Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Empowered Autonomous).

Department of Physics

Date: 02/09/2024

Internal Examination Notice

The students of M.Sc. I and II are hereby informed that the internal examination of current semester is scheduled as per following time table:

Sr. No.	Class and Sem	Paper Code.	Title of the paper	Date and time
1.	M.Sc. I, SEM I	DSC12PHY11	Mathematical Physics	24/09/2024 12:00 to 01:00 pm
2.	M.Sc. I, SEM I	DSC12PHY12	Classical Mechanics	25/09/2024 12:00 to 01:00 pm
3.	M.Sc. I, SEM I	MIN12PHY11	Research Methodology	26/09/2024 12:00 to 01:00 pm
4.	M.Sc. I, SEM I	DSE12PHY11	Solid State Physics-I (Semiconductor Physics)	27/09/2024 12:00 to 01:00 pm
5.	M.Sc. II, SEM III	DSC12PHY31	Statistical Mechanics	24/09/2024 12:00 to 01:00 pm
6.	M.Sc. II, SEM III	DSC12PHY32	Atomic and Molecule Physics	25/09/2024 12:00 to 01:00 pm
7.	M.Sc. II, SEM III	DSE12PHY31	Thin solid films: Deposition and Properties	26/09/2024 12:00 to 01:00 pm

Nature of question paper

- **For M.Sc. I and II**

Total Marks (for each paper) = 20

Q: 1) Select correct alternative (02 marks)

Q: 2) Short answer question (any one out of two) (12 marks)

Q: 3) Short answer question (any one out of two) (06 marks)

(M.Sc. Co-ordinator)

VIVEKANAND COLLEGE KOLHAPUR ESTD JUNE 1964

HOD

HEAD
DEPARTMENT OF PHYSICS
VIVEKANAND COLLEGE, KOLHAPUR
(EMPOWERED AUTONOMOUS)

Education for Knowledge, Science and Culture"
-Shikshanmaharshi Dr. Bapuji Salunkhe
Shri Swami Vivekanand Shikshan Sanstha, Kolhapur

Vivekanand College, Kolhapur (Empowered Autonomous)

Department of Physics

M.Sc. Part-II SEM III Examination (2024-25)
Statistical Mechanics
Paper V (Paper code: DSC12PHY31)

Date : 24/09/2024 Total Marks: 20
Day : 12.00 to 1.00 pm Time :- 1 hour

Instructions:-

1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Use of log table and calculator is allowed.

Q.1) Select correct alternative **(2)**

1) The well known relation between entropy and probability is -------

a) $S = k \log w$ b) $S = K$ c) $S = 1/k \log w$ d) $S = \log w$

2) The phase space is combination of ----------space

a) Position and moment b) position and momentum c) moment and momentum

d) displacement and momentum

Q.2 Attempt any ONE **(12)**

1. Explain ensemble in details
2. Explain Gibb's paradox

Q.3 Attempt any ONE **(06)**

1. Obtain the relation between entropy and probability
2. Explain the concept of phase space

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ESTD JUNE 1964

Vivekanand College, Kolhapur (Empowered Autonomous)

M.Sc. Part-II (Sem-III) DSC- V Internal Examination Sept. 2024

Course Code: DSC12PHY32

Atomic and Molecular Physics

Date: 25/09/2024 Day: Wednesday

Time:12.00-01.00 pm Marks: **20**

Instructions:

1) *All the questions are compulsory.*
2) *Figures to the right indicate full marks.*
3) *Draw neat labeled diagrams wherever necessary.*
4) *Use of log table/calculator is allowed*

Q. 1 A) Select correct alternative. **(02)**

1. The ratio of minimum wavelengths of Lyman and Balmer series will be.

a) 1.25 b) 0.25 c) 5 d) None of the above

2. As the orbit number of the electron increase in a hydrogen atom, the energy of electron…..

a) Increase b) Decrease

c) Remains constant d) Electron energy is always zero.

Q.2) Long answer questions (any one out of two) **(12)**

i. Describe the quantum states of an electron in a hydrogen atom.
ii. Explain the Paschen-Back effect for a two-electron atom.

Q.3) Short answer questions (any one out of two) **(06)**

i. Discuss the implications of the Pauli exclusion principle for two-electron atoms.
ii. Discuss the Zeeman effect for a two-electron atom.

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Vivekanand College, Kolhapur (Empowered Autonomous).

Department of Physics

M.Sc. Part-I SEM I Examination (2024-25)
Solid State Physics-III (Thin solid films: Deposition and Properties)
(Paper code: DSE12PHY31)

Date : 26 /09 /2024 Total Marks: 20
Day : 12.00 to 1.00 pm Time :-

Instructions:-

1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Use of log table and calculator is allowed.

Q.1) Select correct alternative **(3)**

1. SILAR stands for----------.
   a) Successive Ionic Layer Adsorption and Reaction
   b) Successive Ionic Layer Absorption and Reaction
   c) systematic Ionic Layer Adsorption and Reaction
   d) systematic Ionic Layer Absorption and Reaction
2. Sputtering is --------- technique of thin film deposition.
   a) Physics b) Chemical
   c) physics and chemical d) physics or chemical

Q.2) Long answer question (Attempt any ONE) **(12)**

1. Explain briefly spray pyrolysis technique of thin film deposition with deposition mechanism.
2. Explain briefly Chemical vapor deposition technique.

Q.3) Short answer question (Attempt any ONE) **(06)**

1. Write the short note Electrodeposition.
2. Write the short note CBD.

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

Name :- Anjali Bhagwan Kamble.

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-शिक्षणमहर्षी डॉ. बापूजी साळुंखे

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor	

Suppliment No. : I

Roll No. :

Class : M.Sc II

Subject : Statistical Mechanics.

Test / Tutorial No. : Internal Exam.

Div. : 02 + 10 + 06 = 18

Q.1.

1.

→ a) $S = K \log w$.

2.

→ b) position and momentum.

Q.2.

1. Ensemble :

ensemble is are microscopically cell or compartment which is closly bound by the no. of molecules of ideal gas of same identity in the atom

The walls of ensemble are mainly rigid, Impermeable and conducting

There are three types of ensembles.

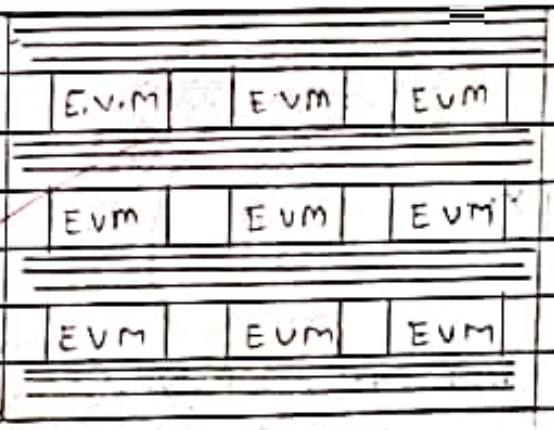
i) Microcanonical ensemble

ii) Canonical ensemble.

iii) Grand canonical ensemble.

i) Microcanonical ensemble -

In microcanonical ensemble the walls are wall the system are combined with the Energy(E), volume (v), Mass (M) the entropy is always same in this type because there is no exterior force on the inner surface. The cells are divided by rigid walls very well by lines of impermeable membrance.

