Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in ELECTROSTATICS – PART 1 (ELECTRODYNAMICS)

1. Coulomb's Law
2. Electric Field & Standard Line diagram
3. Electric Field due to line charge
4. Electric Field due to a charged ring
5. Electric Field due to a charged disc
6. Electric Field due to a charged sphere
7. Electric Field due to Non-Uniform Charge Distribution
8. Electrostatic Potential (ring & sphere)
9. Electrostatic Potential Energy (self energy)
10. Relation between E & V
11. Electric Dipole
12. Electric Flux
13. Conductors

Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

1. COULOMB'S LAW

$$F = \frac{1}{4\pi\varepsilon_0\varepsilon_r}\frac{q_1 q_2}{r^2} \text{ N}$$

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

ε_0 : permittivity of free space 8.85×10^{-12} C^2/Nm^2

ε_r : Relative permittivity of medium

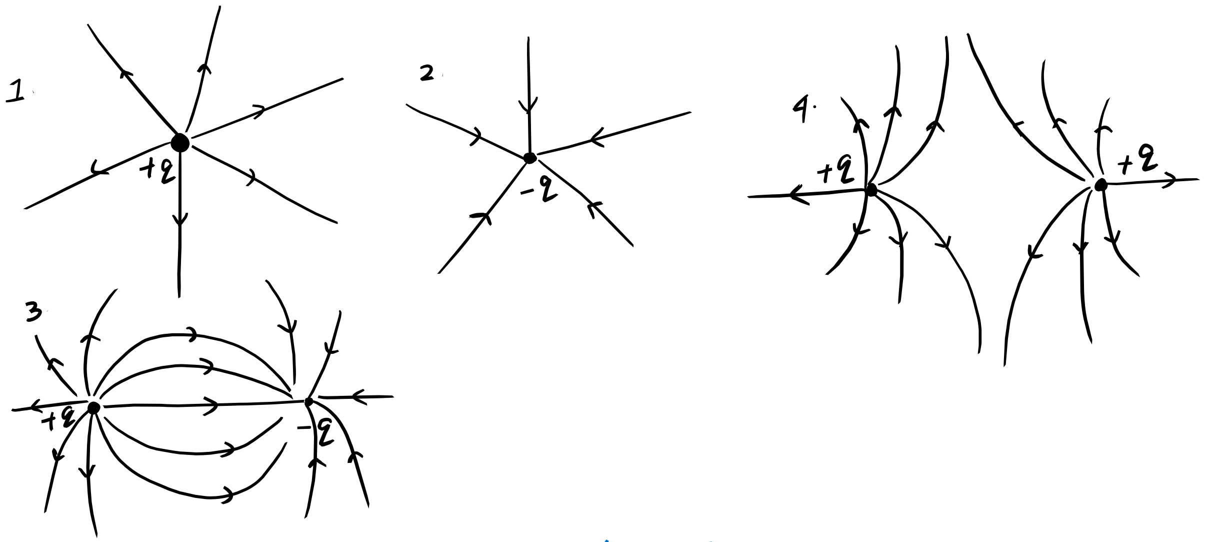
VECTOR Form : $\vec{F}_{21} = \dfrac{Kq_1q_2(\vec{r}_2-\vec{r}_1)}{|\vec{r}_2-\vec{r}_1|^3}$

* Put q_1 and q_2 with sign.

$Q = ne^-$, $n \in I$

$e = 1.6\times10^{-19}$ C

2. ELECTRIC FIELD ($E = Kq/r^2$), N/C

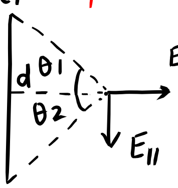


3. ELECTRIC FIELD DUE TO LINE CHARGE

(CHARGE IS UNIFORMLY DISTRIBUTED)

FINITE LENGTH

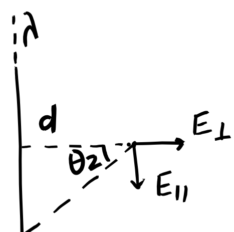
λ C/m



$$E_\perp = \frac{K\lambda}{d}(\sin\theta_1 + \sin\theta_2)$$

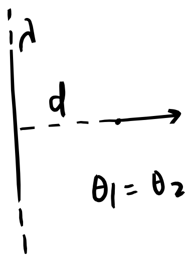
$$E_\parallel = \frac{K\lambda}{d}(\cos\theta_2 - \cos\theta_1)$$

SEMI-INFINITE



$\theta_1 = 90°$, θ_2

INFINITE



$\theta_1 = \theta_2 = 90°$

$$E_\perp = \frac{2K\lambda}{d} = \frac{\lambda}{2\pi\varepsilon_0 d}$$

$E_\parallel = 0$

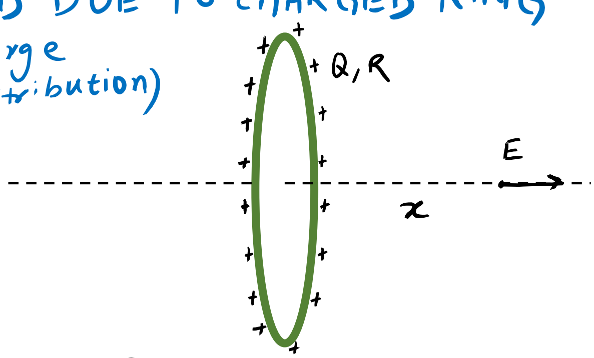
4. ELECTRIC FIELD DUE TO CHARGED RING

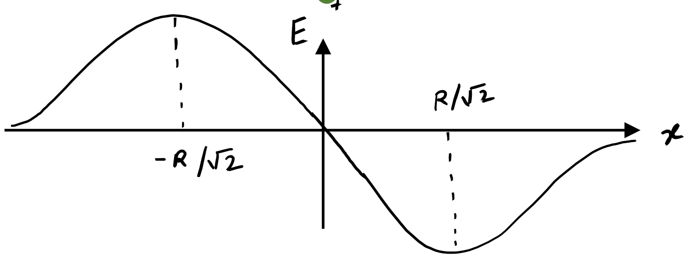
(uniform charge Distribution)

$$E = \frac{KQx}{(x^2+R^2)^{3/2}}$$

↳ at $x = \pm R/\sqrt{2}$, E is Max

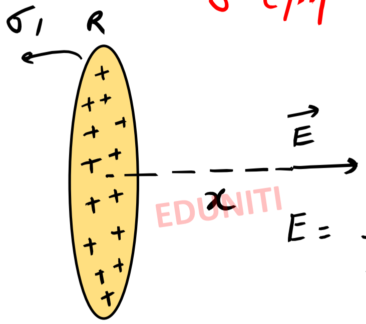
↳ at $x = 0$, $E = 0$ (center)





5. ELECTRIC FIELD DUE TO CHARGED DISC

σ C/m² (UNIFORM CHARGE Distribution)



$$E = \frac{\sigma}{2\epsilon_0}\left(1 - \frac{x}{\sqrt{x^2+R^2}}\right)$$

Case: If Disc is very large ($x << R$)

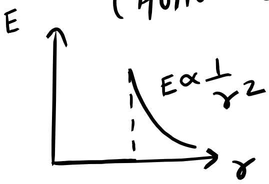
$$\boxed{E = \frac{\sigma}{2\epsilon_0}}$$

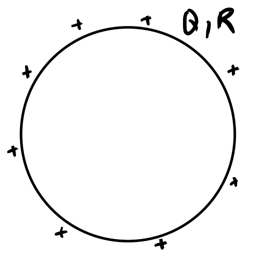
↳ for infinite sheet

6. ELECTRIC FIELD DUE TO CHARGED SPHERE

CONDUCTOR

(Hollow or solid, Q is on surface)



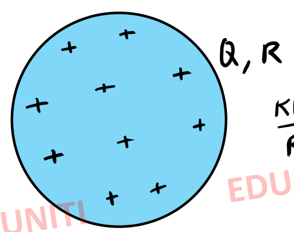


(1) For $r < R$, $E = 0$

(2) For $r \geq R$, $E = \frac{KQ}{r^2}$

NON - CONDUCTOR

(uniformly in solid) ρ C/m³

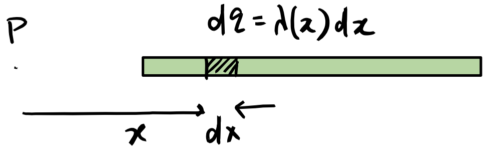


(1) $r < R$, $E = \frac{KQr}{R^3}$ or $\frac{\rho r}{3\epsilon_0}$

(2) $r \geq R$, $E = \frac{KQ}{r^2}$

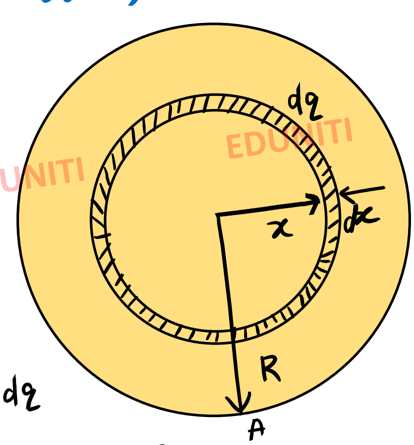
7. ELECTRIC FIELD (NON-UNIFORM CHARGE Distribution)

1.



$$E = \int_a^b \frac{K\lambda(x)\,dx}{x^2}$$

2.



$$E_A = \frac{KQ_{in}}{R^2}$$

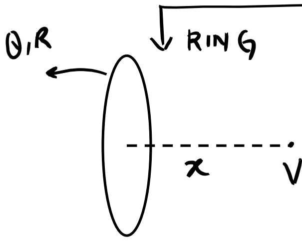
$$Q_{in} = \int dq = \int_0^R \rho(x) \times 4\pi x^2\,dx$$

PART 1 - ELECTROSTATICS

8. ELECTROSTATIC POTENTIAL

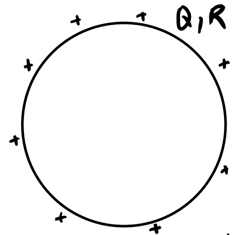
$V = \frac{Kq}{r}$, Put q with sign.

RING



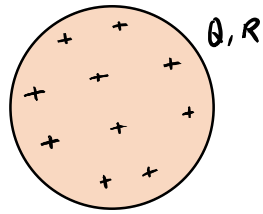
$V = \frac{KQ}{\sqrt{x^2+R^2}}$

SHELL

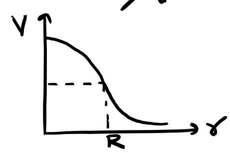


1. $r < R$, $V = KQ/R$
2. $r \geq R$, $V = KQ/r$

SOLID SPHERE



1. $r < R$, $V = \frac{KQ}{2R^3}(3R^2 - r^2)$
2. $r \geq R$, $V = KQ/r$



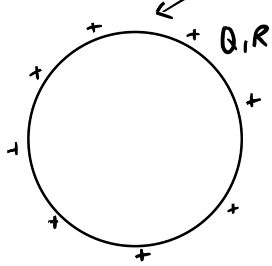
9. ELECTROSTATIC POTENTIAL ENERGY

q_1 •—— r ——• q_2

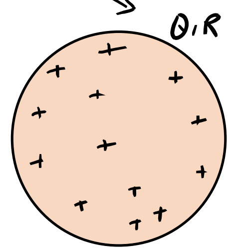
$U = Kq_1q_2/r$

↳ put q_1 and q_2 with sign

SELF ENERGY



$U = \frac{KQ^2}{2R}$



$U = \frac{3KQ^2}{5R}$

10. RELATION BETWEEN E and V

(1.) $\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$

(2.) $\Delta V = -\int \vec{E}\cdot d\vec{r}$

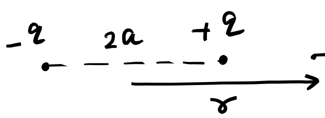
} Here $\frac{\partial V}{\partial x}$ means differentiate V w.r.t x keeping y and z constant.

11. ELECTRIC DIPOLE

($-q$ ----- d ----- $+q$, $P = qd$, direction from -ve to +ve)

(a) ELECTRIC FIELD

AXIAL POINT



$$E = \frac{2PKr}{(r^2 - a^2)^2}$$

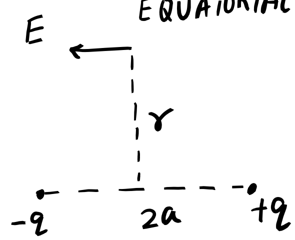
* SHORT DIPOLE ($r >> a$)

$$E_{axial} = 2PK/r^3$$

Direction : Along $\vec{P}$

$P = 2aq$

EQUATORIAL POINT



$$E = \frac{PK}{(r^2 + a^2)^{3/2}}$$

* SHORT DIPOLE ($r >> a$)

$$E_{eq} = PK/r^3$$

Dirn : opp $\vec{P}$

(b) POTENTIAL

AXIAL POINT

$$V = \frac{PK}{r^2 - a^2}$$

SHORT DIPOLE ($r >> a$)

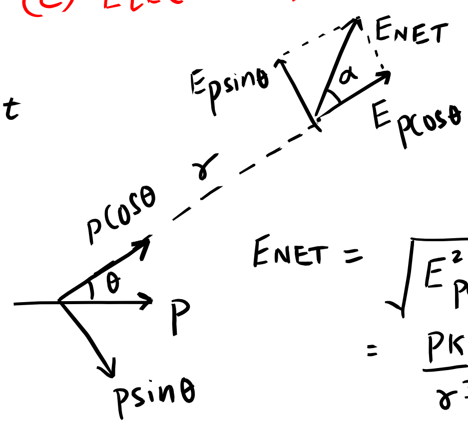
$$V = \frac{PK}{r^2}$$

$P = 2aq$

Equatorial point

$V = 0$

(c) ELECTRIC FIELD AT GENERAL POINT



$$E_{p\cos\theta} = \frac{2p\cos\theta K}{r^3}$$

$$E_{p\sin\theta} = \frac{p\sin\theta K}{r^3}$$

$$E_{NET} = \sqrt{E^2_{p\cos\theta} + E^2_{p\sin\theta}} = \frac{PK}{r^3}\sqrt{1 + 3\cos^2\theta}$$

$$\boxed{\tan\alpha = \frac{\tan\theta}{2}}$$

(d) DIPOLE IN E (uniform)

TORQUE

$\vec{\tau} = \vec{P} \times \vec{E}$

↳ SHM based Question

Potential Energy

$U = -\vec{P} \cdot \vec{E}$

STABLE ↳ $\theta = 0°$, $U_{min} = -PE$

UNSTABLE ↳ $\theta = 180°$, $U_{max} = PE$

↳ $\theta = 90°$, $U = 0$

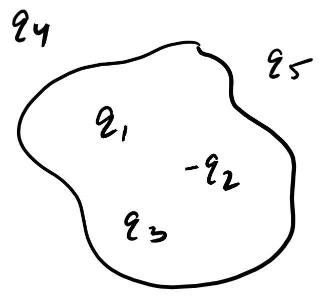
12 ELECTRIC FLUX ($\phi = \vec{E} \cdot \vec{A}$)

GAUSS's LAW

↳ $\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$

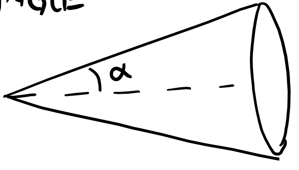
① q_{in} : charge enclosed

② E : Electric field is due to all the charges.



$\phi = \frac{q_1 - q_2 + q_3}{\varepsilon_0}$

Solid ANGLE



$\Omega = 2\pi(1 - \cos\alpha)$

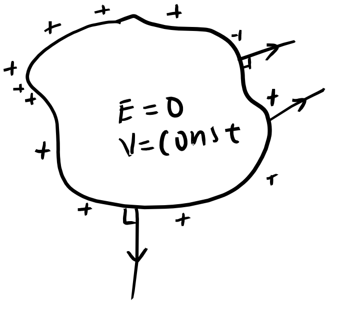
13 CONDUCTOR

(1.) charge remains on surface

(2.) Electric field inside is zero

(3.) V is constant

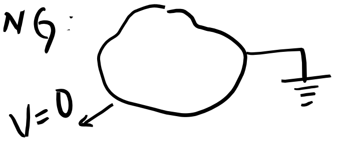
(4.) Field lines are ⊥ to surface



(5.) CONNECTING TWO CONDUCTORS

↳ They share charge untill V of both bodies are same.

(6.) EARTHING:



V of body will always be zero

Space to add concepts learnt from PYQs if any

Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

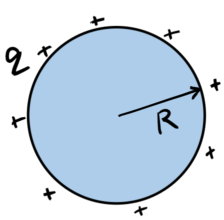
Topics to cover in CAPACITORS – PART 2 (ELECTRODYNAMICS)

1. Spherical and Cylindrical Capacitors
2. Parallel Plate capacitors
3. Charge, Energy Stored, Work done by Battery, Heat
4. Force Between Plates
5. Series / Parallel
6. Alternative figure for plate arrangement
7. Wheatstone bridge (Balanced & Unbalanced)
8. Charge Sharing & Heat generated
9. Dielectric in Electric Field (Induced Charge)
10. Dielectric Slab in Capacitor
11. Effect of slab insertion in a capacitor (at Const. V and Q)
12. Capacitance for Multiple Dielectric Medium
13. Capacitance for Variable K
14. Capacitance for variable dimensions
15. RC – Charging and Discharging

Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

1. CAPACITANCE (unit: Farad)

ISOLATED SPHERE

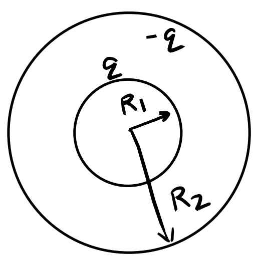


$$C = \frac{q}{V} = \frac{q}{Kq/R}$$

$$C = 4\pi\varepsilon_0 R$$

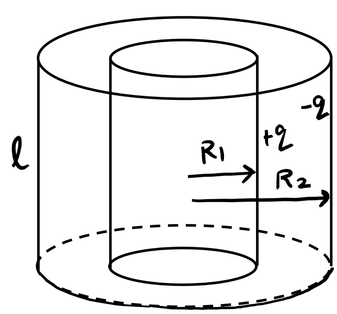
TWO CONDUCTORS

Spherical



$$C = \frac{4\pi\varepsilon_0 R_1 R_2}{R_2 - R_1}$$

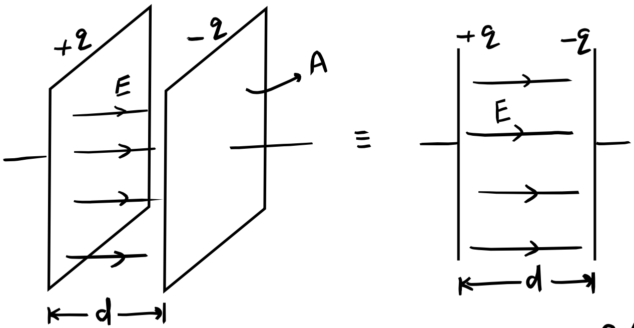
Cylindrical



$$C = \frac{2\pi\varepsilon_0 l}{\ln(R_2/R_1)}$$

PART 2 - CAPACITORS

2. PARALLEL PLATE CAPACITOR



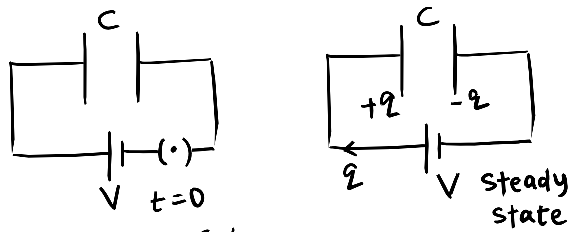
$C = q/V = q/Ed$

$\left(E = \frac{\sigma}{\varepsilon_0} = \frac{q}{A\varepsilon_0}\right)$

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

3. CHARGE / ENERGY STORED

$W_{battery}$ / HEAT DISSIPATION



(i) $q = CV$

(ii) $W_b = q_{flown} \times V = CV^2$

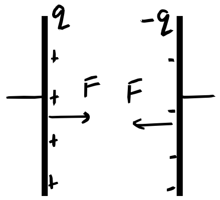
(iii) $U = \frac{1}{2}CV^2$ $\{q^2/2C$

(iv) Heat Dissipated

$= W_b - \Delta U$

$= CV^2 - \frac{1}{2}CV^2 = \frac{1}{2}CV^2$

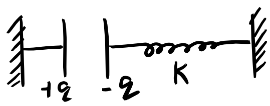
4. FORCE BETWEEN PLATES



$F = q \times E_{-q} = q \times \frac{q}{2A\varepsilon_0}$

$\Rightarrow F = q^2/2A\varepsilon_0$

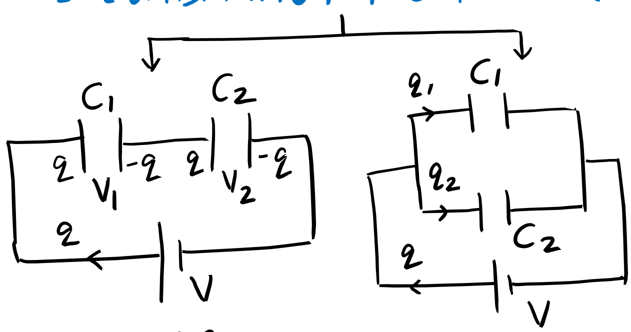
Ex:



x = spring elongation

$\therefore Kx = \frac{q^2}{2A\varepsilon_0}$

5. COMBINATION OF CAPACITOR



(i) $C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$

(ii) $q = C_{eq}V$

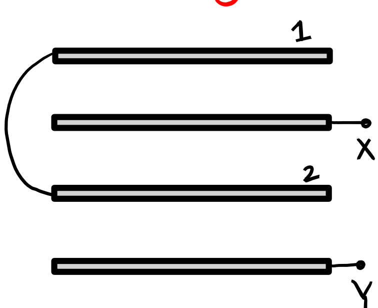
$C_{eq} = C_1 + C_2$

$q_1 = C_1V$, $q_2 = C_2V$

NOTE : (a) n identical Capacitor in series, $C_{eq} = C/n$

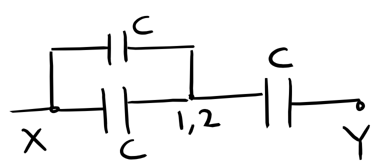
(b) If in parallel, $C_{eq} = nC$

Alternatively.



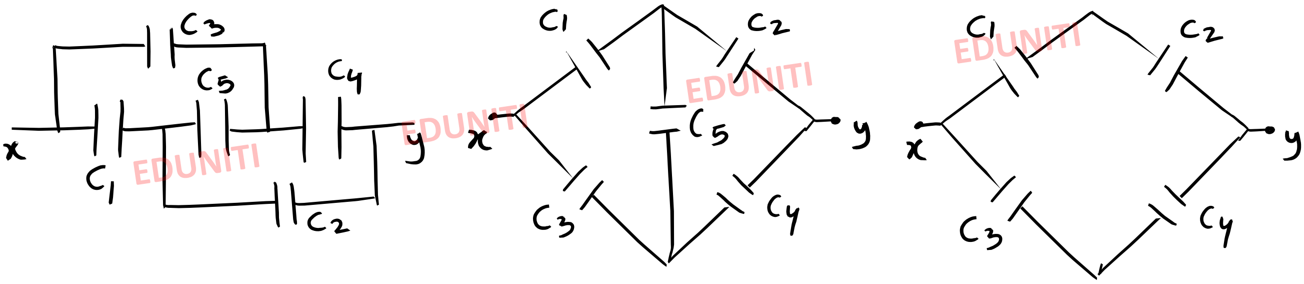
Identical plates

$C = A\varepsilon_0/d$



$C_{eq} = \frac{2C}{3} = \frac{2A\varepsilon_0}{3d}$

6. WHEATSTONE BRIDGE (BALANCED)



If $C_1C_4 = C_2C_3$

7. TECHNIQUE FOR UNBALANCED WHEATSTONE BRIDGE ($C_1C_4 \neq C_2C_3$)

(Point Potential + Junction Rule)

At x: $C_1(x-V) + C_5(x-y) + C_2(x-0) = 0$ — (1)

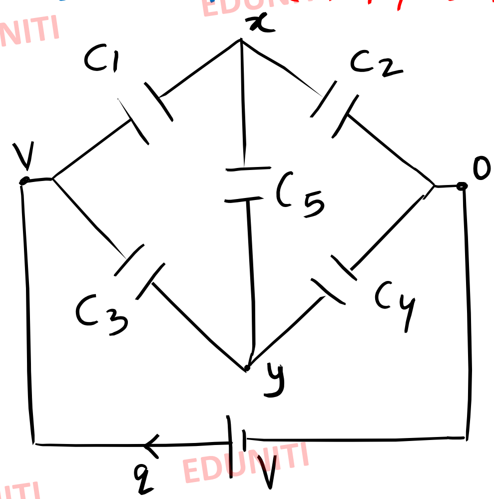
At y: $C_3(y-V) + C_5(y-x) + C_4(y-0) = 0$ — (2)

(a) solve (1) and (2) to find x and y.

(b) Then we can find q_1, q_2, q_3, q_4 and q_5

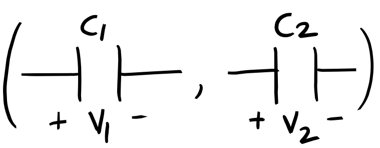
(c) $q = q_1 + q_3$

(d) $C_{eq} = \frac{q}{V}$

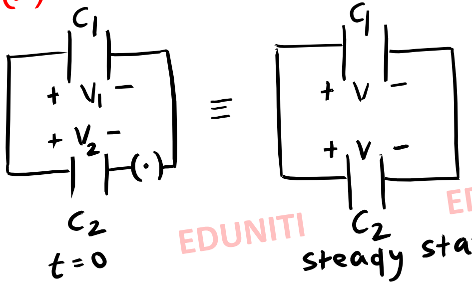


NOTE : This method can be used to solve any kind of circuit.

8. CHARGE SHARING AND HEAT GENERATED



(a) CONNECTED SAME POLARITY



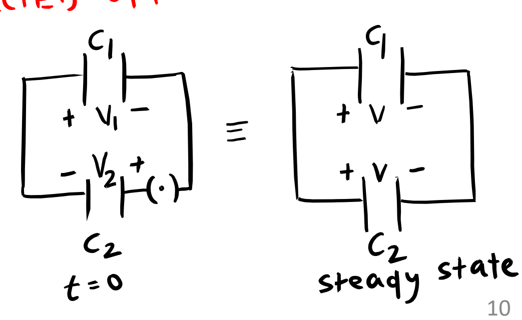
(i) $V = \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$

(ii) $H = \frac{C_1C_2}{2(C_1+C_2)}(V_1-V_2)^2$

(b) (CONNECTED) OPPOSITE POLARITY

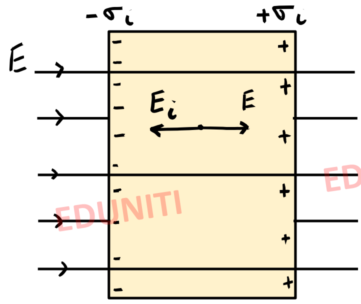
(i) $V = \frac{C_1V_1 - C_2V_2}{C_1 + C_2}$

(ii) $H = \frac{C_1C_2}{2(C_1+C_2)}(V_1+V_2)^2$



9. DIELECTRIC IN EXTERNAL ELECTRIC FIELD

- Insulators (gets polarized in E)
- Dielectric Constant (K or ε_r)
  - for air/vacuum $K = 1$
  - for metal $K \to \infty$



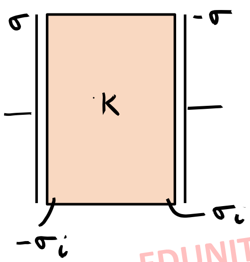
$E_{net} = E - E_i$

$\Rightarrow \frac{E}{K} = E - \frac{\sigma_i}{\varepsilon_0}$

$\Rightarrow \sigma_i = \varepsilon_0 E\left(1 - \frac{1}{K}\right)$

Induced charge density, $\sigma_i = \frac{Q_i}{A}$

10. SLAB IN CAPACITOR



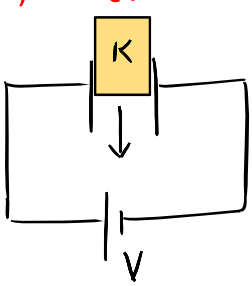
(i) $C = K A \varepsilon_0 / d$

(ii) $\sigma_i = \sigma\left(1 - \frac{1}{K}\right)$

$Q_i = Q\left(1 - \frac{1}{K}\right)$

11 EFFECT OF INSERTING DIELECTRIC IN CAPACITOR

(a) At Constant V (Battery Connected)



(i) $C \to KC$ ($C\uparrow$)

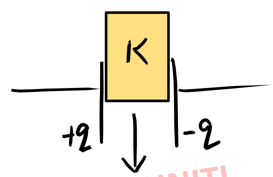
(ii) $q \to Kq$ ($q\uparrow$)

(iii) V is const.

(iv) E is const. $\left(E = \frac{V}{d}\right)$

(V) $U \to KU$ ($U\uparrow$) $\left(U = \frac{1}{2}CV^2\right)$

(b) At Constant charge (Battery removed)



(i) q is const.

