Department of Physics

Vivekanand College, Kolhapur (Autonomous)

Notice for Internal Examination in Physics for B.Sc. III

It is hereby informed that; students of B.Sc. III should note that their Internal Examination in Physics will be conducted as per following time table.

Date	Time	Class	Subject	Topics
Monday, 10/04/2023	02.30 to 03.30 PM	B.Sc. III	Paper VII section I Semiconductor Devices and Instrumentation	Instrumentations: Introduction to CRO and Timer IC 555
Tuesday, 11/04/2023	02.30 to 03.30 PM		Paper VII section II Elements of Modern Physics	Atomic Physics
Wednesday, 12/04/2023	02.30 to 03.30 PM		Paper VIII section I Solid State Physics-I	Magnetic properties of materials
Thursday 13/04/2023	02.30 to 03.30 PM		Paper VIII section II Solid State Physics-II	X-Ray Diffraction

Seating Arrangement (Engineering Building): Room No. 301

Nature of Question Paper

Q.1) Select correct alternative (5 Marks)
Q.2) Long answer type question (10 Marks, Attempt any One)
Q.3) Short answer type question (5 Marks, Attempt any One)
Total Marks: 20 Marks

VIVEKANAND COLLEGE ESTD JUNE 1964 KOLHAPUR - 416003

HOD, Physics
Head of the
Department of Physics
Vivekanand College, Kolhapur

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur

(Autonomous)

Department of Physics

Internal exam (2022-23)

B.Sc.III Sem VI

Attendance Sheet

Roll No.	Name Of The Student	Signature			
		20/04/2023	21/04/2023	22/04/2023	23/04/2023
8201	Bhingardeve Dhiraj Prakash	Dheeraj	Dheeraj	Dheeraj	Dheeraj
8202	Dongare Prathamesh Abaji	PADongare	PADongare	PADongare	PADongare
8203	Dongare Suyash Sanjay	Dongare	Dongare	Dongare	Dongare
8204	Gaikwad Rajnandini Ganesh	ggaikwad	ggaikwad	ggaikwad	ggaikwad
8205	Jadhav Saee Sandeep	Saii	Saii	Saii	Saii
8206	Jamadar Mahek Shakilahmed	Mehek	Mehek	Mehek	Mhek
8207	Kalkutki Shubham Babasaheb	Skalkutki	Skalkutki	Skalkutki	Skalkutki
8208	Kamble Anjali Bhagwan	Anjali	Anjali	Anjali	Anjali
8209	Kothawale Tejas Vikas	KVTejas	KVTejas	KVTejas	KVTejas
8210	Maner Aman Imtiyaj	Amaner	Amaner	Amaner	Amaner
8211	Padmakar Alok Narayan	AManer	AManer	AManer	AManer
8212	Patil Aaryan Pramod	aaeyan	aaeyan	aaeyan	aaeyan
8213	Shinde Vivek Janardan	Shinde	Shinde	Shinde	Shinde
8214	Shingade Aishwarya Deepak	Aish	Aish	Aish	Aish
8215	Singh Sapana Raviranjan	Sing	Sing	Sing	Sing
8216	Warke Shriyash Keraba	Swarke	Swarke	Swarke	Swarke
8217	Yadav Vedaja Ajay	V.A.Yadhav	V.A.Yadhav	V.A.Yadhav	V.A.Yadhav

Internal Examinar.....

VIVEKANAND COLLEGE KOLHAPUR (Autonomous) ESTD JUNE 1964

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Autonomous)

Internal Examination 2022-23

PHYSICS-DSC -1001F1

B.Sc. – III, Sem – VI Semiconductor Devices and Instrumentation

Time: 30 Minutes Marks: 20

Q. 1. LONG Answer Questions (Any one) **(10)**

1. Explain different parameters of Op-amp.
2. Draw the block diagram of IC 555 and explain the working of IC 555.

Q. 2. SHORT Answer Questions (Any two) **(10)**

1. Describe pin configuration of IC 555 with pin diagram.
2. Explain Op-amp as adder and subtractor amplifier.
3. Explain load line with suitable diagram.

VIVEKANAND COLLEGE KOLHAPUR * (Autonomous) * ESTD JUNE 1964

।। ज्ञान, विज्ञान आणि सुसंस्कार यासाठी शिक्षण प्रसार ।।
- शिक्षणमहर्षी डॉ. बापूजी साळुंखे

27635

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

(15/20)

Signature of Supervisor

Suppliment No. :