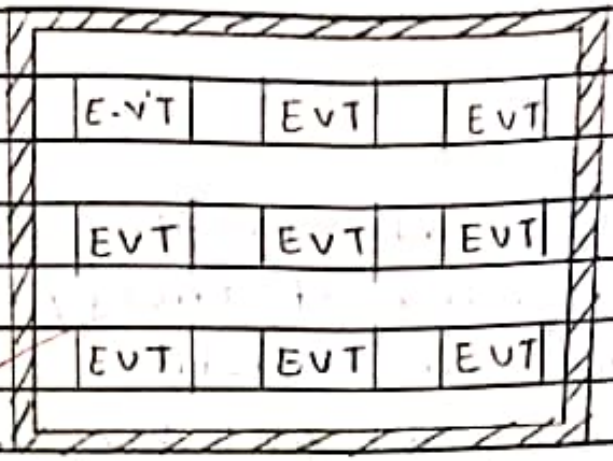


a) Microcanonical ensemble

ii) Canonical ensemble -

In this type the system has energy (E), volume (v) & Temperature (T).

- Because of Temperature (T) factor the energy required to flow inside the cell to maintain the temperature of compartment.
- The walls are rigid and well impermeable and conducting for Temperature.
- as compare to microcanonical ensemble the rate of power is get greater of canonical ensemble
- The entropy is change.

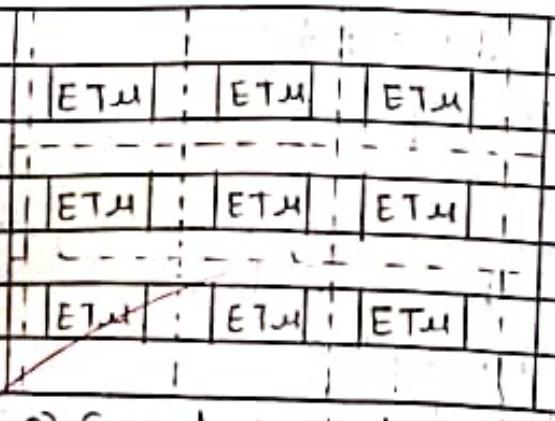


b) canonical ensemble

iii) Grand Canonical ensemble.

In this type the system has energy (E), Temperature (T) and internal energy (u).

- The walls are rigid, permeable because of u and conducting to flow of energy in the cell.
- The entropy is not same because of conducting walls.
- But the energy, temperature & internal energy is same in quantity.
- The walls structure is not that much strong because of this external temperature and can affect the cells / compartment.



c) Grand canonical ensemble.

1. Relation between entropy and probability.

→ For better understanding of thermodynamics the equation of energy is given by Maxwell-Boltzman statistics.

This is the most probable distribution for the system.

$$\therefore d(\log W) - \beta dv = 0 \quad \text{——— (1)}$$

From M.B. statistics

where, W = energy

$$\beta = \frac{1}{KT}$$

$$\therefore d(\log W) = \beta dv$$

$$d(\log W) = \frac{1}{KT} dv \quad \text{——— (2)}$$

∴ For the most probable distribution we have,

$$dQ = dU + Pdv$$

$$dQ = dU + Pdv$$

For a most probable distribution.

$$dU = 0$$

$$\therefore dQ = Pdv$$

put in eqⁿ (2)

d(log) in isochoric system

$$dQ = T\,ds.$$

put in eqⁿ (2)

$$d(\log W) = \frac{1}{KT} \cdot T\,ds$$

Name :- Anjali Bhagwan Kamble.

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VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Suppliment No. : 2.
Roll No. :
Class : M.Sc II

Subject : Statistical Mechanics.
Test / Tutorial No. : Internal Exam.
Div. :

integrating on both sides

$$\int d(\log W) = \frac{1}{KT} \int ds.$$

$$d(\log W) = K \cdot S.$$

At absolute zero kelvin, $S = C = 0$ constant.

The most probable and distinguishable value by Nernst is $S = C = 0$.

$$\therefore \quad S = K \log W.$$

This is the relation between entropy & probability.

06

Name: Vedaja Ajay Yadav

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VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor	

Suppliment No. : 1

Roll No. :

Class : M.Sc II

Subject : Statistical Mechanics

Test / Tutorial No. : Internal Examination.

Div. : 02+10+06 = 18

Q1.

1) a) $S = k \log W$ 01

2) b) position and momentum 01

02

22.

2) Gibb's paradox:

Gibb's paradox involves contrast of mixing of diff ideal gases (but distinguishable) and that of mixing of same gases. In case of different gases it is seen that there is change in entropy and in case of same gases it is seen that there is no change in entropy. In case of different gases the entropy increases.

According to the Boltzman we have relation,

$$S = k \log W \quad \text{—— (1)}$$

where, S = entropy

k = Boltzman constant

W = probability of the system.

Then according to MB statistics,

$$\log W = \log N! + \Sigma n_i \log g_i - \Sigma \log n_i! \quad \text{—— (2)}$$

Hence the most probable distribution of eqn (2) is,

$$\log W = \log \left[\frac{N!}{n_1! n_2! \ldots n_k!} + (g_1)^{n_1} \times (g_2)^{n_2} \times \ldots (g_k)^{n_k} \right]$$

Apply sterling's formula in eqn (2)

$$\log n! = n \log n - n.$$

$\therefore$ Eqn (2) becomes

$$\log W = \log N! + \Sigma n_i \log g_i - (\Sigma n_i \log n_i - n_i)$$

$\therefore$

$$\therefore \log W = \log N! + \Sigma n_i [\log g_i - \log n_i + 1]$$

$$\log W = \log N! + \Sigma n_i \left[\log \left(\frac{g_i}{n_i} \right) + 1 \right] \quad \text{—— (3)}$$

For most probable distribution,

$$n_i = \frac{g_i}{e^{\alpha + \beta E_i}}$$

where $\beta = \frac{1}{kT}$

$$\therefore e^{(\alpha + E_i/kT)} = \frac{g_i}{n_i}$$

$\therefore \log W = \log N! + \sum n_i$

Taking log on both sides

$$\log e^{(\alpha + E_i/kT)} = \log \frac{g_i}{n_i}$$

$$(\alpha + E_i/kT) \log e = \log g_i/n_i$$

$$\therefore \log g_i/n_i = \frac{\alpha + E_i}{kT}$$

$\therefore$ Eqn (3) becomes,

$$\log W = \log N! + \sum n_i \left[\frac{\alpha + E_i}{kT} + 1\right]$$

$$\therefore \log W = \log N! + \sum n_i \alpha + \frac{\sum n_i E_i}{kT} + \sum n_i \quad \text{---(4)}$$

Now put $\sum n_i = N$ and $\sum n_i E_i = \frac{3}{2} NkT$

$\therefore$ Substituting above values in eqn (4)

$$\therefore \log W = \log N! + N\alpha + \frac{3}{2} NkT + N$$

$$\therefore \log W = \log N! + N\alpha + \frac{5}{2} N$$

Q.3.