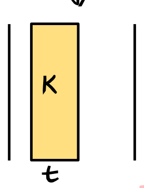
(ii) $C \to KC$ ($C\uparrow$)

(iii) $V \to \frac{V}{K}$ ($V\downarrow$) ($V = q/C$)

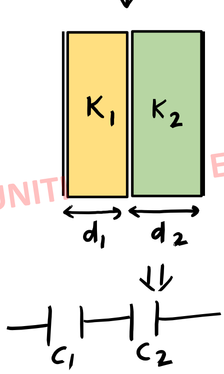
(iv) $E \to E/K$ ($E\downarrow$)

(v) $U \to U/K$ ($U\downarrow$) $U = \frac{q^2}{2C}$

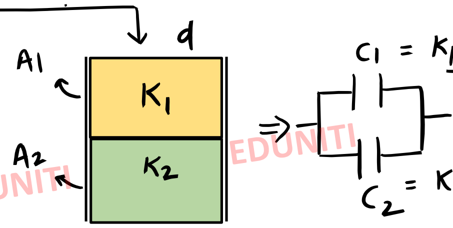
12. CAPACITANCE FOR MULTIPLE DIELECTRIC MEDIUM



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

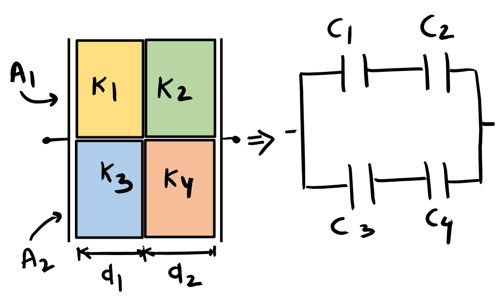


$C_1 = \frac{K_1 A \varepsilon_0}{d_1}$, $C_2 = \frac{K_2 A \varepsilon_0}{d_2}$



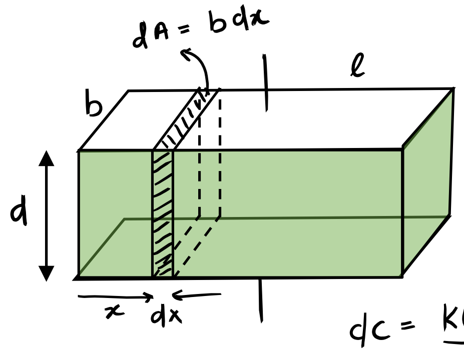
$C_1 = \frac{K_1 A_1 \varepsilon_0}{d}$

$C_2 = K_2 A_2 \varepsilon_0 / d$



13. CAPACITANCE WITH VARIABLE K

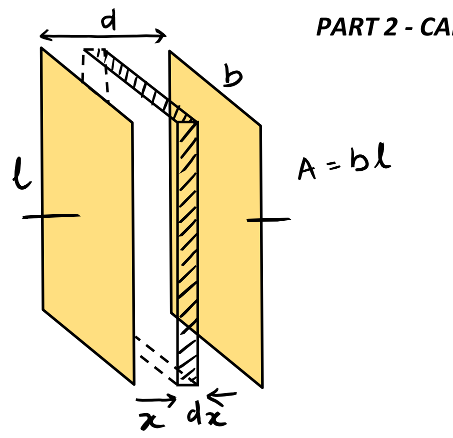
(a)



$$dC = \frac{K(x)\, b\, dx\, \varepsilon_0}{d}$$

$$\Rightarrow C = \frac{b\,\varepsilon_0}{d}\int_0^{l} K(x)\,dx$$

(b)

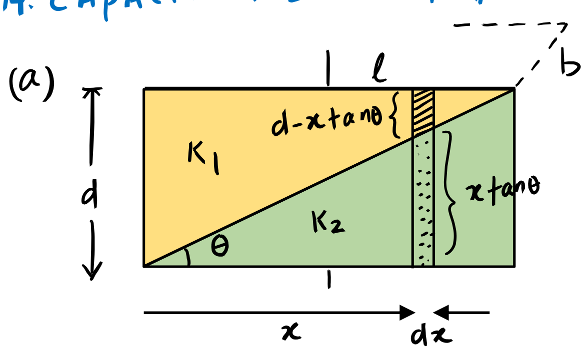


$$dC = \frac{K(x)\, A\, \varepsilon_0}{dx}$$

$$\Rightarrow \frac{1}{C} = \int \frac{1}{dC} = \frac{1}{A\varepsilon_0}\int_0^{d} \frac{dx}{K(x)}$$

14. CAPACITANCE WITH VARIABLE DIMENSIONS

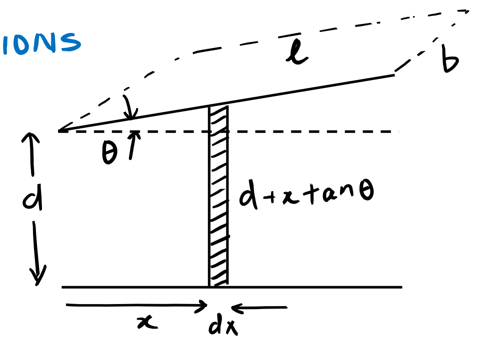
(a)



$$dC_1 = \frac{K_1\, b\, dx\, \varepsilon_0}{d - x\tan\theta}, \quad dC_2 = \frac{K_2\, b\, dx}{x\tan\theta}$$

$$dC_{eq} = \frac{dC_1 \times dC_2}{dC_1 + dC_2} \qquad C_{eq} = \int_0^{l} dC_{eq}$$

(b)

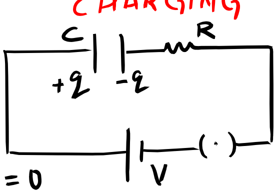


$$dC = \frac{b\, dx\, \varepsilon_0}{d + x\tan\theta}$$

$$\therefore C = b\varepsilon_0 \int_0^{l} \frac{dx}{d + x\tan\theta}$$

15. RC, CHARGING AND DISCHARGING

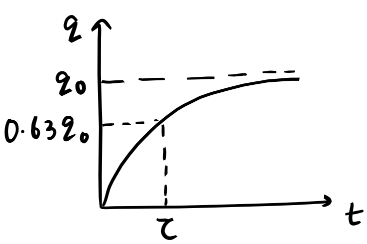
CHARGING



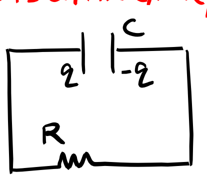
At $t = 0,\ q = 0$

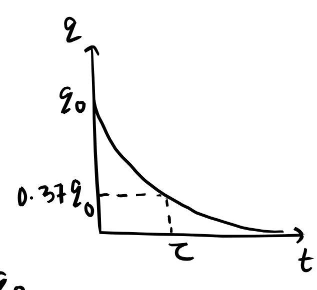
At $t = t,\ q = q_0\left(1 - e^{-t/RC}\right)$ $\quad q_0 = CV$

$RC = \tau$, time const.



DISCHARGING





at $t = 0,\ q = q_0$

at $t = t,\ q = q_0\, e^{-t/RC}$

NOTE:

(1) At $t = 0$, capacitor behaves as conducting wire

(2) At steady state it acts as open circuit

Space to add concepts learnt from PYQs if any

Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in CURRENT ELECTRICITY – PART 3 (ELECTRODYNAMICS)

1. Charge Flow
2. Important current parameters
3. Resistance (dependency and variation with T)
4. Color Code
5. Cell (emf & internal resistance
6. Combination of Cell
7. Kirchhoff's Law (KVL & KCL)
8. Circuit analysis techniques
9. Combination of resistors
10. Wheatstone Bridge
11. Cube resistors
12. Infinite ladder
13. Thermal effect of current
14. Maximum power transfer theorem
15. Concept of power rating
16. Galvanometer to Ammeter & Voltmeter
17. Meter bridge
18. Potentiometer

Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

1. CHARGE FLOW

$$q_{flown} = \int_{t_1}^{t_2} i(t)\,dt$$

Ex: $i(t) = 2\sin 50\pi t$

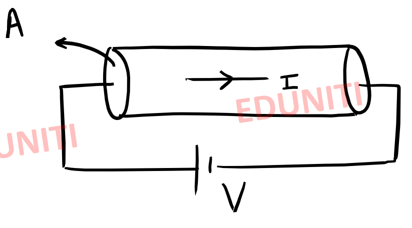
$i(t) = 3t^2$

2. IMPORTANT CURRENT PARAMETERS

→ DRIFT VELOCITY, $V_d = \dfrac{eE\tau}{m}$

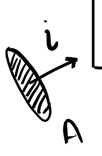
"τ" Relaxation time (avg time elapsed between two collisions)

→ $I = neAV_d$



n: no of free e^- per unit volume

→ MOBILITY, (m^2/Vs) $\mu = \dfrac{V_d}{E} = \dfrac{eE\tau/m}{E} = \dfrac{e\tau}{m}$



→ CURRENT DENSITY, (A/m^2) $J = I/A \Rightarrow I = \vec{J}\cdot\vec{A}$

$\boxed{E = \rho J}$ ρ: Resistivity

3. RESISTANCE $\left(R = \frac{m}{ne^2\tau}\frac{l}{A}\right)$, ohm ($\Omega$)

$\frac{m}{ne^2\tau}$ → ρ : resistivity, $\sigma = \frac{1}{\rho}$ → conductivity

R DEPENDS ON :

- $R \propto l$
- $R \propto 1/A$
- If temperature increases, Resistance also increases. $\left\{\rho = \frac{m}{ne^2\tau}\right.$, If $T\uparrow \Rightarrow \tau\downarrow \Rightarrow \rho\uparrow \Rightarrow R\uparrow$

For small variation in temp°

$R_{T_2} = R_{T_1}(1+\alpha\Delta T)$,

$\rho_{T_2} = \rho_{T_1}(1+\alpha\Delta T)$

↳ For SEMICONDUCTORS

If $T\uparrow \Rightarrow \rho\downarrow \Rightarrow R\downarrow$

(on $\uparrow T$, $n\uparrow$ dominating $\downarrow$ in τ)

Source : NCERT

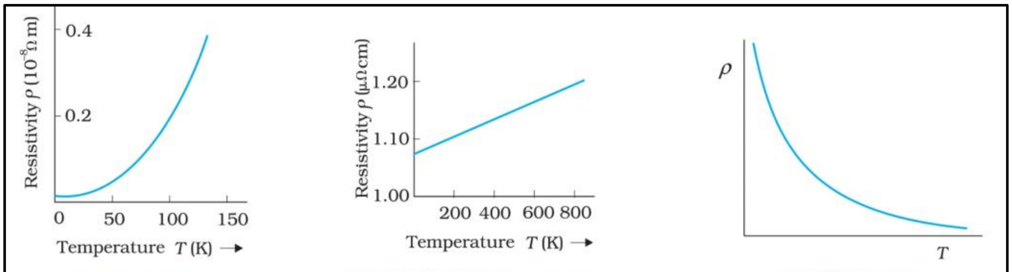


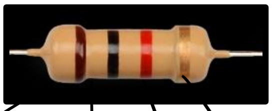
FIGURE 3.9 Resistivity ρ_T of copper as a function of temperature T.

FIGURE 3.10 Resistivity ρ_T of nichrome as a function of absolute temperature T.

↳ Manganin and constantan

FIGURE 3.11 Temperature dependence of resistivity for a typical semiconductor.

4. COLOUR CODE

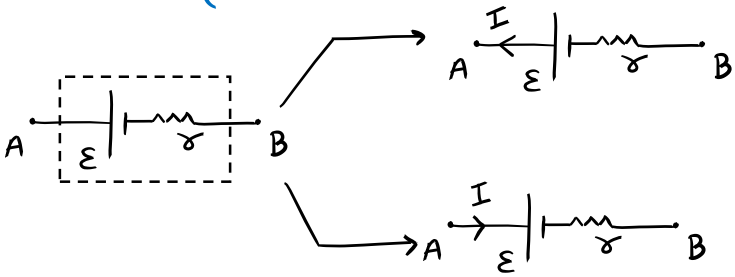


BROWN 1 | BLACK 0 | RED 2 | GOLDEN ± 5%

$R = 10 \times 10^2 \pm 5\%$

Resistor colour codes			
Colour	**Number**	**Multiplier**	**Tolerance (%)**
Black	0	10^0	
Brown	1	10^1	
Red	2	10^2	
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	
Blue	6	10^6	
Violet	7	10^7	
Gray	8	10^8	
White	9	10^9	
Gold		10^{-1}	5
Silver		10^{-2}	10
No colour			20

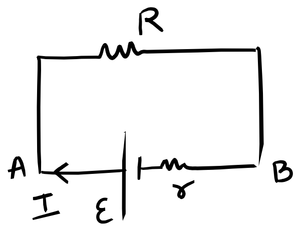
5. CELL (Emf, Internal Resistance)



$V_{AB} = \varepsilon - Ir$, Work done by battery

$V_{AB} = \varepsilon + Ir$, Work done on the battery (charging)

\# Alternative:

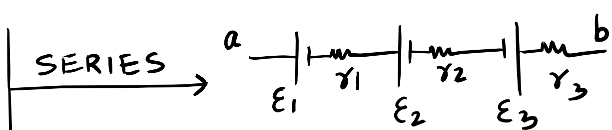


$V_{AB} = IR$

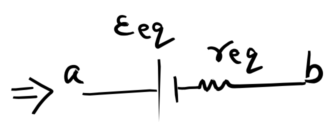
$$V_{AB} = \frac{\varepsilon R}{r+R}$$

6. COMBINATION OF CELL

SERIES



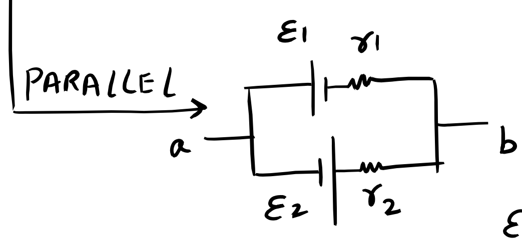
⇒



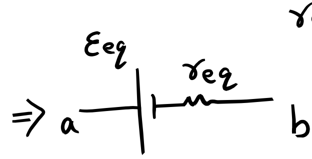
$\varepsilon_{eq} = \varepsilon_1 + \varepsilon_2 - \varepsilon_3$

$r_{eq} = r_1 + r_2 + r_3$

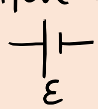
PARALLEL



⇒



$$\varepsilon_{eq} = \frac{\frac{\varepsilon_1}{r_1} - \frac{\varepsilon_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}}, \quad \frac{1}{r_{eq}} = \frac{1}{r_1} + \frac{1}{r_2}$$

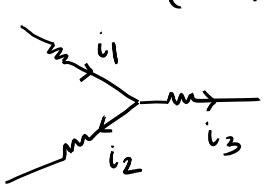
Here we took  as $+\varepsilon$

7. KIRCHHOFF'S LAW (KVL and KCL)

KVL → LOOP RULE

KCL → JUNCTION RULE

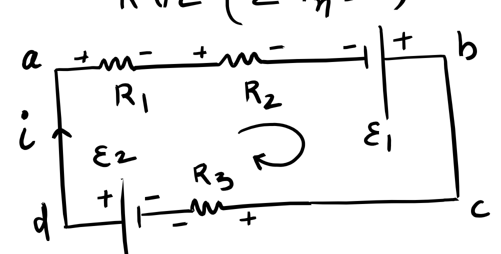
KCL $(\Sigma i_n = 0)$



$i_1 - i_2 - i_3 = 0$

(i towards junction is taken +VE)

KVL $(\Sigma V_n = 0)$ In a loop

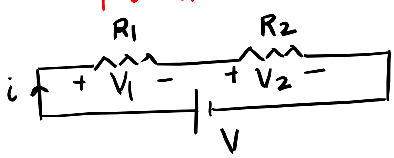


In loop abcda

$iR_1 + iR_2 - \varepsilon_1 + iR_3 - \varepsilon_2 = 0$

8. CIRCUIT ANALYSIS MORE TECHNIQUES

p.d. distribution



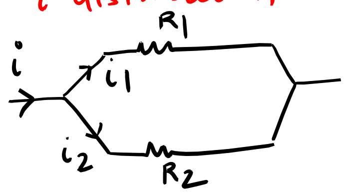
∵ i is same

$\Rightarrow V \propto R$

$V_1 = \dfrac{VR_1}{R_1+R_2}$,

$V_2 = \dfrac{VR_2}{R_1+R_2}$

i distribution



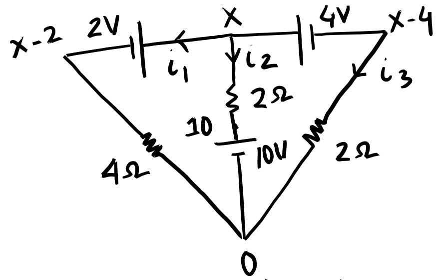
∵ V is same

$\Rightarrow i \propto 1/R$

$i_1 = \dfrac{iR_2}{R_1+R_2}$

$i_2 = \dfrac{iR_1}{R_1+R_2}$

Point Potential Method



$i_1 + i_2 + i_3 = 0$

$\Rightarrow \dfrac{x-2}{4} + \dfrac{x-10}{2} + \dfrac{x-4}{2} = 0$

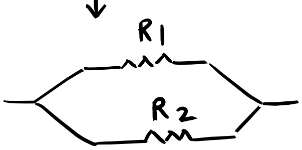
$x = 6V$

9. COMBINATION OF RESISTORS

SERIES

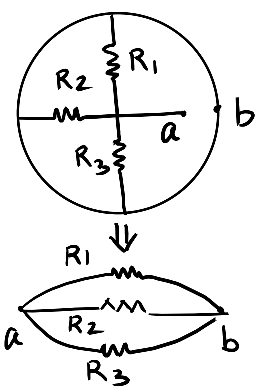
$R_{eq} = R_1 + R_2$

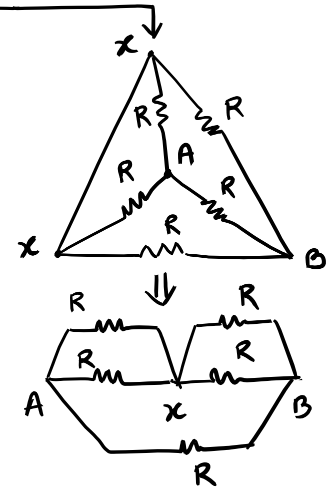
PARALLEL



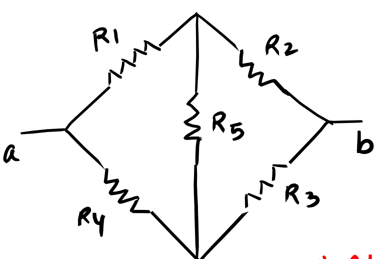
$\dfrac{1}{R_{eq}} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$

$\Rightarrow R_{eq} = \dfrac{R_1R_2}{R_1+R_2}$

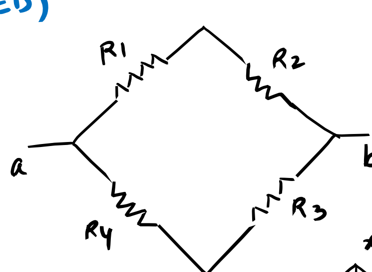




10. WHEATSTONE BRIDGE (BALANCED)

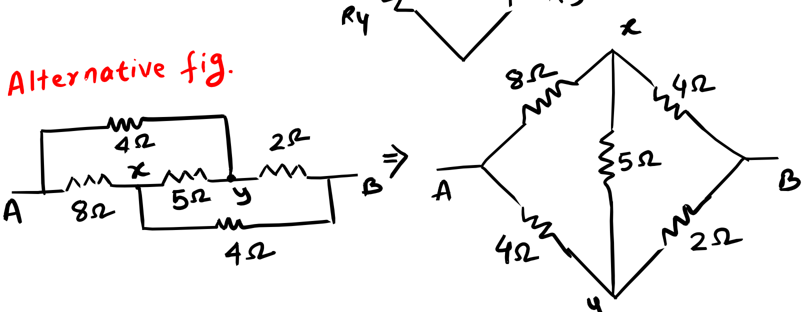


If $R_1R_3 = R_2R_4$ →

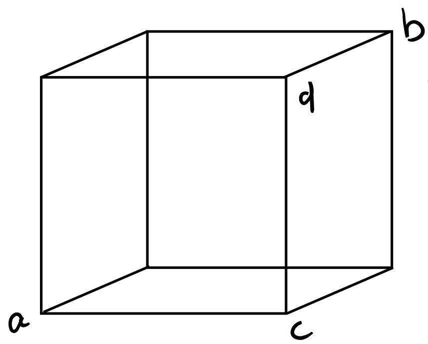


$\left\{ \dfrac{R_1}{R_2} = \dfrac{R_4}{R_3} \right\}$

Alternative fig.

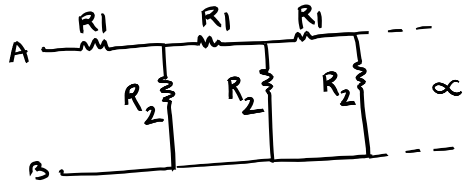


11. CUBE RESISTORS

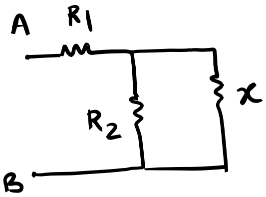


- $R_{eq,ab} = 5R/6$ (body diagonal)
- $R_{eq,ac} = 7R/12$ (edge)
- $R_{eq,ad} = 3R/4$ (face diagonal)

12. INFINITE LADDER



$\Rightarrow$

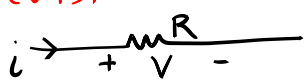


$$R_{AB} = R_1 + \frac{xR_2}{x+R_2}$$

$R_{AB} \to x$

13. THERMAL EFFECT OF CURRENT (JOULES HEATING EFFECT)

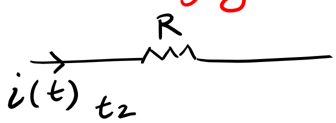
CONSTANT CURRENT



$$P = i^2R = \frac{V^2}{R} = Vi \text{ (Watt)}$$

$$H = i^2Rt = \frac{V^2}{R}t = Vit \text{ (Joules)}$$

Time Varying Current

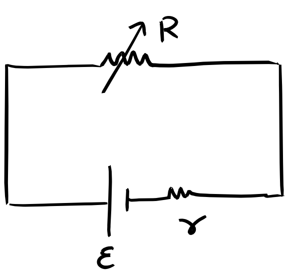


$$H = \int_{t_1}^{t_2} i^2R\,dt$$

$$P_{av} = \frac{\int i^2R\,dt}{\int dt}$$

Ex: $i(t) = i_0 \sin\omega t$

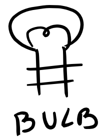
14. MAX POWER TRANSFER THEOREM



CONDITION: $R = r$

for maximum Power transfer, External resistance must be equall to internal resistance.

15. CONCEPT OF POWER RATING



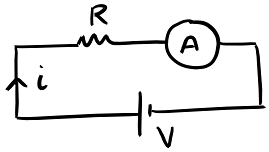
specifications
220V , 50 W
Rated Voltage (220V), Rated Power (50 W)

NOTE:
(i) Means bulb will consume 50 W if 220V is across it.
(ii) $R_{bulb} = \frac{V^2}{P} = \frac{220^2}{50} = 968\,\Omega$
(iii) If $V > 220V$ is across bulb, it will fuse
(IV) More Power ⇒ More Bright

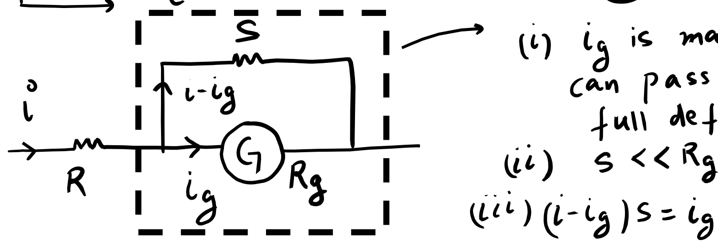
16 GALVANOMETER TO AMMETER AND VOLTMETER

(a) AMMETER

- Connected in series
- IDEAL AMMETER has zero resistance (Practically it has very low resistance)



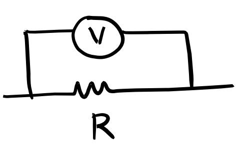
- CONVERSION:

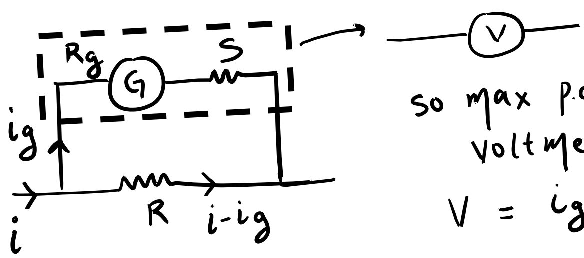


(i) i_g is max current that can pass through G for full deflection
(ii) $S << R_g$ (S : shunt)
(iii) $(i - i_g)S = i_g R_g \Rightarrow i = i_g\left(1 + \frac{R_g}{S}\right)$

(b) Voltmeter

- Connected in parallel
- IDEAL VOLTMETER has infinite Resistance (Practically it has very resistance)





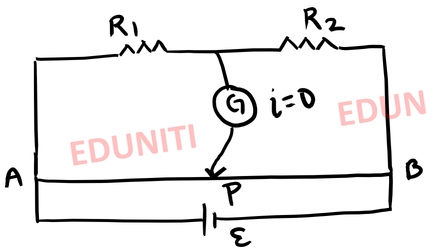
So max p.d. measured by voltmeter is,

$$V = i_g(R_g + S)$$

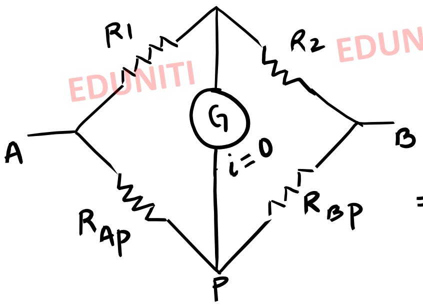
↳ i_g : galvanometer current for full deflection

17. METER BRIDGE

- AIM : to find resistance of R_2
- Based on Balanced WHEATSTONE BRIDGE



$\Rightarrow$



$$\frac{R_1}{R_2} = \frac{R_{AP}}{R_{BP}} \Rightarrow \boxed{\frac{R_1}{R_2} = \frac{l_1}{l_2}}$$

or

$$R_2 = R_1 \times \frac{l_2}{l_1}$$

$AP = l_1$
$BP = l_2$

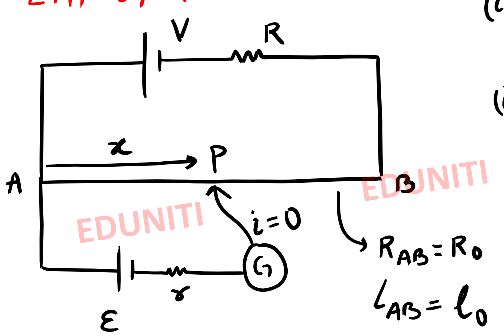
P is "Null-Deflection" Point

Generally $l_1 + l_2 = 100cm$

18. POTENTIOMETER

- AIM: To find emf of a cell and its internal resistance
- Potential gradient (K) : $K = \frac{p.d.}{l}$ V/m (Potential difference per unit Length)

(a) FINDING EMF OF A CELL



$R_{AB} = R_0$
$L_{AB} = l_0$

(i) P is null-deflection pt or balance pt.

(ii) $K = V_{AB}/l_0$, $V_{AB} = \frac{VR_0}{R_0+R}$

(iii) $\varepsilon = V_{AP}$

$\Rightarrow \boxed{\varepsilon = kx}$

NOTE: Max value of ε that can be measured is "$\varepsilon_{max} = V_{AB}$"

(b) FINDING Internal resistance (r)

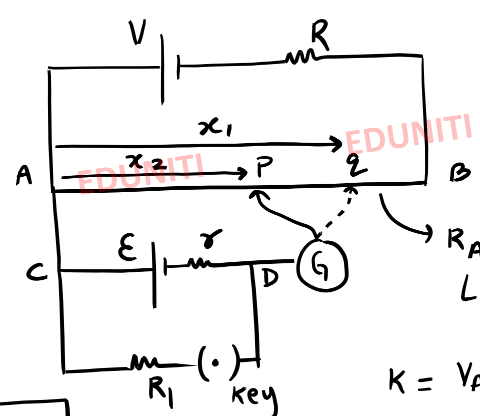
(i) When key is open : (Null deflection at Q)

$\varepsilon = kx_1$ --- (1)

(ii) When key is closed (Null deflection at P)

$V_{CD} = kx_2 \Rightarrow \frac{\varepsilon R_1}{R_1+r} = kx_2$ --- (2)

(1)/(2) : $\frac{R_1+r}{R_1} = \frac{x_1}{x_2} \Rightarrow \boxed{r = R\left(\frac{x_1-x_2}{x_2}\right)}$



$R_{AB} = R_0$
$L_{AB} = l_0$

$K = V_{AB}/l_0$
$= \left(\frac{VR_0}{R+R_0}\right)\frac{1}{l_0}$

Space to add concepts learnt from PYQs if any

Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in MOVING CHARGES & MAGNETIC EFFECT OF CURRENT – PART 4 (ELECTRODYNAMICS)

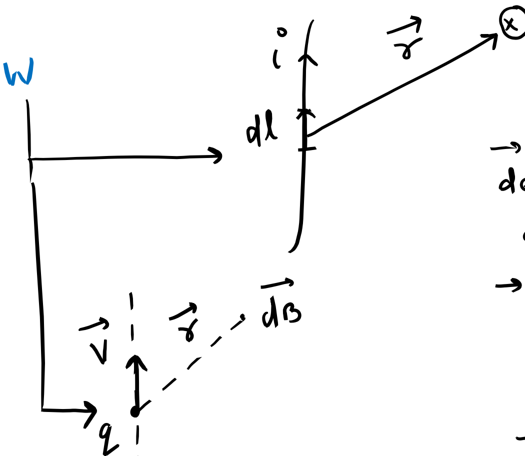
1.Biot Savart's Law
2.B due to current carrying straight wire
3.B due to current carrying circular wire
4.B due to Solenoid & Toroid
5.Ampere circuital Law

FORCE ON CHARGE MOVNIG IN B

6.If velocity is Perpendicular to B
7.If not complete circle
8.Angle of deviation
9.Velocity at angle with B (helical path)
10.Special case (V, E & B are mutually perpendicular)
11.Force on current carrying conductor in B
12.Magnetic Moment
13. Torque on Loop in Magnetic Field
14.Potential of Loop in Magnetic Field

Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

1. BIOT SAVART'S LAW



$$\vec{dB} = \frac{\mu_0}{4\pi}\frac{i(\vec{dl}\times\vec{r})}{r^3}$$

→ direction of $\vec{dB}$ is decided by dirⁿ of $\vec{dl}\times\vec{r}$

→ μ_0 : Permeability of free space

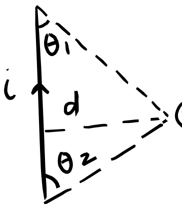
$4\pi\times10^{-7}$ Tm/A

→ $\vec{dl}$ is along current

$$\vec{dB} = \frac{\mu_0}{4\pi}\frac{q(\vec{V}\times\vec{r})}{r^3}$$

2. B DUE TO CURRENT CARYING STRAIGHT WIRE

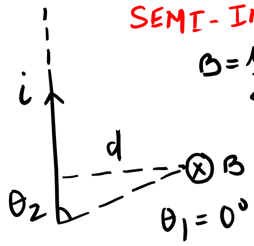
FINITE WIRE



$$B = \frac{\mu i}{4\pi d}\left(\cos\theta_1 + \cos\theta_2\right)$$

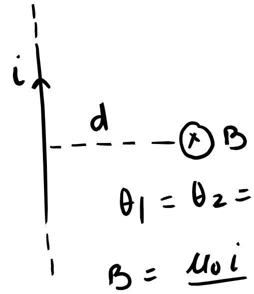
SEMI-INFINITE WIRE

$$B = \frac{\mu_0 i}{4\pi d}\left(1 + \cos\theta_2\right)$$



$\theta_1 = 0°$

INFINITE WIRE

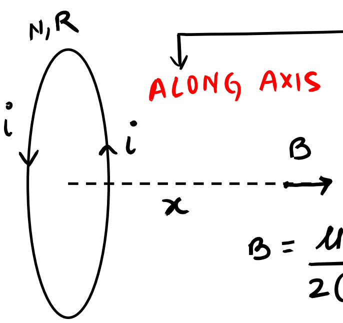


$\theta_1 = \theta_2 = 0°$

$$B = \frac{\mu_0 i}{2\pi d}$$

3. B DUE TO CURRENT CARYING CIRCULAR WIRE

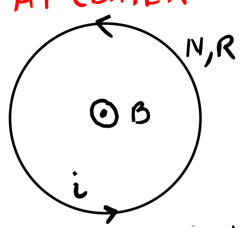
ALONG AXIS



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

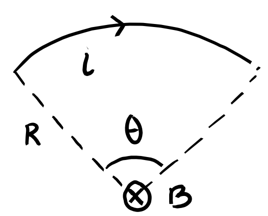
N: No of turns

AT CENTER



$$B = \frac{\mu_0 i N}{2R}$$

AT CENTER DUE TO ARC



$$B = \frac{\mu_0 i}{2R} \times \frac{\theta}{2\pi}$$

4. B DUE TO SOLENOID AND TOROID

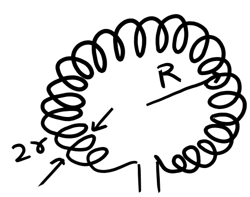
SOLENOID

$B = \mu_0 n i$

n: no of turns / Length (N/ℓ)

Valid for ideal solenoid $(\ell >> r)$

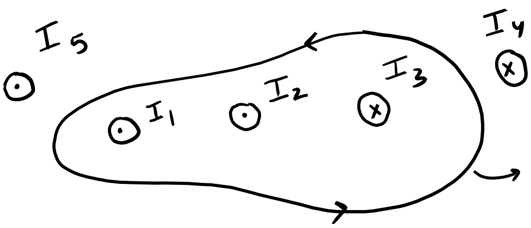
TOROID



$$B = \frac{\mu_0 N}{2\pi R} i \quad (R >> r)$$

N: No of turns

5. AMPERE CIRCUITAL LAW



NOTE: Outward I is +VE

$$\oint \vec{B}\cdot d\vec{l} = \mu_0 (I_1 + I_2 - I_3)$$

NOTE: (i) only I enclosed by Ampere loop considered

(ii) B is due to all current

FORCE ON q MOVING IN B, $\vec{F}_m = q(\vec{V}\times\vec{B})$

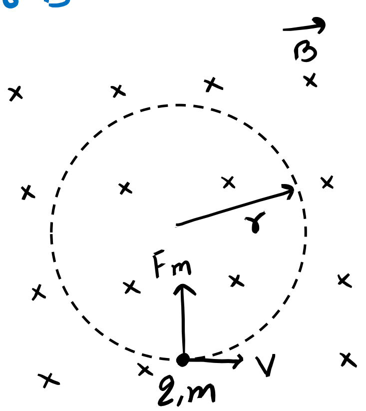
$\vec{F}_m$ is always perpendicular to $\vec{V}$

⇒ Thus no work done.

