Roll No. 2336947

Total No. of Pages : 02

Total No. of Questions : 09

B.Tech.(Artificial Intelligence & Machine Learning/CE/CSE/DS/CS&D/ECE/EEE/EE/IT/ME/Robotics & Artificial Intelligence/Internet of Things and Cyber Security including Block Chain Technolog) (Sem.–1)

ENGINEERING PHYSICS

Subject Code : BTPH101-23

M.Code : 93794

Date of Examination: 14-12-2023

Time : 3 Hrs. **Max. Marks : 60**

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION - B & C have FOUR questions each.**
3. **Attempt any FIVE questions from SECTION B & C carrying EIGHT marks each.**
4. **Select atleast TWO questions from SECTION - B & C.**

SECTION-A

1. **Write short notes on :**

   a) What is a Unit Cell?

   b) Distinguish between Intrinsic and Extrinsic Semiconductors.

   c) What are Type I and Type II Superconductors?

   d) Show that Curl of gradient is zero.

   e) What is Uncertainty Principle?

   f) Distinguish between Stimulated emission and Stimulated absorption.

   g) What is Holography?

   h) Define Normalized frequency.

   i) What are Carbon Nanotubes (CNTs)?

   j) What is the use of He in He-Ne laser?

SECTION-B

2. What are X-rays? Discuss the diffraction of X-ray from crystals and obtain Bragg's law.

3. What is Photodetector? Explain the construction and working of Photodiode. Discuss the disadvantages of Photodiode.

4. What is Meissner effect? Explain it using London equations.

5. a) Write the Maxwell's equations and discuss the physical significance of each equation.

   b) Explain Dielectric polarization. What is Displacement current?

SECTION-C

6. What are Einstein's coefficients? Derive the relation between Einstein's coefficients and discuss the physical interpretation.

7. Define Acceptance angle and Numerical Aperture. Derive the expression for Acceptance Angle.

8. What is Photoelectric Effect? Explain the laws of Photoelectric Effects using Quantum Approach.

9. Explain the synthesis of nanomaterials using Ball Milling and Sol-gel Techniques.

NOTE : Disclosure of Identity by writing Mobile No. or Marking of passing request on any paper of Answer Sheet will lead to UMC against the Student.

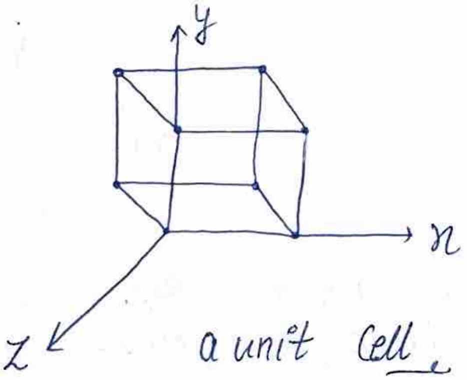
Sec-A :- is Compulsory having ten Questions having 2 marks
Sec-B&C- Contains 4 Question Each section attemps only 5 Coming marks Each such that atleast two Quesn from Section B & C Each.

1 Write short notes on. [Sec-A]

a) What is unit Cell?

Ans "A unit Cell is the smallest portion of a Crystal Lattice that shows the three-dimensional pattern of the Entire Crystal."

↳ It is a smallest part of the Crystal
↳ A unit Cell can't be divide further.
↳ It is a simple and basic fundamental block of the Crystal.



a unit Cell.

(b) Distinguish betn intrinsic and Extrinsic semiconductor?

Ans .. Intrinsic .. semiconductor ..

↳ It is a pure type semiconductor which have Contains Only a pure semiconductor atoms.
↳ There is no doping involved in intrinsic semiconductor
↳ No. of. Electrons is Equal to number of holes

$$n = h$$

↳ Fermi level lies betn Conduction band and Valence Band

$$E_F = \frac{E_C + E_V}{2}$$

↳ Conductivity is low.

eg:- Ge, Si etc.

Extrinsic Semiconductor :-

- It is a impure type semiconductor which contains trivalent (+3) and pentavalent (+5) atoms in small amount.
- Doping is involved in this type of semi-conductor.
- Conductivity is High.
- Fermi level can't lie in the middle of semiconductor.
- no. of holes can't equal to no. of Electrons in Extrinsic

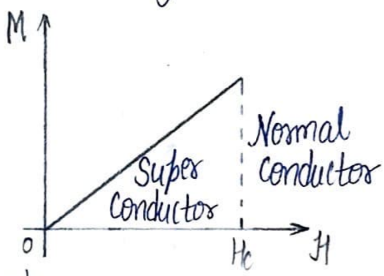
$$\boxed{n \neq h}$$

(C) What are type I and type II superconductors?

Ans :- Type-I

- These superconductors which can tolerate with impurities without affecting the superconducting properties.
- Exhibits perfect & complete Meissner effect
- Behaves as a perfectly diamagnetic material.
- There is only one H_c (Critical Magnetic field).
- Sudden loss of Magnetisation (Easy to Demagnetise).
- It only contains two states
  - Super Conducting state
  - Normal Conducting state

eg:- Pt, Sn, Hg etc.

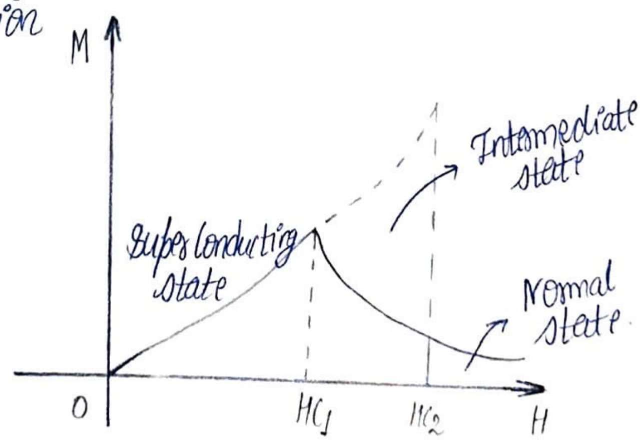


:- Graph :-

Type-II :-

- Those superconductor which cannot tolerate impurities such that Impurity affects the superconducting properties.
- Do not follow Complete Meissner effect
- Does not behaves as a perfect diamagnetic material.
- They have two Critical magnetic field. (HC_1 & HC_2).
- Gradient loss of Magnetisation
- Hard to De-magnetise.
- It contains three states.
  - Superconductor state
  - Normal state
  - Intermediate state

eg :- Nb-Sn, Nb-Ti.



(d) Show that curl of Gradient is zero?

