxed{{}^R\mu_D = \frac{1}{\sin i_c} = \mu}$

→ 

$\boxed{h = r\sqrt{\mu^2 - 1}}$

⇒ Reflection

→ $R = 2f$ OR $\boxed{f = R/2}$

→ $\boxed{\frac{1}{v} + \frac{1}{u} = \frac{1}{f}}$

→ $\boxed{m = -\frac{v}{u}}$ OR $\boxed{m = \frac{f - v}{f}}$

→ $|m| > 1$ Image magnified
$|m| < 1$ Image diminished
$|m| = 1$ Same size

→ m = +ve [Image Virtual & Erect]
m = −ve [Image Real & Inverted]

⇒ Refraction

→ $\boxed{{}^1\mu_2 = n_{21} = \frac{\sin i}{\sin r}}$

→ $\boxed{{}^1\mu_2 = n_{21} = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}}$

→ $\boxed{{}^1\mu_2 \times {}^2\mu_3 \times {}^3\mu_1 = 1}$

→ $\boxed{{}^w\mu_g = \frac{{}^a\mu_g}{{}^a\mu_w}}$ OR $\boxed{{}^1\mu_2 = \frac{{}^a\mu_2}{{}^a\mu_1}}$

QUESTIONS

Chap 9: Ray optics & Optical Instruments

⇒ Compound Microscope

magnifying Power of Compound microscope by definition

$$\boxed{M = \frac{v_o}{u_o} \times \frac{D}{u_e}}$$

$$\boxed{M = m_o \times m_e}$$

m_o = Linear magnification by obj
m_e = magnifying power of eyepiece (Angular magnification)

→ Case 1: Final Image at D

$$\boxed{M = \frac{v_o}{u_o}\left(1+\frac{D}{f_e}\right)} \quad \text{OR}$$

$$\boxed{M = -\frac{L}{f_o}\left(1+\frac{D}{f_e}\right)}$$

L = Length of Microscope Tube
$L = |v_o| + |u_e|$

→ Case 2: Final Image at ∞

$$\boxed{M = \left(\frac{v_o}{u_o}\right)\left(\frac{D}{f_e}\right)} \quad \text{OR}$$

$$\boxed{M = -\frac{L}{f_o} \times \frac{D}{f_e}}$$

⇒ OPTICAL INSTRUMENTS

⇒ Microscope

$$M = \frac{\text{Visual angle formed by Final Image}}{\text{Visual angle formed by object kept at D}}$$

(Angular magnification)

$$\boxed{M = \frac{\beta}{\alpha}}$$

⇒ Simple Microscope

Magnifying power of Simple microscope by definition

$$\boxed{M = \frac{D}{u_e}}$$

→ Case 1: final Image at D

$$\boxed{M = 1 + \frac{D}{f}}$$ maximum magnification

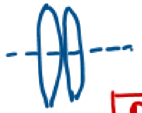
→ Case 2: final Image at ∞

$$\boxed{M = \frac{D}{f}}$$ min magnification

• For Simple Microscope

$$\boxed{\frac{D}{f} \le M \le 1 + \frac{D}{f}}$$

⇒ Combination of lenses



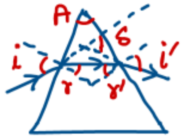
$$\boxed{\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}}$$

$$\boxed{P = P_1 + P_2}$$

Total magnification (m)

$$\boxed{m = m_1 \times m_2 \times m_3 - - -}$$

⇒ PRISM



$$\boxed{A = r + r'}$$

$$\boxed{i + i' = A + \delta}$$

→ at δ_m (angle of min. deviation)