⇒ no change in speed or K.E.

NOTE $K = q\Delta V$

6 If V is ⊥ to B



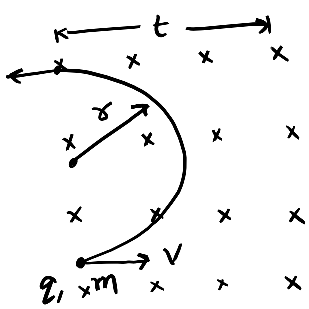
(i) $r = \frac{mV}{qB}$ or $\frac{\sqrt{2mK}}{qB}$

(ii) $T = \frac{2\pi m}{qB}$, time period

(iii) $\omega = \frac{qB}{m}$

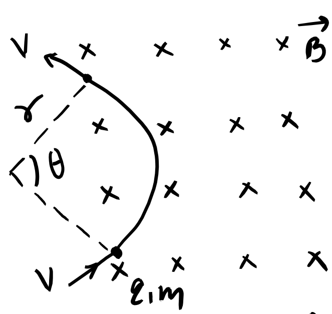
7 IF NOT COMPLETE CIRCLE

(i)



$r < t$, $T = \frac{\pi m}{qB}$

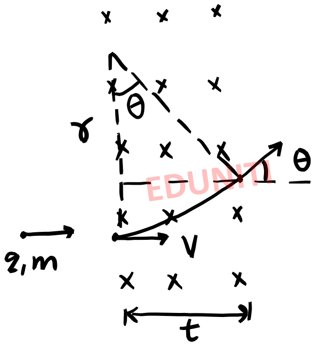
(ii)



$T = \frac{2\pi m}{qB} \times \frac{\theta}{2\pi} = \frac{\theta m}{qB}$

↳ Duration of time inside B

8. ANGLE OF DEVIATION



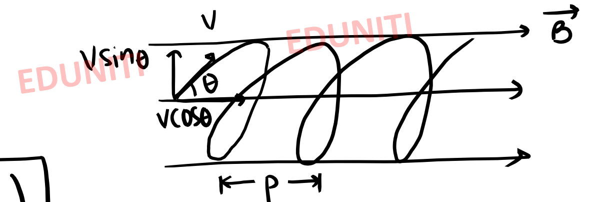
$r > t$

$\sin\theta = t/r$

$= \frac{tqB}{mv}$

$$\therefore \theta = \sin^{-1}\left(\frac{qBt}{mv}\right)$$

9. V AT ANGLE θ to B (Helical path)



(i) $r = \frac{mv\sin\theta}{qB}$

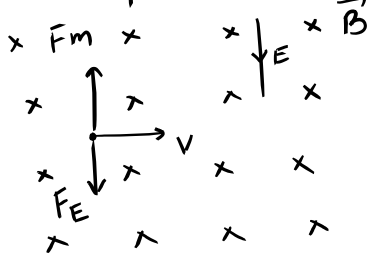
(ii) $T = 2\pi m/qB$

(iii) Pitch, $P = v\cos\theta \times T$

10 SPECIAL CASE

$E \perp B \perp V$

IN this situation possibility of q moving undeviated.



COND^n.

$F_E = F_M$

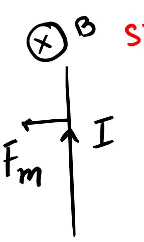
$\Rightarrow qE = qvB$

$$\Rightarrow V = \frac{E}{B}$$

11. FORCE ON I CARYING CONDUCTOR IN B (UNIFORM FIELD)

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

STRAIGTH WIRE



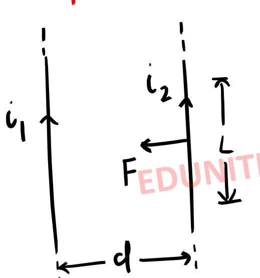
$F_m = IlB$

Closed loop

$F_{Net} = 0$

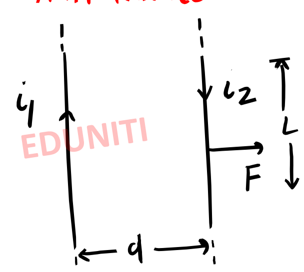
Parallel wire

Parallel i



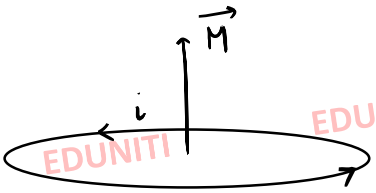
$$F = \frac{\mu_0 i_1 i_2}{2\pi d} L$$

ANTI-PARALLEL i



$$F = \frac{\mu_0 i_1 i_2}{2\pi d} L$$

12. MAGNETIC MOMENT



$\vec{M} = N i \vec{A}$

NOTE:

(i) N : No of turns

(ii) A = Loop area

(iii) Dir^n of M using right hand thumb rule

13. TORQUE ON LOOP in B

$\vec{\tau} = \vec{M} \times \vec{B}$

14 POTENTIAL ENERGY OF LOOP in B

$U = -\vec{M} \cdot \vec{B}$

STABLE → $\theta = 0^\circ \Rightarrow U_{min} = -MB$

UNSTABLE → $\theta = 180^\circ \Rightarrow U_{max} = MB$

15. FORCE ON LOOP IN B (NON-UNIFORM B)

$F = M \frac{dB}{dx}$ [USE IF VARIATION OF B IS SMALL]

M : Magnetic moment of Loop

Space to add concepts learnt from PYQs if any

Space to add concepts learnt from PYQs if any

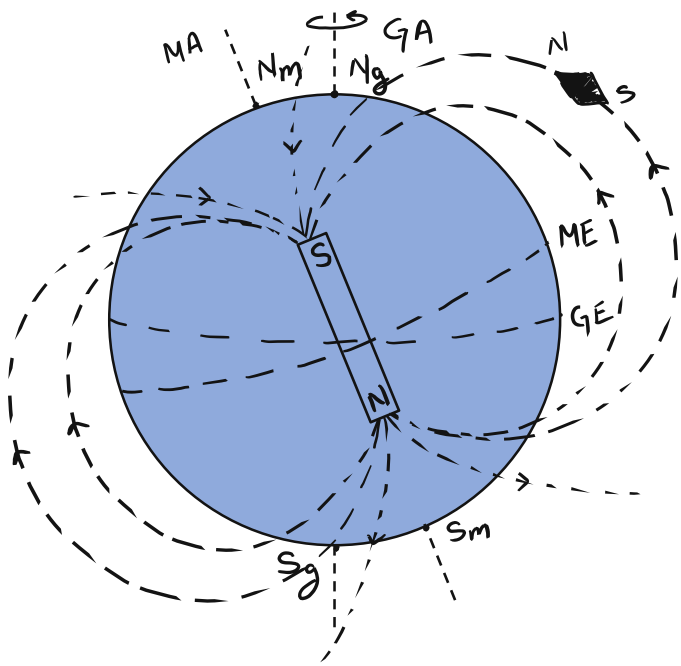
Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in EARTH'S MAGNETISM – PART 5 (ELECTRODYNAMICS)

1-5. Geographical axis, poles & Geomagnetic Poles
6.Geographical and Magnetic Meridian
7.Elements of Magnetic Field
8.True and Apparent angle of dip
9. Oscillation of compass needle

Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

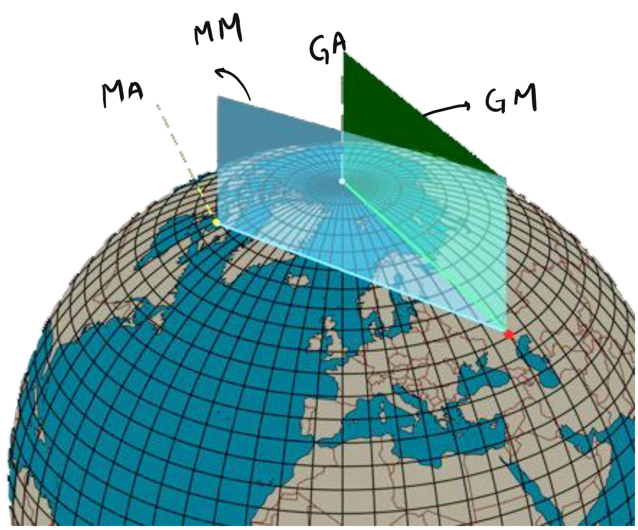
(1) GA : Geographical axis
(2) MA: Magnetic axis
(3) Ng, Sg: Geographical North, south
(4.) Nm, Sm: Geomagnetic North, soutch
(5.) GE, ME: Geographic, Magnetic Equator



6. Geographical and Magnetic Meridian

(a) Geographical Meridian:
A Vertical plane at any place on earth which passes through GA

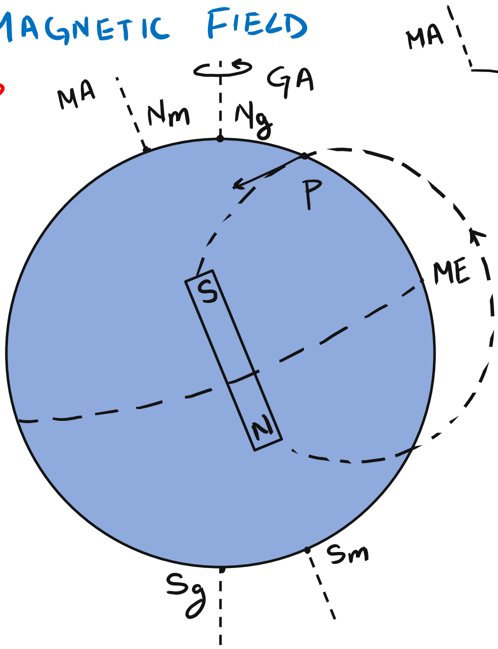
(b) Magnetic Meridian
A Vertical plane on earth that Passes through magnetic axis.
or
Vertical plane that contains magnetic field lines.

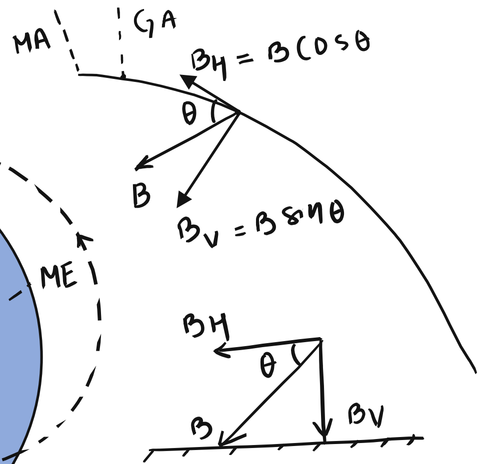


7 ELEMENTS OF MAGNETIC FIELD

(a) ANGLE OF DIP

↳ Angle which magnetic field makes with horizontal in Magnetic Meridian.

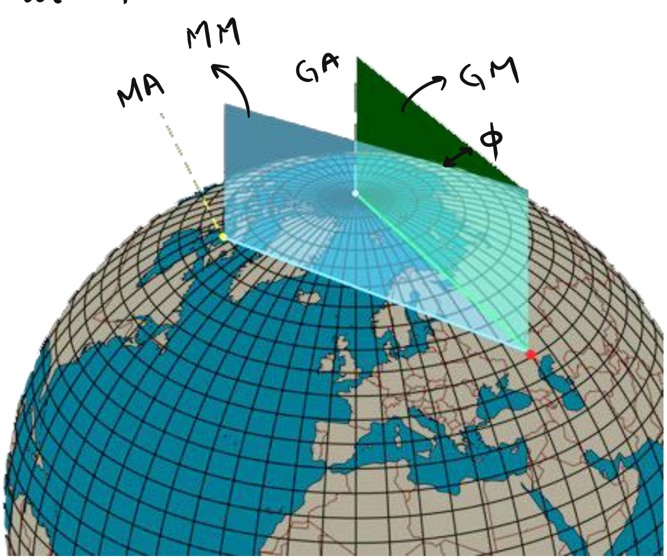


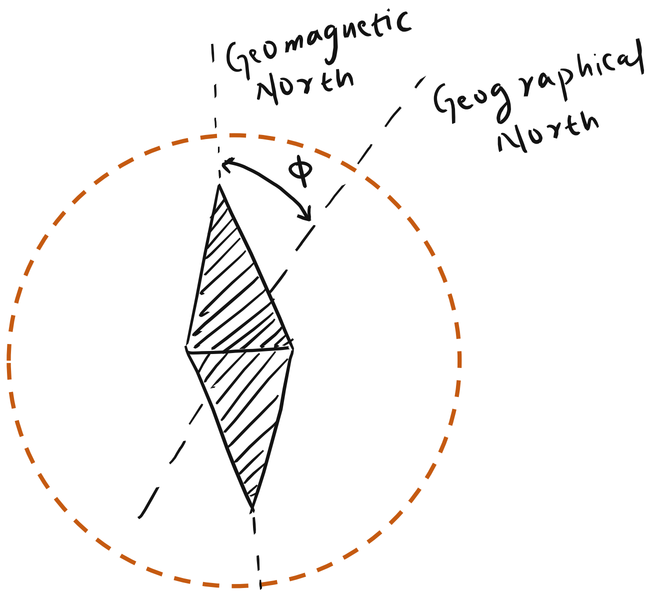


$$\tan\theta = \frac{B_V}{B_H}$$

(b) ANGLE OF DECLINATION (ϕ)

ϕ is angle between Geographical meridian and magnetic meridian at a point





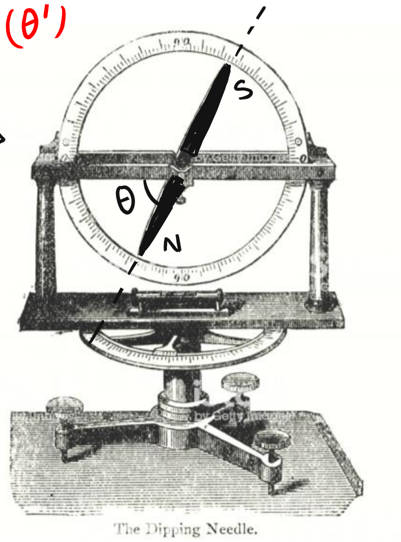
↳ Horizontal plane

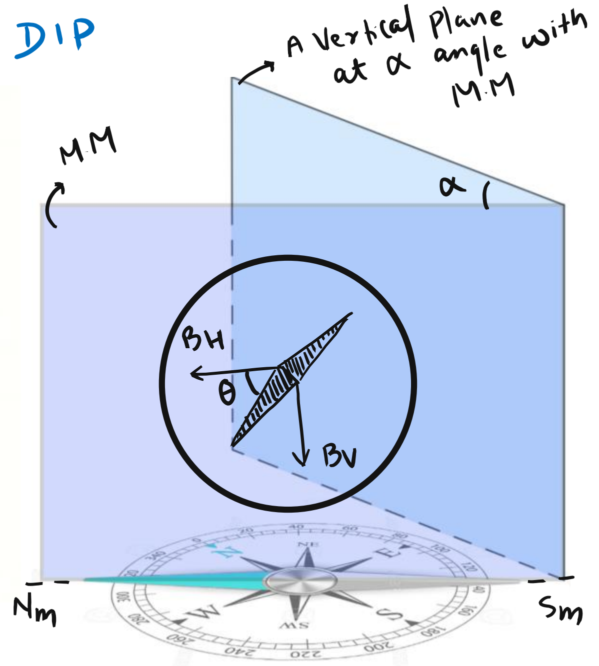
NOTE: Compass in Horizontal Plane always gets aligned along $B_H = B\cos\theta$ and is in Magnetic Meridian.

PART 5 – EARTH'S MAGNETISM

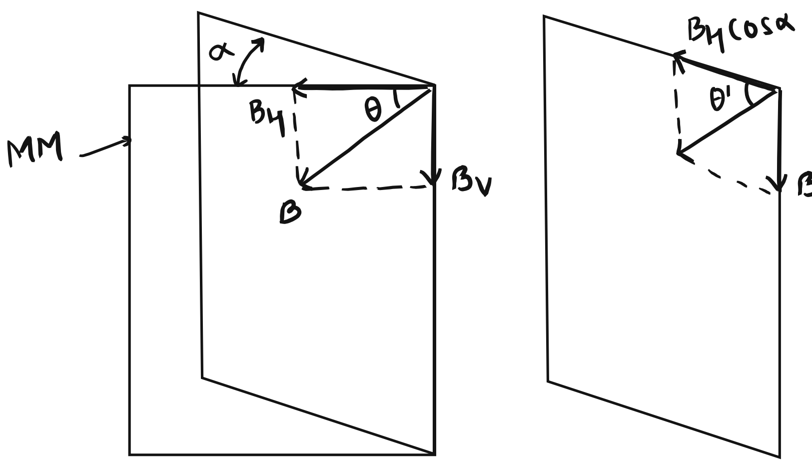
8. TRUE AND APPARENT ANGLE OF DIP
(θ) (θ')

DIP CIRCLE →





IF DIP CIRCLE IS NOT MAGNETIC MERIDIAN ?



$\tan\theta = \dfrac{B_V}{B_H}$

$\tan\theta' = \dfrac{B_V}{B_H\cos\alpha}$

$$\Rightarrow \boxed{\tan\theta' = \frac{\tan\theta}{\cos\alpha}}$$

θ' is called Apparent angle of Dip.

9. OSCILLATION OF COMPASS NEEDLE

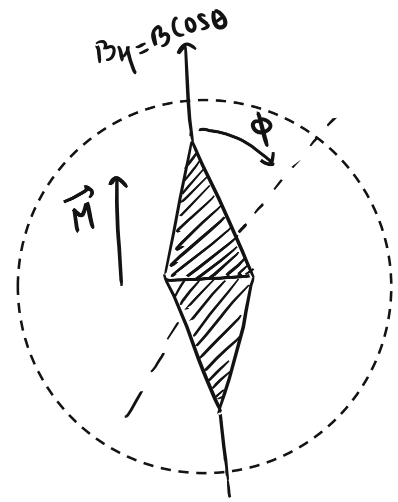
$\vec{M}$: Magnetic moment (md)

$$\boxed{T = 2\pi\sqrt{\frac{I}{MB_H}}}$$

$\tau = MB_H \sin\phi$

$\Rightarrow I\alpha = MB_H\sin\phi$

$\Rightarrow \alpha = \dfrac{MB_H\phi}{I}$ { ϕ is small



Space to add concepts learnt from PYQs if any

Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in MAGNETIC PROPERTIES OF MATTER – PART 6 (ELECTRODYNAMICS)

1. Magnetizing Field, Intensity of Magnetization, Susceptibility
2. Diamagnetic and Paramagnetic Material
3. Ferromagnetic Material
4. Curie's Law
5. Magnetic Hysteresis
6. Hysteresis Curve of Soft Iron and Steel

Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

1. $\vec{H}$, $\vec{I}$, $\vec{B}_{net}$, χ

(a) $\vec{H}$, Magnetizing Field

For external magnetic field $\vec{B}_{ext}$, $\vec{H}$ is defined.

$\vec{B}_{ext} = \mu_0 \vec{H}$, unit of $\vec{H}$ is A/m.

(b) $\vec{I}$, Intensity of Magnetization → (A/m)

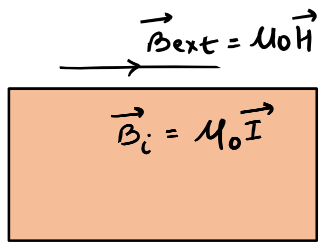
Total magnetic moment of material per unit volume.

$\vec{I} = \frac{\vec{M}}{V}$ (It tells how much a material is magnetized)

(c) χ, Magnetic Susceptibility

Tells about the ease with which a material can be magnetized.

$\chi = I/H$



$\vec{B}_{net} = \vec{B}_{ext} + \vec{B}_i$

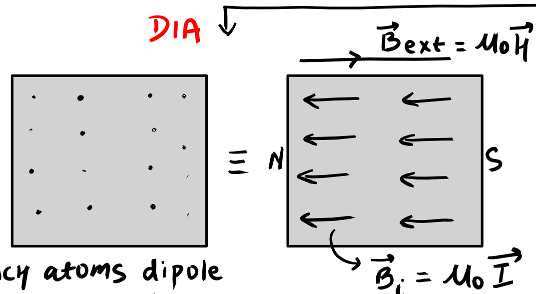
$\Rightarrow \mu_0 \mu_r \vec{H} = \mu_0 \vec{H} + \mu_0 \vec{I}$

$\Rightarrow \mu_r \vec{H} = \vec{H} + \chi \vec{H}$

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

2. DIAMAGNETIC AND PARAMAGNETIC MATERIAL

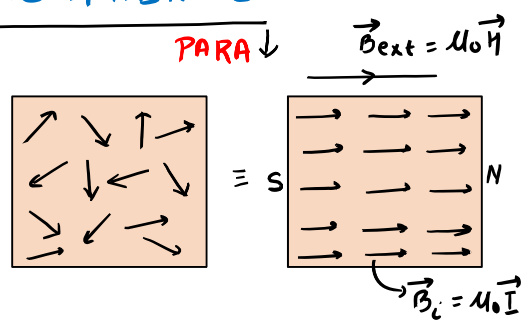
DIA



Each atoms dipole moment is zero

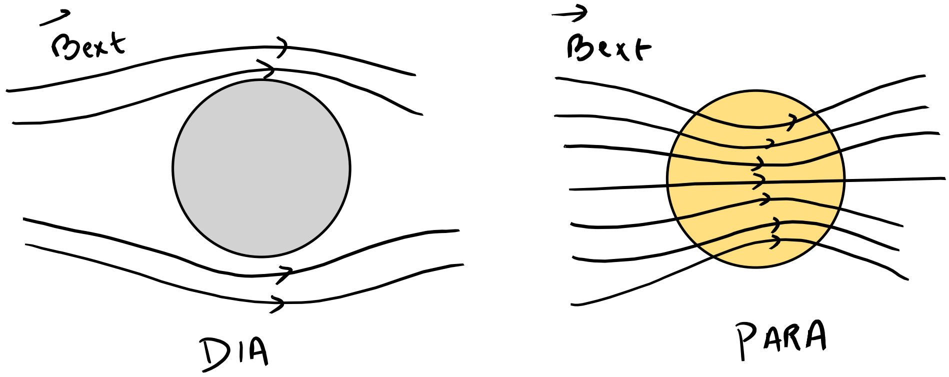
(i) Weakly magnetized
(ii) Material repels $\vec{B}_{ext}$
(iii) $\mu_r = 1 + \chi$
$\mu_r < 1$ and χ is −ve
(iv) Graphite, Bismuth

PARA



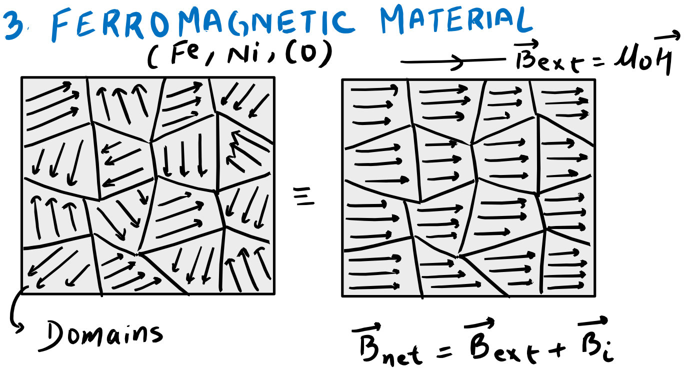
(i) Weakly magnetized
(ii) Material gets weakly attracted to $\vec{B}_{ext}$
(iii) $\mu_r = 1 + \chi$
$\mu_r > 1$ and χ is +ve
(iv) Al, Li, Mg

PART 6 – MAGNETIC PROPERTIES



3. FERROMAGNETIC MATERIAL

(Fe, Ni, Co)



$\vec{B}_{net} = \vec{B}_{ext} + \vec{B}_i$

Here, $B_i >> B_{ext}$

$\Rightarrow I >> H$

$\therefore \chi >> 1$

4. CURIE'S LAW

If T↑, due to thermal agitation, the alignment of dipoles gets disturbed and overall I↓ for a given H.

$\therefore I \downarrow \Rightarrow \chi \downarrow$

(a) FOR PARAMAGNETIC MATERIAL

$\chi = \frac{C}{T}$ C: Curie const. T: Abs Temp°

(b) For Ferromagnetic material

ON heating it to T_c, it changes to Paramagnetic on further ↑T

$\chi = \frac{C'}{T - T_c}$ T_c: Curie Temp°

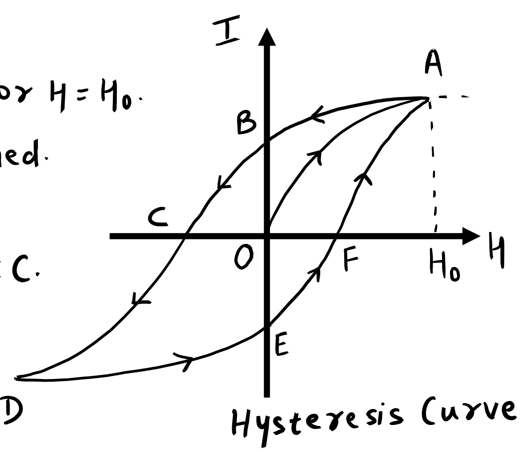
5. MAGNETIC HYSTERESIS

(i) O→A : On ↑H, I↑ and gets Saturated for $H = H_0$.

(ii) A→B: On ↓H to zero, Still I is retained. OB is called "RETENTIVITY".

(iii) B→C : ↑H in reverse direction, I = 0 at C. OC is called "COERCIVITY".

(iv) C→D : Further ↑H and I again gets saturated at D and so on...

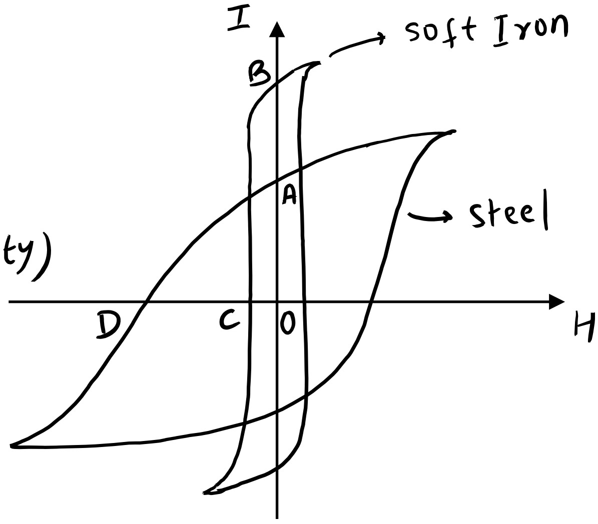


Hysteresis Curve

NOTE : (a) Area of Loop ABCDEFA shows thermal energy or heat produced / Volume in 1 Cyc.

6. HYSTERESIS CURVE :

SOFT IRON VS STEEL



(i) ∵ Soft Iron gets easily magnetized and Looses almost all magnetism easily (Low coercivity)
It is used for "Electromagnets".

(ii) ∵ Steel is difficult to demagnetize
(OD = coercivity)
it is used to make "Permanent Magnets".

<u>Space to add concepts learnt from PYQs if any</u>

Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in ELECTROMAGNETIC INDUCTION – PART 7 (ELECTRODYNAMICS)

1. Faraday's Law
2. Direction of Induced Current : Lenz's law
3. Charge Flown (due to induced emf)
4. Coil rotation in uniform magnetic field
5. Motional emf
6. Motional emf in random shaped wire
7. Motional emf of rotating conductors
8. Parallel rail track problems
9. Induced Electric Field in Time Varying Magnetic Field (TVMF)
10. Eddy Currents
11. Self Induction
12. How to find L ?
13. Battery Polarity induced in an Inductor
14. Growth and Decay of Current
15. Magnetic energy Stored
16. Behavior of L at t = 0 and at steady state
17. Mutual Inductance
18. How to find M ?
19. LC Oscillations

Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

1. FARADAY'S LAW, $\varepsilon = -\frac{d\phi}{dt}$

(a) Flux, $\phi = \vec{B}\cdot\vec{A} = BA\cos\theta$

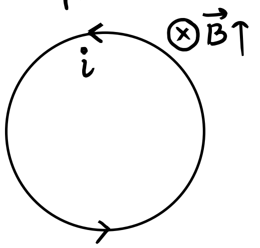
(b) Magnitude is given by $\left|\frac{d\phi}{dt}\right|$

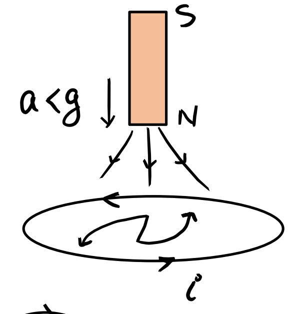
(c) Direction of induced emf (ε) or induced current ($i = \varepsilon/R$) is given by LENZ's LAW

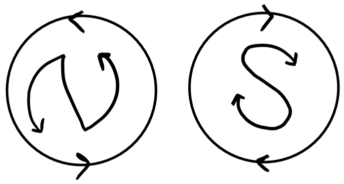
2. DIRECTION OF INDUCED CURRENT

LENZ's LAW : Direction of i will such that its effect will oppose the change in flux.

Examples:

(a) 

(b) 

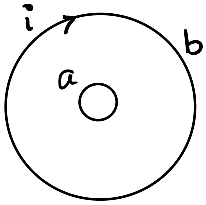


3. CHARGE FLOWN, $q_{flown} = \frac{\Delta\phi}{R}$

(a) $\Delta\phi$ is change in flux, $|\phi_f - \phi_i|$

(b) R is resistance of coil

Example:



$a << b$

If direction of i is reversed,

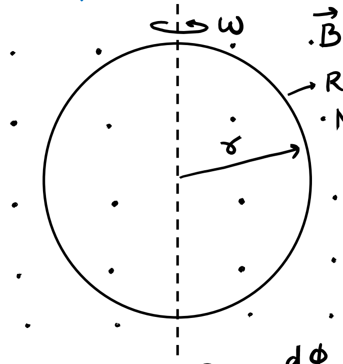
$\Delta\phi = 2 \times BA$

$= 2 \times \frac{\mu_0 i}{2b} \times \pi a^2$

q_{flown} in small coil $= \frac{\Delta\phi}{R}$

R is resistance of small coil

4. COIL ROTATION IN UNIFORM MAGNETIC FIELD



At $t = 0$, $\vec{A} \parallel \vec{B}$

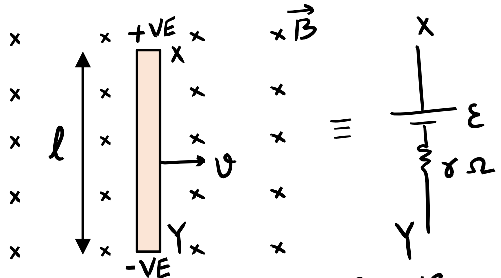
At $t = t$, $\theta = \omega t$

$\phi = NBA\cos\omega t$

$\varepsilon = -\frac{d\phi}{dt} = \underbrace{NBA\omega}_{\varepsilon_0} \sin\omega t$

$i = \underbrace{\frac{\varepsilon_0}{R}}_{i_0} \sin\omega t$

5. MOTIONAL EMF

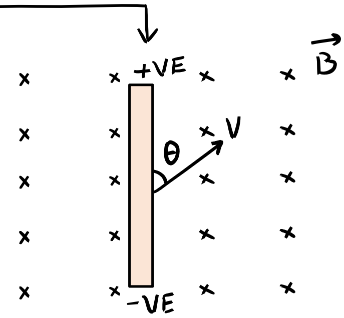


(a) $E = vB$

(b) $\varepsilon = Blv$

(c) applicable only if v, B and l are mutually perpendicular

NOTE: If any two are parallel $\varepsilon = 0$

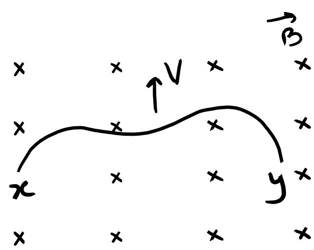


$\varepsilon = Bl$ (component of $v \perp$ to l)

$= Blv\sin\theta$

+VE Polarity is towards direction of $\vec{v} \times \vec{B}$.