Ans. The gradient of a scalar funⁿ multiplied with curl such that,

$$\nabla \times (\nabla v) = \nabla \times \left(\frac{\partial r}{\partial x}\hat{x} + \frac{\partial r}{\partial y}\hat{y} + \frac{\partial r}{\partial z}\hat{z}\right)$$

$$= \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ \frac{\partial r}{\partial x} & \frac{\partial r}{\partial y} & \frac{\partial r}{\partial z} \end{vmatrix}$$

$$= \hat{x}\left(\frac{\partial^2 r}{\partial y \partial z} - \frac{\partial^2 r}{\partial z \partial y}\right) + \hat{y}\left(\frac{\partial^2 r}{\partial z \partial x} - \frac{\partial^2 r}{\partial x \partial z}\right) + \hat{z}\left(\frac{\partial^2 r}{\partial x \partial y} - \frac{\partial^2 r}{\partial y \cdot \partial x}\right)$$

$= 0$ (Hence proved)

(e) What is uncertainity principle?

Ans. Uncertainity principle states that (It is Impossible to Determine Exact position and momentum of microscopic particle simultaneously).

↳ "We can't determine position & momentum of microscopic particle at a same time. there is a certain delay betⁿ them.

$$\Delta x \cdot \Delta P \geq \frac{h}{4\pi}$$

$$\Delta x \cdot \Delta P \geq 4\pi h$$

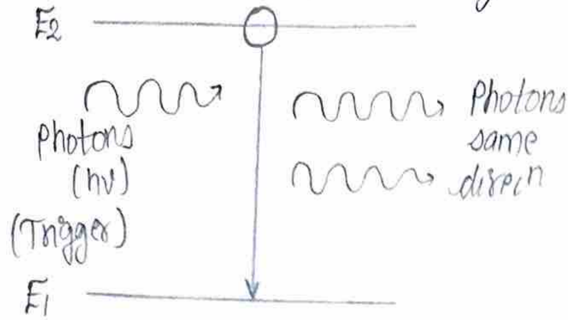
Where $\Delta x \approx$ Position.
$\Delta P \approx$ Momentum.

(f) distinguish betⁿ stimulated Emission and stimulated absorbption?

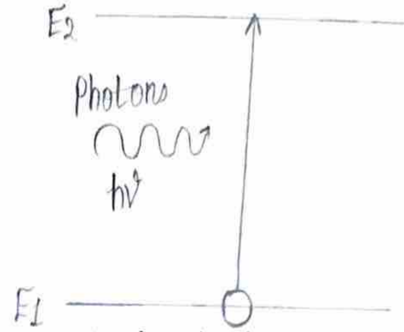
Ans. Stimulated Emission

↳ Stimulated Emission is the process by which an Incoming Photon of a specifies frequency can interact with an Excited atomic Electron (or other Excited molecular state), causing It to drop to a lower Energy level.

L This process is held by External help.
L Resultant a Coherent light will be in output.



Stimulated Emission



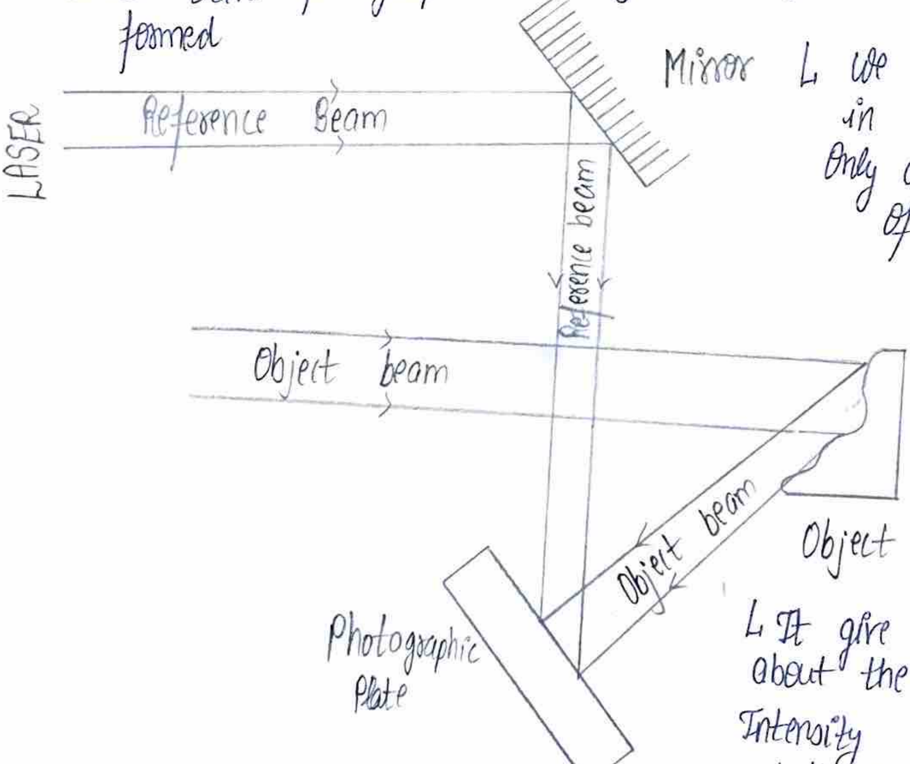
Stimulated absorbtion.

Stimulated absorbtion

L Stimulated absorbtion means a Electron(subatomic particle) goes to higher Energy state with the the help of External Energy.
L External agent is involved in this process.
L Coherent Output can't produce.

(9) What is holography?

Ans Holography L Holography is a Complete 3D imaging of the Object.
L It produce 3D Image.
L Intensity and phase both are recorded in hologram rather than photograph has Only Intensity is recorded (2D) Image formed



L We Construct the image in Holography by Only a Single part of photographic plate.

L It give more information about the Object because Intensity and phase both are recorded in Hologram.

Holography diagram

The most important term of X-rays diffraction is

(h) Define normalised frequency?

Ans ↳ Normalised frequency is also known as V- number.

↳ It tells about the optical fiber which is single mode and Multimode.

$$V = \frac{2\pi a}{\lambda}\sqrt{(\mu_1)^2 - (\mu_2)^2} = \frac{2\pi a}{\lambda} \times N.A \text{ (numerical aperture)}.$$

if $V < 2.405$ (the fibre is single mode)

if $V > 2.405$ (the optical fiber is multimode

and

if $V = 2.405$ the we calculate the threshold wavelength of the signal.

Here V = Normalised frequency.

a = radius.

λ = wavelength.

N.A = normalised freqency.