Roll No. : 8203

Class : B Sc III

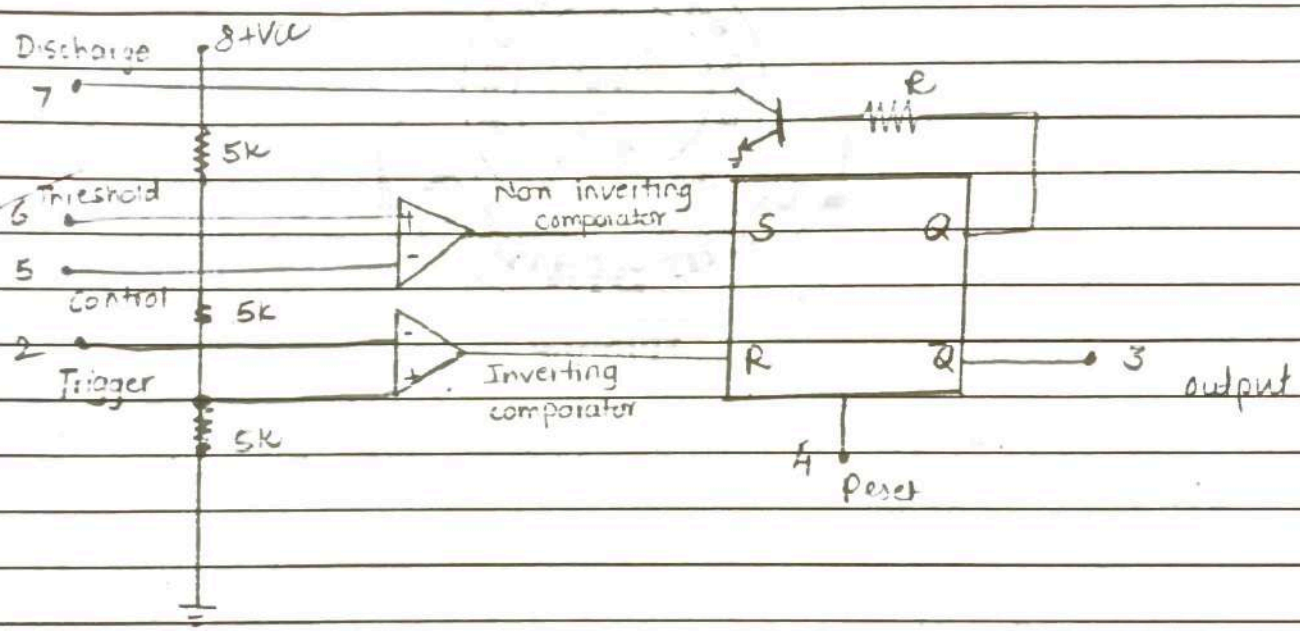
Subject : Semiconductor device and Instrumentation

Test / Tutorial No. :

Div. :

Q 1)

2) Block diagram of IC 555



It contains a voltage divider, two comparators, RS flip-flop and an NPN transistor. The IC 555 uses three resistors of 5kΩ therefore, the name is given as IC 555.

Voltage divider Network :-

The voltage divider is formed by using a series Combination of three resistances of 5kΩ. As it is a series

network it provides two reference voltages of + 2/3 Vcc and + 1/3 Vcc. The reference voltages are applied to the comparators constructed by using op-amp.

Comparators :-

IC 555 consists of two comparators named as Threshold comparator and Trigger comparators. The threshold comparators is non-inverting and it has a reference voltage of 2/3 Vcc. The pin no. 6 is the input terminal of the threshold comparator. When the Threshold voltage is greater than the reference voltage of 2/3 Vcc it produces high output voltage and when the threshold voltage is less than the reference voltage is less than the reference voltage of 2/3 Vcc it produces a low output voltage.

The trigger comparator is an inverting comparator and it has a reference voltage of 1/3 Vcc. The pin no. 2 is the input terminal of trigger comparator. When the trigger voltage is less than the reference voltage of 1/3 Vcc it produces high output voltage and when the trigger voltage is greater than the reference voltage of 1/3 Vcc it produces a low output voltage.

The outputs of both comparators are given to the RS flip-flop circuit.

R-S flip flop →

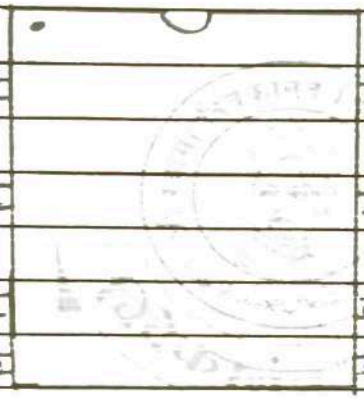
R-S flip flop operates with either +Ve block transition. It has two points R and S and two outputs Q(+) and Q(+') they are complement of each other. This is the state stable of R-S flip flop give below.

S	R	Q	$\bar{Q}$
0	0	Nc	Nc
0	1	0	1
1	0	1	0
1	1	–	–

The outputs of both comparators are applied input of RS flip flop.

Q 2)

1)



Pin 1 :- It is a ground terminal. All voltages are measured with respect to ground terminal.

Pin 2 :- The trigger pin is used to feed the trigger input.

Pin 3 :- Output is available at this pin.

Pin 4 :- Whenever Ic is to be reset or disabled negative pulse is applied to pin 4.