$\boxed{i = i'}$ and $\boxed{r = r'}$

→ Refractive Index of Prism material

$$\boxed{\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin(A/2)}}$$

→ For small angled Prism

$$\boxed{\delta = (\mu - 1)A}$$

QUESTIONS

Chap 9: Ray optics & Optical instruments

⇒ ASTRONOMICAL Telescope

$$M = \frac{\text{Visual angle formed by final Image}}{\text{Visual angle formed by object}}$$

$$\boxed{M = \frac{\beta}{\alpha}}$$

magnifying Power of Refracting Telescope by definition

$$\boxed{M = -\frac{f_o}{u_e}}$$

→ Case 1: Final Image at D

$$\boxed{M = -\frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right)}$$

L= length of Telescope

$$\boxed{L = |f_o| + |u_e|}$$

→ Case 2: Final Image at ∞

$$\boxed{M = \frac{-f_o}{f_e}} \quad \&$$

$$\boxed{L = |f_o| + |f_e|}$$ length of Telescope

For larger magnification in Telescope ⇒ $\boxed{f_o >> f_e}$

QUESTIONS

Chap 10: Wave optics

⇒ **Imp. Note**

If $I_1 = I_2 = I_0$ (Intensities are same)

then $\boxed{I = 4I_0 \cos^2 \phi/2}$

In another form

$\boxed{I = I_{max} \cos^2 \phi/2}$ Here $I_{max} = 4I_0$

⇒ **Relation b/w Phase & Path diff.**

$$\boxed{\Delta\phi = \frac{2\pi}{\lambda} \times \Delta p}$$

$\Delta\phi$ = Phase diff. (Angle)

Δp = Path diff. (distance)

⇒ **Effect on λ, ν, v during Refraction**

→ freq ν unchanged

$$\boxed{{}^1\mu_2 = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}}$$

→ λ & v changed in Refraction

→ $\boxed{{}^a\mu_1 = \frac{c}{v}}$ (Absolute Refractive Index)

⇒ **Intensity at any point in interference**

$$\boxed{A^2 = a_1^2 + a_2^2 + 2a_1a_2 \cos\phi}$$

$I \propto A^2$ (In wave)

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

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

ϕ = Constant Phase diff.

QUESTIONS

Chap 10: Wave Optics

→ Angular width of a fringe

$$\boxed{\theta = \frac{\beta}{D} = \frac{\lambda}{d}}$$

→ If apparatus immersed in a liquid of refractive Index (μ)

then λ will decrease $\lambda' = \lambda/\mu$

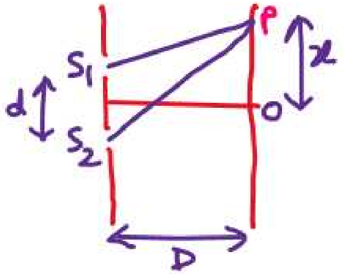
Consequently fringe width decreases

$$\boxed{\beta' = \frac{\beta}{\mu}}$$

⇒ Theory of Interference fringes

Path diff at Point P

$$\boxed{\Delta p = \frac{xd}{D}}$$



→ Position of Bright fringes

$$\boxed{x_n = \frac{nD\lambda}{d}}$$ n^{th} bright fringe

$n = 0, 1, 2, 3, ---$

→ Position of Dark fringe

$$\boxed{x'_n = \frac{(2n-1)D\lambda}{2d}}$$ n^{th} Dark fringe

$n = 1, 2, 3, ---$

→ Fringe Width

$$\boxed{\beta = \frac{D\lambda}{d}}$$ → All fringes of equal width.

⇒ Condition for Constructive Interference (Maxima)

Phase diff. even multiple of π → $\boxed{\Delta\phi = 2n\pi}$

Path diff even multiple of $\lambda/2$ → $\boxed{\Delta p = 2n(\lambda/2)}$

Path diff. integral multiple of λ → $\boxed{\Delta p = n\lambda}$

Here $n = 0, 1, 2, 3, ---$

⇒ Condition for destructive Interference (Minima)

Phase diff odd multiple of π → $\boxed{\Delta\phi = (2n-1)\pi}$

Path diff. odd multiple of $\lambda/2$ → $\boxed{\Delta p = (2n-1)\lambda/2}$

Here $n = 1, 2, 3, ---$

QUESTIONS

⇒ Secondary Maxima

Angular width $\boxed{\theta = \lambda/a}$

Linear width $\boxed{\beta = \frac{D\lambda}{a}}$ Half of Central maxima

→ Distance of n^{th} maxima from 'O' centre of screen

$$\boxed{x_n = \frac{(2n+1)D\lambda}{2a}}$$

→ Direction of n^{th} minima

$$\boxed{\theta'_n = (2n)\left(\frac{\lambda}{2a}\right) = n\frac{\lambda}{a}} \quad n = 1, 2, 3 \ldots$$