6. MOTIONAL EMF IN RANDOM SHAPED WIRE



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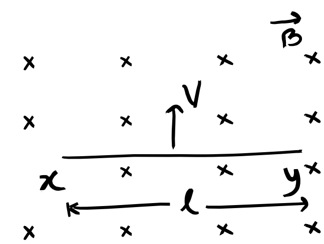
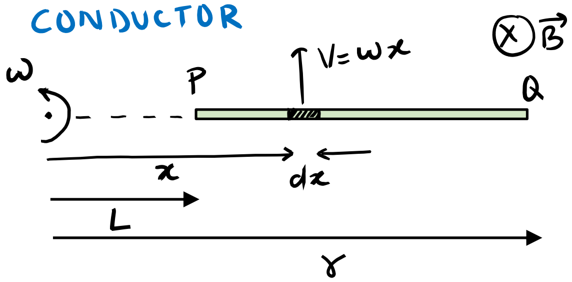


$\varepsilon = Blv$

7 MOTIONAL EMF OF ROTATING CONDUCTOR



$d\epsilon = B\,dx \times \omega x$

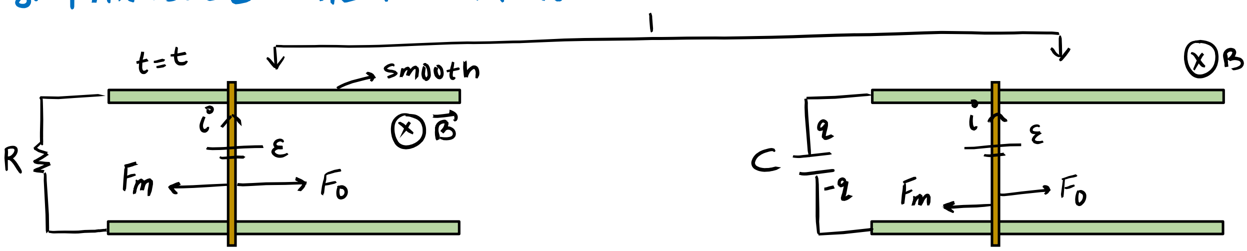
$\Rightarrow \epsilon = B\omega \int_L^r x\,dx$

$\Rightarrow \epsilon = \frac{1}{2}B\omega(r^2 - L^2)$

NOTE: (a) If $L = 0$, $\epsilon = \frac{1}{2}B\omega r^2$

(b) For above fig P at higher potential.

8. PARALLEL RAIL TRACK PROBLEMS



$F_m = ilB = \frac{Blv}{R} \times lB$

(i) $\frac{dv}{dt} = \frac{F_0 - F_m}{m}$

$v = \frac{F_0 R}{B^2 l^2}\left(1 - e^{-\frac{B^2 l^2 t}{mR}}\right)$

At $t \to \infty$ (steady state)

Terminal Vel, $V_t = \frac{F_0 R}{B^2 l^2}$

$P = F_0 V_t$ = Power across R

$q = C\epsilon \Rightarrow q = CBlv$

$\Rightarrow i = \frac{dq}{dt} = CBla$

$F_0 - F_m = ma$

$\Rightarrow F_0 - (CBla)lB = ma$

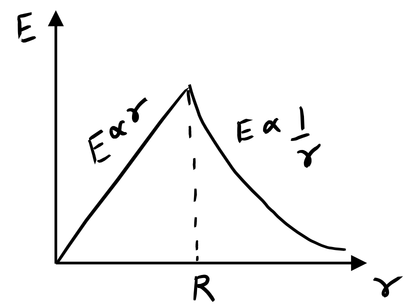
$\therefore a = \frac{F_0}{m + B^2 l^2 C}$

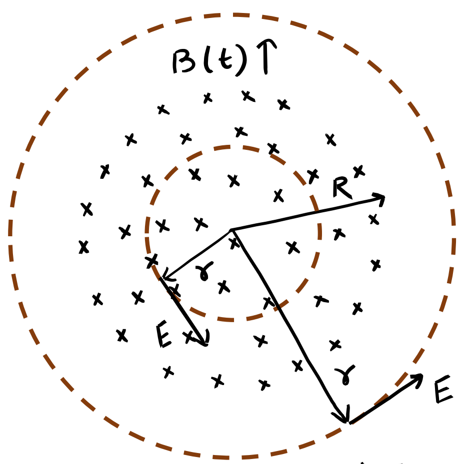
↳ a is const.

9. INDUCED ELECTRIC FIELD IN TIME VARYING MAGNETIC FIELD ((cylindrical region)

for $r < R$, $E = \frac{r}{2}\frac{dB}{dt}$

For $r \geq R$, $E = \frac{R^2}{2r}\frac{dB}{dt}$

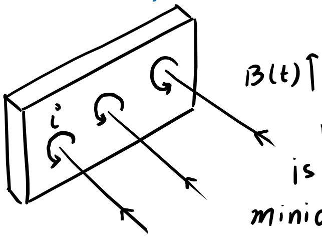




(i) E is in closed loop

(ii) Here it is Non-conservative in nature

10. EDDY CURRENTS



When a metal body is placed in TVMF, miniature currents are induced.

Due to this current heat is dissipated

11. SELF INDUCTION

↳ A property of coil by which it opposes the change in itself.

(a) For any coil carying current I,

$\phi \propto I$ (self flux linkage due to own I)

$\Rightarrow \phi = LI$

↳ Inductance
UNIT: Henry, H

(b) If I varies, Emf induced

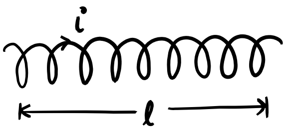
$\mathcal{E} = -L\frac{dI}{dt}$ or $\mathcal{E} = \left|L\frac{dI}{dt}\right|$

↳ Polarity of $\mathcal{E}$ can be found by LENZ's LAW

12. HOW TO FIND L ?

Example

INDUCTOR or SOLENOID



N Turns
A : Area

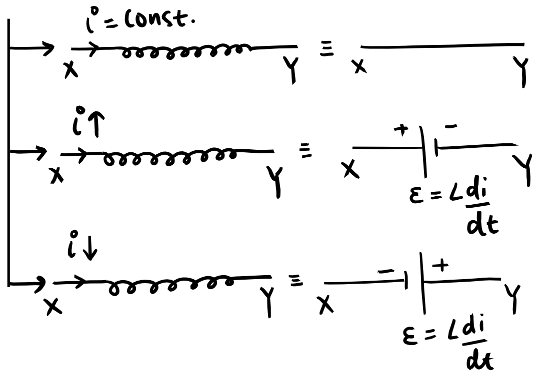
$\phi = NBA \Rightarrow \phi = N \times \frac{\mu_0 N i}{l} A$

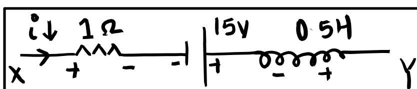
$\Rightarrow \phi = \left(\frac{\mu_0 N^2 A}{l}\right) i$ $\quad \therefore L = \frac{\mu_0 N^2 A}{l}$

NOTE: If any medium inside

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

13. BATTERY POLARITY INDUCED IN INDUCTOR





$i = 5\,A$

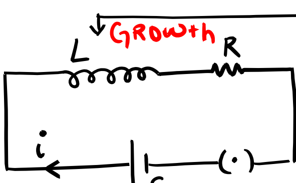
$\frac{di}{dt} = 10\,A/s$

$V_x - V_y = 5 - 15 - 5 = -15\,V$

14. GROWTH AND DECAY OF CURRENT (LR)

GROWTH

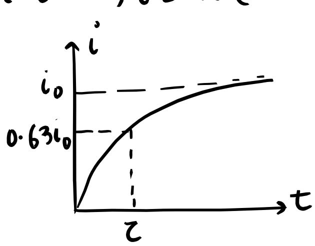
at time t



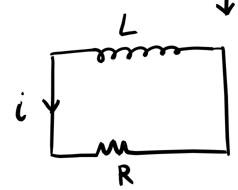
at $t=0$, $i = 0$

at $t = t$, $i = i_0\left(1 - e^{-Rt/L}\right)$

$\begin{cases} i_0 = \mathcal{E}/R \\ \tau = L/R \end{cases}$ ↳ Time const.



DECAY

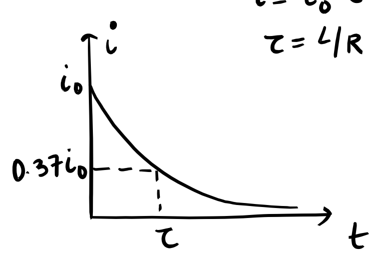


→ at time t

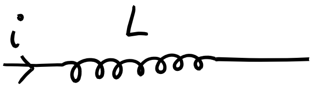
at $t=0$, $i = i_0$ | at $t = t$

$i = i_0 e^{-Rt/L}$

$\tau = L/R$



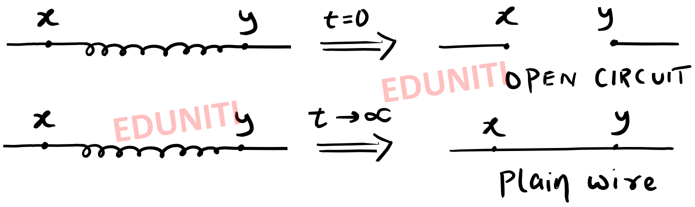
15. ENERGY STORED



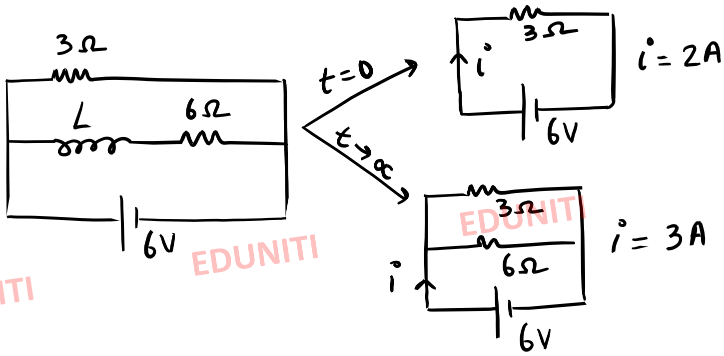
Magnetic energy stored is,

$U = \frac{1}{2} L i^2$

16. BEHAVIOR OF L AT t=0 AND t→∞

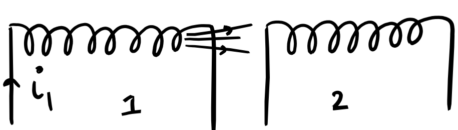


Example:



17. MUTUAL INDUCTION

Property of pair of coils due to which a change in current in 1 coil is opposed by emf induced in other coil because of ϕ LINKAGE.



$\phi_2 = M i_1$

↳ M is Mutual Inductance

↳ $\varepsilon_2 = -M \frac{di_1}{dt}$

NOTE $M = K\sqrt{L_1 L_2}$ K: coupling factor

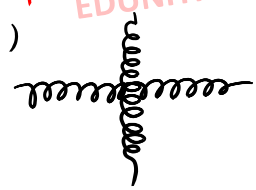
$0 \leq K \leq 1$

L_1 and L_2 are self inductance of coil 1 and coil 2

→ K gives idea of % flux Linkage

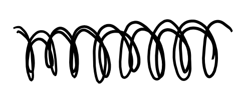
Example:

(i)



$K = 0$

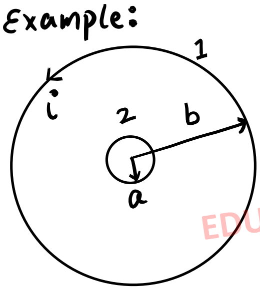
(ii)



$K = 1$

18. HOW TO FIND M ?

Example:



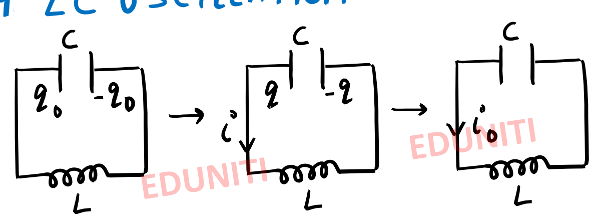
$a << b$

$\phi_2 = \frac{\mu_0 i}{2b} \times \pi a^2$

$\Rightarrow \phi_2 = \left(\frac{\mu_0 \pi a^2}{2b}\right) i$

$\therefore M = \frac{\mu_0 \pi a^2}{2b}$

19. LC OSCILLATION



(a) Total energy is const

$\frac{q_0^2}{2C} = \frac{q^2}{2C} + \frac{1}{2} L i^2 = \frac{1}{2} L i_0^2$

(b) $\omega = \frac{1}{\sqrt{LC}}$, $T = 2\pi\sqrt{LC}$

(c) General equation

$q = q_0 \sin(\omega t + \phi)$, $i = i_0 \cos(\omega t + \phi)$

Space to add concepts learnt from PYQs if any

Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in ALTERNATING CURRENT – PART 8 (ELECTRODYNAMICS)

1. Average and RMS current
2. R, L, C taken individually in circuit (Phase relation)
3. LR Circuit across AC source
4. RC Circuit across AC source
5. LC Circuit across AC Source
6. RLC Series
7. Power in AC Circuit and Power factor
8. Resonant Frequency in RLC Series
9. Current variation with frequency, Bandwidth, Quality factor
10. RLC in Parallel
11. Transformer

Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

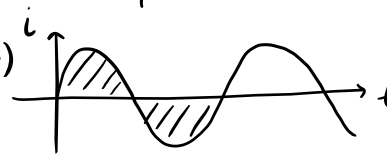
1. I_{av} AND I_{rms}

$$I_{av} = \frac{\int_{t_1}^{t_2} i(t)\,dt}{t_2 - t_1}$$

$$I_{rms} = \sqrt{\frac{\int_{t_1}^{t_2} i^2(t)\,dt}{t_2 - t_1}}$$

NOTE: $\int i\,dt$ is area under i v/s t curve

(i)



for $i = i_0 \sin\omega t$

$i_{av} = 0$

NOTE:

$i(t)$ → R

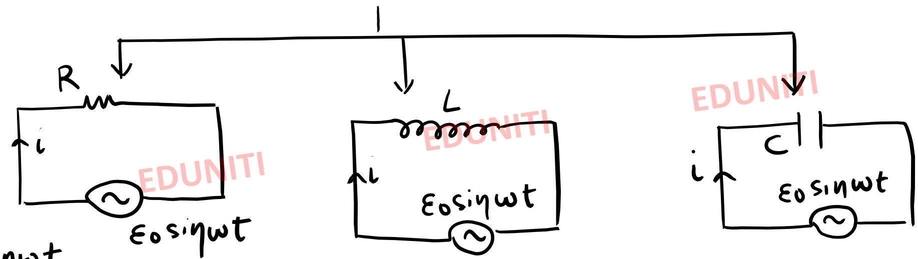
I_{rms} → R

In same time, same heat is dissipated

Ex: If $i = i_0 \sin\omega t$

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

2. PHASE RELATION BETWEEN $\mathcal{E}$ AND i (R, L, C TAKEN INDIVIDUALLY)



R:

$i = i_0 \sin\omega t$

(a) $i_0 = \varepsilon_0 / R$

(b) i and ε in phase

(c) R doesn't depend on ω

L:

$i = i_0 \sin(\omega t - \frac{\pi}{2})$

(a) $i_0 = \frac{\varepsilon_0}{X_L}$, $X_L = \omega L$ → Inductive Reactance

(b) i lags by $\pi/2$

(c) At $\omega \to 0$, $X_L \to 0$; $\omega \to \infty$, $X_L \to \infty$

C:

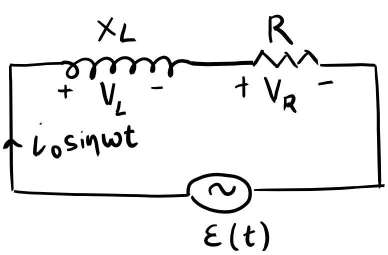
$i = i_0 \sin(\omega t + \frac{\pi}{2})$

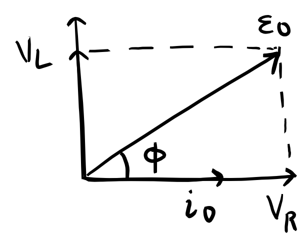
(a) $i_0 = \varepsilon_0 / X_C$, $X_C = 1/\omega C$ → CAPACITIVE REACTANCE

(b) i Leads by $\pi/2$

(c) At $\omega \to 0$, $X_C \to \infty$; $\omega \to \infty$, $X_C \to 0$

3. LR CIRCUIT (PHASOR Dig.)





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

(b) $\tan\phi = X_L / R$

(c) ε leads i by ϕ

$\therefore \varepsilon = \varepsilon_0 \sin(\omega t + \phi)$ → $\varepsilon_0 = i_0 Z$

(d) $v_L = V_L \sin(\omega t + \pi/2)$ → $V_L = i_0 X_L$

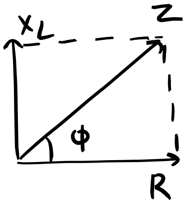
$\varepsilon_0 = \sqrt{V_L^2 + V_R^2} \Rightarrow i_0 Z = \sqrt{(i_0 X_L)^2 + (i_0 R)^2}$

$Z = \sqrt{X_L^2 + R^2}$ → Impedance

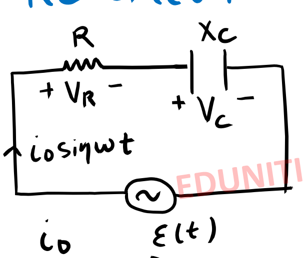
$\tan\phi = \frac{V_L}{V_R} = \frac{X_L}{R}$

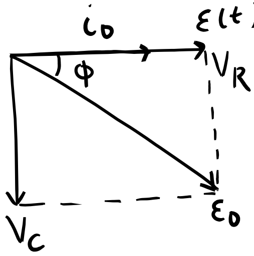
NOTE:

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



4. RC CIRCUIT





$\varepsilon_0 = \sqrt{V_R^2 + V_C^2}$

$i_0 Z = \sqrt{(i_0 R)^2 + (i_0 X_C)^2}$

$\Rightarrow Z = \sqrt{R^2 + X_C^2}$ → Impedance

$\tan\phi = \frac{V_C}{V_R} = \frac{X_C}{R}$

(a) $Z = \sqrt{X_C^2 + R^2}$, $X_C = \frac{1}{\omega C}$

(b) $\tan\phi = X_C / R$

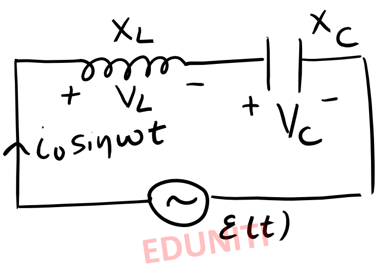
(c) ε lags i by ϕ

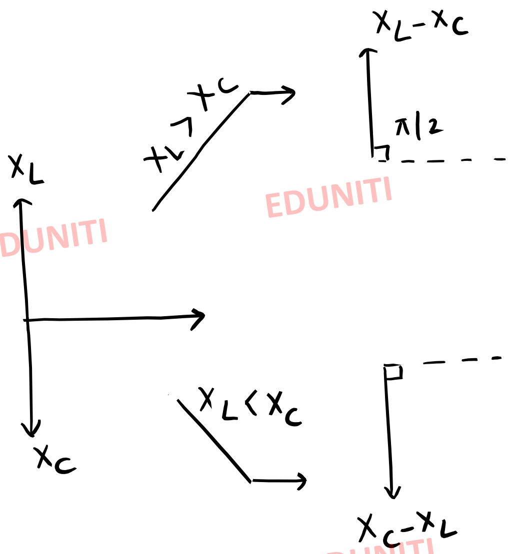
$\therefore \varepsilon = \varepsilon_0 \sin(\omega t - \phi)$ → $\varepsilon_0 = i_0 Z$

(d) $v_C = V_C \sin(\omega t - \frac{\pi}{2})$

PART 8 – AC

5 LC CIRCUIT





(a) $Z = X_L - X_C$

(b) ε leads i by $\pi/2$

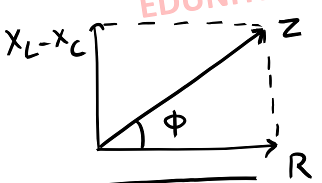
(c) $\varepsilon = \varepsilon_0 \sin(\omega t + \frac{\pi}{2})$
↳ $i_0 Z$

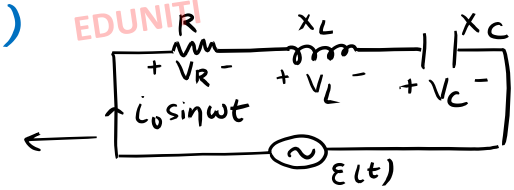
(a) $Z = X_C - X_L$

(b) ε lags i by $\pi/2$

(c) $\varepsilon = \varepsilon_0 \sin(\omega t - \frac{\pi}{2})$

6 RLC (SERIES)





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

$\tan\phi = \dfrac{X_L - X_C}{R}$

(a) If $X_L > X_C$ (Inductive) ⇒ ε leads by ϕ → $\varepsilon = \varepsilon_0 \sin(\omega t + \phi)$ ↳ $i_0 Z$

If $X_C > X_L$ (capacitive) ⇒ ε lags by ϕ → $\varepsilon = \varepsilon_0 \sin(\omega t - \phi)$

(b) $v_L = V_L \sin(\omega t + \pi/2)$
↳ $V_L = i_0 X_L$

$v_C = V_C \sin(\omega t - \pi/2)$
↳ $V_C = i_0 X_C$

7 POWER IN AC CIRCUIT

$P_{av} = \varepsilon_{rms} i_{rms} \cos\phi$

NOTE: In questions If nothing mentioned, take given supply voltage as ε_{rms}.

Power factor, $\cos\phi = R/Z$

- → only C, $\cos\phi = 0$ ⇒ $P_{av} = 0$
- → only L, $\cos\phi = 0$, ⇒ $P_{av} = 0$
- → only R, $\cos\phi = 1$, ⇒ P_{av} is Max
- → RL, $\cos\phi = \dfrac{R}{\sqrt{X_L^2 + R^2}}$
- → RC, $\cos\phi = \dfrac{R}{\sqrt{X_C^2 + R^2}}$
- → RLC, $\cos\phi = \dfrac{R}{\sqrt{R^2 + (X_L - X_C)^2}}$

PART 8 – AC

8. RESONANT FREQUENCY (SERIES RLC)

↳ That value of ω for which impedance is purely resistive. $(Z = R)$

(a) $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$

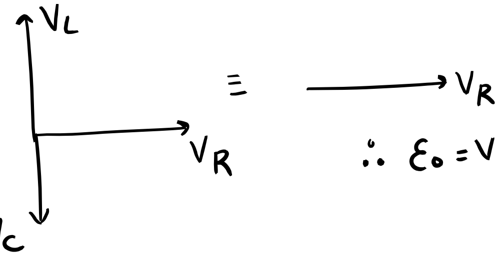
for $\omega L = \frac{1}{\omega C}$, $Z = R$ $\Rightarrow \omega_R = \frac{1}{\sqrt{LC}}$

(b) At resonance, $P_{av} = i^2_{rms} R = \frac{\varepsilon^2_{rms}}{R}$ $(\cos\phi = 1)$

(c) $\because X_L = X_C$

$\Rightarrow V_L = V_C$

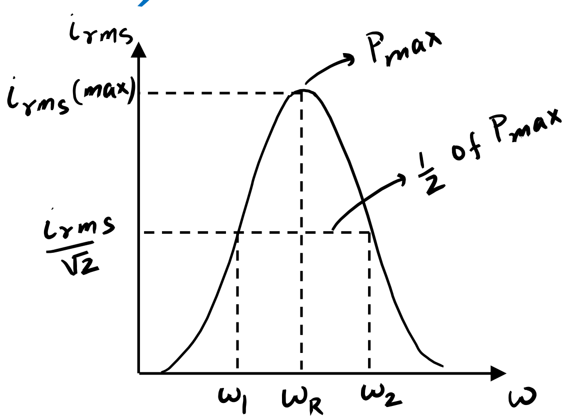
∴ All supply is across Resistor.



$\therefore \varepsilon_0 = V_R$

9. CURRENT VARIATION WITH ω (SERIES RLC)

$$i_{rms} = \frac{\varepsilon_{rms}}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$



(a) For ω_1 and ω_2

P_{av} is $\frac{1}{2}$ of P_{max}.

(b) BANDWIDTH

$\Delta\omega = \omega_2 - \omega_1 = R/L$

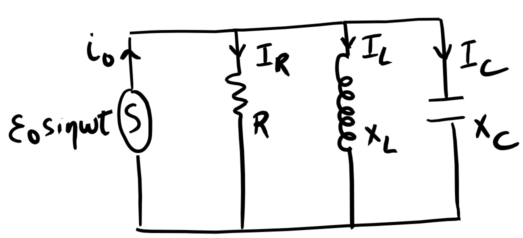
(c) QUALITY FACTOR (Q factor)

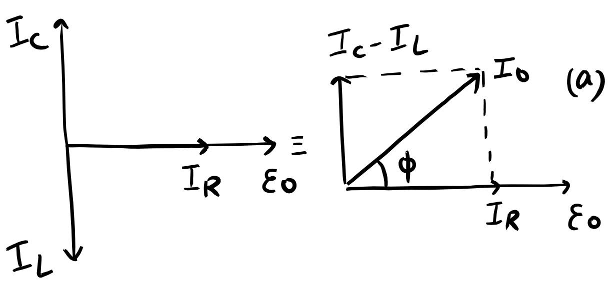
$Q = \frac{\omega_R}{\Delta\omega} = \frac{1}{\sqrt{LC}} \times \frac{L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}$

(d) If $\omega < \omega_R \Rightarrow X_C > X_L$ (i Leads)

(e) $\omega > \omega_R \Rightarrow X_L > X_C$ (i Lags)

10. RLC (PARALLEL)





(a) $\tan\phi = \frac{I_C - I_L}{I_R} = \frac{\frac{\varepsilon_0}{X_C} - \frac{\varepsilon_0}{X_L}}{\frac{\varepsilon_0}{R}}$

(b) $I_0 = \sqrt{I_R^2 + (I_C - I_L)^2}$

$\Rightarrow \frac{\varepsilon_0}{Z} = \sqrt{\left(\frac{\varepsilon_0}{R}\right)^2 + \left(\frac{\varepsilon_0}{X_C} - \frac{\varepsilon_0}{X_L}\right)^2}$

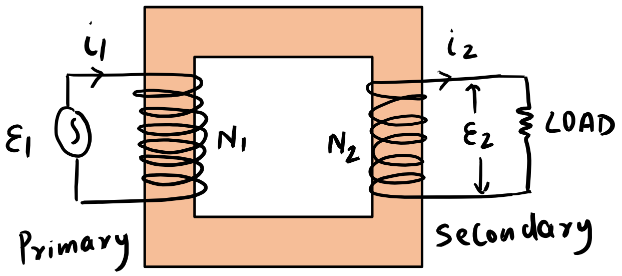
$\Rightarrow \frac{1}{Z} = \sqrt{\frac{1}{R^2} + \left(\frac{1}{X_C} - \frac{1}{X_L}\right)^2}$

(c) $\omega_R = \frac{1}{\sqrt{LC}}$

(d) At ω_R, Z is max

$\Rightarrow i$ is min.

11. TRANSFORMER



N_1 and N_2 are number of turns.

(a) $\dfrac{\mathcal{E}_1}{\mathcal{E}_2} = \dfrac{N_1}{N_2}$

- $N_1 > N_2 \Rightarrow \mathcal{E}_1 > \mathcal{E}_2$ (step down transformer)
- $N_2 > N_1 \Rightarrow \mathcal{E}_2 > \mathcal{E}_1$ (step up transformer)

(b) For ideal transformer (No losses)

$\mathcal{E}_1 i_1 = \mathcal{E}_2 i_2$

(c) Losses

- Cu loss (Joules heating)
- Eddy current (Heat due to it)

Space to add concepts learnt from PYQs if any

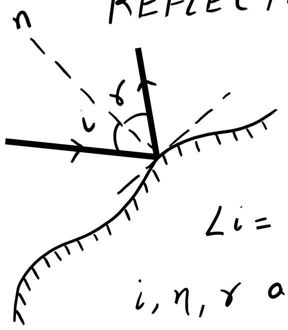
Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel

Topics to cover in RAY OPTICS – PART 1

1. Law of reflection
2. Vector form of reflected ray
3. Minimum mirror length to see ones image
4. Angle of deviation
5. Mirror rotation
6. Image velocity
7. Spherical Mirror – Important Terms
8. Mirror Formulae
9. Magnification (Transverse & Longitudinal)
10. Image formation in Concave Mirror (2 imp case of magnification)
11. Diameter of image of Sun (distant object)
12. Image velocity in spherical mirrors
13. Refraction – Snell's Law
14. Apparent Depth (image formation due to Plane surface)
15. Shifting due to Slab
16. Lateral displacement
17. Spherical Refraction Image Formulae
18. Thin Lenses: Lens Formulae & Lens Makers Formulae
19. Magnification
20. Optical Power
21. Combination of thin lenses
22. Combination of Lenses and Mirrors (equivalent focal length)
23. Displacement method to measure focal length of convex lens
24. Critical angle and TIR
25. Prism
26. Dispersive Power
27. Condition of deviation without dispersion
28. Condition of dispersion without deviation

Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

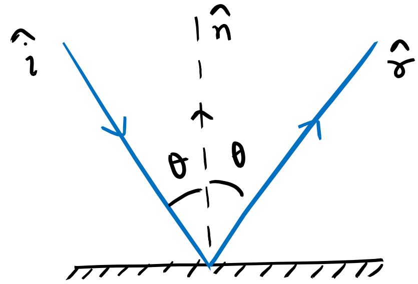
1. REFLECTION



$\angle i = \angle r$

i, n, r are in same plane

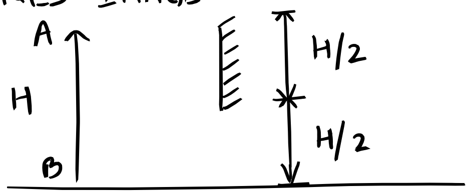
2. VECTOR FORM OF REFLECTED RAY



$$\hat{r} = \hat{i} - 2(\hat{i}\cdot\hat{n})\cdot\hat{n}$$

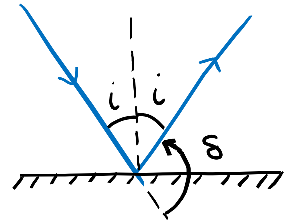
$\hat{i}$, $\hat{r}$ and $\hat{n}$ are unit vectors along incident ray, reflected ray and normal.