1) Relation between probability and entropy:

For better understanding of thermodynamics, statistical mechanics was developed. The basic concept of thermodynamics entropy and probability is given by Boltzman and it is given in eqn (1).

We have relation from MB statistics,

$$d(\log W) - \beta dU = 0 \quad \text{—(1)}$$

where, U = internal energy

β = Boltzman constant $\beta = \frac{1}{kT}$

W = ~~workdone~~ probability by the system.

$\therefore$ Eqn (1) becomes

$$d(\log W) = \frac{1}{kT} \cdot dU. \quad \text{—(2)}$$

For a system undergoing isobaric process the system has not to do any work. And then by 1st law of thermodynamics,

$$dU = dQ + dW.$$

But $dW = PdV$

$\therefore dU = dQ + PdV.$

As for isochoric process $dV = 0$

$\therefore dU = dQ$

On Substituting values, eqn (2) becomes.

$$d(\log W) = \frac{1}{kT} dQ. \quad \text{—(3)}$$

Then according to the defn of entropy

$$ds = \frac{dQ}{T}$$

$\therefore dQ = Tds$

Substituting the value of dQ in eqn (3)

$$\therefore d(\log W) = \frac{1}{kT} \cdot Tds. \quad \text{—(4)}$$

Name: Vedaja Ajay Yadav

SUPPLIMENT

Signature of Supervisor

Suppliment No. : 2

Roll No. :

Class : M.Sc II

Subject : Statistical Mechanics

Test / Tutorial No. : Internal Examination.

Div. :

On integrating eqn (4)

$$\int d(\log W) = \frac{1}{k}\int dS$$

$$\therefore \log W = \frac{1}{k} \cdot S$$

$$k \log W + c = S \quad \text{---(5)}$$

When system attains absolute zero temperature then the probabil is maximum and $T = 0K$. $W = 1$ = maximum

$$\therefore 0 + c = S$$

$$\therefore c = S$$

But according to Nernst.

$c = 0$ and $S = 0$

Substituting this values in eqn (5) we get

$$S = k \log W.$$

where,

S = entropy

W = probability

k = Boltzman constant

Gavi Balasaheb Gavade

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VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor	

Suppliment No. :

Roll No. : 1306

Class : MSc. II (Physics)

Subject : Atomic & Molecular Physics.

Test / Tutorial No. :

Div. :

17/20

Q. 1. MCQ.

1) 0.25

2. ~~b) decrease~~ a) Increases.

Q. 2.

1. Quantum state of an electron in hydrogen atom.

As Pauli said- every ~~ato~~ electron from an atom possess different set of quantum no.

Quantum ~~no~~ is state is ~~that~~ set of quantum no. which are describing the position, magnetic angular momentum, orbit no as well as the spin of electron.

$1s^1$

⊕ → Hydroge

1) Principal quantum no. -

→ denoted by 'n'

→ It describe in which energy level or shell the electron belongs.

According to K, L, M, N... shells, 1, 2, 3, 4 are no.

In case of hydrogen as it having 1 electron in K shell.

$n = 1$

2) Azimuthal / Orbit quantum no. - (l)
- denoted by (l)
- It describes in which ~~orbit~~ subshell electron is like in s, p, d, f like wise

Subshell	s	p	d	f
l	0	1	2	3

As hydrogen is in s shell.
For hydrogen
$\boxed{l = 0}$

3) ~~Orbital quanta angular momentum, magnetic~~ orbital angular momentum (m_l)
→ denoted by (m_l)
It is dependent on the l value.
as $m_l = +l$ to $-l$
In hydrogen $l=0$

$\therefore \boxed{m_l = 0}$

4) Spin quantum no. (m_s)
It is represented by (m_s)
as $m_s = +1/2$ & $-1/2$
$+1/2 \Rightarrow$ clockwise spin of electron
$-1/2 \rightarrow$ anticlockwise spin of electron
for hydrogen
$\boxed{m_s = +1/2}$

∴ In case of hydrogen,

n (Principle quantum no.) = 1

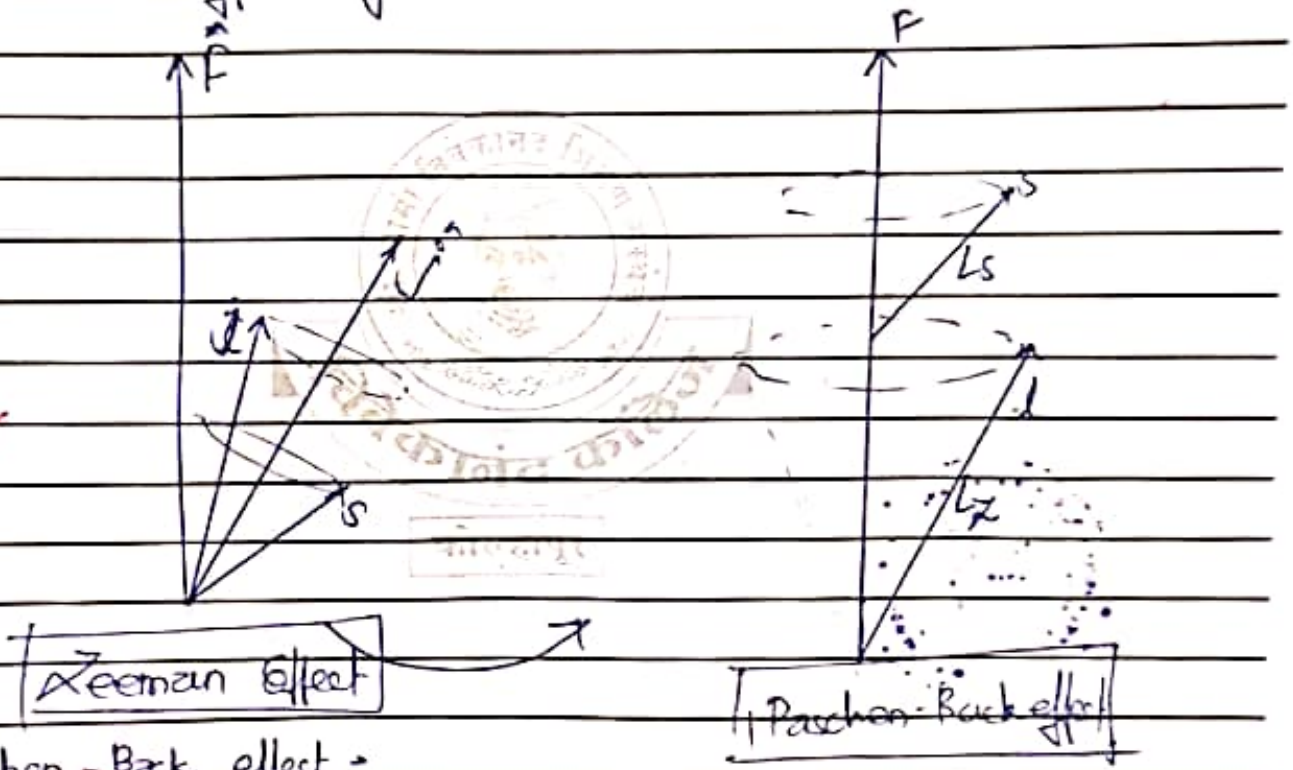
l = 0

m_l = 0

m_s = +1/2

| 1, 0, 0, +1/2 |

2. 2. Paschen-Back effect for 2 ~~atom~~ electron atom



Paschen - Back effect :-

~~As the stronger magnetic field is applied then coupling between the internal magnetic field, the coupling between l & s get change / broke down & the independently revolve around the magnetic component. on the respective components, L_z & S_z like wise.~~