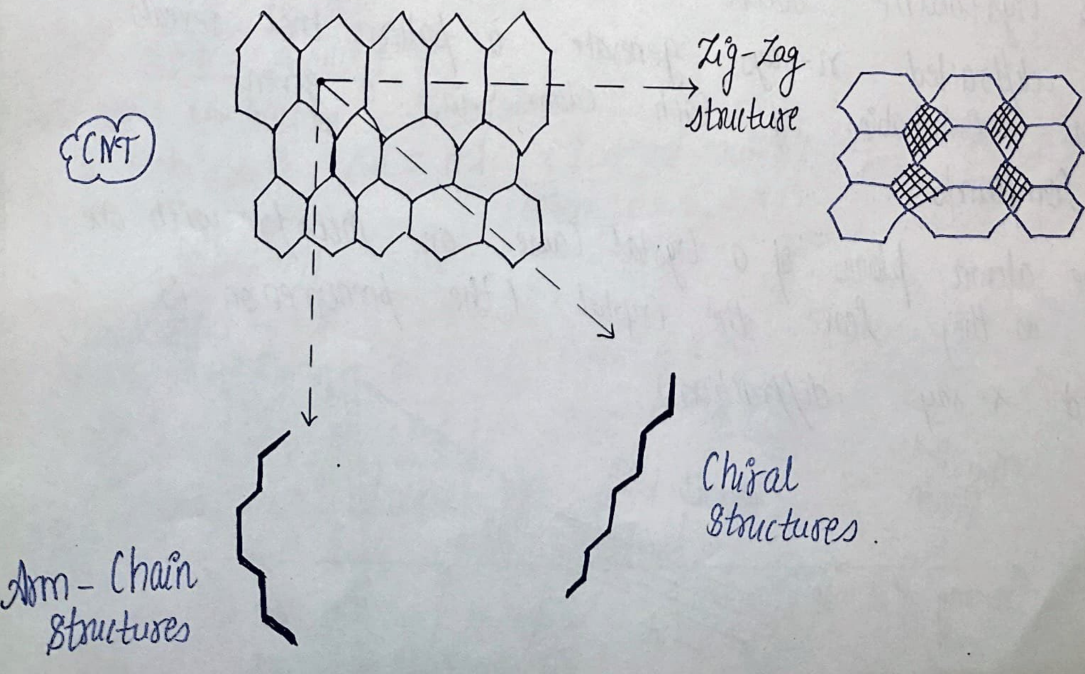
(i) What are Carbon nanotubes (CNT's)?

Ans CNT:- CNT stands for Carbon nanotubes.

↳ CNT are made up of Carbon actually species a carbon allotropes (Buckminister fullerence) which is actually (C-60) Contains 20 Hexagonal and 12 pentagonal rings.

↳ Diameter of CNT (2nm - 5nm) and length about 100 μm.

↳ CNT is a 1-D nanomaterial called nanowire or nanotube or nano rod.



(J) What is the uses of the He-Ne laser?

Ans The uses of Helium-Neon laser are :-

- Surveying
- Construction
- Supermarket
- Checkout scanners
- Printers
- etc.

↳ He-Ne used also as in laboratory for bar-code readers. and many more.

|| Sec-B ||

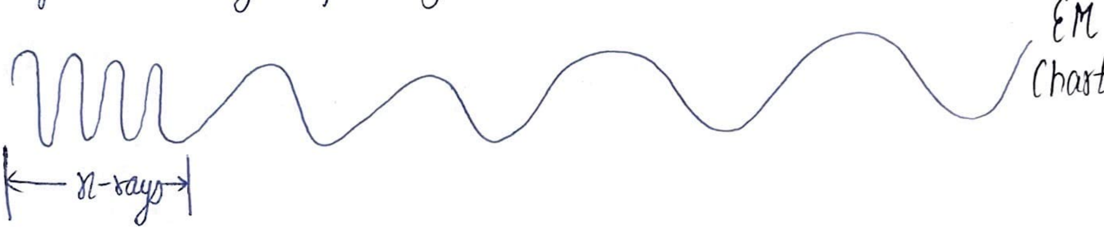
Q2 What are X-rays? Discuss the diffraction of X-rays from Crystals and Obtain Bragg's law?

Ans X-rays..

"X-rays are a form of Electromagnetic radiation, similar to Visible light"

↳ X rays are have higher Energy and can pass through most Objects, including the body.

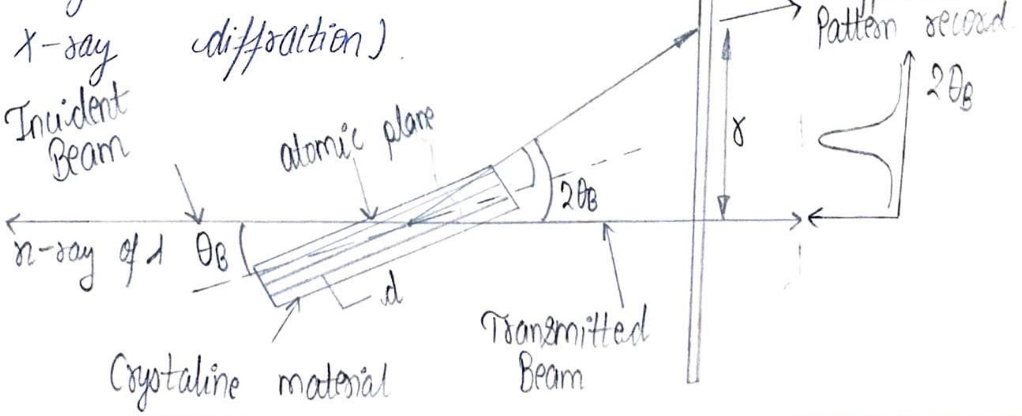
↳ X-rays have High frequency and short wavelength.



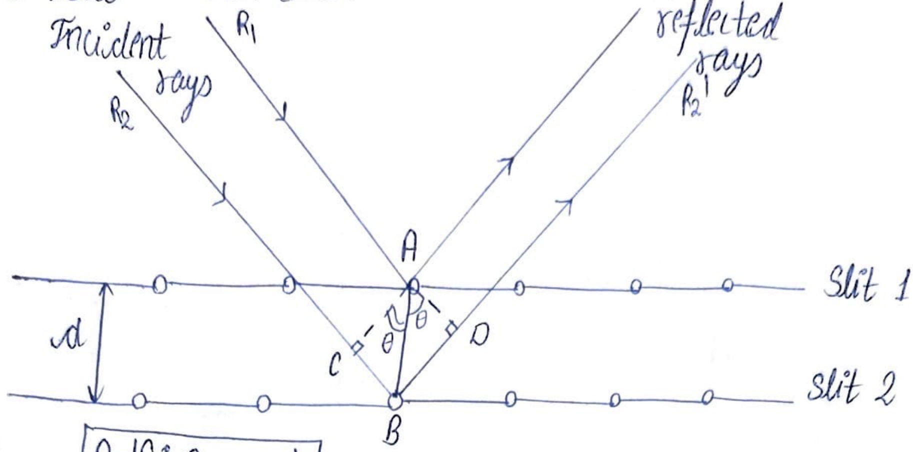
and, "the phenomena by which x-rays are reflected from the atoms in a Crystalline solid is Called diffraction."