3. MINIMUM MIRROR LENGTH TO SEE ONES IMAGE



* Assuming eye level at A

4. ANGLE OF DEVIATION (δ)

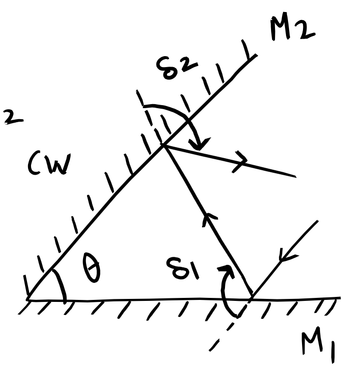


$\delta = \pi - 2i$

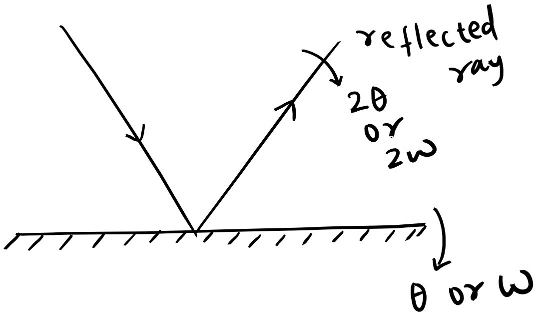
Here it is ACW rotation

$\delta_{NET} = \delta_1 + \delta_2$

$= 2\pi - 2\theta$ CW

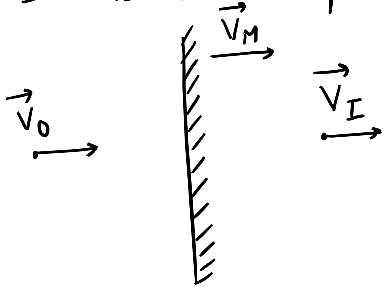


5. MIRROR ROTATION



↳ If mirror rotated by angle θ, reflected ray rotates by 2θ. (ω is angular vel)

6. IMAGE VELOCITY



$$\vec{V}_{O/M} = -\vec{V}_{I/M}$$

$$\Rightarrow \vec{V}_O - \vec{V}_M = -(\vec{V}_I - \vec{V}_M)$$

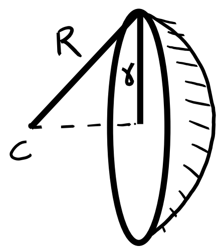
$$\Rightarrow \boxed{\vec{V}_I = 2\vec{V}_M - \vec{V}_O}$$

* These are all velocities Normal to mirror surface.

SPHERICAL MIRROR

7. MIRROR IMPORTANT TERMS

(a)



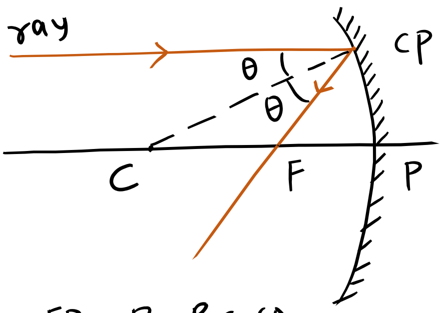
r : radius of aperture

$2r$: Aperture size

C : center of Curvature

R : Radius of Curvature

(b)



$CP = R$

$$FP = R - \frac{R}{2}\sec\theta$$

NOTE:

If rays were PARAXIAL (close to axis)

then θ is very small $\Rightarrow \sec\theta \approx 1$

$\Rightarrow$ F is FOCUS

and $\boxed{FP = \frac{R}{2}}$

8. MIRROR FORMULAE

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \quad \text{or} \quad \boxed{v = \frac{uf}{u-f}}$$

- Put u, f with sign
- f is -VE for CONCAVE and +VE for CONVEX Mirror

9. MAGNIFICATION

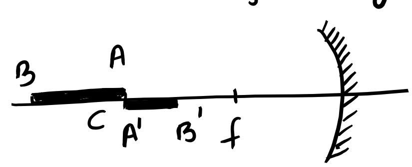
→ TRANSVERSE, $m = \frac{h_i}{h_o} = \frac{-v}{u} = -\frac{f}{u-f}$

* Put terms with sign
* Erect image ⇒ m is +VE
* INVERTED ⇒ m is -VE

→ LONGITUDNAL

$$m = \frac{\text{Image Length along PA.}}{\text{Object Length along PA}}$$

Ex:

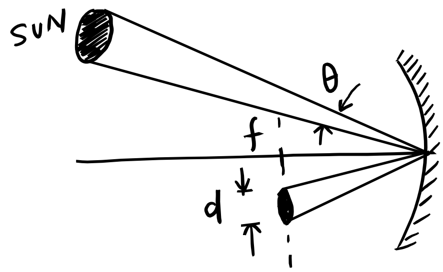


$$m = \frac{A'B'}{AB}$$

10. Six standard cases of image formation in CONCAVE MIRROR.

- → Must remember them all
- → Magnified image
  - Object between f and C (Real image) — m is -VE
  - Object between Pole and focus (Virtual image) — m is +VE.

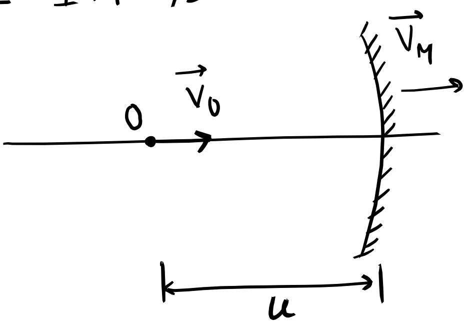
11. Diameter of image of SUN (Distant object)



$d = \theta f$

→ θ in radians

12. IMAGE VELOCITY



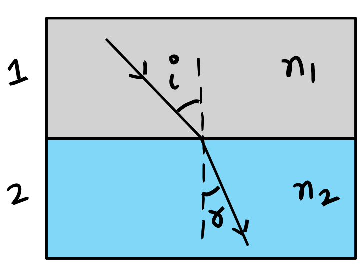
$$V_{I/M} = -\left(\frac{v}{u}\right)^2 V_{O/M}$$

If $V_M = 0$ then, $V_I = -\left(\frac{f}{u-f}\right)^2 V_O$

→ put u, f, V_O with sign

REFRACTION

13. SNELL'S LAW



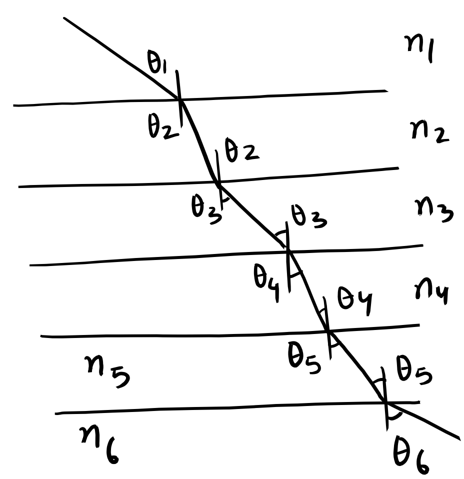
(a.) $n_1 \sin i = n_2 \sin r$

(b) As per this fig $n_2 > n_1$

(c) $\frac{n_2}{n_1} = \frac{V_1}{V_2} = \frac{\lambda_1}{\lambda_2}$

V_1 and V_2 are speed of light in medium 1 and 2.

#

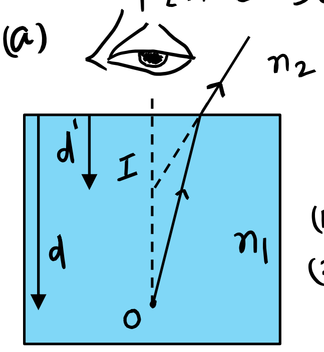


$n_1 \sin\theta_1 = n_2 \sin\theta_2 = n_3 \sin\theta_3 = \ldots\ldots = n_6 \sin\theta_6$

$\therefore$ $n \sin\theta = \text{Constant}$

14. IMAGE FORMATION DUE TO PLANE SURFACE

(a)



$$d' = d\frac{n_2}{n_1}$$

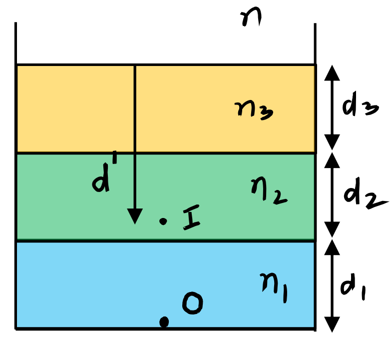
(1.) d' is Apparent depth

(2.) d' < d If $n_1 > n_2$

d' > d If $n_1 < n_2$

(3.) Paraxial rays or observer is looking from above

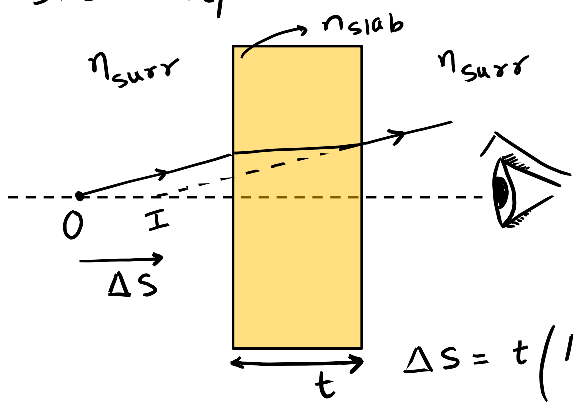
(b)



$$d' = n\left(\frac{d_1}{n_1} + \frac{d_2}{n_2} + \frac{d_3}{n_3}\right)$$

15. SHIFTING DUE TO SLAB

(a)

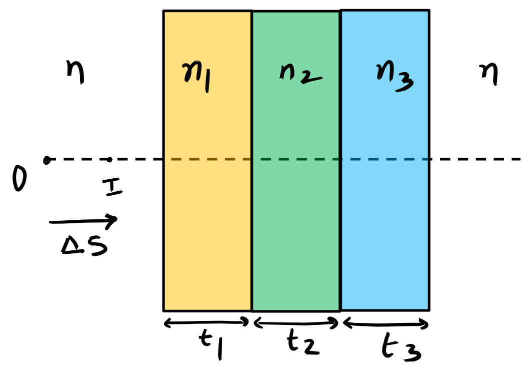


$$\Delta S = t\left(1 - \frac{n_{surr}}{n_{slab}}\right)$$

(1.) valid for paraxial

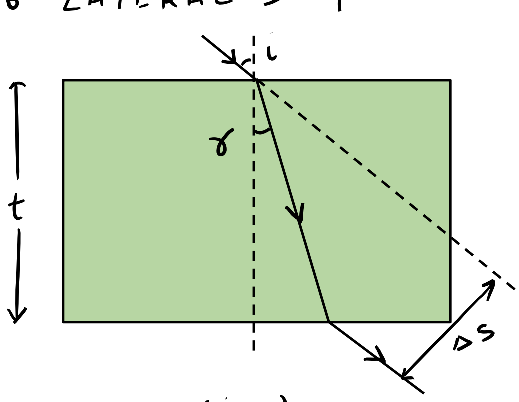
(2.) valid only if medium around slab is same

(b)



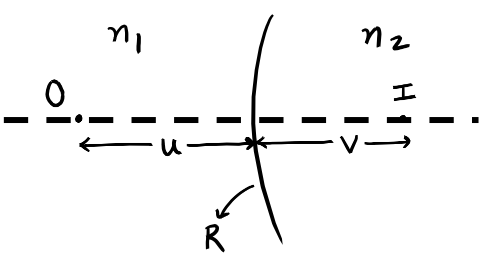
$$\Delta S = t_1\left(1 - \frac{n}{n_1}\right) + t_2\left(1 - \frac{n}{n_2}\right) + t_3\left(1 - \frac{n}{n_3}\right)$$

16. LATERAL DISPLACEMENT



$$\Delta S = \frac{t\sin(i-r)}{\cos r}$$

17. SPHERICAL REFRACTION IMAGE FORMULAE



$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

(1.) Put u, v, R with sign

(2.) n_2 is medium where rays are going

18. THIN LENSES: LENS FORMULAE

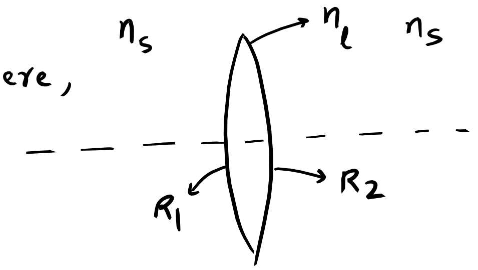
$$\frac{1}{V} - \frac{1}{u} = \frac{1}{f} \quad \text{or} \quad V = \frac{uf}{u+f}$$

(1.) f is +VE for converging lens and -VE for diverging lens

(2.) Valid for paraxial rays

LENS MAKER'S FORMULAE

Here,



$$\frac{1}{f} = \left(\frac{n_l}{n_s} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

(1.) Valid only if lens is surrounded by only one medium.

(2.) Put R_1, R_2 with sign

19. MAGNIFICATION

$$m = \frac{h_i}{h_o} = \frac{V}{u} = \frac{f}{u+f}$$

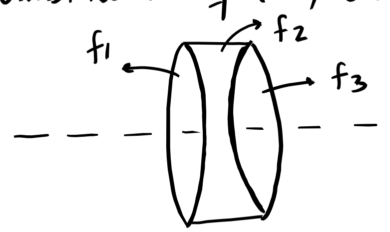
↳ Transverse mag

20. OPTICAL POWER

$$P = \frac{1}{f_l}$$

- ↳ UNIT: DIOPTER
- ↳ put f_l with sign
- ↳ put f_l in meters

21. Combination of thin lenses, f_{eq}



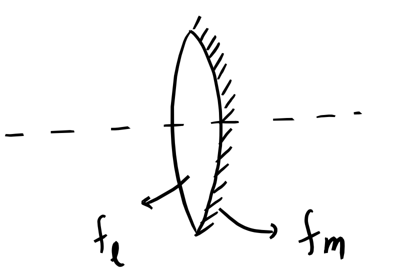
$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}$$

(1.) put f_1, f_2, f_3 with sign

(2.) Lenses must be in contact

(3.) f_1, f_2, f_3 are individual focal lengths w.r.t surrounding medium.

22. COMBINATION OF LENS and MIRRORS (f_{eq})



$$\frac{1}{f_{eq}} = \frac{1}{f_m} - \frac{2}{f_l}$$

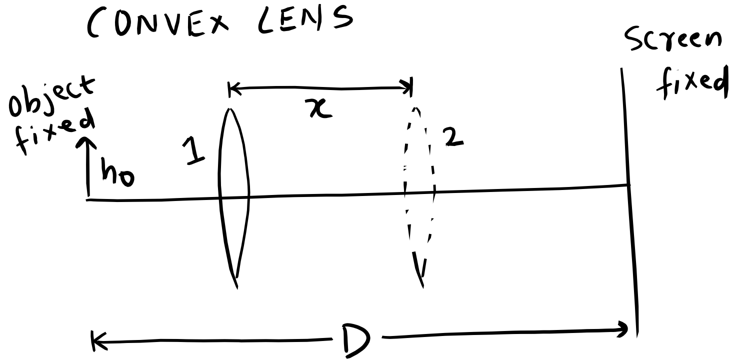
(1.) Put f_m, f_l with sign.

(2.) If f_{eq} is +VE ⇒ Equivalent Convex mirror

If f_{eq} is -VE ⇒ Concave mirror

If f_{eq} is ∞ ⇒ Plane Mirror

23. DISPLACEMENT METHOD TO MEASURE FOCAL LENGTH OF CONVEX LENS



$$f = \frac{D^2 - x^2}{4D}$$

D : Distance between screen and object

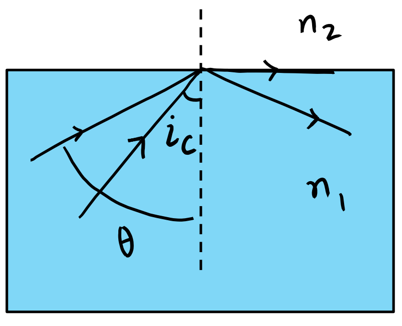
x : Distance between two positions of lens.

$$h_o = \sqrt{h_1 h_2}$$

h_1 : image height when LENS is at posⁿ 1

h_2 : when at posⁿ 2

24. CRITICAL ANGLE AND TIR



(1) Here $n_1 > n_2$

(2) i_c : critical angle for which $r = 90°$

(3) If $\theta > i_c \Rightarrow$ TIR

$\sin i_c = \frac{n_2}{n_1}$ or $i_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$

25. PRISM

(1.) A : ANGLE of PRISM , $A = r_1 + r_2$

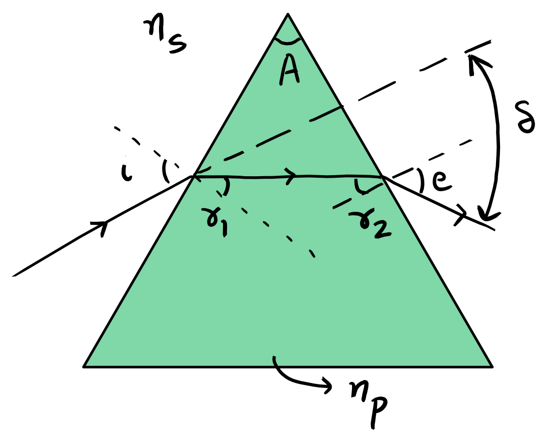
(2) δ : ANGLE of Deviation

$\delta = i + e - A$

(3.) For δ to be minimum, δ_{min}

$i = e \Rightarrow r_1 = r_2 = r$

$$\frac{n_p}{n_s} = \frac{\sin\left(\frac{\delta_m + A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

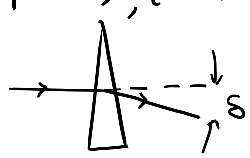


n_p : R.I of PRISM

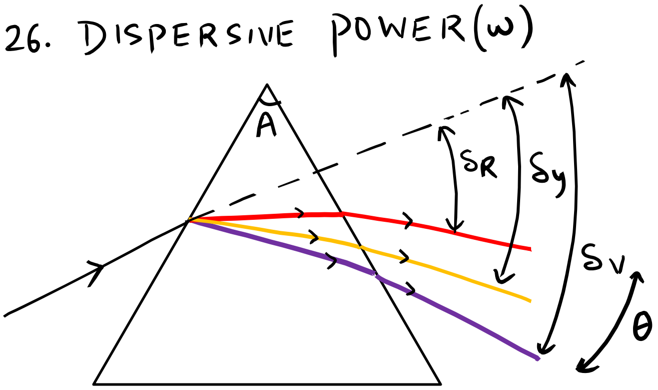
n_s : RI of Surrounding

(4.) If A is very small (THIN PRISM), then

$$\delta = A\left(\frac{n_p}{n_s} - 1\right)$$



26. DISPERSIVE POWER (ω)



$\delta_R = A(n_R - 1)$, $\delta_y = A(n_y - 1)$, $\delta_V = A(n_V - 1)$

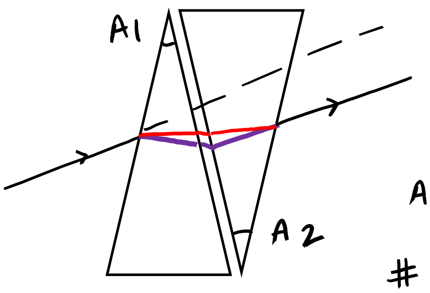
n_R, n_y, n_V are R.I. of medium for Red, yellow and violet color

(Cauchy's eq^n, $n = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4} + \ldots$)

(a) θ (Dispersion Angle) $= \delta_V - \delta_R = \boxed{A(n_V - n_R)}$

(b) ω (Dispersive power) $= \frac{\delta_V - \delta_R}{\delta_y} = \boxed{\frac{n_V - n_R}{n_y - 1}}$

27. CONDITION for DEVIATION WITHOUT DISPERSION



$\theta_{NET} = 0$

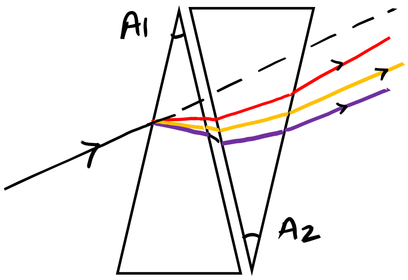
$\Rightarrow \theta_1 = \theta_2$

or

$A_1(n_{V_1} - n_{R_1}) = A_2(n_{V_2} - n_{R_2})$

Achromatic prism Combination

28. CONDITION FOR DISPERSION WITHOUT DEVIATION



Here final emergent yellow is parallel to incident white light

so, $\delta_{net} = 0 \Rightarrow \delta_1 = \delta_2$

$\Rightarrow A_1(n_{y_1} - 1) = A_2(n_{y_2} - 1)$

Space to add concepts learnt from PYQs if any

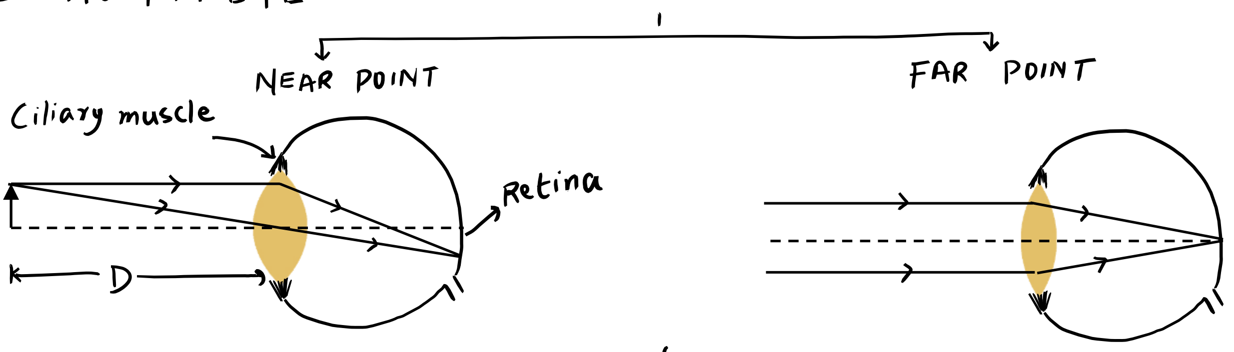
Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in OPTICAL INSTRUMENTS – PART 2

1. Human Eye
2. Eye Defects
3. Angular size
4. Simple Microscope
5. Compound Microscope
6. Refracting Telescope
7. Limit of Resolution & Resolving Power

Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

1 HUMAN EYE



Least distance of Distinct Vision, D = 25cm (for normal eye)

For a normal eye far point is Infinity.

NOTE:
(a) Ciliary muscle changes eye lens curvature to change 'f' so that sharp image is formed on RETINA.

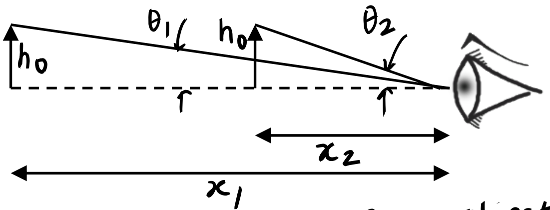
2. EYE DEFECTS

NAME	DEFECT	CORRECTIVE LENS
Myopia Nearsightedness	- Far object not clear - Rays converge before Retina	concave lens
Hypermetropia Farsightedness	- Near object not clear - Rays converge after Retina	Convex lens
Presbyopia	Elderly person, generally is not able to read a book at about 25 cm distance from the eye	Bifocal lens
Astigmatism	- Distorted image - generally occurs if the eye is myopic or hypermetropic.	Cylindrical lens

Presbyopia: old age issue of hardening of eye lens

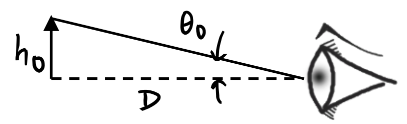
Astigmatism: cornea not spherical in shape

3. ANGULAR SIZE

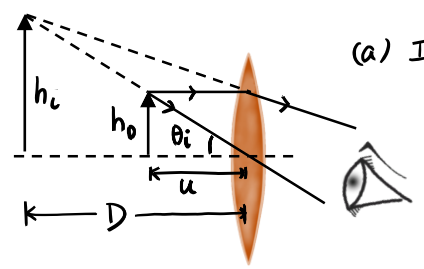


$\theta_1 = \frac{h_0}{x_1}$, $\theta_2 = \frac{h_0}{x_2}$ { Same object appears large if close to our eye }

4. SIMPLE MICROSCOPE



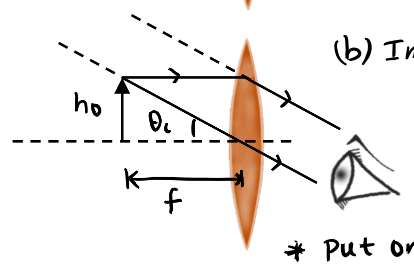
Angular size of object, $\theta_0 = \frac{h_0}{D}$



(a) Image at Near point, D

$\theta_i = \frac{h_0}{u}$, $u = \frac{Df}{D+f}$

$m = \frac{\theta_i}{\theta_0} = 1 + \frac{D}{f}$



(b) Image at Far Point, ∞

$\theta_i = h_0/f$

$m = \frac{\theta_i}{\theta_0} = \frac{D}{f}$

* Put only magnitudes

5. COMPOUND MICROSCOPE

$m = m_o \times m_e$

Image at D

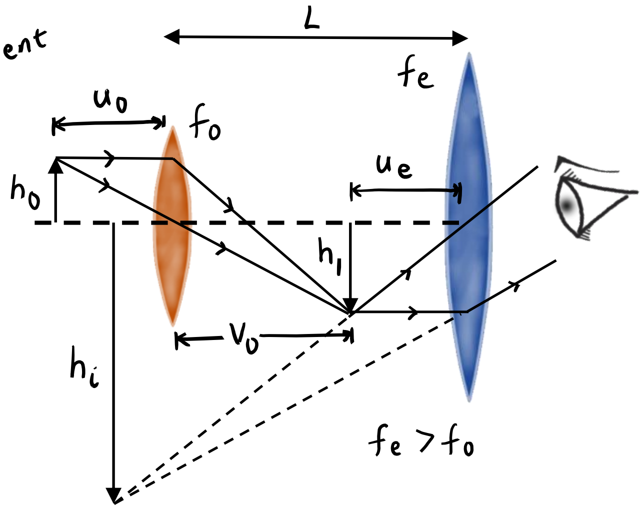
$$m = \frac{V_o}{u_o}\left(1 + \frac{D}{f_e}\right)$$

Image at ∞ (normal Adjustment)

$$m = \frac{V_o}{u_o}\frac{D}{f_e}$$

Generally $f_o \ll L$, $f_e \ll L$

$$m = \frac{L}{f_o}\left(1 + \frac{D}{f_e}\right) \qquad m = \frac{L}{f_o}\frac{D}{f_e}$$



Tube length (L)

(a) If image at D, $L = V_o + u_e$

(b) If image at ∞, $L = V_o + f_e$

6. REFRACTING TELESCOPE

$\theta_o = h_1/f_o$, $\theta_i = h_1/u_e$, $u_e = \frac{D f_e}{D + f_e}$

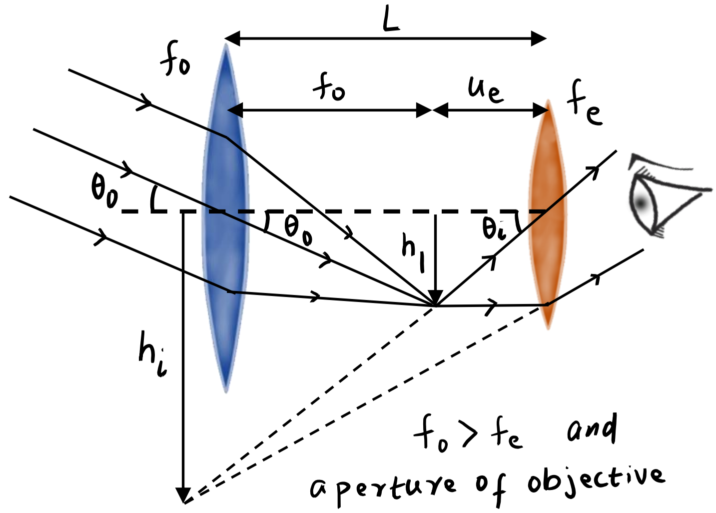
Image at D

$$m = \frac{\theta_i}{\theta_o} = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right)$$

Image at ∞

$\theta_i = h_1/f_e$

$$\therefore m = \frac{\theta_i}{\theta_o} = \frac{f_o}{f_e}$$



$f_o > f_e$ and aperture of objective is large to capture more light.

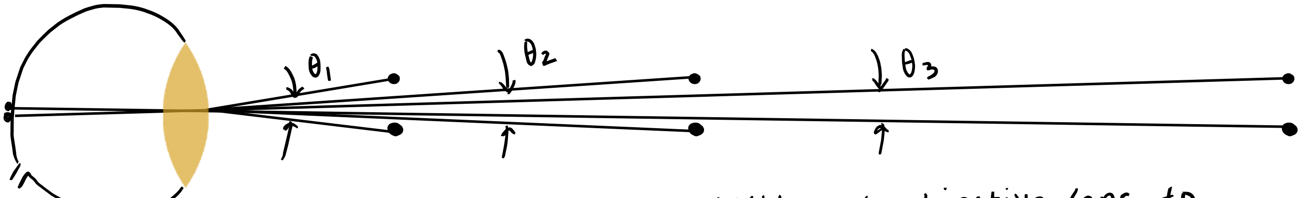
Tube length

(a) If image at D, $L = f_o + u_e$

(b) If image at ∞, $L = f_o + f_e$

* In all formulae Put only magnitudes.

7. LIMIT OF RESOLUTION, RESOLVING POWER

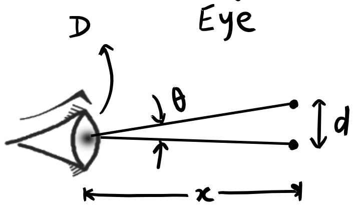


Limit of resolution tells the ability of objective lens to resolve two objects distinctively.

(a) There will be a minimum value of θ for which two objects are just resolved in image that θ is called "Limit of Resolution" and $\frac{1}{\theta}$ is "Resolving power"

7. LIMIT OF RESOLUTION, RESOLVING POWER (RP)

Eye



Limit of Resolution, $\theta = \frac{1.22\lambda}{D}$

$RP = 1/\theta$, $d = \theta x$

Telescope

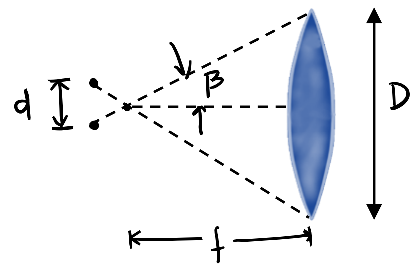
D = Aperture of Objective lens

Two stars will be just resolved if,

$\theta = \frac{1.22\lambda}{D}$, $RP = \frac{D}{1.22\lambda}$

If distance of star is x, separation between them, $d = x\theta$

Microscope



$d_{min} = \frac{1.22\lambda}{2\mu \sin\beta}$

$RP = \frac{1}{d_{min}}$

(i) Numerical Aperture (NA) $= \mu \sin\beta$

(ii) μ: Refractive index of medium between Lens and object

Space to add concepts learnt from PYQs if any

Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in YDSE & INTERFERENCE– PART 1 (Wave Optics/EM Waves)

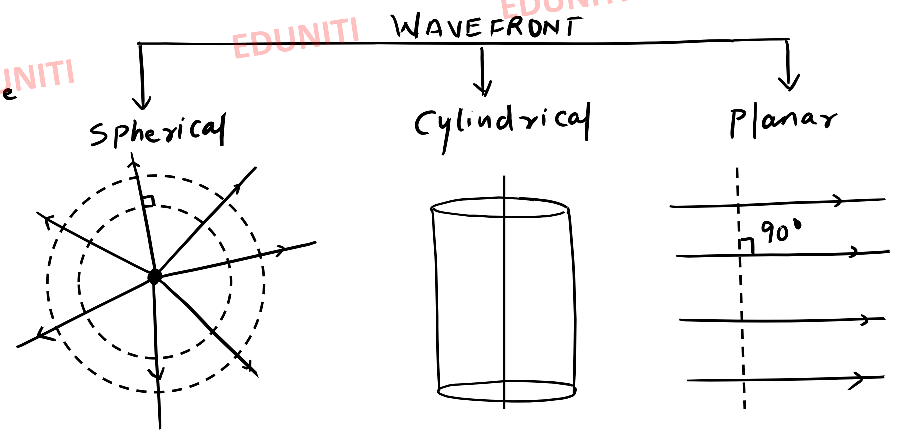
1. Wavefront
2. Net Amplitude and Intensity, Phase and Path difference relation
3. Constructive and Destructive Interference
4. YDSE
5. Position of Dark and Bright Fringes
6. Fringe Width and Angular Fringe Width
7. Effect on Fringe Width if YDSE Setup is in a Medium
8. Geometrical and Optical Path Length
9. Thin Film in YDSE
10. Shifting of Fringe in Oblique Incidence
11. White Light in YDSE
12. Slit Width effect in YDSE
13. Interference in Thin Films

Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

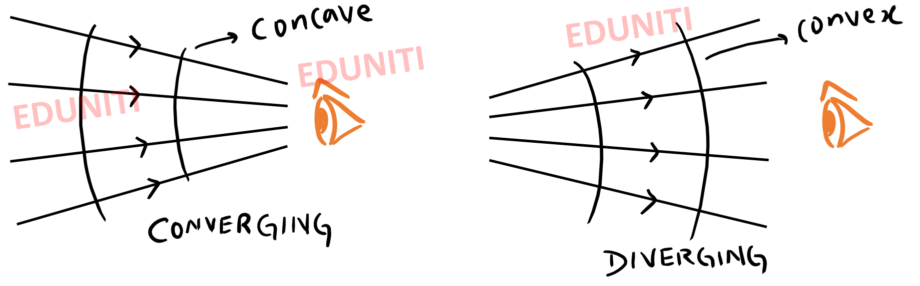
1. WAVEFRONT

When light propagates, the cross section where all particles oscillate in same phase is called wavefront.