As the stronger external magnetic field is applied then the coupling between l & s get change / broke down & the independently revolve around the magnetic component. on the respective components, L_z & S_z like wise.

$L_z = m_l \frac{\hbar}{2\pi}$ where, $m_l = 0, \pm 1$

$L_s = m_s \frac{\hbar}{2\pi}$ where, $m_s = \pm 1/2$

A we consider angular momentum, velocity

$$\omega_L = \frac{e}{2m} B$$

This is orbital orbital velocity.

& $\omega_S = \frac{2 \cdot e}{2m} B$

It is spin angular velocity.

As total energy they given

$$E_L = \omega_L L_z$$

$$= \frac{e}{2m} B \, m_\ell \frac{\hbar}{2\pi}$$

$$= \frac{eBm_\ell \hbar}{4\pi m} \quad \text{①}$$

$$E_S = \omega_S L_S$$

$$= \frac{2 \cdot e}{2m} B \, m_s \frac{\hbar}{2\pi}$$

$$= \frac{2 \, eBm_s \hbar}{4\pi m} \quad \text{②}$$

from eq^n no ① ②

$$\Delta E = E_L + E_S$$

$$= \frac{eBm_\ell \hbar}{4\pi m} + \frac{2 \cdot eBm_s \hbar}{4\pi m}$$

$$\Delta E = \frac{eB\hbar}{4\pi m} (m_\ell + 2m_s)$$

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SUPPLIMENT

Signature of Supervisor	

Suppliment No. :

Roll No. : 1206

Class : M.Sc. II (Physics)

Subject : Atomic & Molecular Physics

Test / Tutorial No. :

Div. :

As the magnetic field get stronger and stronger. The l or electron ~~forces~~ splits & forces different ~~orbital~~ l or revolution & s or spin.

as the magnetic field increased further the electron spin quantum moment & orbital quantum moment get separated & revolve around the magnetic field independently.

5

Q3. 1. Pauli - exclusion principle -

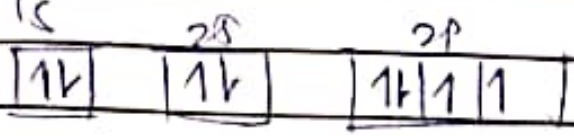
Statement - 1) No electron in same atom have exact same set of quantum no.s.

2) Electrons in same orbit have opposite spin.

As we take an example of Oxygen atom.

$Z = 8$.

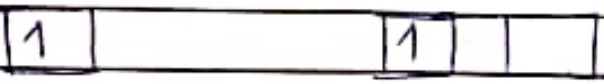
electronic configuration of $O_8 = 1s^2\ 2s^2\ 2p^4$



As we seen above,

If we consider 2 electrons of an atom.

let n_1 = 1s' n_2 = 2p'



As principle quantum no describes the no. of shell.

$\therefore n_1 = 1$ $n_2 = 2$

Orbital quantum no → l no of subshell.

$l_1 = 0$ $l_2 = 0$

Magnetic quantum no.

$m_{l_1} = 0$ $m_{l_2} = +1$

as it is in $2p_x$ shell

Spin quantum no

$m_{s_1} = +1/2$ $m_{s_2} = +1/2$

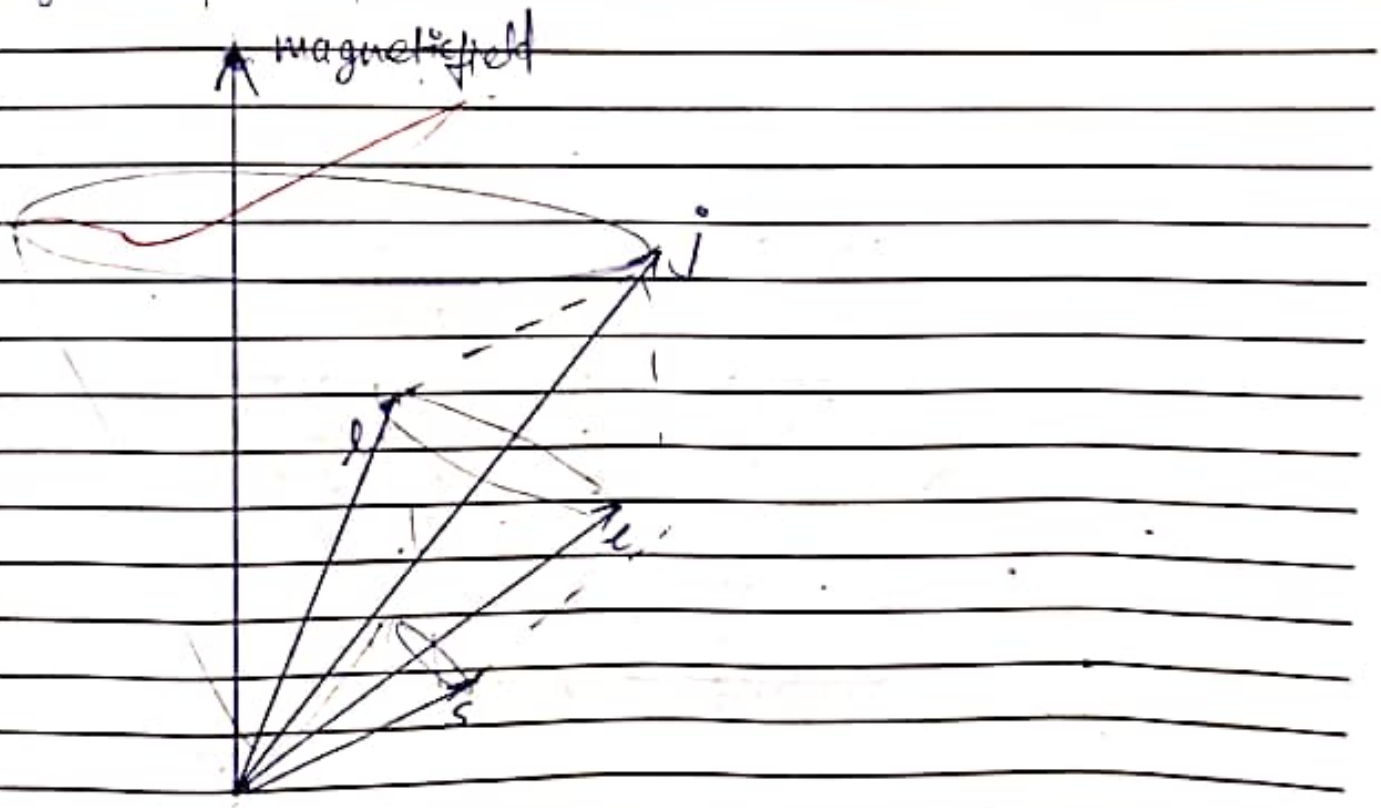
∴ Both electron posses different set of electrons quantization no.