↳ The diffracted x-rays generate a pattern that reveals structural orientation of Each atom in a given Compounds.

↳ "The atomic planes of a Crystal Cause an interfere with one another as they leave the Crystal. (the phenomenon is Called X-ray diffraction)



The most important foam of x-rays diffraction is Bragg's law such that,

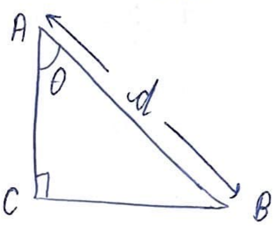


To prove :- $\boxed{2d\sin\theta = n\lambda}$

Proof

Consider a two slits (1 and 2) and having a distance betn two slits is d. So, ray R_1 incident at A and gets reflected and Ray 2 incident at B and get Reflected. and, AD ⊥r R_2' and AC ⊥r to R_2. and $\angle BAC = \angle BAD = \theta$

So, In Δ ABC,



$\sin\theta = \frac{BC}{AB}$

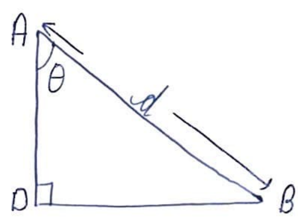
Such that,

$BC = AB\sin\theta$

$\boxed{BC = d\sin\theta}$ — ①

and,

Similarly Consider In Δ ABD



$\sin\theta = \frac{BD}{AB}$

$BD = AB\sin\theta$

$\boxed{BD = d\sin\theta}$ — ②

∴ We Constructive Interferance

Path diff $\Delta x = n\lambda$ (Integral multiple of wavelength)

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

Path diff $= n\lambda$

So, $BC + BD = n\lambda$

$d\sin\theta + d\sin\theta = n\lambda$ {from ① & ②}

$\boxed{2d\sin\theta = n\lambda}$ ← Hence Proved

where, d = distance betn two slits

θ = angle of ray incidence.

n = Integral Multiple

λ = wavelength.

Q3 What are photo detector ? Explain the construction and working of photodiode. Discuss the disadvantage of photodiode.

Ans Photo detector :- "Photodetectors are devices used for the Detection of light. they are usually based on the external or internal crystal photoelectric effect".

↳ They transform optical signal into Electrical signals.

↳ "Semi-conductor devices which can be implicated to detects the photons presence. such device are known as photo detections".

Photo diode :-

"A photo-diode is a pn-junction diode that consumes light Energy to produce an Electric current. sometimes it is also called a photo-detector, a light detector and photo-sensor".

These diodes are particularly designed for reverse bias condition. (It means P-side of photodiode is connected to negative terminal and n-side is connected to positive terminals)

Construction

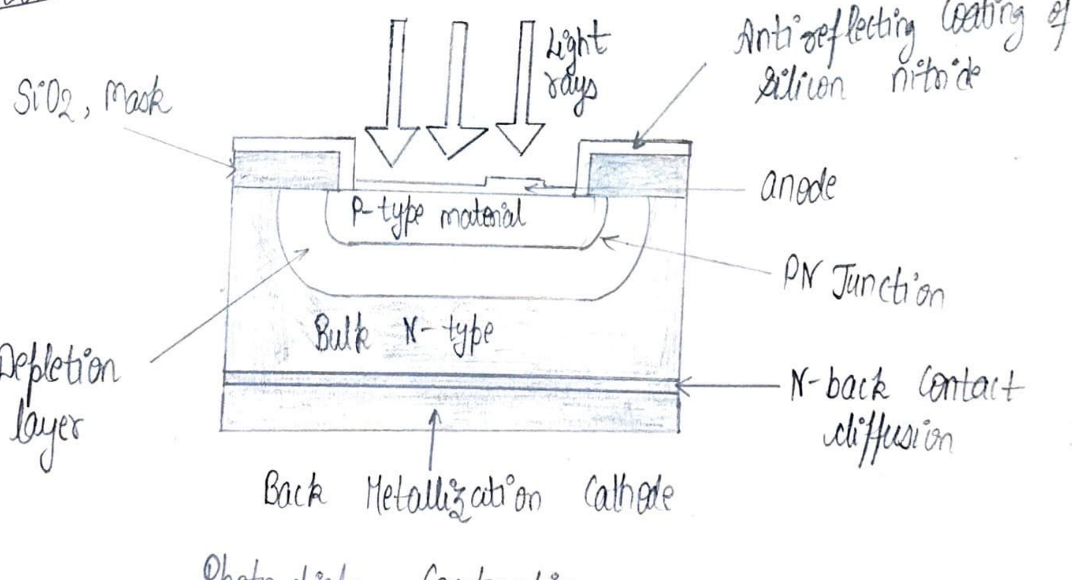
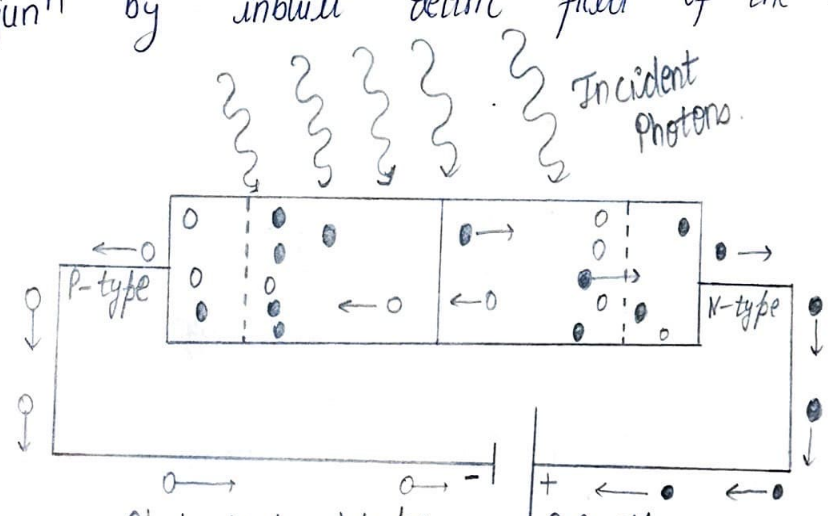


Photo diode Construction :-

"The photodiode is made using two semiconductors like p-type & N-type. In this design, the formation of p-type material can be done from the diffusion of the p-type substrate which is lightly doped. So, the p+ ions layer can be formed because of the diffusion method. On the substrate of N-type, the N-type Exitaxial layer can be grown. (The development of a P+ diffusion layer can be done over the heavily doped N-type Epitaxial

Layer. The Contacts are designed with metals to make two Terminals like anode and Cathode. The front region of the diode Can be separated into two types like active & Non-active surfaces.