Pin 5 :- The threshold and trigger levels are controlled using this pin.

Pin 6 :- This is the non-inverting input terminal comparator which compares the voltage applied to the terminal with refrence voltage 2/3 V_{CC}.

Pin 7 :- This pin is connected internally to the collector of transistor and mostly a capacitor is connected between this terminal and ground. When transistor saturates capacitor discharges through the transistor when the transistor is cut-off the capacitor charge.

Pin 8 :- A supply terminal of +45V to +16V is applied to the terminal with respect to ground.

।। ज्ञान, विज्ञान आणि सुसंस्कार यासाठी शिक्षण प्रसार ।।
– शिक्षणमहर्षी डॉ. बापूजी साळुंखे 34609

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

15/20

Suppliment No. :

Roll No. : 8216

Class : B.Sc III

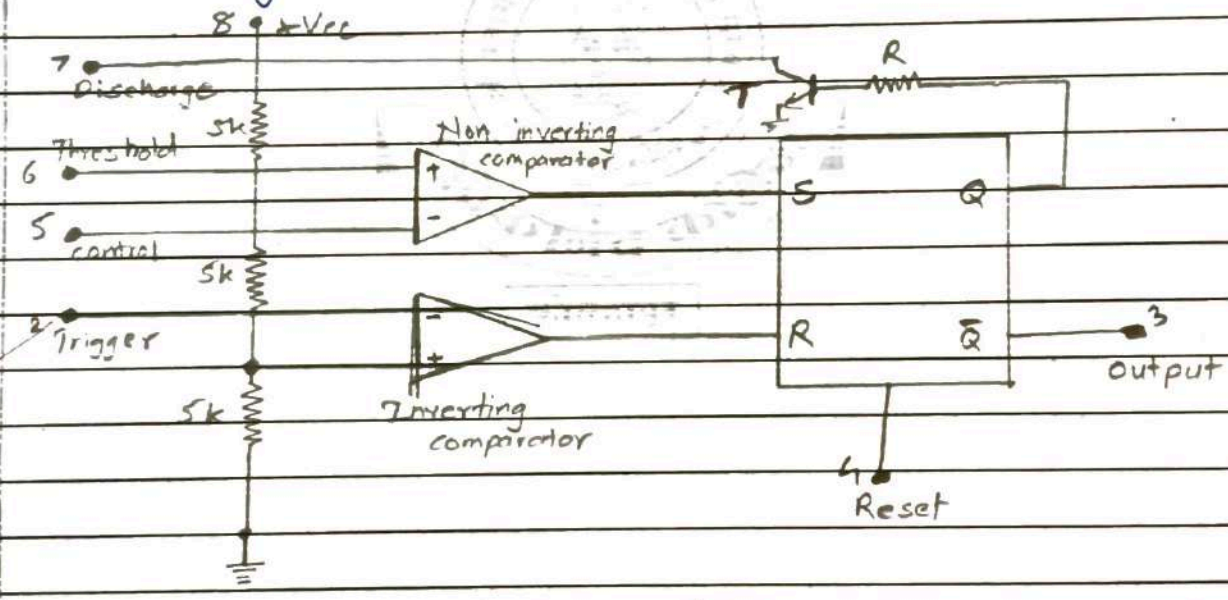
Subject : Semiconductor device & Instrumentation

Test / Tutorial No. : Internal exam

Div. :

Q.1

2) Block diagram of IC 555



It contains a voltage divider, two comparators, RS flip-flop, and an NPN transistor. The IC 555 uses three resistors of 5 kΩ, therefore, the name is given as IC 555.

Voltage divider network :-

The voltage divider is formed by using a series

combination of three resistances of 5 kΩ. As it is a series network it provides two reference voltages of +2/3 Vcc and +1/3 Vcc. The reference voltages are applied to the comparators constructed by using op-amp.

comparators :-

IC 555 consists of two comparators named as Threshold comparator and Trigger comparators.

The Threshold comparator is non-inverting and it has a reference voltage of 2/3 Vcc. The pin no. 6 is the input terminal of the Threshold comparator. when the Threshold voltage is greater than the reference voltage of 2/3 Vcc it produces high output voltage and when the Threshold voltage is less than the reference voltage is less than the reference voltage of 2/3 Vcc it produces a low output voltage.

The Trigger comparator is an inverting comparator and it has a reference voltage of 1/3 Vcc. The pin no 2 is the input terminal of Trigger comparator. when the Trigger voltage is less than the reference voltage of 1/3 Vcc it produces high output voltage and when the Trigger voltage and ~~when the~~ is greater than the reference voltage of 1/3 Vcc it produces a low output voltage. The outputs of both comparators are given to the RS flip flop circuid.