1st electron ⇒ n, l, m_l, m_s → $1, 0, 0, +1/2$

2nd electron ⇒ n, l, m_l, m_s → $1, 0, 0, +1/2$

2. Zeeman effect:

When a weak magnetic field is applied on atom, The interaction between L & S coupling between in an atom become stronger. & they revolve around the L & S revolve around the magnetic field.
They will make split energy spectra - & give splitted spectra.



Eventually the resultant, component j will be there & it will revolve around the magnetic field.
And as a result we are able to see different. shifts of yellow colour.
This is zeeman effect.

Name :- Anjali Bhagwan Kamble.

॥ ज्ञान, विज्ञान आणि सुसंस्कार यांसाठी शिक्षण प्रसार ॥

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SUPPLIMENT

Signature of Supervisor :

Suppliment No. : 1.

Roll No. :

Class : M.Sc II

Subject : Atomic and Molecular physics.

Test / Tutorial No. : Internal Exam.

Div. :

12/20

Q.1.

1.

→ b) 0.25

2.

→ ~~b) Decreases.~~ a) increase

Q.2.

ii. Paschen - Back effect -

→ The Paschen Back effect is the ~~strong~~ strong field effect.

The spliting of energy levels in the contact of magnetic field is called as Paschen Back effect.

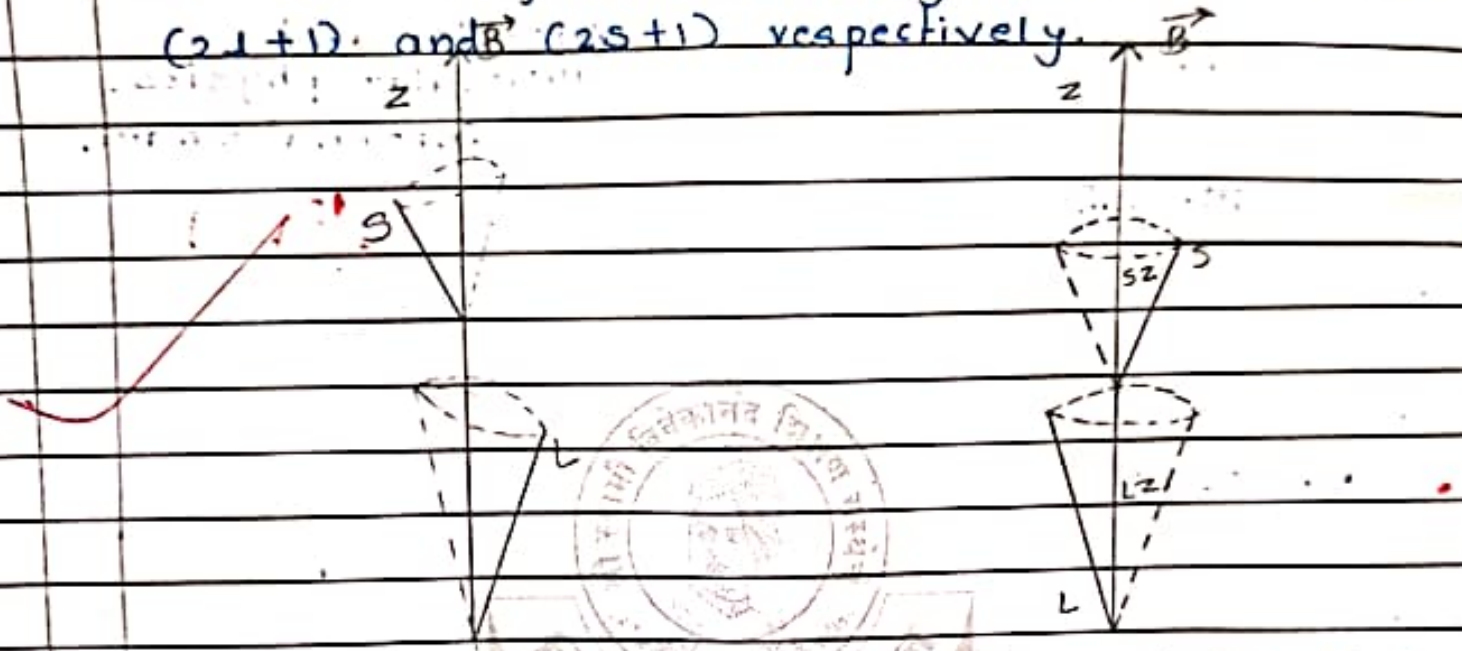
This effect overcomes of zeeman effect which is weak field effect.

In paschen - Back effect the the particle

ii are in the direction of strong & external magnetic field.

The L & S particle is closely bound in the direction of z & $\vec{B}$

The L & S have only possible values is $(2l+1)$ and $(2s+1)$ respectively.



(a) Zeeman effect weak field (b) Paschen Bork effect strong field

In fig. b we can observe that the L & S are in the direction of z & magnetic field $\vec{B}$

So,

$$L_z = m_l \frac{h}{2\pi} \quad \& \quad S_z = m_s \frac{h}{2\pi}$$

for interaction with the z,

$$\omega_L = \frac{|\vec{\mu}_l|}{|\vec{L}|} B \qquad \omega_S = \frac{|\vec{\mu}_l|}{|\vec{S}|} B$$

$$\omega_L = \frac{e}{4\pi} B \qquad \omega_S = 2 \frac{e}{4\pi} B$$

2 ii. interaction energy.

for S,

$$\Delta E_S = \omega_S S_Z$$

$$\Delta E_S = 2 \cdot \frac{e}{4\pi} B M_S \frac{h}{2\pi}$$

$$\Delta E_S = 2 \cdot \frac{ehM_S B}{4\pi}$$

for L,

$$\Delta E_L = \omega_L L_Z$$

$$\Delta E_L = \frac{e}{4\pi} B \cdot M_L \frac{h}{2\pi}$$

$$\Delta E_L = \frac{ehM_L B}{4\pi}$$

∴ Total internal energy.

$$\Delta E = \Delta E_S + \Delta E_L$$

$$\Delta E = 2 \cdot \frac{ehM_S}{4\pi} B + \frac{ehM_L}{4\pi} B$$

$$\Delta E = \frac{ehB}{4\pi} (2M_S + M_L)$$

In wave no.

$$-\Delta T = \frac{\Delta E}{hc}$$

$$-\Delta T = (M_L + 2M_S) \frac{ehB}{4\pi} \cdot \frac{1}{hc}$$

$$-\Delta T = [(M_L + 2M_S) L'] \quad \text{—— Lorentz formula.}$$

i. Pauli exclusion principle.