Opposite of Interference, even multiple π minima है।

→ Distance of n^{th} minima from 'O' centre of screen.

$$\boxed{x'_n = \frac{nD\lambda}{a}}$$

⇒ Central Maxima

Angular width $= 2\theta = \frac{2\lambda}{a}$

Linear width $= \beta_0 = \frac{2D\lambda}{a} = 2\beta$

⇒ Comparison of I_{max} & I_{min}

$$\boxed{\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)^2 = \left(\frac{a_1+a_2}{a_1-a_2}\right)^2 = \left(\frac{\frac{a_1}{a_2}+1}{\frac{a_1}{a_2}-1}\right)^2}$$

$$r = \frac{a_1}{a_2} = \sqrt{\frac{I_1}{I_2}} = \text{amplitude Ratio}$$

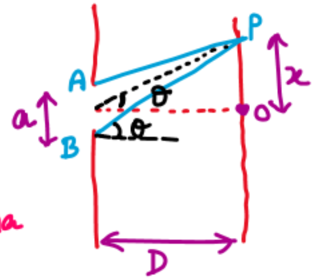
$$\boxed{\frac{\omega_1}{\omega_2} = \frac{I_1}{I_2} = \frac{a_1^2}{a_2^2}}$$

ω_1 & ω_2 width of two Slits

⇒ Diffraction at a Single Slit

→ Path diff b/w A & B

$$\boxed{p = a\sin\theta}$$



→ Direction of Secondary maxima

$$\boxed{\theta_n = \frac{(2n+1)\lambda}{2a}} \quad n = 1, 2, 3 \ldots$$

$\boxed{a = \text{Width of Slit}}$

opposite of Interference, odd multiple π maxima है।

QUESTIONS

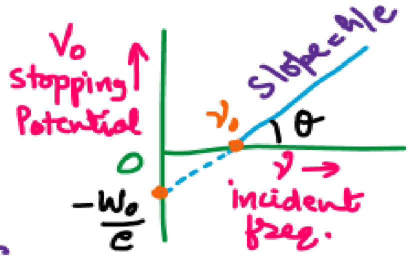
⇒ Determination of Planck's Constant (h) & Work function (W_0 or ϕ_0)

$K_{max} = h\nu - W_0$

$K_{max} = eV_0$

$eV_0 = h\nu - W_0$

$$\boxed{V_0 = \left(\frac{h}{e}\right)\nu - \frac{W_0}{e}}$$



Compared with

$$\boxed{y = mx + c}$$

$$\boxed{\begin{aligned} m &= h/e \\ c &= -W_0/e \end{aligned}}$$ #

Slope $= h/e \Rightarrow \boxed{h = e \times \text{slope}}$

$$\boxed{W_0 = e \times \text{magnitude of y intercept}}$$

⇒ Rest mass of Photon is zero

$$m_0 = m\sqrt{1 - \frac{v^2}{c^2}} = m\sqrt{1 - \frac{c^2}{c^2}} = 0$$

⇒ From Einstein's mass-energy relationship

the equivalent mass of Photon

$$E = mc^2 = h\nu \Rightarrow \boxed{m = \frac{h\nu}{c^2}}$$

⇒ Linear momentum of Photon

$$\boxed{p = mc = \frac{h\nu}{c} = \frac{h}{\lambda}}$$

⇒ $\boxed{1\,eV = 1.602 \times 10^{-19}\,J}$

⇒ $\boxed{K_{max} = \frac{1}{2}mV_{max}^2 = eV_0}$

⇒ Einstein's Photoelectric equations

→ $\boxed{K_{max} = \frac{1}{2}mV_{max}^2 = h\nu - W_0}$

→ $\boxed{K_{max} = \frac{1}{2}mV_{max}^2 = h\nu - h\nu_0 = h(\nu - \nu_0)}$

⇒ $\boxed{K_{max} = \frac{1}{2}mV_{max}^2 \propto \nu}$

QUESTIONS

Chap 11: Dual Nature

⇒ de-Broglie's Wave eqⁿ

$$\boxed{\lambda = \frac{h}{mc} = \frac{h}{p}}$$

→ True for any particle of mass m moving with velocity v must be associated with matter wave of wavelength λ