Rs Flip flop :-

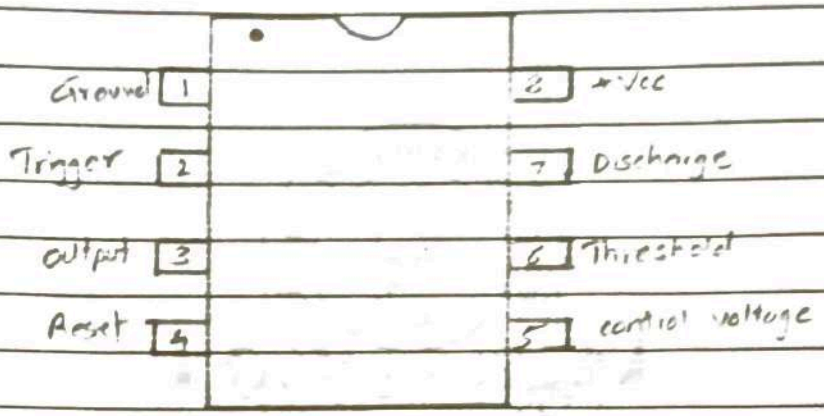
R-S flip flop operates with either +ve clock transition. It has two inputs R and S and two outputs Q(t) and Q(t') they are complement of each other This is the state stable of R-S flip flop give below.

S	R	Q	$\bar{Q}$
0	0	No	No
0	1	0	1
1	0	1	0
1	1	-	-

The outputs of both comparators are applied input of RS flip flop as shown.

Q. 2

1)



Pin 1 :- It is a ground terminal. All voltages are measured with respect to ground terminal.

Pin 2 :- The trigger pin is used to feed the trigger input. ~~when the IC 555 is set up as~~

Pin 3 :- output is available at this pin.

Pin 4 :- whenever IC is to be reset or disabled negative pulse is applied to pin 4.

Pin 5 :- The threshold and trigger levels are controled using this pin.

Pin 6 :- This is the non-inverting input terminal comparator which compares the voltage applied to the terminal with reference voltage 2/3 Vcc.

Pin 7 :- This pin is connected internally to the

collector of transistor and mostly a capacitor is connected between this terminal and ground. when transistor saturates capacitor discharges through the transistor when the transistor is cut-off the capacitor charge.

Pin 8:-

A supply terminal of +45V to +16V is applied to the terminal with respect to ground.

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Autonomous)

Internal Examination 2022-23

PHYSICS-DSC -1001F1

B.Sc. – III, Sem – VI Elements of Modern Physics

Time: 30 Minutes

Marks: 20

Q. 1. LONG Answer Questions (Any one) **(10)**

1. Write explanation of anomalous Zeeman effect on Vector atom model.
2. Explain Zeeman Effect (normal, anomalous) .

Q. 2. SHORT Answer Questions (Any two) **(10)**

1. Write down selection rules for spectral lines in Zeeman effect.
2. Write a note on quantum numbers.
3. Explain vector atom model.

08065

Signature of Jr. Super.

विवेकानंद कॉलेज (स्वायत्त) कोल्हापूर.

परीक्षेच्या — या विषयाच्या प्रयोग परीक्षा

Practical Examination in Internal Examination

at the Atomic Examination

12/20

उमेदवाराचा आसन क्रमांक (Candidate's Seat No.) B203

विभाग (Section)

उमेदवारांना सूचना

१. प्रश्न काळजीपूर्वक वाचा आणि त्याप्रमाणे विचारलेला प्रयोग करा.

२. उपकरणांच्या वापराबाबत तुम्हांला काही माहीत नसेल तर परीक्षक किंवा प्रयोगशाळा सहाय्यक यांना तुम्हाला मदत करण्याविषयी विनंती करा.

३. कोणताही विद्युतप्रयोग करण्यापूर्वी, प्रत्यक्ष पुरविलेली सर्व उपकरणे आणि सर्व 'कनेक्शन' नीट पाहून घेऊन संबंधित कामाची नीटनेटकी कार्ययोजना करण्याची नितांत आवश्यकता आहे आणि ह्या नंतर, पुढे काम चालू करण्याविषयी परीक्षकांची परवानगी मिळविणे आवश्यक आहे.

४. सर्व निरीक्षणे कोष्टकवजा तक्त्यात भरावी. मधल्या सर्व गणना आणि निर्णय हे शक्य तितक्या सुवाच्यपणे आणि स्पष्टपणे नोंदविलेले असणे हे हितावह आहे.

५. प्रारंभिक किंवा अंतिम निरीक्षणात संख्यावाचक आकडे एकावर एक लिहू नयेत. जर लिहिलेला कोणताही आकडा नको असेल तर त्यावर एक रेघ ओढून पाहिजे असलेला आकडा त्याच्याजवळ लिहा.

६. प्रयोगशाळेतून बाहेर पडण्यापूर्वी आपले टेबल चांगल्या स्थितीत आहे याची खात्री करा.