→ · In pauli exclusion principle states that, the two or more particles with half integral spin does not i.e. fermions cannot have the same quantum no. or state.

· This exclusion principle was found by Austlian scientist in 1925.

· In two-electron atoms they can follows the statement :- when two particles of same atom are in the orbit their principle quantum no. (n), orbital quantum no. (l) and spin quantum no. (s) are same but their magnetic quantum no. (m_l) are have two different values.

· The values are in half integral i.e. $+\frac{1}{2}$ or $-\frac{1}{2}$ so for above m_l have value $m_l = +\frac{1}{2}$ or $m_l = -\frac{1}{2}$

· But they do not have both the values at a time.

· In integral spin the particle have two values are in steady state called as Bosons.

· Bosons does not follows the pauli exclusion principle.

· In Bosons. the value of a particle is in integral spin if they do not change their energy if they goes from one shell to another.

· In this exclusion principle the particle

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3 i. is going ~~from~~ to upper state and decreases their energy.

· In the case of fermions the energy is varying from lower state to upper state. while in Bosons the energy remains same in all states.

3.

ii. Zeeman effect –

The spliting of energy level in the presence of electric field.

Dak: 28/9/2024

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25/26

Q1]

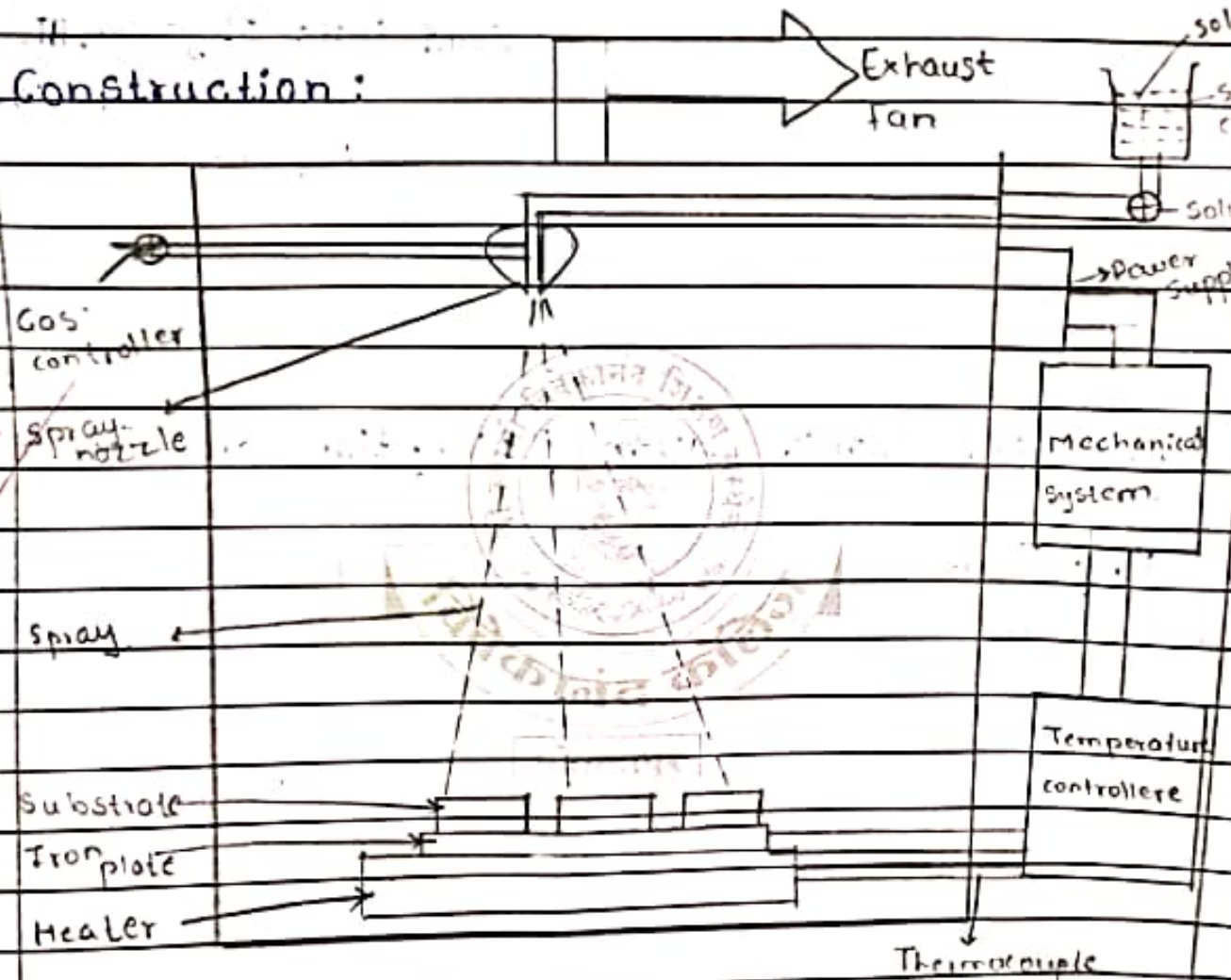
1. a) Successive Ionic layer Adsorption and Reaction

2. a) Physical.

Principle:

The Spray pyrolysis is technique of synthesizing nanomaterial by spraying precursor onto a hot substrate.

Construction:



Working:

a) Prepare a precursor solution and pour it in a solution container.

b) Set the required parameter such as speed on mechanical system and temperature on temperature controller.

c) Thermocouple is used to measure the temperature inside the system.

d) The spray nozzle here is rotating nozzle which uniformly spray solution on large areas of substrate.

e) ~~The Switch~~ e. Place the substrate on iron plate and switch on the system.

f) The solution to be sprayed is controlled by solution controller.

f) The compressed air gas is required to carry out the process.
So the flow of compressed gas is given to the system, this produces droplets of solution called aerosols to uniformly deposit a layer on the substrate

g) The pressure of the gas is controlled.

h) The by products which are volatile are exhausted out by exhaust fan.

Mechanism of film.

a)

b) Solvent evaporation takes place

c) Vaporization of precipitate leads to the formation of droplets / aerosol which approaches the substrate.

d) Precipitate approaches the substrate in succession.

e) Growth of ~~ee~~ nuclei begins to occur on substrate

f) finally, nuclei grows to give a thin layer film.

Reaction:

Consider aqueous solution of nickel chloride is used to form nickel oxide layer of thin film on glass substrate.