Wave front is Normal to Propagation direction

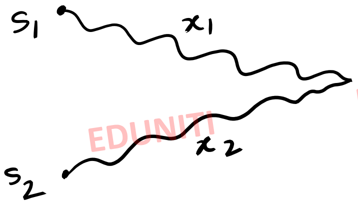


Ex:



2. A_{net} and I_{net} IN INTERFERENCE (Coherent source, same ω)

$y_1 = A_1 \sin(\omega t - kx)$



$y_2 = A_2 \sin(\omega t - kx)$

$y = y_1 + y_2 = A_1 \sin(\omega t - kx_1) + A_2 \sin(\omega t - kx_2)$

Phase difference, $\Delta\phi = k(x_2 - x_1) = k\Delta x$

$$\Rightarrow \boxed{\Delta\phi = \frac{2\pi}{\lambda}\Delta x}$$

$$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\Delta\phi}$$

If $A_1 = A_2 = A$

$$A_{net} = 2A\cos\frac{\Delta\phi}{2}$$

$(I = kA^2)$

$$I_{net} = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\Delta\phi$$

If $I_1 = I_2 = I_0$

$$I_{net} = 4I_0\cos^2\frac{\Delta\phi}{2}$$

3. $\Delta\phi$, Δx, A_{net}, I_{net}

$$A_{net} = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\Delta\phi}$$

$$I_{net} = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\Delta\phi$$

INTERFERENCE

CONSTRUCTIVE

(i) $\Delta\phi = 2n\pi$

(ii) $2n\pi = \frac{2\pi}{\lambda}\Delta x$

$\Delta x = n\lambda$

(iii) $A_{net} = A_1 + A_2$

If $A_1 = A_2 = A$

$A_{net} = 2A$

(iv) $I_{net} = (\sqrt{I_1} + \sqrt{I_2})^2$

If $I_1 = I_2 = I_0$

$I_{net} = 4I_0$ (MAXIMA)

DESTRUCTIVE

(i) $\Delta\phi = (2n+1)\pi$

(ii) $(2n+1)\pi = \frac{2\pi}{\lambda}\Delta x$

$\Delta x = (2n+1)\frac{\lambda}{2}$

(iii) $A_{net} = A_1 - A_2$

If $A_1 = A_2 = A$

$A_{net} = 0$

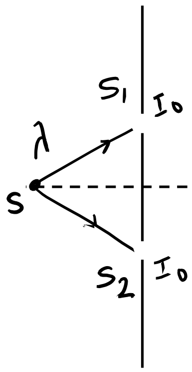
(iv) $I_{net} = (\sqrt{I_1} - \sqrt{I_2})^2$

If $I_1 = I_2 = I_0$

$I_{net} = 0$ (MINIMA)

4. YOUNG'S DOUBLE SLIT EXPERIMENT (YDSE)

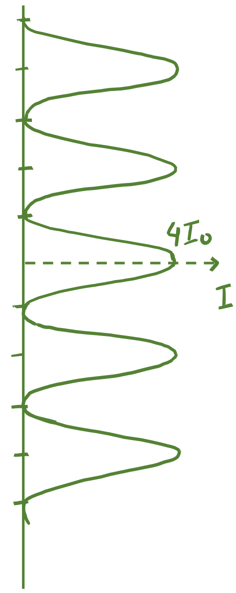
C. Central Bright fringe
B. Bright fringe
D. Dark fringe



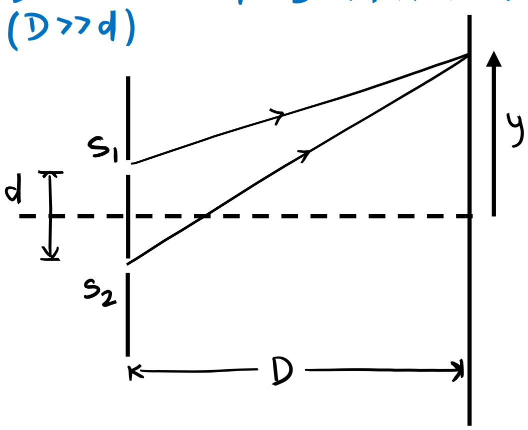
S_1 and S_2 are slits.

Screen	Δx	I_{net}
D	$5\lambda/2$	0
B	2λ	$4I_0$
D	$3\lambda/2$	0
B	λ	$4I_0$
D	$\lambda/2$	0
C	0	$4I_0$
D		
B		
D		
B		
D		

SCREEN



5. DISTANCE OF BRIGHT AND DARK FRINGES (D>>d)



Path difference at y, $\Delta x = \frac{yd}{D}$

BRIGHT FRINGE

$\Delta x = n\lambda$

$\Rightarrow \frac{y_n d}{D} = n\lambda$

$\Rightarrow y_n = \frac{n\lambda D}{d}$

DARK FRINGE

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

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

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

6. FRINGE WIDTH AND ANGULAR FRINGE WIDTH

↳ Distance between two successive bright or dark fringe.

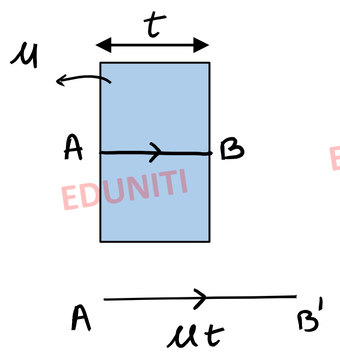
(a) $\beta = \frac{\lambda D}{d}$ (b) $\beta_\theta = \frac{\lambda}{d}$

7. β IF YDSE SETUP IS IN A MEDIUM OF REFRACTIVE INDEX μ

If in air, $\beta = \frac{\lambda D}{d}$

In medium, $\beta' = \frac{\lambda D}{\mu d} = \frac{\beta}{\mu}$

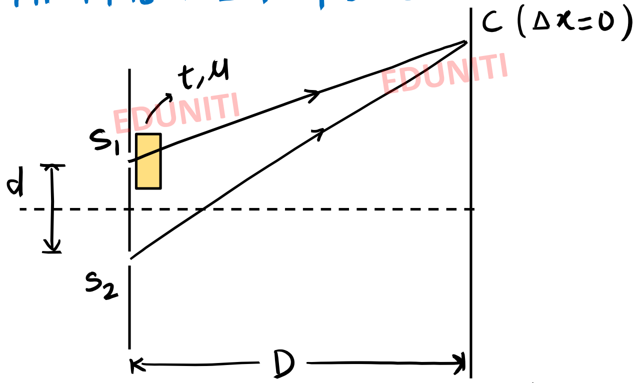
8. GEOMETRICAL AND OPTICAL PATH LENGTH



Geometrical Path = AB = t

Optical Path = AB' = μt

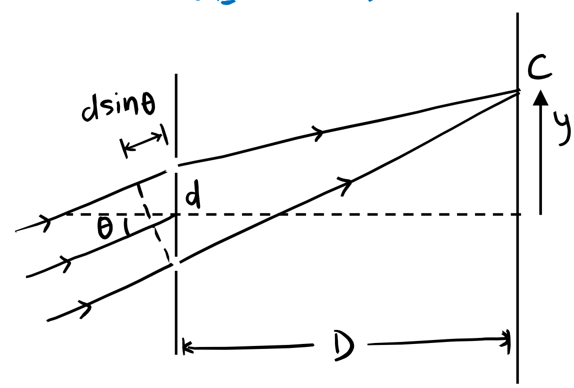
9. THIN FILM IN YDSE



$t(\mu-1) = \frac{yd}{D}$

$\Rightarrow y = \frac{tD(\mu-1)}{d}$ → shift in fringe Pattern

10. SHIFTING OF FRINGE IN OBLIQUE INCIDENCE

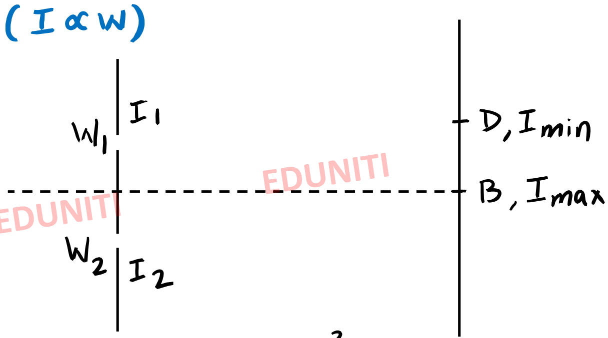


FRINGE SHIFTS UP

$d\sin\theta = \frac{yd}{D}$

$\Rightarrow y = D\sin\theta$

12. SLIT WIDTH EFFECT IN YDSE ($I \propto w$)



$I_{max} = (\sqrt{I_1}+\sqrt{I_2})^2$

$I_{min} = (\sqrt{I_1}-\sqrt{I_2})^2$

Here we don't see contrasting fringe pattern

11. WHITE LIGHT IN YDSE

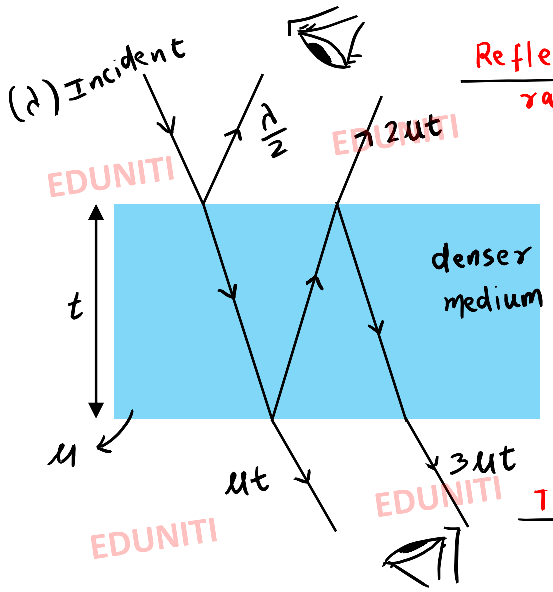
(1.) CENTRAL BRIGHT fringe is white colour

(2.) As you move a little away you see Reddish colour (violet destructive interference)

(3.) Move further away its bluish colour.

13. INTERFERENCE IN THIN FILMS (normal incidence)

NOTE: When reflection is from denser medium $\frac{\lambda}{2}$ path difference is added



Reflected rays
- CONSTRUCTIVE: $2\mu t - \frac{\lambda}{2} = n\lambda$
- DESTRUCTIVE: $2\mu t - \frac{\lambda}{2} = (2n+1)\frac{\lambda}{2}$

Transmitted rays
- Constructive: $2\mu t = n\lambda$
- Destructive: $2\mu t = (2n+1)\frac{\lambda}{2}$

<u>Space to add concepts learnt from PYQs if any</u>

Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in DIFFRACTION & POLARIZATION– PART 2 (Wave Optics/EM Waves)

1. Diffraction
2. Intensity variation in Diffraction from Single Slit
3. Fringe Pattern, Angular Position of Minima
4. Diffraction by Circular Aperture
5. Polarization of Light
6. Malus Law
7. Methods of Polarization of Light by
   a) Reflection of Light (Brewster's Law)
   b) Double Refraction
   c) Scattering
   d) Dichroism
8. Nicol Prism
9. Doppler's Effect in Light

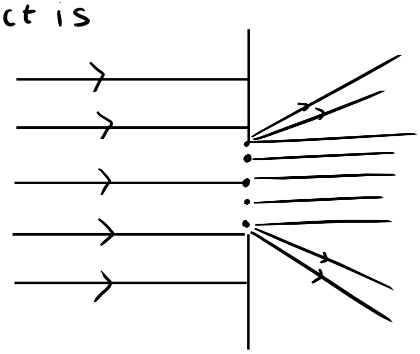
Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

1 DIFFRACTION

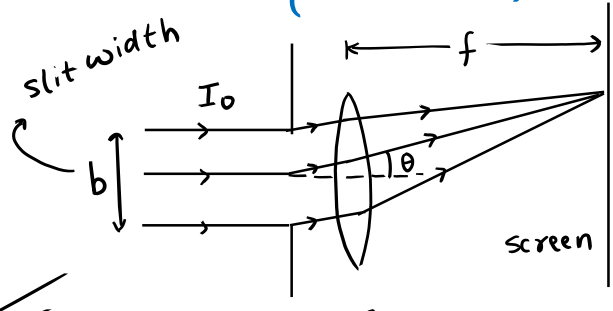
It is bending of light around corners/edges.

If slit size is very large, Diffraction effect is negligible

But if small, effect is significant



2. INTENSITY IN DIFFRACTION (SINGLE SLIT)



$I(\theta) = I_0 \frac{\sin^2\beta}{\beta^2}$, $\beta = \frac{\pi b \sin\theta}{\lambda}$

↳ MINIMA at $\beta = n\pi$

∴ $n\pi = \frac{\pi b \sin\theta}{\lambda}$

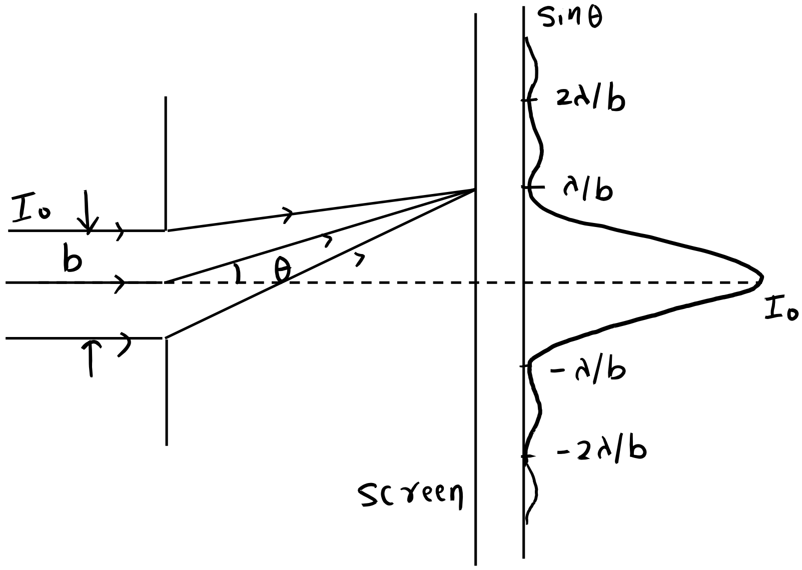
$\boxed{\sin\theta = \frac{n\lambda}{b}}$ and $\boxed{\theta = \frac{n\lambda}{b}}$ if θ is small.

3. FRINGE PATTERN

(a) for $\theta = 0°$, $I = I_0$

(b) n^{th} MINIMA, $\sin\theta = \frac{n\lambda}{b}$ $n \neq 0$

(c) unlike YDSE, here both fringe width and Intensity decreases as you move away from central Maxima.



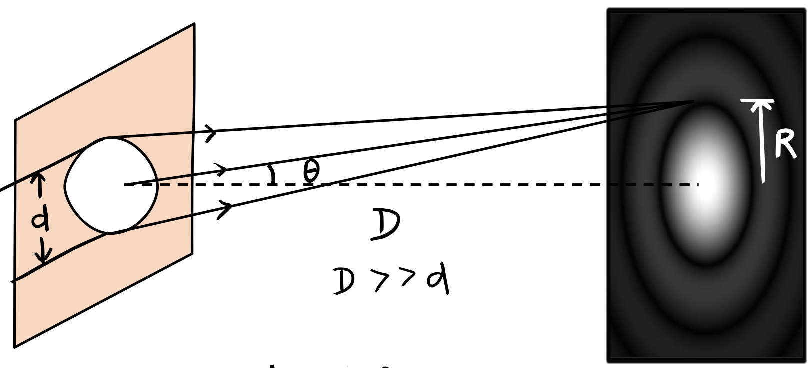
$$I(\theta) = I_0 \frac{\sin^2\beta}{\beta^2}, \quad \beta = \frac{\pi b \sin\theta}{\lambda}$$

4. DIFFRACTION BY CIRCULAR APERTURE

First MINIMA on screen,

$$\theta = 1.22\frac{\lambda}{d}$$

(a) RADIUS of 1st Dark fringe or radius of central bright fringe, $R = \theta D = \frac{1.22\lambda D}{d}$



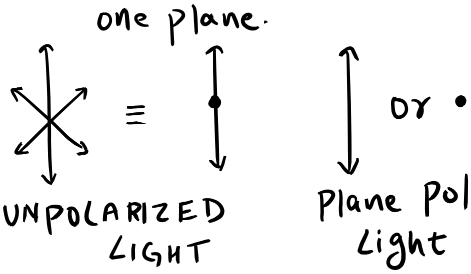
Circular fringes

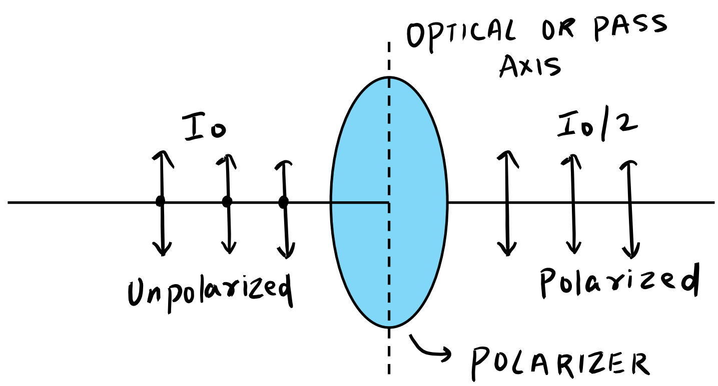
(b) If light is converged using convex lens at the screen placed at focal plane of Lens,

$$R = \theta f = \frac{1.22\lambda f}{d}$$

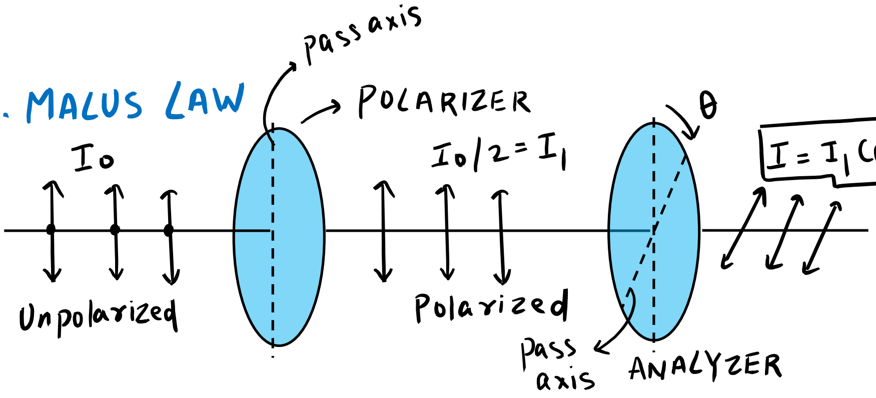
5. POLARIZATION OF LIGHT

↳ Electric Field oscillating in one plane.



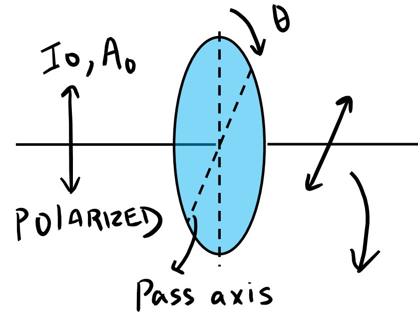


6. MALUS LAW



$$I = I_1 \cos^2\theta$$

#Generalized

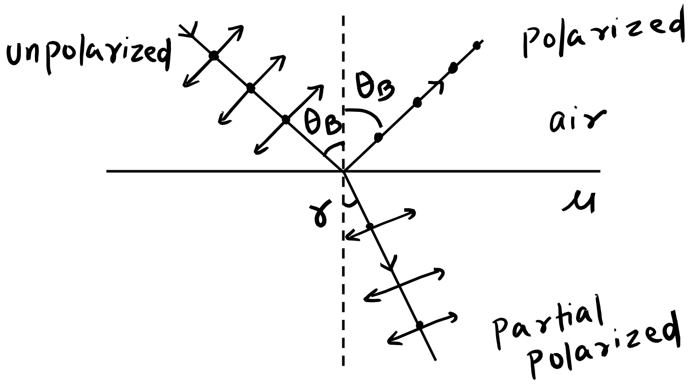


$A = A_0 \cos\theta$

$I = I_0 \cos^2\theta$

7. METHODS OF POLARIZATION OF LIGHT

(a) REFLECTION (BREWSTER'S LAW)



BREWSTER'S ANGLE (θ_B)

θ_B for which angle between reflected and refracted ray is 90°

$\therefore r = 90 - \theta_B$

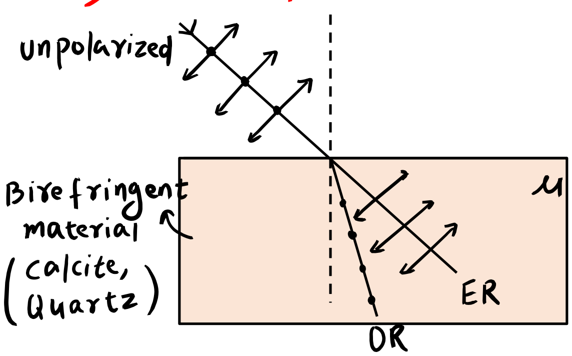
SNELL'S LAW :

$\sin\theta_B = \mu \sin(90 - \theta_B)$

$$\Rightarrow \theta_B = \tan^{-1}\mu$$

Brewster's Law

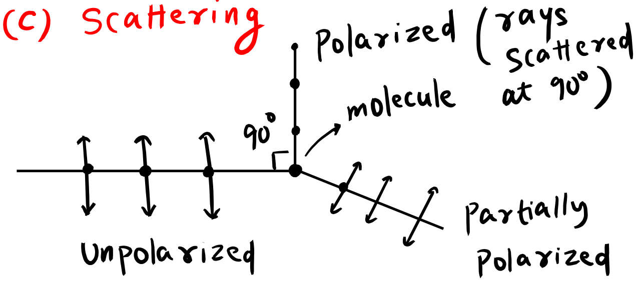
(b) Double Refraction



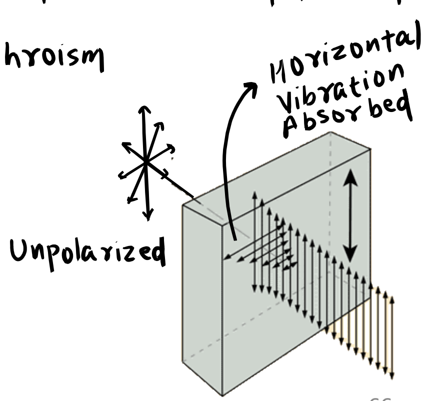
OR : Ordinary ray (Polarized normal to plane)

ER : ExtraOrdinary ray (Polarized in plane)

(c) Scattering

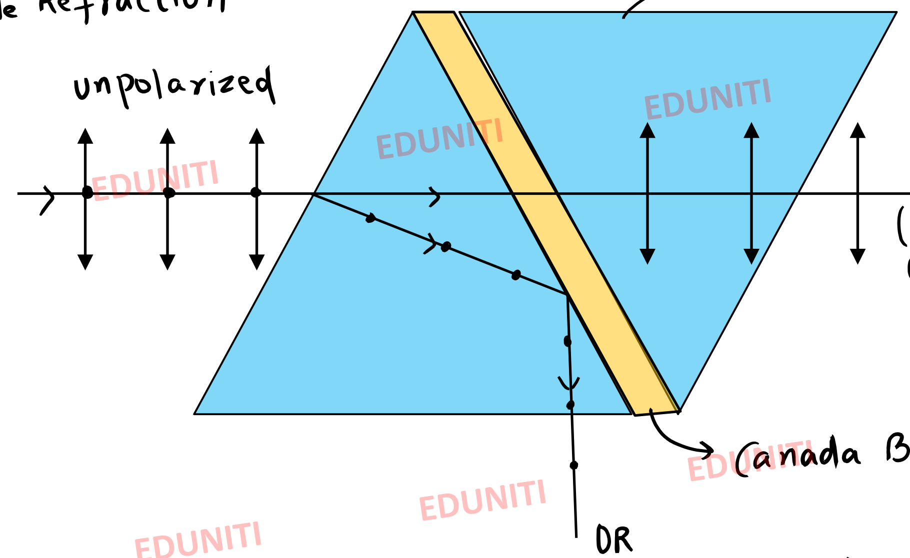


(d) Dichroism



8. NICOL PRISM

↳ uses Double Refraction



9. Doppler's Effect in light

(1) $\dfrac{\Delta f}{f} = -\dfrac{V_{radial}}{c}$

$\Delta f = f_{app} - f$ (f is freq of source, f_{app} is observed freq)

V_{radial} (radial vel of source relative to observer)

NOTE. Valid if source speed is $<< c$

(2) $f\lambda = c \Rightarrow \dfrac{\Delta f}{f} = -\dfrac{\Delta\lambda}{\lambda}$ (for small changes in f & λ)

$\Rightarrow \dfrac{\Delta\lambda}{\lambda} = \dfrac{V_{radial}}{c}$ { use to find radial Velocity of distant Galaxy

Space to add concepts learnt from PYQs if any

Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in EM Waves – PART 3 (Wave Optics/EM Waves)

1. Types of EM Waves
2. Displacement Current
3. Ampere – Maxwell Law
   a. NCERT Solved Ex.
4. Maxwell's Equation
5. EM Waves equation and Key Points
   a) Relation among c, E and B
   b) Intensity of EM Waves
   c) Speed of EM Waves

Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

1. TYPES OF EM WAVES

↳ Transverse waves

↳ Electric and magnetic field Energy density is same.

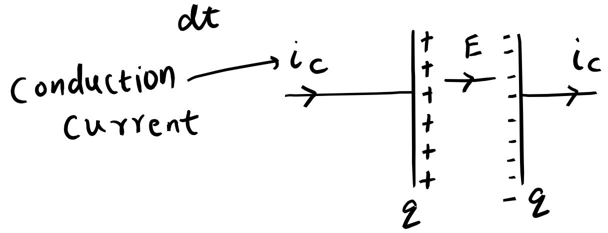
$u_B = \frac{B^2}{2\mu_0}$, $u_E = \frac{1}{2}\varepsilon_0 E^2$

Type	Wavelength Range	Production	Detection
Radio	>0.1 m	Rapid acceleration and deceleration of electrons in aerials	Receiver's aerials
Microwave	0.1 m to 1 mm	Klystron valve or magnetron valve	Point contact diodes
Infra-red	1 mm to 700 nm	Vibration of atoms and molecules	Thermopiles, Bolometer, Infrared photographic film
Light	700 nm to 400 nm	Electrons in atom emit light when they move from one energy level to a lower energy level	The eye, photocells, photographic film
Ultraviolet	400 nm to 1 nm	Inner shell electrons in atoms moving from one energy level to lower level	Photocells, Photographic film
X-rays	1 nm to 0.001 nm	X-ray tubes or inner shell electrons	Photographic film, Geiger tubes
Gamma rays	< 0.001 nm	Radioactive decay of the nucleus	Photographic film, Geiger tubes

2. DISPLACEMENT CURRENT (i_d)

i_d is due to time varying electric field.

$$i_d = \varepsilon_0 \frac{d\phi_E}{dt}, \quad \phi_E \text{ is electric flux}$$



(a) If q changes, E changes

$\Rightarrow i_d = \varepsilon_0 A \times \frac{1}{A\varepsilon_0}\frac{dq}{dt} = \frac{dq}{dt}$

∴ In capacitor for time varying current conduction current is same as i_d.