$$\boxed{\lambda = \frac{h}{p} = \frac{h}{mv}}$$

$\lambda \propto \frac{1}{p}$

If $v = 0$ then $\lambda = \infty$

∴ No matter wave if $v = 0$

QUESTIONS

Chap 12: Atoms

⇒ Speed of an e^- in Bohr's rad.

$$\boxed{v = \frac{c}{137}}$$ e^- speed in Bohr's radius

In General

$$\boxed{v_n = \frac{1}{137}\frac{c}{n}}$$

⇒ Relation b/w orbit radius & e velocity

$$\boxed{r = \frac{kZe^2}{mv^2}}$$

• Here $K = \frac{1}{4\pi\varepsilon_0}$

• Z = atomic no. for Hydrogen it is 1.

⇒ orbital speed of an electron in n^{th} orbit

$$\boxed{v = \frac{2\pi kZe^2}{nh}}$$

$K = \frac{1}{4\pi\varepsilon_0}$

Z = atomic no.

⇒ Radius of n^{th} orbit

$$\boxed{r = \frac{n^2h^2}{4\pi^2 mkZe^2}}$$

m = mass of e^-

$K = \frac{1}{4\pi\varepsilon_0}$

⇒ Bohr's Radius (r_0)

→ In this $Z=1$ & $n=1$

$$\boxed{r_0 = \frac{h^2}{4\pi^2 mke^2} = 0.53\ \mathring{A}}$$

$r_n = n^2 r_0$ ... relation

⇒ α - particle

$$\boxed{m_\alpha = 4m_p} \quad \boxed{q_\alpha = 2q_p = +2e}$$

⇒ distance of closest approach (r_0)

→ when α particle is shoots to nucleus of Atom

$$\boxed{r_0 = \frac{2kZe^2}{K_\alpha} = \frac{4kZe^2}{mv^2}}$$

Here $K = \frac{1}{4\pi\varepsilon_0}$, K_α = K.E. of α-part.

⇒ Bohr's Quantisation Cond^n

$$\boxed{L = mvr = \frac{nh}{2\pi}}$$ $n = 1, 2, 3 \ldots$

L = Angular momentum

QUESTIONS

Chap 12: Atoms

⇒ Spectral Series Hydrogen

$$\boxed{\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]}$$

$\bar{\nu}$ → Wave no.

R → Rydberg Constant

$$\boxed{R = 1.0973 \times 10^7\ m^{-1}}$$

n_i = initial orbit

n_f = Final orbit

⇒ Short Formula of Total Eng. of an e^- in n^{th} orbit Hydrogen atom

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

⇒ Bohr's model of Hydrogen Atom

① Speed of e^- $\boxed{v_n = \frac{v_1}{n}}$

v_1 = Speed of e^- in 1^{st} orbit $= \frac{c}{137}$

② Time period $\boxed{T_n = n^3 T_1}$

③ Radius $\boxed{r_n = n^2 r_1}$

④ Energy $\boxed{E_n = -\frac{13.6}{n^2}\ eV}$

⇒ Energy of the electron

$$\boxed{E_n = -\frac{2\pi^2 m k^2 Z^2 e^4}{n^2 h^2}}$$

–ve energy indicates e^- is bound to nucleus by electrostatic attraction.