$NiCl_2(aq) + 6H_2O \longrightarrow NiO + 2HCl + 5H_2O$

The properties of film depends upon:

a) Temperature of substrate
b) Ambient atmosphere
c) Spray rate
d) Carrier gas
e) droplet size
f) cooling deposition time

The thickness of the film depends upon

a) distance between spray nozzle and substrate
b) concentration of precursor solution
c) amount of solution

Advantages of spray pyrolysis method are:

a) It gives high deposition rate
b) It produces good quality, uniformity and reproducibility of thin film
c) It is cost effective technique that can cover large areas

Disadvantages:

a) Removal of hazardous gases, toxic gases
b) less environment friendly

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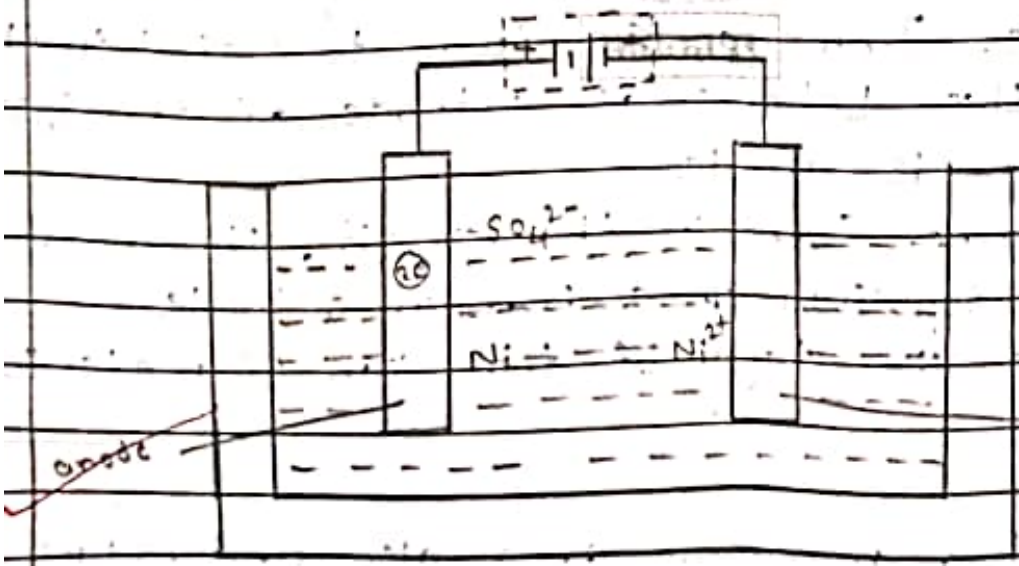
Principle:

Electrodeposition is a technique of coating layer of one metal on the top of another metal to improve surface properties.

Construction:



Reactions:

At anode :- $Ni \longrightarrow Ni^{2+} + 2e$

At cathode : $Ni^{2+} + 2e \longrightarrow Ni$

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Working:

a) Prepare an electrolyte solution for eg., here $NiSO_4$ solution.

b) Immerse Thus, prepare a chemical bath in container.

c) Immerse the substrate on which we want deposition.

d) Given an external power supply to these two electrodes.

e) When current flows through electrolyte, the cations (Ni^{2+}) moves towards cathode and anion moves towards anode (SO_4^{2-}).

f) The deposition of material takes place by charge transfer reaction.

g) In other words, the electroplating is done by electrodeposition; which is analogous to galvanic cell acting in reverse.

h) Take a bath of solution containing one or more metal ions. Immerse the item to coated in the solution, this behaves as cathode of the system and another is anode.

i) When current flows in the circuit, the metal ions are deposited on a item or cathode. This forms the layer of thin film of metal ions.

Advantages:

a) It can cover maximum area also underedges and cuts.

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Subject : SSP III (Thin solid films: Deposition & Properties)

Test / Tutorial No. : Internal Exam.

Div. : 18/20

1.

1.

→ a) Successive Ionic Layer Adsorption and Reaction.

2.

→ a) Physical.

3

2. CBD.

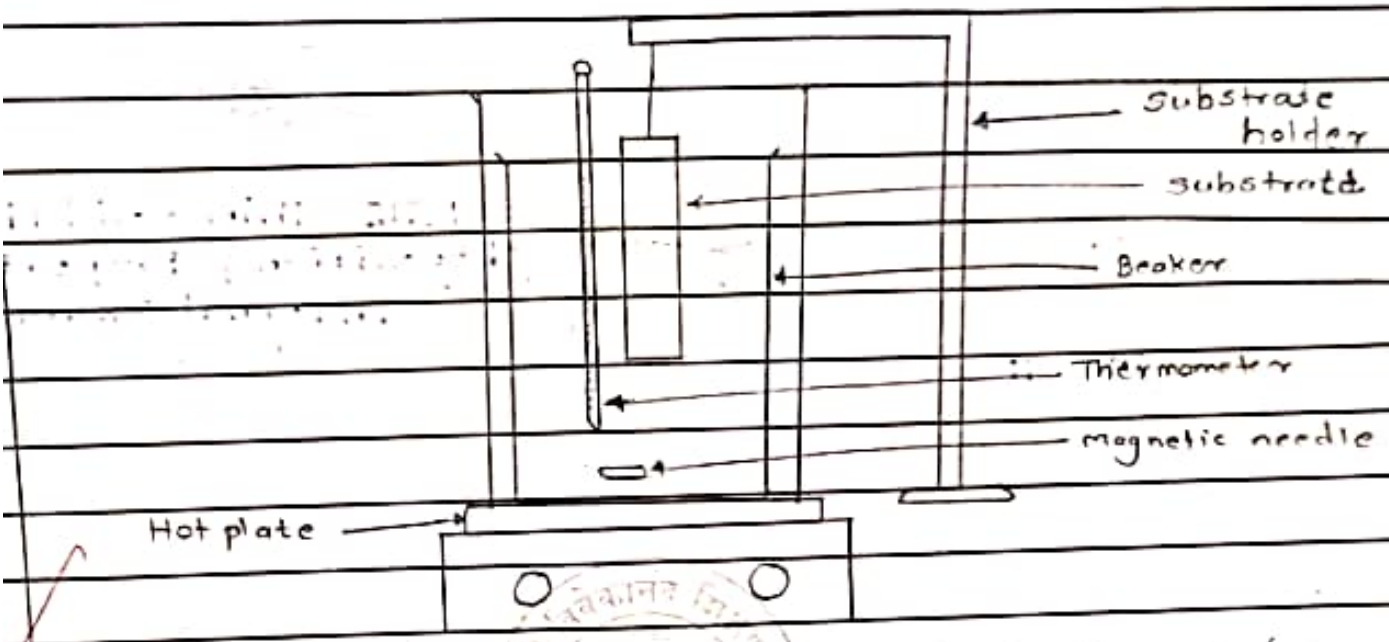
→ The CBD stands for chemical Bath Deposition.

∴ The CBD technique is one of most simple and convinient method for the deposition.

∴ It can be do in small laboratory and in very easy way.

∴ The deposited slide ~~is~~ is very good in condition as compared to other techniques.