(b) Between plates $i_d \neq 0$, $i_c = 0$

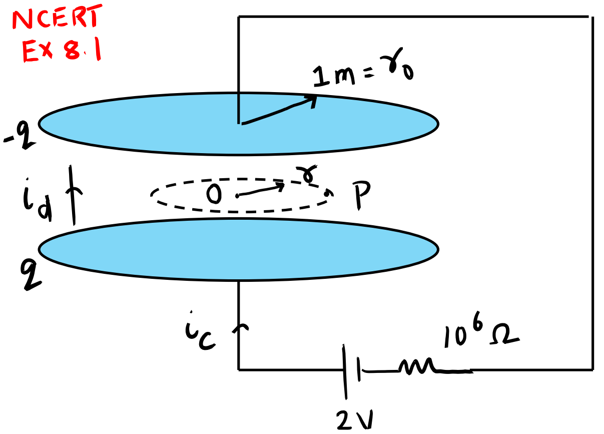
Outside plates $i_c \neq 0$, $i_d = 0$

(c) i_d is uniform across plate cross-section

3. AMPERE'S LAW

$$\oint \bar{B}\cdot d\bar{l} = \mu_0 i_{enclosed} \longrightarrow i_c + \varepsilon_0 \frac{d\phi_E}{dt}$$

NCERT EX 8.1



$C = 10^{-9}$ F, at t=0 charging starts. Find B at P (OP = 0.5m) at $t = 10^{-3}$ s

Sol^{n}: Consider Ampere loop of $\frac{1}{2}$m radius (r), parallel to plates.

$$\oint \bar{B}\cdot d\bar{l} = \mu_0(i_c + i_d) \,,\quad i_c = 0$$

$$\Rightarrow B \times 2\pi r = \mu_0 \varepsilon_0 \frac{d\phi_E}{dt} \,,\quad \phi_E = E\pi r^2$$

$$\Rightarrow \phi_E = \frac{\sigma}{\varepsilon_0}\pi r^2 = \frac{q}{\pi r_0^2 \varepsilon_0}\pi r^2$$

$$\boxed{\phi_E = q/4\varepsilon_0}$$

$$\Rightarrow B \times 2\pi r = \mu_0 \varepsilon_0 \times \frac{1}{4\varepsilon_0}\frac{dq}{dt}$$

$$\Rightarrow B \times \pi = \frac{\mu_0}{4}\frac{dq}{dt} \,,\quad 'q = q_0(1 - e^{-t/RC})'$$

$$\Rightarrow B\pi = \frac{\mu_0}{4} \times \frac{CV}{RC} e^{-t/RC}$$

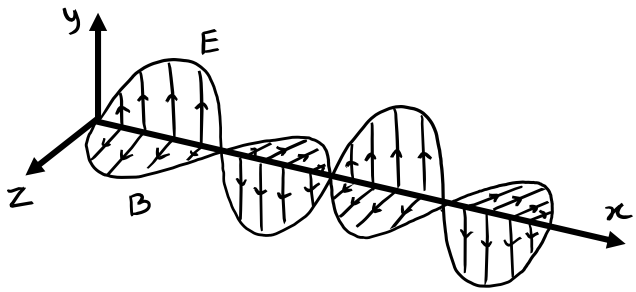
$$\Rightarrow B = 10^{-7} \times \frac{2}{10^6} e^{-1} = \boxed{7.35 \times 10^{-14}\,T}$$

4. MAXWELL'S EQUATIONS

1. Gauss's Law in Electrostatics, $\phi_E = \oint \bar{E}\cdot d\bar{A} = q_{in}/\varepsilon_0$
2. Gauss's Law for Magnetism, $\phi_B = \oint \bar{B}\cdot d\bar{A} = 0$ { due to closed loop lines of field. This explains why monopole can't exist
3. Faraday's Law, $\oint \bar{E}\, d\bar{l} = -\frac{d\phi_B}{dt}$
4. Ampere-Maxwell Law, $\oint \bar{B}\cdot d\bar{l} = \mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$

5. EM WAVES EQUATION AND KEY POINTS

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



KEY POINTS

(a) RELATION AMONG $\hat{C}, \hat{E}, \hat{B}$ (unit vectors along direction of propagation, Electric field and magnetic field)

$\hat{C} = \hat{E} \times \hat{B}$, $\hat{B} = \hat{C} \times \hat{E}$, $\hat{E} = \hat{B} \times \hat{C}$

(b) FROM WAVE EQUATION

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

- E along $\hat{j}$, $E_{rms} = E_0/\sqrt{2}$
- Wave propagation along $+$ve x-axis

(c) RELATION BETWEEN E_0 and B_0

$$E_0 = c B_0$$

(d) SPEED OF EM WAVES

$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}} \text{ in free space}$$

$$C_{medium} = \frac{1}{\sqrt{\mu_r \mu_0 \epsilon_r \epsilon_0}} = \frac{c}{\sqrt{\mu_r \epsilon_r}}$$

(e) INTENSITY

$$I = \frac{1}{2}\epsilon_0 c E_0^2 = \epsilon_0 c E_{rms}^2$$

NOTE: In above intensity due to Electric field $= \frac{I}{2} = \frac{1}{2}\epsilon_0 c E_{rms}^2$

Space to add concepts learnt from PYQs if any

Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in ZENER DIODE – PART 1 (SEMICONDUCTORS)

1. Fundamentals of PN Diode
2. Forward and Reverse Biased
3. Zener Diode

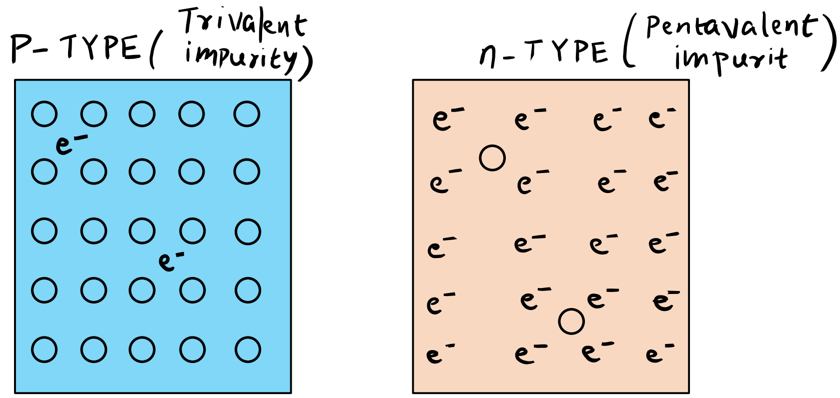
Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

1. FUNDAMENTALS

○ → holes

e^- → conduction electron

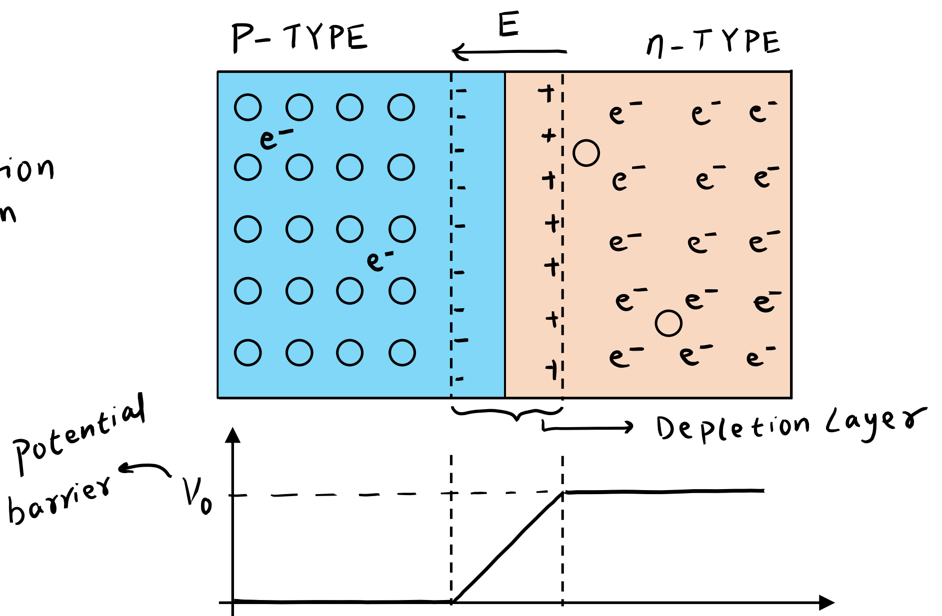
Extrinsic semiconductor →



	P-TYPE	n-TYPE
Majority charge carriers	holes	electrons
Minority charge carriers	electrons	holes

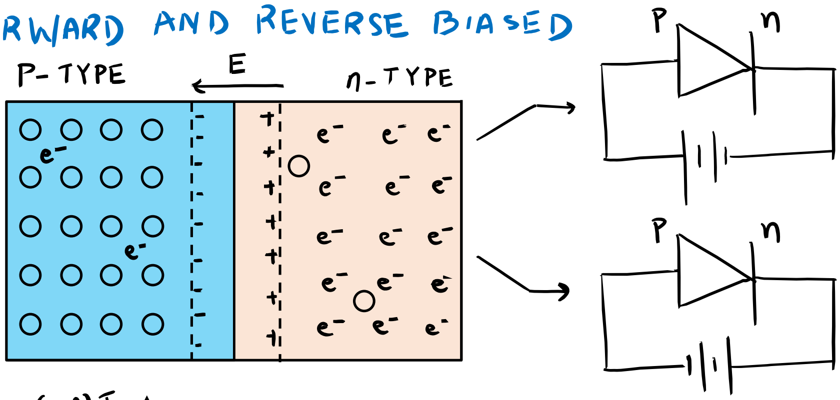
○ → holes

e^- → conduction electron



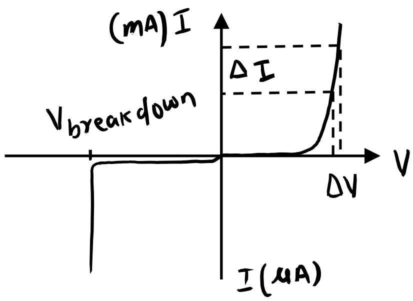
* For Si, V_0 is 0.7V

2. FORWARD AND REVERSE BIASED



Forward biased
↳ Current due to majority charge carriers.

Reverse biase
↳ very small current due to minority charge carriers

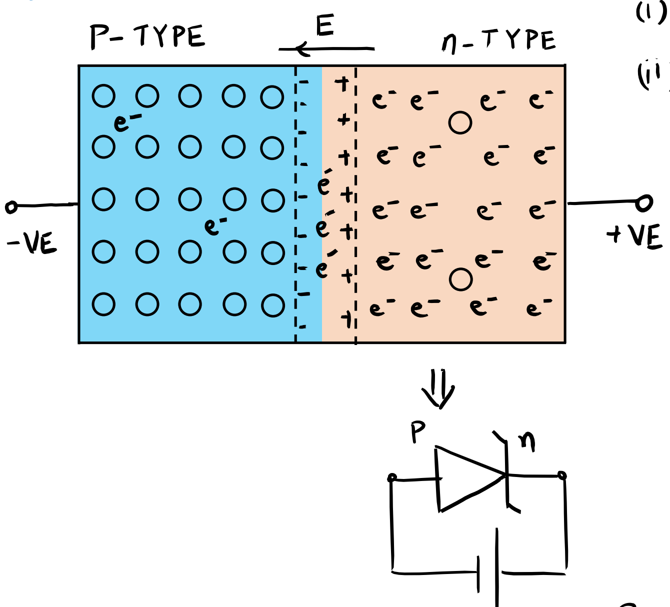


① For ideal diode Resistance is zero (FB) and infinite (RB).

② Dynamic Resistance,

$$R = \frac{\Delta V}{\Delta I}$$

3. ZENER DIODE



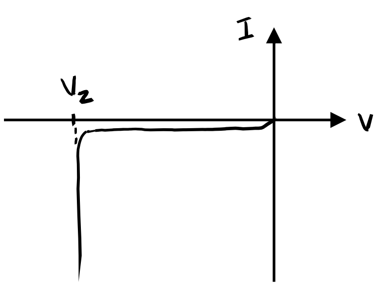
(i) It is heavily doped

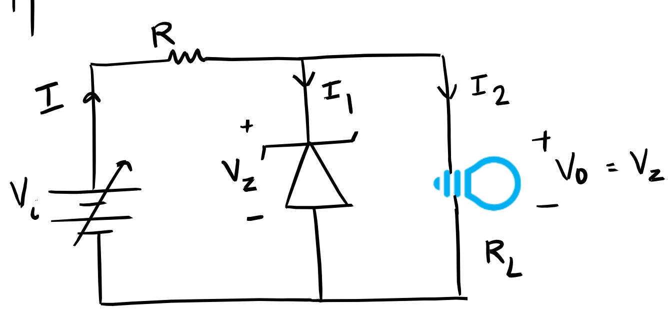
(ii) Depletion region very thin
⇒ E is very large.

(iii) In RB state, E strength ↑ and e⁻ covalent bonds in depletion region breaks

(iv) This e⁻ moves to n side and reverse current flows from n to p.

Zener Breakdown





① ↳ As p.d. across crosses V_z (breakdown voltage), almost all current passes through diode.

② ↳ And constant V_z is across it

③ $I_2 = \frac{V_z}{R_L}$

④ $I = I_1 + I_2$

Space to add concepts learnt from PYQs if any

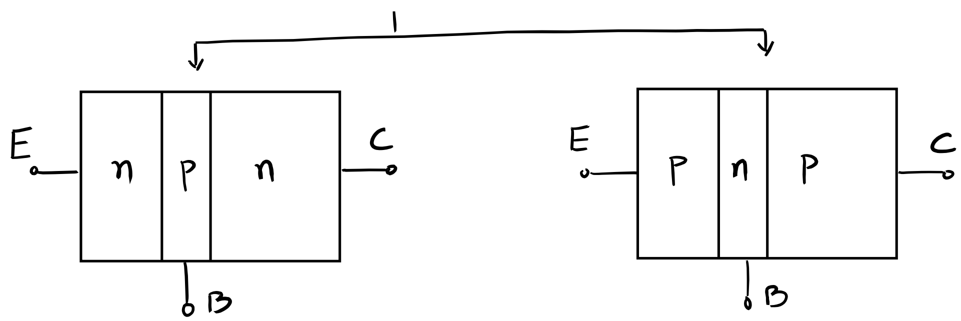
Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in TRANSISTORS – PART 2 (SEMICONDUCTORS)

1. Transistors Types
2. Symbol
3. Working of Transistors
4. DC Current Gain
5. Characteristic Curves
6. Transistor as Amplifier
7. CE Amplifier
8. Gain in CE Amplifiers

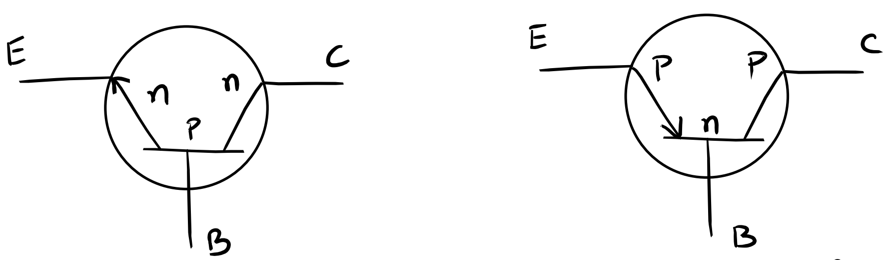
Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

1. TRANSISTORS (3 terminal – 2 Junction Device)



	SIZE	DOPING
E, Emitter	Moderate	Highly Doped
B, BASE	Very thin	Lightly Doped
C, Collector	Large	Moderately Doped

2. CIRCUIT SYMBOL

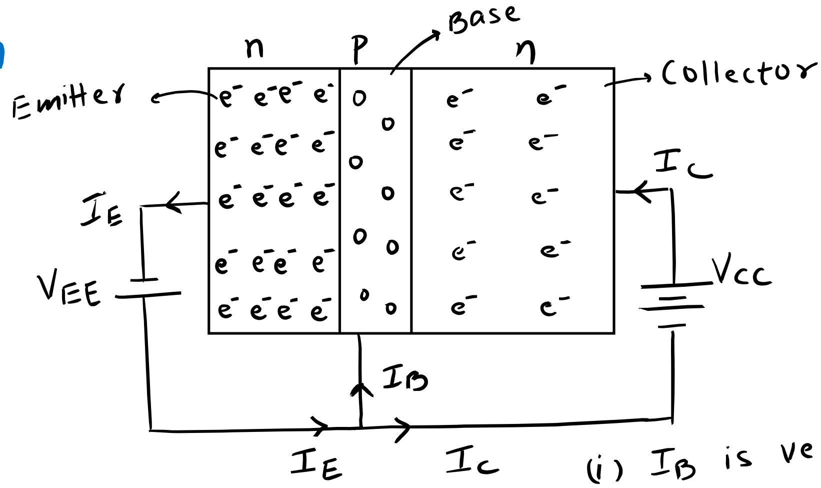


Arrow from p → n

3. WORKING

BE : forward biased

BC : Reverse biased



(i) I_B is very small (μA)

(ii) $I_E = I_C + I_B$

I_C is almost 0.95 to 0.98 I_E

4. DC CURRENT GAINS

↳ Base current Amplification factor, $\beta = \frac{I_C}{I_B}$

↳ Emitter current Amplification factor, $\alpha = I_C / I_E$

↳ $I_E = I_C + I_B \Rightarrow \frac{I_C}{\alpha} = I_C + \frac{I_C}{\beta}$

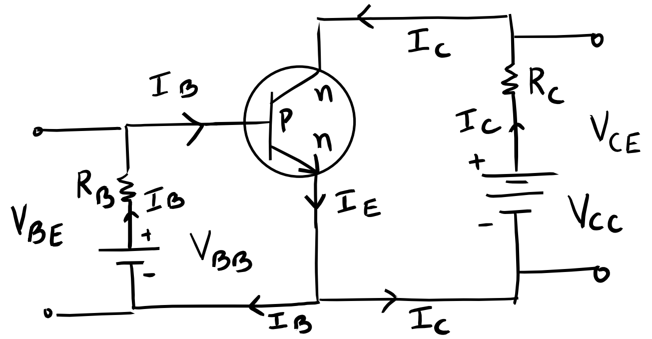
$$\Rightarrow \boxed{\alpha = \frac{\beta}{1+\beta}}$$

NOTE: $\because I_B << I_C$

$\Rightarrow \beta$ is large

and α is a little smaller than 1.

5. CHARACTERISTIC CURVE



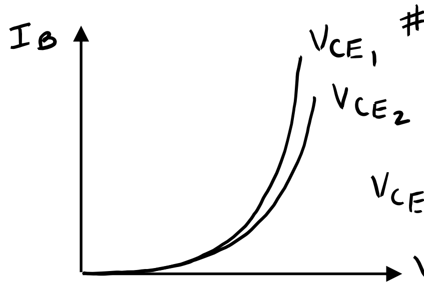
(1) $V_{CE} = V_{CC} - I_C R_C$

(2) $V_{BE} = V_{BB} - I_B R_B$

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

At saturation $V_{CE} = 0$

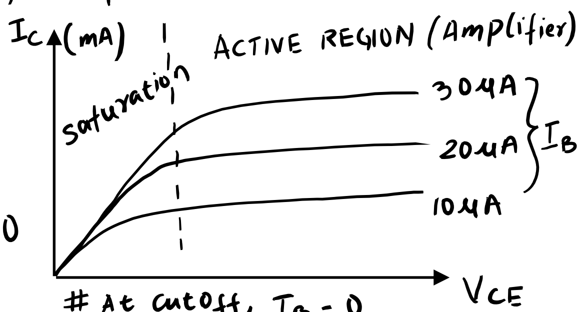
(a) Input characteristic



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

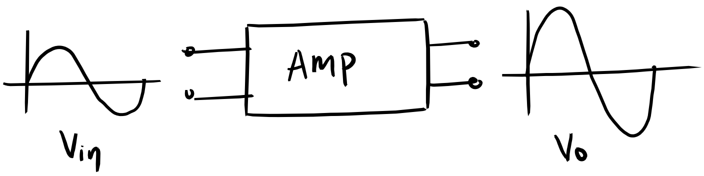
$V_{CE_2} > V_{CE_1}$

(b) output characteristic



At cutoff, $I_B = 0$

6. TRANSISTOR AS AMPLIFIER

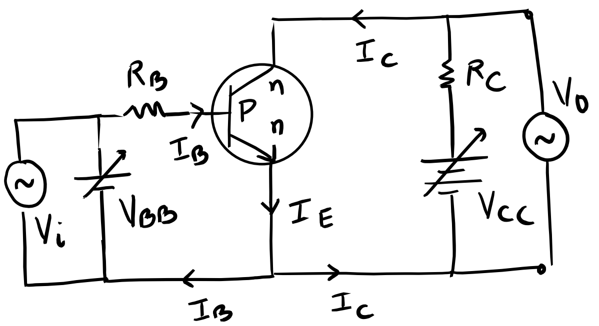


- Common Base Amplifier
- Common Emitter Amplifier
- Common Collector Amplifier

7. COMMON EMITTER AMPLIFIER

V_o → 180° phase out.

8. GAIN IN CE Amplifier



A small variation in input current causes large variation in output current.

(i) AC Current gain, $\beta_{AC} = \frac{\Delta I_C}{\Delta I_B}$

(ii) AC voltage gain, $A_V = \frac{\Delta V_o}{\Delta V_i} = \frac{\Delta I_C R_o}{\Delta I_B R_i}$

$\Rightarrow A_V = \beta_{AC} \frac{R_o}{R_i}$

(iii) AC Power gain, $A_p = A_V \times \beta_{AC}$

$= \beta_{AC}^2 \frac{R_o}{R_i}$

Space to add concepts learnt from PYQs if any

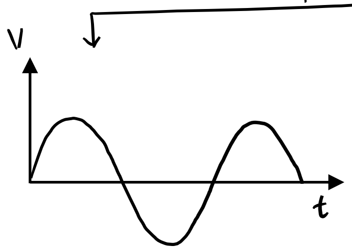
Note: To best use these 1st watch the video from "Revision Series Playlist" on Eduniti YouTube Channel (PYQs are also there for practice)

Topics to cover in LOGIC GATES – PART 3 (SEMICONDUCTORS)

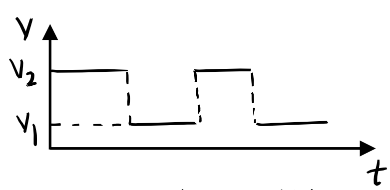
1. Analog and Digital Signal
2. Logic Gates (Types)
3. NOT Gate
4. AND Gate
5. OR Gate
6. Rules of Boolean Algebra & De Morgan's Theorem
7. NAND Gate
8. NOR Gate
9. Exclusive Gates (XOR & XNOR)

Note: For video refer Revision Series Playlist on EDUNITI YouTube Channel

1. ANALOG & DIGITAL SIGNAL



ANALOG SIGNAL



DIGITAL SIGNAL

↳ It has two states

(1.) High → 1

(2.) Low → 0

Logic gates are integral part of Digital Electronics

2. LOGIC GATES

↳ Electrical cicuits using logical relation between input and output voltages

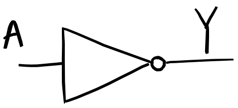
- → NOT Gate
- → AND Gate
- → OR Gate

} BASIC GATES

- → NAND Gate
- → NOR Gate

} UNIVERSAL GATES

3. NOT GATE (Inversion Gate)



$Y = \bar{A}$

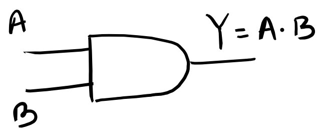
TRUTH TABLE

A	$Y = \bar{A}$
1	0
0	1

Truth Table : Relation between Input and Output.

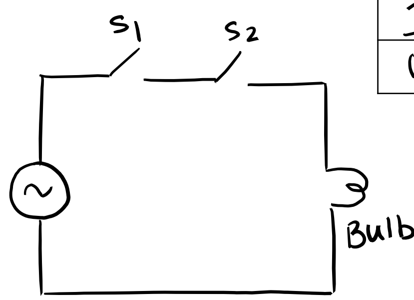
4. AND GATE

↳ output high (1), if both input is high (1)
↳ output low (0), if either input is low (0)



TRUTH TABLE

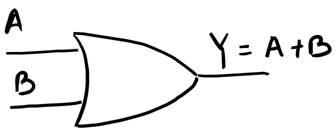
A	B	$Y = A \cdot B$
1	0	0
0	1	0
1	1	1
0	0	0



⇒ switch close : 1
switch open : 0
Bulb Glow = 1
else = 0

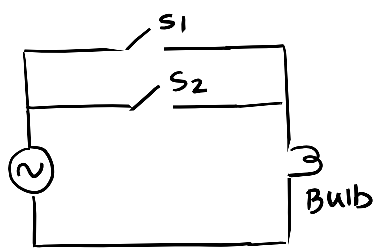
5. OR GATE

↳ output high (1), if either input is high (1)
↳ output low (0), if both input low (0)



TRUTH TABLE

A	B	$Y = A + B$
1	0	1
0	1	1
1	1	1
0	0	0



6 RULES OF BOOLEAN ALGEBRA & DE MORGAN'S THEOREM

(a) $A + 0 = A$

(b) $A + A = A$

(c) $A \cdot A = A$

(d) $A \cdot \bar{A} = 0$

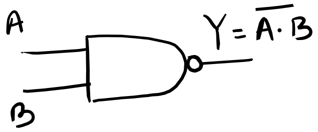
(e) $\bar{\bar{A}} = A$

DE MORGAN'S THEOREM

$\overline{A \cdot B} = \bar{A} + \bar{B}$ $\quad$ $\overline{A + B} = \bar{A} \cdot \bar{B}$

↳ Boolean Expressions

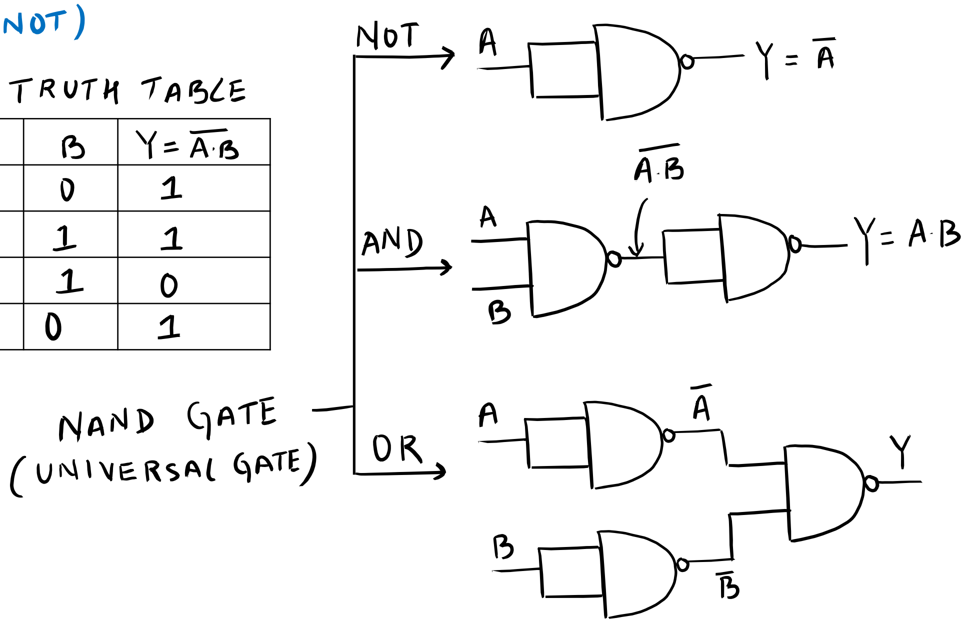
7. NAND GATE (AND + NOT)



\# Inverts the AND Gate output

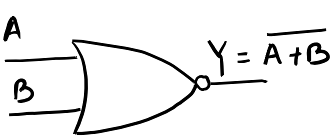
TRUTH TABLE

A	B	$Y = \overline{A \cdot B}$
1	0	1
0	1	1
1	1	0
0	0	1



\# $Y = \overline{\overline{A} \cdot \overline{B}} = \overline{\overline{A}} + \overline{\overline{B}} = \boxed{A + B}$

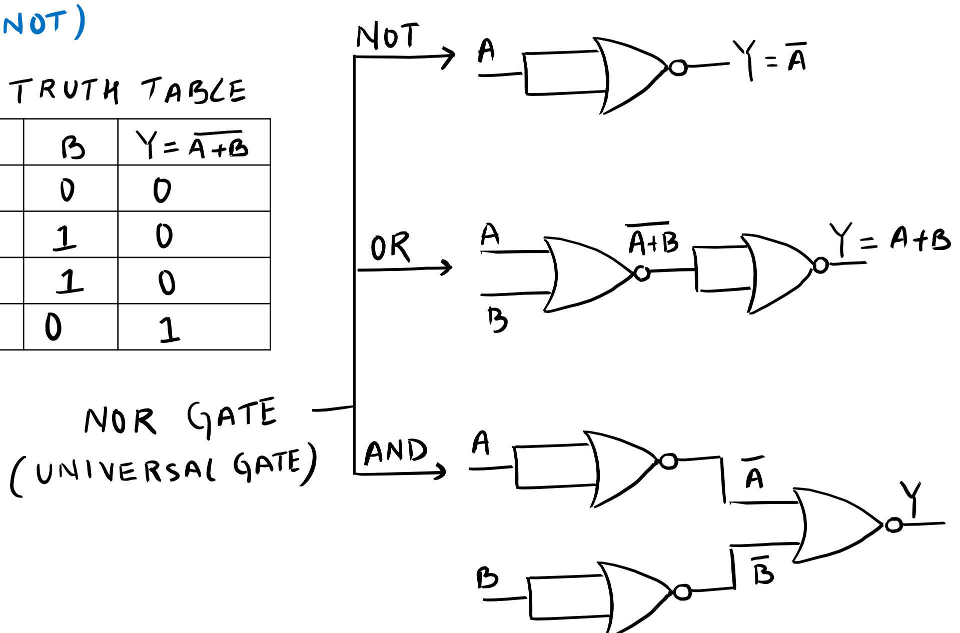
8. NOR GATE (OR + NOT)



\# Inverts the AND Gate output

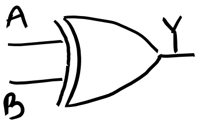
TRUTH TABLE

A	B	$Y = \overline{A + B}$
1	0	0
0	1	0
1	1	0
0	0	1



\# $Y = \overline{\overline{A} + \overline{B}} = \overline{\overline{A}} \cdot \overline{\overline{B}} = \boxed{A \cdot B}$

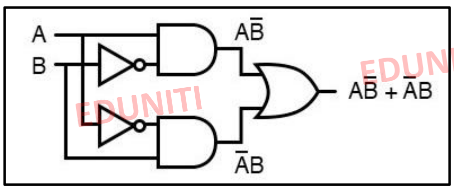
9 Exclusive Gates



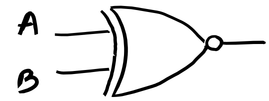
$Y = \bar{A} \cdot B + A \cdot \bar{B}$

XOR (Exclusive OR Gate)

A	B	Y
1	0	1
0	1	1
1	1	0
0	0	0



XNOR (Exclusive NOR Gate)



$Y = \bar{A}\,\bar{B} + AB$

A	B	Y
1	0	0
0	1	0
1	1	1
0	0	1

Space to add concepts learnt from PYQs if any

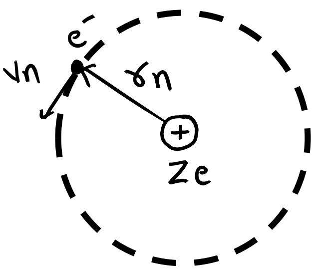
Topics to cover in Atomic Physics (PART 1 – Modern Physics)

1. Bohr's 3 Postulates
2. Radius, Speed, Angular Freq, Time Period & Energy in nth Orbit
3. Energy Level of Hydrogen type atom (1e system)
4. Excitation of atom
5. Wavelength of emitted radiation
6. Number of spectral lines
7. Hydrogen Spectral Series

Note: For video refer Revision Series Playlist in EDUNITI YouTube Channel

1. BOHR'S POSTULATES (for single e^- system)

1st



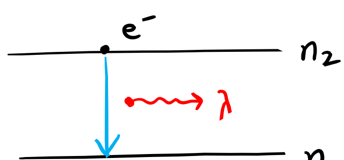
$$\frac{Kze^2}{r_n^2} = \frac{mv_n^2}{r_n}$$

2nd — Bohr's Quantization

$$mv_n r_n = \frac{nh}{2\pi}$$

$(n \in I)$

3rd — Release of energy



$$\frac{hc}{\lambda} = E_{n_2} - E_{n_1}$$

2. BOHR'S MODEL ($1e^-$ system)

→ Radius of n^{th} orbit, $r_n = \dfrac{n^2h^2}{4\pi^2 kze^2 m} = 0.529 \times \dfrac{n^2}{z}$ Å ($r_n \propto \dfrac{1}{m_e}$)

→ Velocity in n^{th} orbit, $V_n = \dfrac{2\pi kze^2}{nh} = 2.18 \times 10^6 \times \dfrac{z}{n}$ m/s

→ $\omega_n = \dfrac{V_n}{r_n}$ $\omega_n \propto \dfrac{z^2}{n^3}$ rad/s

→ $T_n = \dfrac{2\pi}{\omega_n}$ $T_n \propto \dfrac{n^3}{z^2}$ s

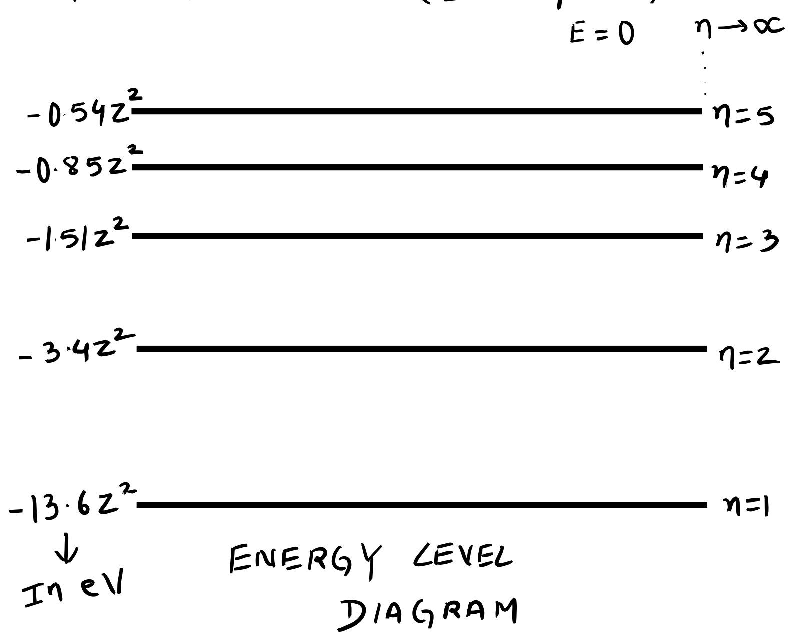
} Focus more on relations

→ $E_n = K_n + U_n = -\dfrac{KZe^2}{2r_n} = -13.6 \times \dfrac{z^2}{n^2}$ eV

3. ENERGY LEVEL OF HYDROGEN TYPE ATOM ($1e^-$ system)

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

NOTE: Learn them for speed solving.