Working:- The working principle of a photodiode is, when a photon of ample Energy strikes the diode, it makes a couple of an Electron-hole. this Mechanism is also Called the inner Photoelectric effect. If the absorbtion arises in the depletion region junction, then the Carriers are removed from the junn by inbuilt Electric field of the depletion region.



Photodiode Working Principle

Therefore, holes in the region move toward the anode, and Electrons Move toward the Cathode, and a photocurrent will be generated. The Entire Current through the diode is the sum of the absence of light and the photocurrent. so the absent Current must be reduced to maximize the sensitivity of the device.

Disadvantages:-

↳ Rapid increase in dark Current and it depends on temperature.
↳ Require amplification at low illumination level.
↳ Photodiode Characteristics are temperature dependents and have poor temperature ability.

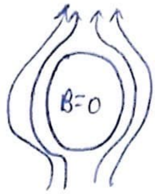
Q4 What is Meissner effect? Explain it using London Eqn?

Ans "This phenomenon was discovered by German physicist "Walther Meissner" & 'Robert Ochsenfeld' in 1933.

↳ "When superConductors, are Cooled down below the Critical tempn Magnetic field

Expel and magnetic field do not allow to penetrate inside them. this phenomenon in superconductor is called (Meissner Effect).

Conductor
$T > T_c$



$T < T_c$
Super Conductors.

| T_c = Critical temperature |

and,
from London eqn
London theory help us to understand the concept of Superconductors.
- There are two types of Electrons in super Conductor.

$$n = n_s + n_n$$

where, n_s = Super Electron (all Current flow from super Electrons there is no resistance and hinderance available for super Electron".
n_n = Normal Electron.

for super Conductors $E = 0$ and $B = 0$ (inside).
then, (i) Below Critical temperature (T_c)

$$J = J_s \text{ (Current density)}$$

$$J = n_s e v_s \text{ (where, } v_s \rightarrow \text{ Velocity of Super Electrons)}$$

$$F = ma$$

$$eE = m\frac{dv_s}{dt}$$

where, $$\boxed{\frac{dv_s}{dt} = \frac{eE}{m}} \quad -①$$

Now, diff eqn ① wrt time

$$\frac{dJ_s}{dt} = n_s e \frac{dv_s}{dt} \quad -②$$

Put dv_s/dt value from ① in eq②.

$$\frac{dJ_s}{dt} = n_s e \times \frac{eE}{m} = \frac{n_s e^2 E}{m}$$

So, $$\boxed{\frac{dJ_s}{dt} = n_s \frac{e^2}{m} E} \text{ \{first london eqn\}} \quad -Ⓐ$$

if $E = 0$

J_s is steady Current (Const).

and,

(ii) by Maxwell Eqn (3). {faraday law of Induction}.

$$\nabla \times E = -\frac{dB}{dt}$$

also, from london 1st Eqn.

$$\frac{dJ_s}{dt} = \frac{n_s e^2}{m} E$$

taking curl of this eqn on both sides.

$$\nabla \times \frac{dJ_s}{dt} = \nabla \times \frac{n_s e^2}{m} E$$

$$\frac{d}{dt}(\nabla \times J_s) = \frac{n_s e^2}{m}(\nabla \times E) \quad \{\text{diff wrt time}\}$$

Put Maxwell eq ③.

$$\frac{d}{dt}(\nabla \times J_s) = \frac{n_s e^2}{m}\left(\frac{-dB}{dt}\right)$$

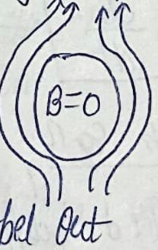
$$\frac{d}{dt}(\nabla \times J_s) = \frac{-d}{dt}\left(\frac{n_s e^2 B}{m}\right)$$

So, $\nabla \times J_s = \frac{n_s e^2}{m} B$ {london Second Eqn}.

if $B = 0$

$\nabla \times J_s = 0$ — Irrotational

Hence, Magnetic field Expel out



Hence, Meissner effect proved by london Eqn

Q5 (a) Write the Maxwell Eqn and discuss the physical significance of Each Eqn.

Ans The Maxwell Eqn are :-

1. $\nabla \cdot D = \rho$ — ① {from Gauss law Electrostatics}.

2. $\nabla \cdot B = 0$ — ② {from Gauss law of Magnetisation}.

3. $\nabla \times E = -\frac{dB}{dt}$ — ③ {from faraday's Law}.

4. $\nabla \times H = \frac{dD}{dt} + J$ — ④ {Ampere - Maxwell law}.

1 Maxwell's first eqn

↳ Signifies that: the total Electric displacement through the surface enclosing a volume is equal to the charge within the volume. Integrating this over an arbitrary volume r, we get ∫r.∇.

$$\boxed{\nabla \cdot D = \rho} \quad — ①$$

2 Maxwell's Second eqn..

↳ Signifies that "Closed surface integral of Magnetic flux density is always equal to total scalar magnetic flux enclosed within that surface of any shape or size lying in any medium".

↳ "the total outward flux of Magnetic Induction B through any closed surface S is equal to zero".

$$\boxed{\nabla \cdot B = 0} \quad — ②$$

3 Maxwell's Third eqn..

↳ It states that "whenever there are n-turns of conducting coil in a closed path placed in a time-varying Magnetic field, an alternating electromotive force gets induced in each coil.

$$\boxed{\nabla \times E = -\frac{dB}{dt}} \quad — ③$$

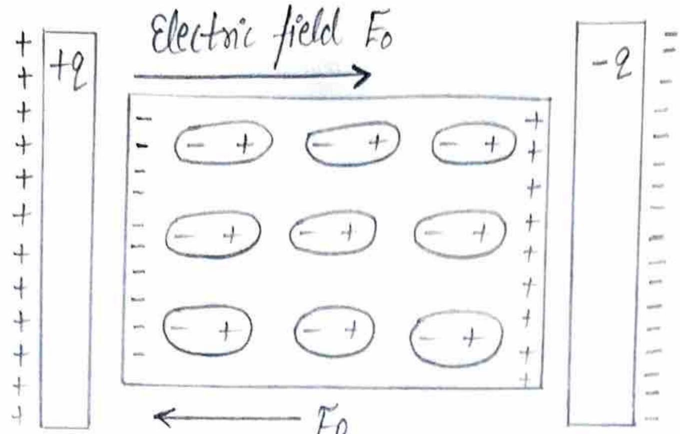
4 Maxwell's fourth eqn..