Experimental setup. –



Construction :-

- The beaker consist of solution and the substrate is placed in between the solution with the help of substrate holder.
- The magnetic needle is in the bottom of solution for ~~string~~ stir.
- Thermometer is placed to maintain the temperature.
- All this is on the hot plate.

Working –

- Prepare the solution of given material in maximum 50 of DDW.
- With the help of amonia adjust the pH of the solution for good film.
- Take all this process on the magnetic stirrer with the help of magnetic needle.
- When the solution is becomes transparent

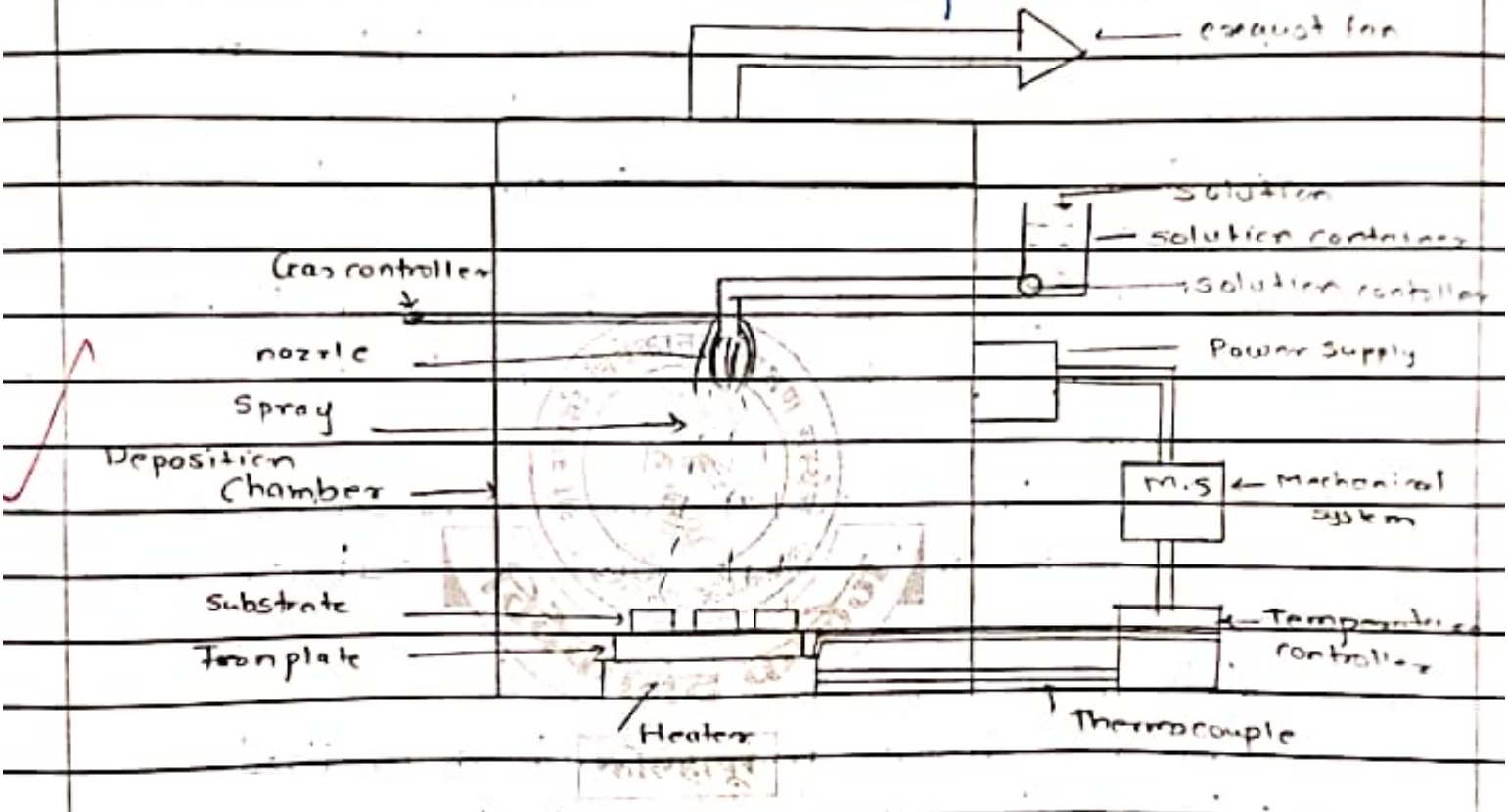
take it on the hot plate.
· Maintain the temperature around 70°C.
· After heating dip the substrate in this solution.
· Maintain the temperature again after 15-20 minutes and leave it for ~~2 or~~ 2-3 hr.
· After this take out the slide and dry it with the drayer with cold vapour.
· Then leave for 10-15 min and completly dry it.
· Clean one side of substrate and placed it in the muffle furnace at 400°C for 4-5 hours.
· After this turn of furnace & cool down the substrate and then take it out of furnace.

Advantages :-
· It is simple and convinient method.
· Does not required large area.
· Not so costly.
· No harmful chemical used.

Disadvantages :-
· ~~Fatne~~ Takes too much time.

1. Spray pyrolysis technique :-

Spray pyrolysis technique of synthesis nanomaterials spraying on hot substrate. It is chemical method used for deposition.



Principle -

It works on the principle of spraying the precursor solution on the hot substrate in the form of aerosole.

Construction and Working -

. The technique is takes place in the closed packed chamber with high temperature.
. The precurs solution is pored into a beaker with then there is a solution container which converts the solution into aerosoles.

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Class : M.Sc.II

Subject : SSP III (Thin Solid Films) Deposition and properties
Test / Tutorial No. : Internal Exam.
Div. :

- These formed aerosols are then sprayed on the substrate. During this process the temp. has to be maintain very well. As also the pressure so for cont-ing there are controllers.
- The formed aerosole fall on the substrate with the help of nozzle.
- Here the distance between nozzle and substrate has to be maintained to get perfect slide or deposition.
- The hardness of glass are formed during the process of are thrown out with the help of exaust fan.

Advantages -
- We can get the good type of film.
- Required short time.
- No solution is waste
- Layer of deposition is seen.

Disadvantages -
- You have to take precaution during experiment

because of smell

- Have to maintain the pressure all the time.
- The flow of solution have to maintain.

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Department of Physics

B.Sc. / M.Sc. Part – II, Semester – III, PHYSICS Paper - I

Title of the Paper: Stastical Mechanics, S.M. and Solid State Physics

Name of Teacher: _____

Attendance Sheet – Internal Exam - M.Sc-II

Sr. No.	Name of the Student	24/09/24 Statistical mech.	25/09/24 Atomic nucle. Phy.	26/09/24 (SSP)			
1)	AKASH . B. KAVATHEKAR						
2)	Sujash S. Dongare						
3)	Dhiraj . P. Bhingardeve						
4)	Devkule Nishigandha. N						
5)	Anjali B. Kamble.						
6)	Mahek S. Jamodar						
7)	Vedaja A. Yadav						
8)	Gouri Balasaheb Gavade						
9)	~~Mahe~~						
10)							
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