INSTRUCTIONS TO CANDIDATES

1. Read the question carefully and perform the experiment as required.
2. If there be anything the apparatus that you do not know, ask the examiner or the laboratory assistant to help you,
3. Before doing any electrical experiment, it is obsolutely essential that you make a neat working sketch of all apparatus actually provided and of the necessary connection, and obtain the examiner's permission to proceed.
4. Express all observations in a tabular form.
   It is also desirable that all intermediate calculations and results should be entered as neatly and clearly as possible
5. No numerical figures should be written over either in the preliminary or final observations. If any figure is shought to be discarded it should be run through and the desired figure written near to it.
6. Please see that your table is in good order before you leave the laboratory.

(येथून लेखनास सुरवात करा.) (Begin writing here.)

Q.1	Write a note on Quantum Numbers associated with vector model.
Q.2	Explain Spin Orbit Interaction
Q.3	What is zeeman effect ? Explain Normal effect and anomolnous zeeman effect ?
Q.4	Explain Zeeman Spliting of D_1 & D_2 lines.

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No. 1.) → Quantum — Numbers

Quantum Numbers according to vector a
model is such as. we can defined
Quantum numbe simply.

① Total + Principal Quantum Number :- (n)

Total + Principal Quantum number represent by 'n' and it's defined the orbit of atom where's e⁻ stayed. basically with the's quantum we can find the position of e⁻ in orbit. In Bohr's sommerfield model and it can be defined as -

$$P_n = \frac{nh}{2\pi}$$

if n=1 then it will be in K-shell, for n=2 it L-shell and for n=3 it's M-she

② Orbital angular Number :- (l) this quantum number is represented by (l) which can ~~contains~~ defines the subshell where's the e⁻ stayed. and it depend upon the no. of (n-1) value

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

i.e. if $n = 5$ then the value of l will be 0, 1, 2, 3, 4. $\boxed{P_l = \sqrt{l} \frac{h}{2\pi}}$

3) Spin momentum number :- it this quantom is represent by [S] and simly defines the value of e⁻'s spin motion. and e⁻ has only two spin motion which $= \pm 1/2$.

$$ds = \frac{sh}{2\pi}$$

4) Total ~~A~~ or Anguller moment :- $\vec{J}$ it's defined with ~~#~~ Intraction of $\vec{L}$ & $\vec{S}$ Quantum numbers, it is the resultant. and the value of this no. is -

$$\boxed{\vec{J} = \vec{L} + \vec{S}}$$

∴ $\vec{S}$ has only fix value such $\pm 1/2$

So that $\boxed{\vec{J} = \vec{L} \pm 1/2}$

it's $\boxed{P_{\vec{J}} = \frac{J + (J+1)\hbar}{2\pi}}$

5) Magnetic moment number :- it's represented by $\vec{m}$. & it's depend on projection of $\vec{L}$ which has ranging like $-l$ to $+l$ i.e if $l = 2$ then, the value of m will be $+2, +1, 0, -1, -2$ it contain '0' and has integers only

$$\boxed{P_m = \frac{mh}{2\pi}}$$

Section	Q. No.												
	Marks												

प्र. क्र. / Q. No. 3.

Explained by the atomic model :-

In the atom like one valence e- Splitted like Hydrogen & ionised Helium. due to external magnetic field Spectral lines are splitted out and occours in to componet is known as zeeman effect. When the magnetic field of the atom is strong then the splitting of Spectrum is occu into two or three lines. it's called 'Normal zeeman effect' which can explained quantitatively by classical theory. But when the the magnetic field is weak then the Splitting of lines is spectrum occours in to more than 3- component is "anomonious zeeman effect"

Anomoious Zeeman Effect by Vector model.

When the weak magnetic of field is on the Orbital. atom. then atom has orbital motion ($\vec{l}$) as well as it has spin motion. ($\vec{s}$) it mean e- has both orbital angular momentum & spin angular momentum. due to the Intract of both momentum we get resultant $\vec{J}$. It's known as $\vec{J}$.

$\vec{l}$ & $\vec{s}$ precession about $\vec{J}$

Section	Q. No.											
	Marks											

प्र. क्र.
Q. No.

In the Hydrogen and ionised Heli The coupling of $\bar{I} + \bar{S}$ is not broken so, that the resultant we get $\bar{J}$. Now let move on the $\bar{H}$ which comes due to precession of $\bar{J}$ about $\bar{H}$, as shown in fig. given below.