↳ This is a time dependent eqn which represents the modified differential form of Ampere's Circuital law according to which magnetic field is produced due to combined effect of conduction current density and displacement current density.

$$\boxed{\nabla \times H = \frac{dD}{dt} + J}$$

(b) Explain Dielectric polarization. what is displacement current.

Ans.. Dielectric polarization.. "When an electric field is applied to a capacitor, the dielectric material (or electric insulator) become polarized, such that the negative charges in the material orient themselves toward the positive electrode and the positive charges shift toward the negative electrode.



Dielectric polarization

Displacement Current :- "Displacement current is a quantity appearing in Maxwell's equations that is defined in terms of the rate of change of Electric displacement field."
↳ Displacement current has the units of Electric current density.

Eqⁿ of displacement current

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

Here, I_d = displacement current.

//Sec-C//

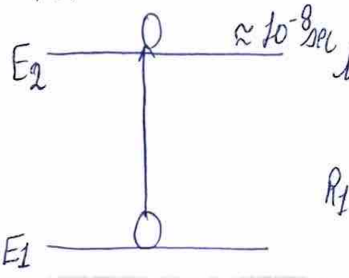
Q6 What are Einstein coefficients? Derive the relⁿ betⁿ Einstein coefficients and discuss the physical Interpretation?

Ans **Einstein coefficients** :- "Einstein coefficients are quantities describing the probability of absorption or Emission of a photon by an atom or Molecule.
↳ The Einstein A coefficients are related to the rate of spontaneous Emission of light, and the Einstein B coefficients are related to the absorption and stimulated Emission of light.

Proof

to prove :- To find the value of $\frac{A_{21}}{B_{21}} = ?$

so, we have,



$u(\omega)$ = Energy density of External sources.
$E(\nu)$ = Energy

$R_1 \propto u(\omega) \cdot N_1$ {Ground state is N_1}.
(Energy) (N_1 = No. of atoms in ground states)

$R_1 = B_{12}\, \mu(\omega) N_1$ — ①

and, B = Einstein coefficient of absorption & Emission.

$R_2 = B_{21}\, \mu(\omega) . N_2$ [∵ $R_2 \propto \mu(\omega) N_2$].

($\mu(\omega)$ → Energy; N_2 → Excited state atom)

and,

$R_3 \propto N_2 \Rightarrow R_3 = A_{21} N_2$

A → spontaneous Emmision.

$R_1 = R_2 + R_3$

$$B_{12}\, \mu(\omega) N_1 = A_{21} N_2 + B_{21}\, \mu(\omega) N_2$$

$$B_{12} N_1 \mu(\omega) - B_{21} N_2 \mu(\omega) = A_{21} N_2$$

$$\mu(\omega)(B_{12} N_1 - B_{21} N_2) = A_{21} N_2$$

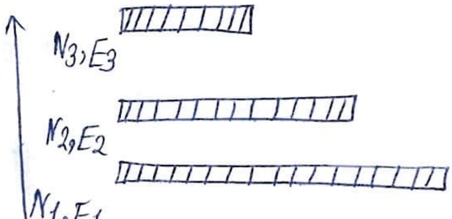
$$\mu(\omega) = \frac{A_{21} N_2}{(B_{12} N_1 - B_{21} N_2)}$$

$$= \frac{A_{21} N_2}{B_{21} N_2 \left[\frac{B_{12} N_1}{B_{21} N_2} - 1\right]}$$

at Equillibrium $B_{12} = B_{21}$ so, [∵ $\frac{B_{12}}{B_{21}} = 1$]

$$= \frac{A_{21}}{B_{21}\left[\frac{N_1}{N_2} - 1\right]}$$

Ground state atom always more than Excited state.



$$N_2 = N_1 e^{\frac{-(E_2 - E_1)}{KT}}$$

{∵ $E_2 - E_1$ = Energy diff }

$$\frac{N_1}{N_2} = e^{\frac{(E_2 - E_1)}{KT}} = e^{\frac{h\nu}{KT}}$$

and,

$$\mu(\omega) = \frac{A_{21}}{B_{21}} \cdot \frac{1}{\left(e^{\frac{h\nu}{KT}} - 1\right)} \quad — ④$$

This radiation must be identical to the radiation formula given by plank which gives density of photons as

$$\rho(\nu) = \frac{8\pi h \nu^3}{c^3}\left[\frac{1}{e^{h\nu/KT} - 1}\right]$$

and, $\frac{A_{21}}{B_{21}} = \frac{8\pi h\nu^3}{c^3}$

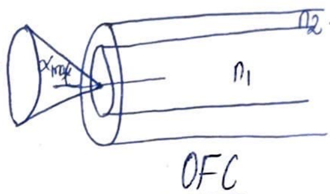
i.e $\boxed{A_{21} = \frac{8\pi h \nu^3}{c^3} \cdot B_{21}}$ Hence proved.

Q7 Define acceptance angle and Numerical aperture. Derive the expression for acceptance angle.

Ans .. acceptance angle .. "The maximum angle of a ray (against the fiber axis) hitting the fiber core which allows the incident light to be guided by the core".

↳ denoted by α_{max}.

and, $\boxed{\alpha_{max} = \frac{\text{acceptance cone}}{2}}$



.. Numerical aperture .. (N.A) .. "The sine of the largest angle an incident ray can have for total internal reflection in the core".

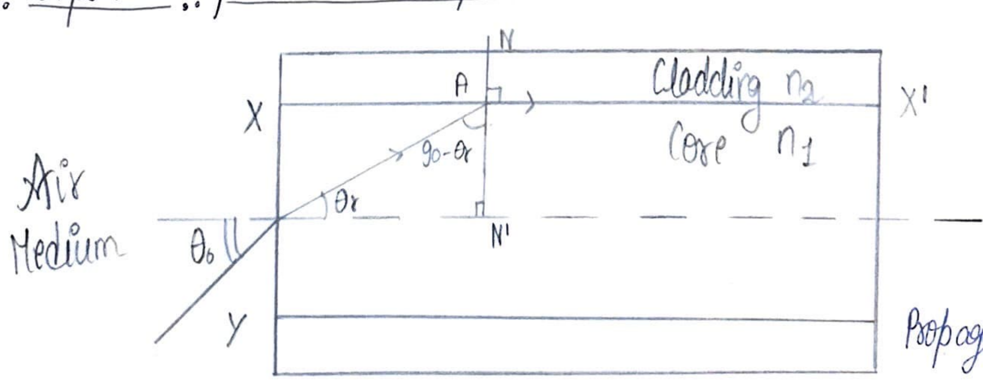
$$N.A = \sqrt{\frac{(n_1)^2 - (n_2)^2}{(n_0)^2}}$$

and n_1 = Core R.I

n_2 = Cladding R.I

n_0 = Outside medium R.I (Generally air).