⇒ Imp. Relation b/w Total Energy (E), Kinetic Energy (K) & Potential Eng. (U) when e^- revolving in orbit

$$\boxed{E = -K = \frac{U}{2}}$$ In hydrogen

In Hydrogen

$$\boxed{K = \frac{e^2}{8\pi\varepsilon_0 r}} \qquad \boxed{U = -\frac{e^2}{4\pi\varepsilon_0 r}}$$

$$\boxed{E = K + U = -\frac{e^2}{8\pi\varepsilon_0 r}}$$

Chap 12: Atoms

⇒ Spectral Series Hydrogen

① Lyman Series ($n_f = 1, n_i = 2, 3, ---$)

$$\boxed{\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{n_i^2}\right]}$$

→ belongs to Ultraviolet Region

② Balmer Series ($n_f = 2, n_i = 3, 4, ---$)

$$\boxed{\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{n_i^2}\right]}$$

→ lies in Visible Region.

③ Paschen Series ($n_f = 3, n_i = 4, 5, --$)

$$\boxed{\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{3^2} - \frac{1}{n_i^2}\right]}$$

→ lies in Infrared Region

④ Brackett Series ($n_f = 4, n_i = 5, 6 ---$)

$$\boxed{\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{4^2} - \frac{1}{n_i^2}\right]}$$

→ in Infrared Region.

⑤ Pfund Series ($n_f = 5, n_i = 6, 7, --$)

$$\boxed{\bar{\nu} = \frac{1}{\lambda} = R\left[\frac{1}{5^2} - \frac{1}{n_i^2}\right]}$$

→ Infrared Region.

⇒ Some important Points

① For shortest λ put $\boxed{n_i = \infty}$
(Highest Energy)
max ν

ex. for Balmer Series for shortest λ
$n_i = \infty, \; n_f = 2$

② For longest λ put $\boxed{n_i = n_f + 1}$
(min ν)

→ This is called H_α line of min ν

ex. for H_α longest λ for Balmer
$n_i = 3, \; n_f = 2$

③ H_β line $\boxed{n_i = n_f + 2}$

④ H_γ line $\boxed{n_i = n_f + 3}$

ex. H_γ for Balmer Series
$n_i = 5, \; n_f = 2$

QUESTIONS

QUESTIONS

Chap 12: Atoms

⇒ **Imp. Point**

Ground Level $n = 1$

1st excited state $= n = 2$

2nd excited state $= n = 3$

- - - - -

⇒ **Shortcut Formula**

$$\boxed{E = \frac{12400}{\lambda (\text{in } \mathring{A})} \text{ eV}}$$

⇒ **Total Energy of Hydrogen atom**

$E_1 = -13.6$ eV

$E_2 = -3.4$ eV

$E_3 = -1.51$ eV

$E_4 = -0.85$ eV

$E_5 = -0.54$ eV

$E_6 = -0.38$ eV

Clearly e^- has certain definite energy levels this is called energy quantisation.

QUESTIONS

Chap 13: Nuclei

⇒ Atomic mass unit (amu ≡ u)

$1u = \frac{1}{12}$ actual mass of C-12 atom

$1u = 1.660565 \times 10^{-27}$ Kg

$1 eV = 1.602 \times 10^{-19}$ J

$1 MeV = 10^6 eV = 1.602 \times 10^{-13}$ J

million electron Volt

$\boxed{1 amu = 931 MeV}$

⇒ Avg. Atomic mass

for example chlorine contains 75% of ${}^{35}_{17}Cl$ & 25% of ${}^{37}_{17}Cl$

Avg. atomic mass of chlorine

$$= \frac{35 \times 75 + 37 \times 25}{75 + 25} = 35.50$$

⇒ Isotopes, Isobars etc.

① Isotopes (A diff, Z same)
ex. ${}^{1}_{1}H$, ${}^{2}_{1}H$ & ${}^{3}_{1}H$

② Isobars (A same, Z diff)
ex ${}^{3}_{1}H$, ${}^{3}_{2}He$

③ Isotones (Same no. of neutrons)
ex. ${}^{37}_{17}Cl$, ${}^{39}_{19}K$

④ Isomers (Same A, Same Z) but in diff energy states.