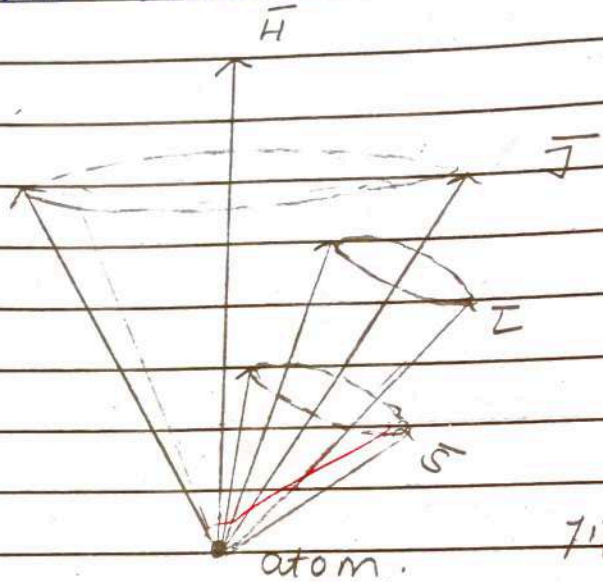


Fig. (B)

From the figure (B) we can see $\bar{J}$ precession about $\bar{H}$. i.e. energy could change.

$$\boxed{dE = \frac{eh}{4\pi m}} \quad \text{---} \ (1)$$

Section	Q. No.												
	Marks												

Q. No. 4)

Splitting of D_1 lines :-

D_1 lines transition are -

$$P_{1/2} \longrightarrow S_{1/2}$$

In ~~this~~ $P_{1/2}$ splitting it has ~~&~~ two m_j 's values. So we can say that $P_{1/2}$ line state in two components which is

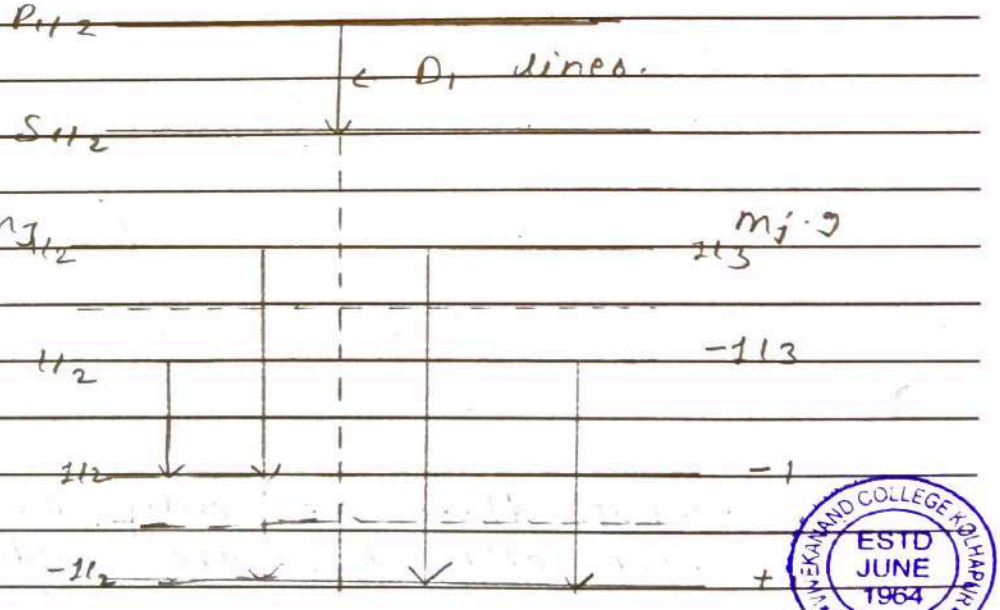
$$+1/3 \text{ , } -1/3.$$

while $S_{1/2}$ has two m_j 's values which are $+1, -1$.

So in total we have 4 components in D_1 - line transition.

i.e. Total value

$$\boxed{\Delta m_J = 0, \pm 1}$$



12/20 P

08028

Signature of Jr. Super.

विवेकानंद कॉलेज (स्वायत्त) कोल्हापूर.

परीक्षेच्या ——— या विषयाच्या प्रयोग परीक्षा

Practical Examination in Internal Examination

at the ——— Examination

उमेदवाराचा आसन क्रमांक (Candidate's Seat No:) 8204 विभाग (Section) Physics (Atomic Physics)

उमेदवारांना सूचना

१. प्रश्न काळजीपूर्वक वाचा आणि त्याप्रमाणे विचारलेला प्रयोग करा.
२. उपकरणांच्या वापराबाबत तुम्हांला काही माहीत नसेल तर परीक्षक किंवा प्रयोगशाळा सहाय्यक यांना तुम्हाला मदत करण्याविषयी विनंती करा.
३. कोणताही विद्युतप्रयोग करण्यापूर्वी, प्रत्यक्ष पुरविलेली सर्व उपकरणे आणि सर्व 'कनेक्शन' नीट पाहून घेऊन संबंधित कामाची नीटनेटकी कार्ययोजना करण्याची नितांत आवश्यकता आहे आणि ह्या नंतर, पुढे काम चालू करण्याविषयी परीक्षकांची परवानगी मिळविणे आवश्यक आहे.
४. सर्व निरीक्षणे कोष्टकवजा तक्त्यात भरावी. मधल्या सर्व गणना आणि निर्णय हे शक्य तितक्या सुवाच्यपणे आणि स्पष्टपणे नोंदविलेले असणे हे हितावह आहे.
५. प्रारंभिक किंवा अंतिम निरीक्षणात संख्यावाचक आकडे एकावर एक लिहू नयेत. जर लिहिलेला कोणताही आकडा नको असेल तर त्यावर एक रेघ ओढून पाहिजे असलेला आकडा त्याच्याजवळ लिहा.
६. प्रयोगशाळेतून बाहेर पडण्यापूर्वी आपले टेबल चांगल्या स्थितीत आहे याची खात्री करा.