.. Expression for numerical aperture ..



Propagation of light

Consider a optical fiber having TIR (total Internal reflection) at two places XY and XX'

So, by Snells law,

Case. 1 $n_0 \sin\theta_0 = n_1 \sin\theta_r$ {by Snells law}. {TIR at xy}

$$\sin\theta_0 = \frac{n_1}{n_0}\sin\theta_r$$

$$\sin\theta_0 = \frac{n_1}{n_0}\sqrt{1-\cos^2\theta_r} \quad \text{—} \ (1)$$

{ Using Identity $\sin\theta = \sqrt{1-\cos^2\theta_r}$ }

Case. 2 TIR at xx' interface.

$$n_1 \sin(90-\theta_r) = n_2 \sin 90$$

$$n_1 \cos\theta_r = n_2(1)$$

$$n_1 \cos\theta_r = n_2$$

$$\boxed{\cos\theta_r = \frac{n_2}{n_1}} \quad \text{—} \ (2)$$

So, put $\cos\theta_r$ value in eq (1) from (2)

$$= \frac{n_1}{n_0}\sqrt{1-\left(\frac{n_2}{n_1}\right)^2}$$

$$= \frac{n_1}{n_0}\sqrt{1-\frac{(n_2)^2}{(n_1)^2}}$$

$$= \frac{n_1}{n_0}\sqrt{\frac{(n_1)^2-(n_2)^2}{(n_1)^2}}$$

$$= \frac{\cancel{n_1}}{n_0}\frac{\sqrt{(n_1)^2-(n_2)^2}}{\cancel{n_1}}$$

$$\sin\theta_0 = \frac{\sqrt{(n_1)^2-(n_2)^2}}{n_0}$$

Put $n_0 \approx 1$ (air).

So, $\sin\theta_0 = \sqrt{(n_1)^2-(n_2)^2}$.

$$\sin\theta_0 = N.A$$

$$\boxed{\theta_0 = \sin^{-1}(N.A)} \Rightarrow \boxed{N_A = \sin\alpha_{max}}$$

and,

Let, Core refractive index is μ_1.

Cladding refractive index is μ_2.

according to identity,

$$(\mu_1)^2-(\mu_2)^2 = (\mu_1+\mu_2)(\mu_1-\mu_2).$$

$$= \left(\frac{\mu_1+\mu_2}{2}\right)\left(\frac{\mu_1-\mu_2}{\mu_1}\right). 2\mu_1$$

{ Multiply & Divide by $2\mu_1$ in num & deno. }

$\therefore$ $\left(\frac{\mu_1+\mu_2}{2}\right) \approx \mu_1$ and $\left(\frac{\mu_1-\mu_2}{\mu_1}\right) = \Delta$

So,

$$(\mu_1)^2 - (\mu_2)^2 = 2(\mu_1)^2 \Delta$$

Underoot both sides.

$$\sqrt{(\mu_1)^2 - (\mu_2)^2} = \sqrt{2\Delta} \cdot \sqrt{(\mu_1)^2}$$

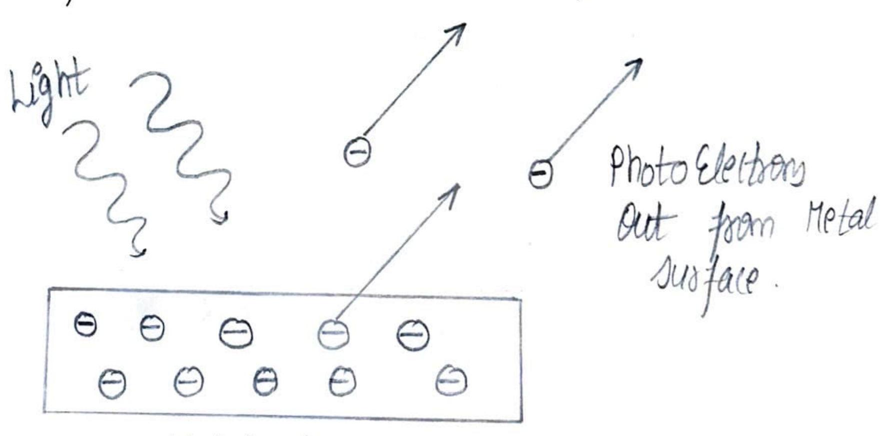
$$\sqrt{(\mu_1)^2 - (\mu_2)^2} = \mu_1 \sqrt{2\Delta}$$

$$\boxed{N.A = \mu_1 \sqrt{2\Delta}}$$ Hence proved.

Q8 What is photoelectric effect? Explain the laws of photoelectric Effect using Quantum approach?

Ans Photo Electric effect :- "When light shines on a metal, Electrons can be ejected from the surface of the metal in a phenomenon known as the photoelectric effect".

↳ "This process is also known as photoemission, and the electrons that are ejected from the metal are called photo Electrons".



Metal sheets

and, (Quantum theory of light).

Based on Quantum theory, in the photo electric effect only discrete amount of Energy, known as Quanta, can be absorbed or released by Electrons (packet). Photon's Energy is precisely proportional to the frequency of the radiation.

$$E = h\nu$$

E = photon Energy

h = Planks Constant

ν = radiation.

↳ Einstein (1905) created the Quantum theory of light, which States that Electromagnetic radiation travelled as tiny packets of Energy Called Quanta, or photons, that behaved like particles, rather than continuous waves.

↳ Einstein's work on Quanta of light provides the foundation for an revolutionary new idea: Our whole universe is Composed of tiny, discreate Chunks of Energy and Matter.

"Electromagnetic radiation is emitted in bursts of Energy - photons, the Energy of a photon is given by $E = hf$, where f is the frequency of the radiation and h is planks Constant.

$[h = 6.6 \times 10^{-34}$ Js].

But Velocity of light = frequency times wavelength $\boxed{c = f\lambda}$

Substituting $\boxed{f = \frac{c}{\lambda}}$ into $E = hf$

Photon Energy $\boxed{E = \frac{hc}{\lambda}}$

Q9 Explain the synthesis of nanomaterials using ball-Milling and sol-gel techniques?