⇒ $q_p = 1.6 \times 10^{-19}$ C

$m_p = 1.6726 \times 10^{-27}$ Kg

(1836 times of rest mass of e^-)

($m_e = 9.1093837 \times 10^{-31}$ Kg)

⇒ $q_n = 0$ (charge on neutron)

$m_n = 1.6749 \times 10^{-27}$ kg

(Slightly greater than proton)

⇒ Important Terms

① Nucleons (for protons & neutrons)

② Atomic no. (no. of Protons) = Z

③ Mass no. $= n_p + n_n = A$

④ No. of Neutrons $= N = A - Z$

⑤ Nuclear Mass = Total mass of protons & neutrons in the nucleus.

⑥ Representation

${}^{A}_{Z}X$ X = element
Z = atomic no.
A = mass no.

Chap 13: Nuclei

QUESTIONS

⇒ Binding Energy & BEN

$$\boxed{B.E. = \Delta m c^2}$$

$$\boxed{B.E.N. = \frac{B.E.}{A}}$$

⇒ Nuclear Fission

$${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3\,{}^{1}_{0}n + Q$$

⇒ Nuclear Fusion

$${}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{4}_{2}H + 21.6\ MeV$$

⇒ Nuclear Force

1. Stongest Force
   $F_g : F_e : F_n = 1 : 10^{36} : 10^{38}$
2. Short Range force
   about 2-3 fm from nucleon.
3. Variation with distance
   P.E min at $r_0 \simeq 0.8$ fm
   (Strongest attraction at r_0)
4. Charge independent
5. Saturation effect
6. Spin dependent character
7. Nuclear force due to exchange of mesons.
8. Non-Central forces.

⇒ Mass defect

$$\boxed{\Delta m = [Z m_p + (A-Z) m_n - m_N]}$$

m_N = actual mass of nucleus

⇒ Radius of Nucleus

$$\boxed{R = R_0 A^{1/3}}$$

$R_0 = 1.2 \times 10^{-15}$ m
A = mass no.

⇒ Nuclear density

$$\boxed{\rho_{nu} = \frac{3m}{4\pi R_0^3} = \text{Constant}}$$

m = Avg. mass of nucleon

Imp. Note ρ_{nu} is independent from Size (R) & mass no. (A).

approx. Same for all nucleus.

QUESTIONS

Chap 14: Semiconductors

⇒ Forward Biasing p-n junction

1. Barrier pot. decreases to $(V_B - V)$
2. Depletion layer width decreases
3. effective Resistance across p-n jun. decreases
4. Current (I) in mA

⇒ Intrinsic Semiconductor

$$\boxed{I = I_e + I_h}$$

I = Total Current
I_e = Electron Current
I_h = hole current

⇒ Extrinsic Semi.

n type
Si/Ge + Pentavalent Dopants
ex. Ar, Sb & P
$(n_e >> n_h)$

p type
Si/Ge + Trivalent dopants
ex. Al, In, B
$(n_h >> n_e)$

⇒ In a doped Semiconductor

Under thermal equilibrium

$$\boxed{n_e \times n_h = n_i^2}$$

⇒ Intrinsic Semiconductor

$$\boxed{n_e = C e^{-E_g/2KT}}$$

n_e = no. of e^- set free at absolute temp T.
K = Boltzman Constant
E_g = Ionisation Energy
T = Absolute Temp.

⇒ Intrinsic Semiconductor

$$\boxed{n_e = n_h = n_i}$$

n_e = no. density of free e^-
n_h = no. density of holes
n_i = Intrinsic charge Carrier Concentration.

QUESTIONS

⇒ Rectifier

① Half wave

$\boxed{\text{output freq} = \text{Input freq.}}$

② Full Wave

$\boxed{\text{output freq} = 2 \times \text{Input freq.}}$

⇒ Reverse Biasing p-n jun.

① Barrier potential increases to $(V_B + V)$

② depletion layer width Increases

③ Resistance of p-n jun. becomes very large

④ No current through majority charge carriers.

⑤ very small current due to minority charge carriers (Reverse current) of order μA.

⇒ Dynamic Resistance

$$\boxed{r_d = \frac{\Delta V}{\Delta I}}$$

Thank You

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