INSTRUCTIONS TO CANDIDATES

1. Read the question carefully and perform the experiment as required.
2. If there be anything the apparatus that you do not know, ask the examiner or the laboratory assistant to help you,
3. Before doing any electrical experiment, it is obsolutely essential that you make a neat working sketch of all apparatus actually provided and of the necessary connection, and obtain the examiner's permission to proceed.
4. Express all observations in a tabular form.
   It is a'so desirable that all intermediate calculations and results should be entered as neatly and clearly as possible
5. No numerical figures should be written over either in the preliminary or final observations. If any figure is shought to be discarded it should be run through and the desired figure written near to it.
6. Please see that your table is in good order before you leave the laboratory.

(येथून लेखनास सुरवात करा.) (Begin writing here.)

(1) write a not on quantum no.s asociated with vector atom - model?

(2) Explain spin orbit interaction?

(3) What is zeeman effect? Explain normal effect and anomolus zeeman effect?

(4) Explain zeeman sputing of D_1 & D_2 lines.

VIVEKANAND COLLEGE KOLHAPUR (Autonomous) ESTD JUNE 1964

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

③ → Zeeman effect :-

Zeeman effect is a magneto-optic phenomena. If a source of light producing line spetrum is placed in a magnetic field the spetral lines are spit up into components such spliting of spectral lines due to external magnetic field known as zeeman effect

When the magnetic field is comparitively strong the the spliting occurs into two or three lines it is called as Normal zeeman effect. & can be explained quantitatively by classical theory

When the magnetic field is comparatively weak then spliting of spetral line occurs into more than 3 components and is known as Anomolous zeeman effect.

Explaination of Anomolous zeeman effect based on the vector anomolus

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

Consider annomolous zeeman effect for one electron system. i.e. the atom with one valence electron like alkali

Spining of electrons.

$\vec{L}$ = angular momentum

$\vec{S}$ = spining angular momenta

$\vec{J}$ = resultant of both 'L' & 'S' precess about 'J'

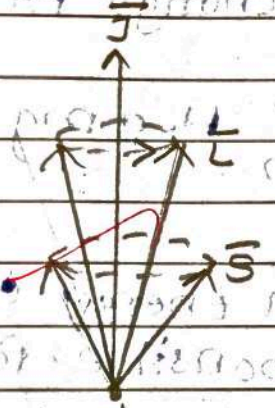
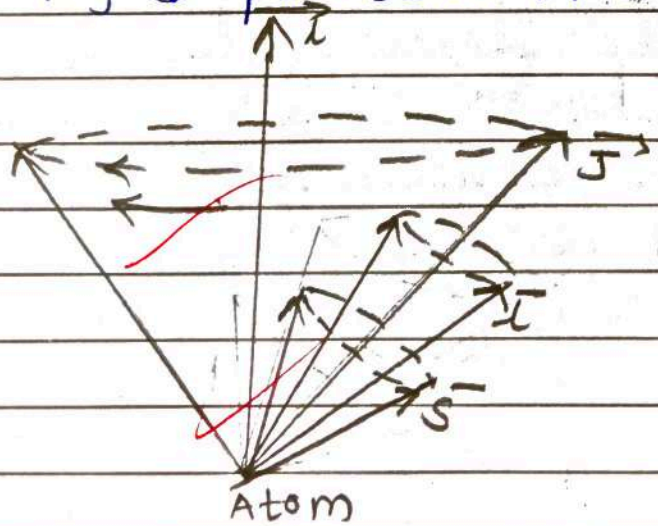


fig ① precession of $\vec{L}$ & $\vec{S}$ about 'J'



precession of $\vec{J}$ about $\vec{H}$

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

when such atom is placed in external weak magnetic field the internal magnetic interaction is strong than comparatively. 'J' is not broken i.e J and the resulatant vector 'J' Here begins to precess about $\vec{H}$ as shown in Fig (B) Due to such type of precesion of resulatant 'J' abut $\vec{H}$ energy of an atom changes, the expression for change in energy is

$$dE = \frac{eh}{4\pi m} H \cdot g\, mg \qquad \text{—①}$$

this change in Energy emagnetic interaction energy is responsible for more complex spliting of the spectral lines.

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

$P^{1/2}$ has MJ. g values which are $1/3, -1/3$ values therefore, $P^{1/2}$ state spit into two components.

$S^{1/2}$ has MJ. g values which are $1, -1$ values therefore $S^{1/2}$ state spit into two components.

As $P^{1/2}$ & $S^{1/2}$ has to two components each Hence there are total 4 transistion are pasible.