ENERGY LEVEL DIAGRAM

4 EXCITATION OF ATOM

↳ For e^- to absorb energy and excite from n_1 to n_2, the energy absorbed must be exactly equal to $E_{n_2} - E_{n_1}$

Ex:

n=3 ———— -1.51eV

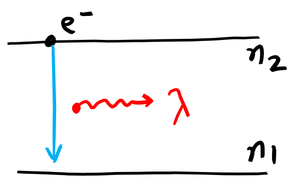
n=1 ———— -13.6eV

$\because E_3 - E_1 = 12.09\text{eV}$

* Thus 12.09 eV of energy must be absorbed.

5. λ OF EMITTED RADIATION

$$\frac{hc}{\lambda} = E_{n_2} - E_{n_1}$$



$$\Rightarrow \frac{1}{\lambda} = Rz^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right), \quad R \sim 10^7 \text{ m}^{-1}$$

↳ Rydberg's Constant

IMPORTANT.

(a) $\lambda = \frac{12430}{\Delta E \text{ (in eV)}} \text{ Å}$ or $= \frac{1243}{\Delta E \text{ (in eV)}} \text{ nm}$

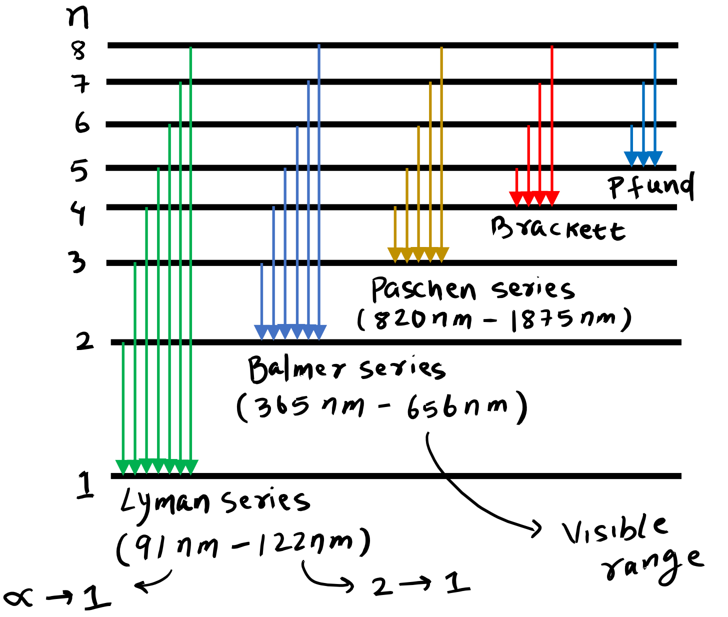
(b) $\Delta E = \frac{12430}{\lambda (\text{Å})} \text{ eV}$

6. NUMBER OF SPECTRAL LINES

↳ possible number of photon energies emitted due to de excitation of e^- from $n = n_2$ to $n = 1$ state

$$= {}^{n}C_2 = \frac{n(n-1)}{2}$$

7. HYDROGEN SPECTRAL SERIES



Space to add concepts learnt from PYQs if any

Topics to cover in Photoelectric Effect (PART 2 – Modern Physics)

1. Electron Emission (Work Function & Types of Emission)
2. Photoelectric Emission
3. Effect of Intensity and Temperature on Photoelectric Effect
4. Stopping Potential & Graphs

Note: For video refer Revision Series Playlist in EDUNITI YouTube Channel

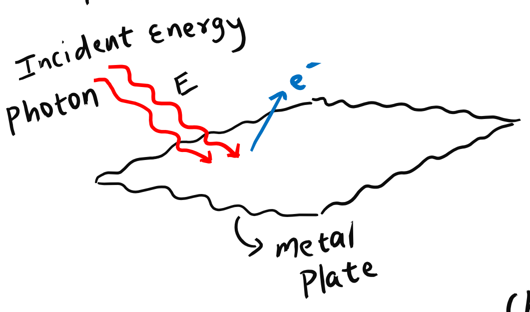
1. ELECTRON EMISSION

↳ Work function, ϕ (Minimum Energy required to eject e^- from metal surface)

TYPES —

Type	ENERGY SOURCE
→ Photoelectric Emission	Electromagnetic radiation
→ Thermionic Emission	Heat
→ Field Emission	External Electric Field
→ Secondary Emission	Collision (bombarding α-particle)

2. PHOTOELECTRIC EMISSION



(a) Threshold frequency (ν_{th}), Threshold wavelength (λ_{th})

$$\phi = h\nu_{th} = \frac{hc}{\lambda_{th}}$$

ν_{th}: minimum freq. to start photoelectric effect.

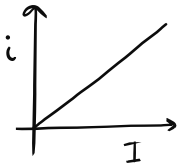
(b) If $\nu > \nu_{th}$ ($E > \phi$)

e^- comes out with V_{max}, $\frac{1}{2}mV_{max}^2 = E - \phi$

$\Rightarrow K_{max} = h\nu - h\nu_{th}$

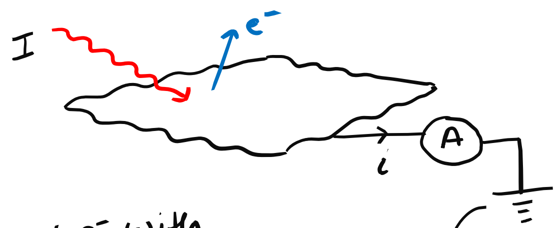
NOTE: e^- may come out with $V < V_{max}$ if it collides with other e^-.

3. EFFECT OF INTENSITY (I) and TEMP° (T) ON PHOTOELECTRIC EFFECT



(a) If I↑ ⇒ i also ↑

(b) If Temp° ↑ ⇒ No effect



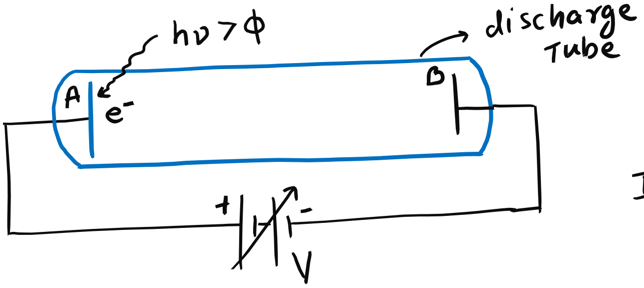
Grounded to keep plate neutral.

NOTE: ↑I doesn't ↑KE of e⁻ with which it comes out.

$$[K = h\nu - \phi]$$

K depends on ν of incident energy.

4. STOPPING POTENTIAL



(a) e⁻ with V_{max} moves to B

(b) Battery does –ve work

(c) so energy at B = $K_{max} - eV$

If for a $V = V_0$, $K_{max} - eV_0 = 0$

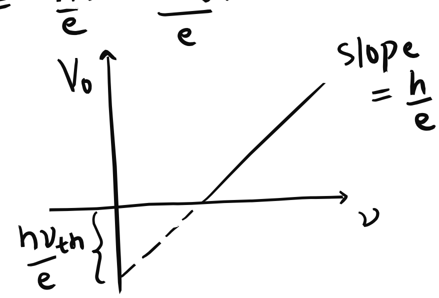
⇒ V_0 is stopping potential

∴ $\boxed{eV_0 = K_{max}}$

(d) $V_0 = \frac{K_{max}}{e} = \frac{E - \phi}{e} = \frac{h\nu}{e} - \frac{h\nu_{th}}{e}$

$$\boxed{V_0 = \frac{h\nu}{e} - \frac{h\nu_{th}}{e}}$$

Einstein Photoelectric Equation



Space to add concepts learnt from PYQs if any

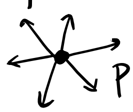
Topics to cover in Dual Nature of Light (PART 3 – Modern Physics)

1. Photon Flux & Photon Density
2. Wave Particle Duality
3. De Broglie's Hypothesis
4. Radiation Force and Radiation Pressure (Projected Area Concept)
5. Atom Recoil During De-Excitation

Note: For video refer Revision Series Playlist in EDUNITI YouTube Channel

1. PHOTON FLUX / PHOTON DENSITY

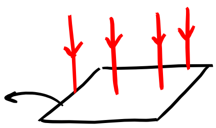
→ Number of photons emitted / sec, $N = \frac{P}{hc/\lambda} = \boxed{\frac{P\lambda}{hc}}$



P(watt)

→ PHOTON FLUX, ϕ_P (no. of photons per sec per unit Area)

A



$$\phi_P = \frac{N}{A} = \frac{1}{A} \times \frac{P\lambda}{hc} = \boxed{\frac{I\lambda}{hc}}$$

→ PHOTON DENSITY, $\rho_N = \frac{\phi_P}{c} = \boxed{\frac{I\lambda}{hc^2}}$ {Just put I to get ρ_N}

Ex: P • - - - r - - - | $I = \frac{P}{4\pi r^2}$

POINT SOURCE

2. WAVE PARTICLE DUALITY

PARTICLE NATURE

(a) Treated as photon

(b) Energy, $E = Pc$ (P → momentum)

WAVE NATURE

Treated as EM waves

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

$$Pc = \frac{hc}{\lambda}$$

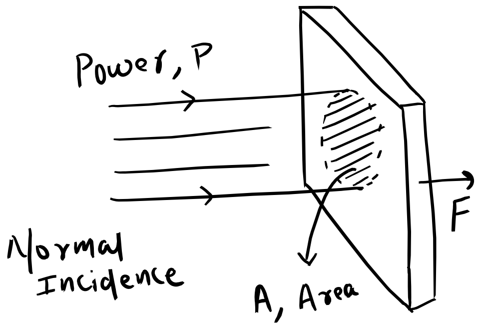
$$\Rightarrow \boxed{P = \frac{h}{\lambda}} \rightarrow \text{photon momentum}$$

3. DE BROGLIE'S HYPOTHESIS

(If light behaves as particle then physical particle too can behave as waves)

$$\lambda = \frac{h}{P} \quad \text{or} \quad \boxed{\lambda = \frac{h}{mv}}$$

4. RADIATION FORCE / PRESSURE



(a) Mostly body is black body (absorbs all light)

(b) Momentum is tranferred to body

(c) Thus body experiences FORCE (RADIATION FORCE)

F = no of photons/sec × momentum change

$$= \frac{P\lambda}{hc} \times \frac{h}{\lambda} = \boxed{\frac{P}{c}}$$

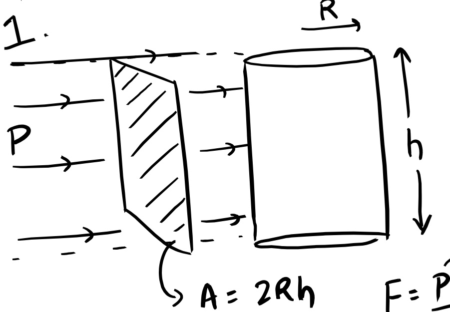
{ P: Power, $P = IA$

Radiation Pressure $= \frac{F}{A} = \frac{P/c}{A} = \boxed{\frac{I}{c}}$

> NOTE: If surface is perfectly reflective, $F = \frac{2P}{c}$, Pressure $= 2I/c$

PROJECTED AREA

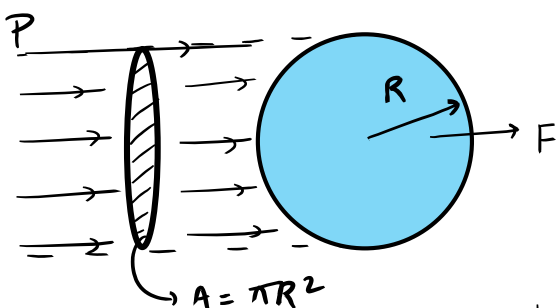
1.



$F = \frac{P}{c} = \frac{I\,2Rh}{c}$ (power)

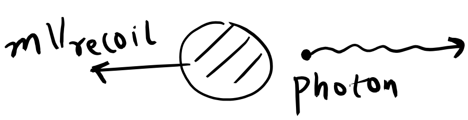
(Assuming Black Body)

2.



$F = \frac{P}{c} = \frac{I\pi R^2}{c}$ { Black Body

5. ATOM RECOIL DURING DE-EXCITATION



Hydrogen type atom ($1e^-$ system)

$\lambda = \frac{12430}{\Delta E \text{ (in eV)}}$ Å

$\therefore mV_{recoil} = \frac{h}{\lambda}$

$$\Rightarrow \boxed{V_{recoil} = \frac{h}{\lambda m}}$$

↳ m : mass of atom

λ : wavelength of Photon

h : Planck's Constant

Space to add concepts learnt from PYQs if any

Topics to cover in Radioactivity (PART 4 – Modern Physics)

1. Radioactivity (activity & units)
2. Radioactive Decay Law
3. Half Life Time
4. Mean Life Time
5. Simultaneous Decay Equation
6. Radioactive Series

Note: For video refer Revision Series Playlist in EDUNITI YouTube Channel

1. RADIOACTIVITY (ACTIVITY, UNITS)

(a) Unstable nucleus disintegrate spontaneously.

(b) This phenomena of disintegration is called "ACTIVITY", A_c

Also known as decay rate

$A_c = -dN/dt$

X → Y

Parent Nucleus → Daughter Nucleus

(c) UNIT of Activity is dps (decay per sec)

- 1 Bq (Becquerel) = 1 dps
- 1 Ci (curie) = 3.7×10^{10} dps $= 3.7 \times 10^{10}$ Bq
- 1 Ru (Rutherford) = 10^6 dps

2. RADIOACTIVE DECAY LAW ($X \xrightarrow{\lambda} Y$)

X ↳ ACTIVE NUCLEI

(a) Activity ∝ Number of Active nuclei

$-\frac{dN}{dt} \propto N \Rightarrow -\frac{dN}{dt} = \lambda N$ {Activity, $A_c = \lambda N$}

λ ↳ Decay Constant (tells how fast decay occurs)

↓ Integrate

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

← Radioactive decay eqn

(i) N_0 is NO of Nuclei at $t=0$

(ii) $A_c = A_{c0} e^{-\lambda t}$

3. HALF LIFE TIME (T)

↳ time taken to become half

At $t=0$, $N=N_0$ $\Rightarrow \frac{N_0}{2} = N_0 e^{-\lambda T}$

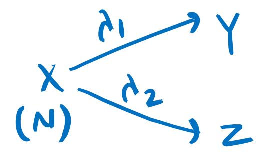
$t=T$, $N=\frac{N_0}{2}$

$\Rightarrow$ $\boxed{T = \frac{\ln 2}{\lambda}}$ or $\frac{0.693}{\lambda}$

4. MEAN LIFE TIME

$$\boxed{\tau = \frac{1}{\lambda}}$$

5. SIMULTANEOUS DECAY



$A = \lambda_1 N + \lambda_2 N$

$\Rightarrow -\frac{dN}{dt} = N(\lambda_1 + \lambda_2)$

$$\boxed{N = N_0 e^{-(\lambda_1+\lambda_2)t}}$$

NOTE: Radioactive decay eqn in terms of T:

$N = N_0 e^{-\lambda t} \Rightarrow N = N_0 e^{-\frac{\ln 2}{T}t}$

$$\boxed{N = N_0 (2)^{-t/T}}$$

and, $A_c = A_{c0}(2)^{-t/T}$

6. RADIOACTIVE SERIES

$A_1 \xrightarrow{\lambda_1} A_2 \xrightarrow{\lambda_2} A_3 \; - \; - \; - \; - \; A_n$

↳ Stable end product

	SERIES	PARENT	END PRODUCT
4n	THORIUM	$_{90}Th^{232}$	$_{82}Pb^{208}$
4n+1	NEPTUNIUM	$_{93}Np^{237}$	$_{83}Bi^{209}$
4n+2	URANIUM	$_{92}U^{238}$	$_{82}Pb^{206}$
4n+3	ACTINIUM	$_{92}U^{235}$	$_{82}Pb^{207}$

Artificial as $T_{1/2}$ is too low and so don't exist in nature

Space to add concepts learnt from PYQs if any

Topics to cover in Nuclear Physics (PART 5 – Modern Physics)

1. How to write a Nuclear Reaction
2. Nuclear Force
3. Nucleus Size & Stability of Heavy Nucleus
4. Nuclear Binding Energy
5. Binding Energy Per Nucleon
6. Nuclear Fusion & Fission
7. Alpha, Beta & Gamma decay

Note: For video refer Revision Series Playlist in EDUNITI YouTube Channel

1. HOW TO WRITE A NUCLEAR REACTION

$C + c \longrightarrow D + d$

- C → Initial nuclei
- c → Attacking Particle
- D + d → END NUCLEI
- d → emitting Particle (RADIATION)

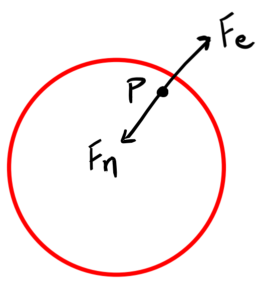
$C(c,d)D$

2. NUCLEAR FORCE

$^{A}_{Z}X$ — Mass no ← A, Atomic no ← Z

→ Strong attractive short range force.

$F_{nn} = F_{np} = F_{pp}$



(i) F_e : repulsive electrostatic force

F_n : net attractive nuclear force

$F_e = F_n \Rightarrow$ Stable Nucleus

3. NUCLEUS SIZE AND STABILITY OF HEAVY NUCLEUS

↳ Size of Nucleus ∝ Atomic mass

$\Rightarrow \frac{4}{3}\pi R^3 \propto A \Rightarrow \boxed{R = R_0 A^{1/3}}$

R_0 → fermi-const. $R_0 \sim 10^{-15}$ m

↳ If $R\uparrow \Rightarrow F_n \downarrow$

So, Nucleus gets unstable

$\Rightarrow$ Decay starts

$X \longrightarrow Y +$ Radiation

4. NUCLEAR BINDING ENERGY

the energy required to separate an atomic nucleus completely into its constituent protons and neutrons, or, equivalently, the energy that would be liberated by combining individual protons and neutrons into a single nucleus.

$Zp + (A-Z)n \longrightarrow {}^{A}_{Z}X + E_b$

E_b → BINDING ENERGY

NOTE: When reactants combine to form stable product, THERE IS MASS LOSS called "MASS DEFECT"

$$\boxed{\Delta m = Zm_p + (A-Z)m_n - M_x}$$

and, $E_b = \Delta m c^2$ { Δm if in AMU, 1 AMU = 1.66×10^{-27} kg

or

$$\boxed{E_b = \Delta m\,(\text{in AMU}) \times 931.5\ \text{MeV}}$$

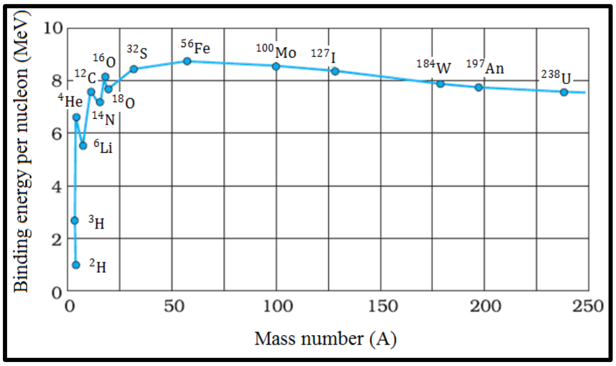
5. BINDING ENERGY PER NUCLEON

↳ $^{A}_{Z}X$ A is no of nucleons

NOTE: E_b is lower for A < 30 and A > 170

$$BE/nucleon = \frac{E_b}{A}$$

↓ tells how stable is a nucleus



6. NUCLEAR FISSION AND FUSION

Fission ↓ $X \rightarrow Y + Z + \Delta E_2$ (splitting)

Fusion ↳ $A + B \rightarrow C + \Delta E_1$ (JOINING of nucleus)

(i) In both Energy released

(ii) $\Delta E_1 = (m_A + m_B - m_C)c^2$

$\Delta E_2 = (m_X - m_Y - m_Z)c^2$

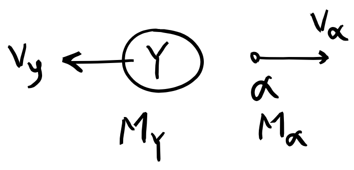
*NOTE: Energy released (+VE) or even supplied (−VE) is called Q-value

$$Q = \Delta m c^2$$

7. Alpha, BETA AND GAMMA DECAY

(a) α-decay (4e Nucleus) $\quad ^{A}_{Z}X \rightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}\alpha + E$, $\quad Q = (M_X - M_Y - M_\alpha)c^2$

NOTE: THIS energy is released in form of Kinetic energy.



$M_Y V_Y = M_\alpha V_\alpha$ — (i), $\quad Q = \frac{1}{2}M_Y V_Y^2 + \underbrace{\frac{1}{2}M_\alpha V_\alpha^2}_{K_\alpha}$ — (ii)

from (i) and (ii)

$$K_\alpha = \frac{Q M_Y}{M_\alpha + M_Y} = \boxed{\frac{Q(A-4)}{A}}$$

(b) Beta Decay (e^- or e^+)
e^- ↓ electron, e^+ ↳ positron

$\nu \rightarrow$ neutrino

$\bar{\nu} \rightarrow$ antineutrino

β^+ Decay

$p \rightarrow n + e^+ + \nu$

$^{A}_{Z}X \rightarrow {}^{A}_{Z-1}Y + e^+ + \nu$

$\Delta m = M_X - M_Y - 2m_e$

β^- Decay

$n \rightarrow p + e^- + \bar{\nu}$

$^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + e^- + \bar{\nu}$

$\Delta m = M_X - M_Y$

K capture

$p + e^- \rightarrow n + \nu$

$^{A}_{Z}X \rightarrow {}^{A}_{Z-1}Y + \nu$

$\Delta m = M_X - M_Y$

(C) Gamma Decay (EM Radiation)

(In K capture, e^- is captured from K-shell)

$X \rightarrow Y^* + \alpha$, $Y^* \rightarrow Y + \gamma$

Y^* → Excited state

$\Rightarrow X \rightarrow Y + \alpha + \gamma$

NOTE: It can happen even for β-decay

Space to add concepts learnt from PYQs if any

Topics to cover in X-Rays (PART 6 – Modern Physics)

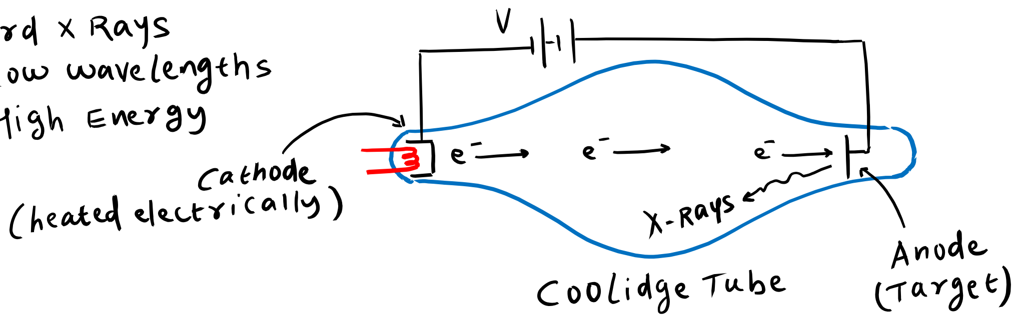
1. Soft and Hard X-Rays
2. Production of X-Rays : Coolidge Tube
3. Continuous X-Ray Production
4. Characteristic X-Ray Production
5. Complete Spectrum
6. Moseley's Law

Note: For video refer Revision Series Playlist in EDUNITI YouTube Channel

1. X-RAYS ($\approx 1\,\text{Å}$)

- Soft X-RAYS
  - High wavelength
  - Low energy
- Hard X Rays
  - Low wavelengths
  - High Energy

2. PRODUCTION OF X-RAYS (X-ray tubes)



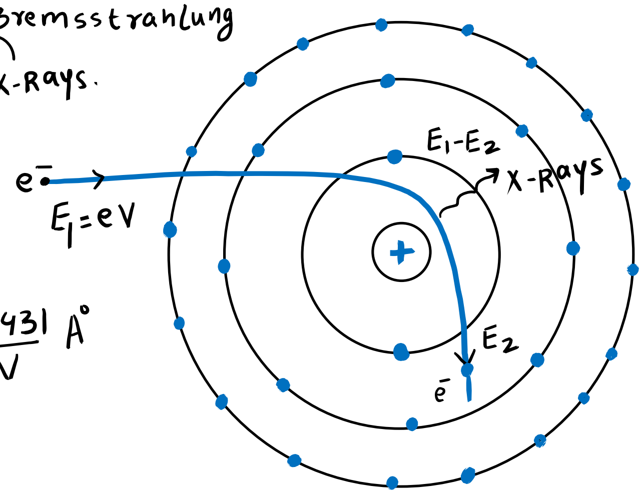
Coolidge Tube

X-Rays are produced by incidence of accelerated e^- on target material

- Continuous X-Rays (Bremsstrahlung)
- Characteristic X-Rays

3. CONTINUOUS X-RAY

↳ Deceleration of e^- when deflected by atomic nucleus causes production of X-Rays. (This Phenomena is called Bremsstrahlung)

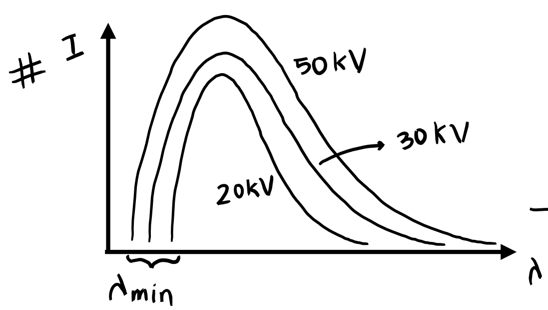


(a) Energy of X-rays, $E = E_1 - E_2$

$E_{max} = E_1 = eV \quad (E_2 = 0)$

Cutoff Wavelength of X-Ray,

$\lambda_{min} = \frac{hc}{E_{max}} = \frac{hc}{eV} = \frac{12431}{V}\,\text{Å}$



→ X-Rays Continuum Radiation spectra

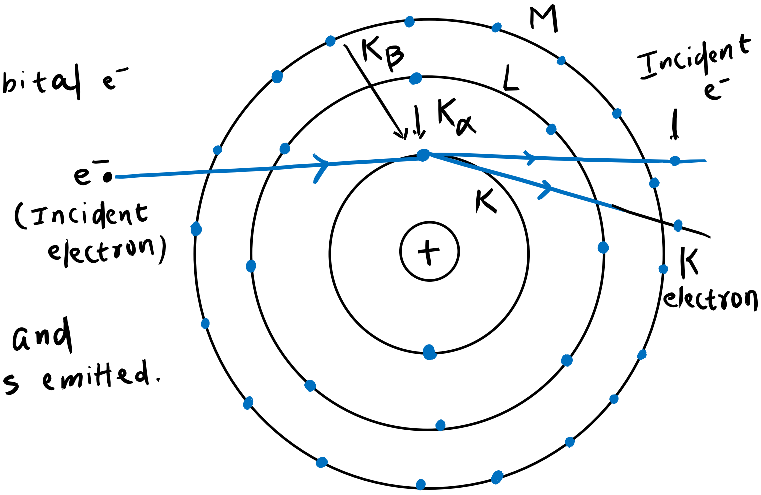
4. CHARACTERISTIC X-RAY

(i) some incident e^- Knocks off orbital e^- of K, L, M . shell.

(ii) If eV > Binding Energy of "K shell e^-", only then it is removed

(iii) e^- from L, M, N.. can jump to K and during this photon (x-ray) is emitted.

↳ $\lambda = \frac{hc}{\Delta E}$



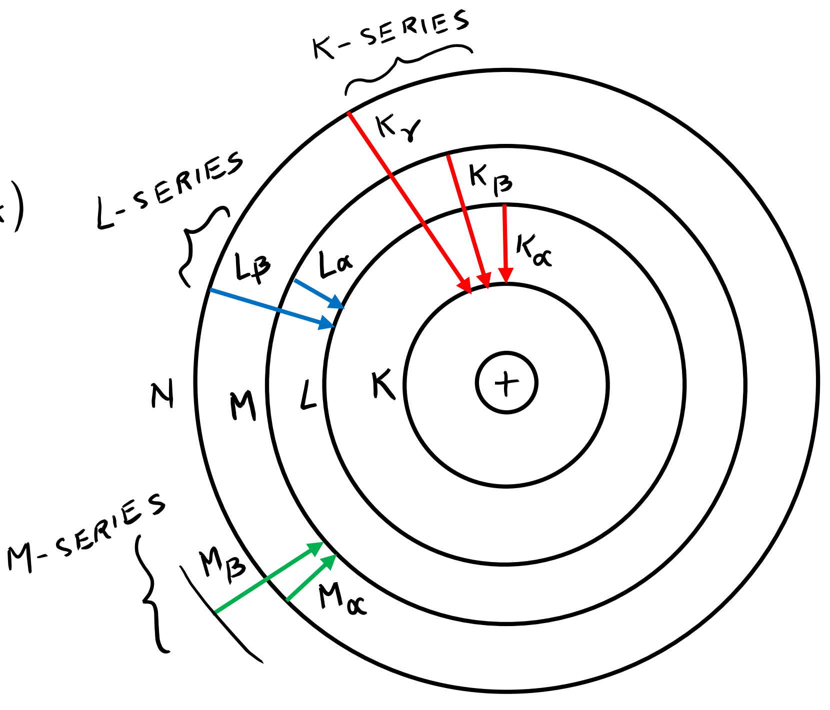
(a) K_α X-Ray ⟶ If e^- Jumps from L ⟶ K
(b) K_β → e^- Jumps from M ⟶ K
(c) K_γ → e^- Jumps from N → K

} K- Series

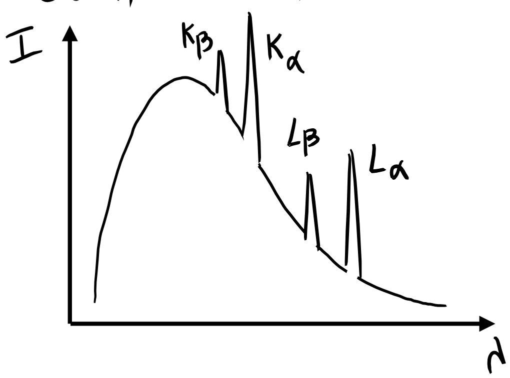
NOTE:

(i) If you compare K_β and K_α

$\lambda_{K_\beta} < \lambda_{K_\alpha}$ $(\because \Delta E_{MK} > \Delta E_{LK})$



5. COMPLETE SPECTRUM



$K_\beta : M \to K$
$K_\alpha : N \to K$
$L_\beta : N \to L$
$L_\alpha : M \to L$

6. MOSELEY'S LAW ($\sqrt{\nu} = a(z-\sigma)$)

λ of characteristic X-Rays

$$\frac{1}{\lambda} = R(z-\sigma)^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$z-\sigma$ → effective atomic no

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

$$\Rightarrow \nu = RC(z-\sigma)^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

For K-Series
$\sigma = 1$
R $10^7 m^{-1}$
↳ Rydbergs const.

$$\therefore \sqrt{\nu} = a(z-\sigma)$$

$a \rightarrow \sqrt{RC\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)}$

↳ square root of frequency is linearly proportional to Atomic number.

Space to add concepts learnt from PYQs if any