Ans The synthesis of nanomaterials are :-

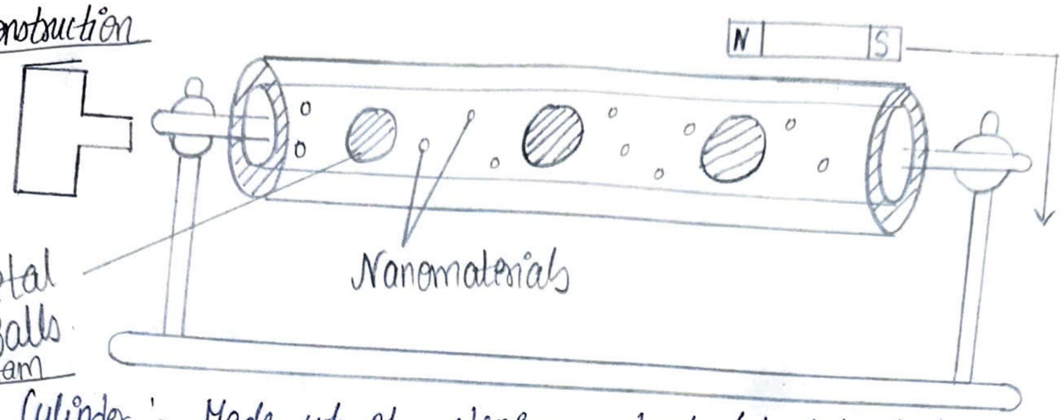
1. By using ball-milling methods

↳ Ball milling is a top-down Approach for the synthesis of nanomaterials.

"Process was developed by Benjamin & His co-workers at Internal Nikel Company in the late 1960".

"nanoparticle means size reduced to 10^{-9}m)

Construction

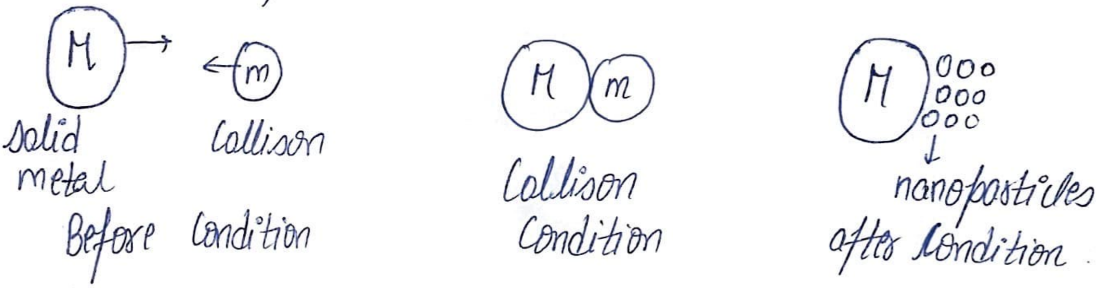


Diagram

1 Cylinder :- Made up of stenium steel (bad conductors of heat)
2 Rotator :- Rotate cylindrical part of the ball milling.
3 Powder of substance whose nanomaterial will form.
4 . Different size of spherical Metal balls.

Working principle

↳ Principle of ball miling is " Impact " → (Short time force).



Working

- We fill 60% of volume of Cylinder by powder of Substance (nanomaterial) & Metal balls.

↳ The velocity of Cylinder is responsible for this process.
↳ If velocity of cylinder is increases then Impact is also increase
↳ Velocity of Cylinder neither high nor low.
↳ Milling time is also responsible for synthesis of nanomaterial.

Advantage.

↳ Low Cheap
↳ Not Complex.

Disadvantage ..

↳ Produce more waste.
↳ Proper range nanomaterial will not form
↳ More Crystal defects.

Sol - gel techiniques

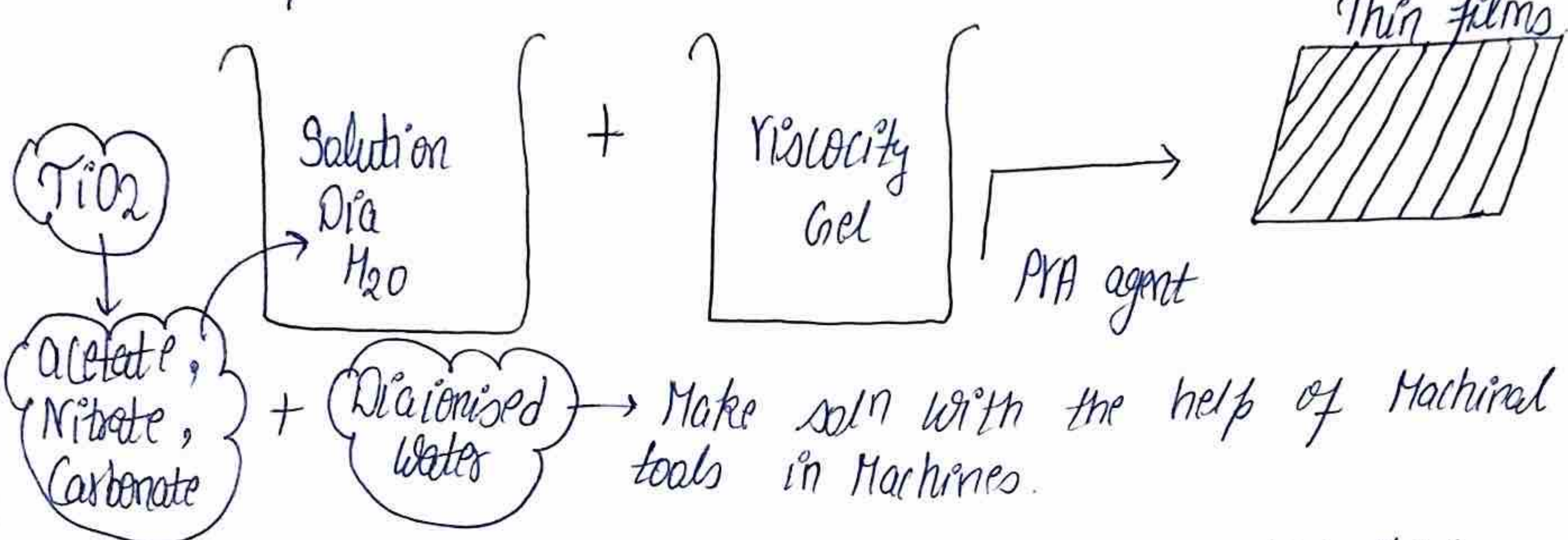
" Sol gel technology is a well - established

Colloidal chemistry technology which offers possibility to produce various materials with novel, predefined properties in a simple process and at relative low process cost.

↳ Wet Chemical Method

↳ possible to form

- nano thin films
- Nano - powders
- nano - particles



→ Make soln with the help of Machinal tools in Machines.

PVA (Poly-vinyl-alcohol) Gely agent to make particle thick.

"The main benifits of sol-gel processing are the High purity and uniform nano structure achievable at low temp"

advantages

- Produce uniformity in nanomaterials.
- Not much Crystal Defects.
- Easy to Make & Synthesis.

Disadvantages

- Chemical process becomes toxic
- top to bottom approach it Produce Much waste.
- Very Complex process.