The appropriate selection rule for these transitions is

$$\boxed{\Delta M_J = 0 \pm 1}$$

This, D1 line of Sodium split up into 4 componets in annomolus zeeman effect

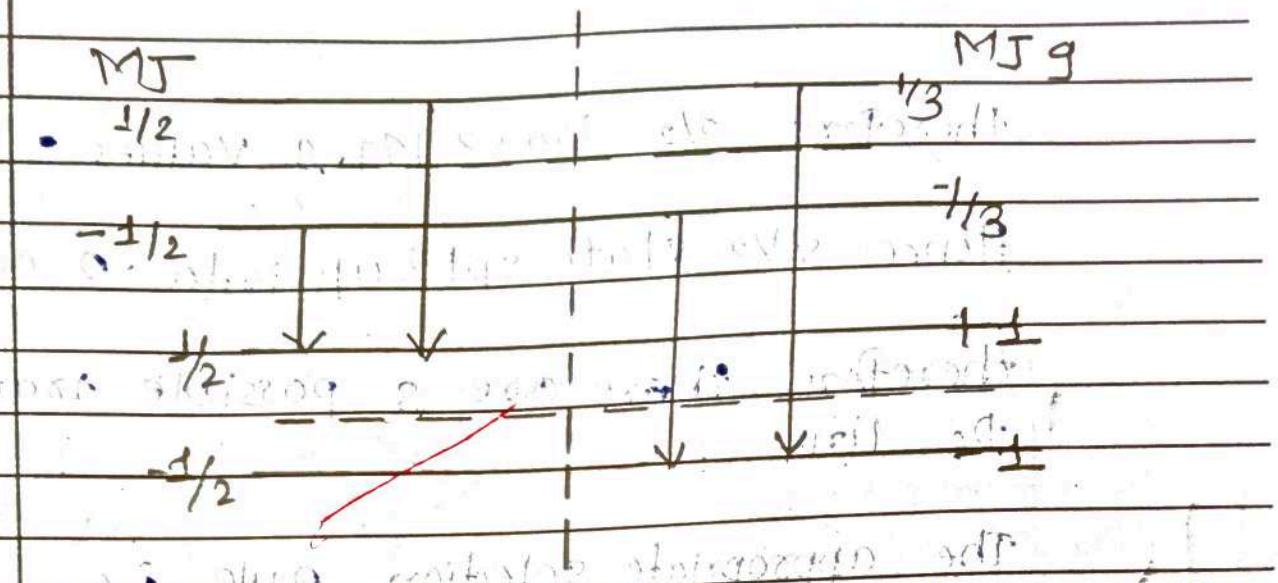
$P^{1/2}$

D1 line is

$S^{1/2}$

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.



All 4 transition are allowed by selection rule $\Delta M_J = 0 \pm 1$

Spliting of D_2 line

For D_2 - Line transitions are

$P_{3/2} \longrightarrow S_{1/2}$

P3/2 has M_J. 9 values = 4 which are

2, 2/3, -2/3, -2

Therefore, P 3/2 state ~~up~~ split up in 4 components

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

therefore 3/2 has 2 MJ.g values $\pm 1, -1$

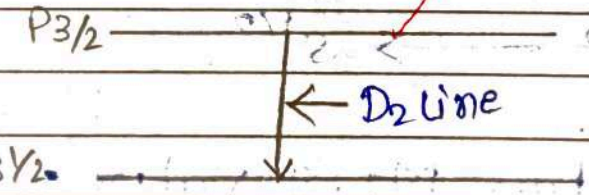
Hence $s_{1/2}$ state split up into 2 components

therefore there are 8 possible transition are D_2 line

The appropriate selection rule is

$$\Delta MJ.g = 0, \pm 1$$

This D_2 Line of Sodium split up into 8 components in annomalous Zeeman effet which is known as



Name :- Ruturaj S. Inamdar 16/20

08043

Signature of Jr. Super.

विवेकानंद कॉलेज (स्वायत्त) कोल्हापूर.

परीक्षेच्या ——— या विषयाच्या प्रयोग परीक्षा

Practical Examination in Physics (

at the Internal Examination Examination

उमेदवाराचा आसन क्रमांक (Candidate's Seat No.) 8209

विभाग (Section) Total = 1+1 = 2

उमेदवारांना सूचना

१. प्रश्न काळजीपूर्वक वाचा आणि त्याप्रमाणे विचारलेला प्रयोग करा.

२. उपकरणांच्या वापराबाबत तुम्हांला काही माहीत नसेल तर परीक्षक किंवा प्रयोगशाळा सहाय्यक यांना तुम्हाला मदत करण्याविषयी विनंती करा.

३. कोणताही विद्युतप्रयोग करण्यापूर्वी, प्रत्यक्ष पुरविलेली सर्व उपकरणे आणि सर्व 'कनेक्शन' नीट पाहून घेऊन संबंधित कामाची नीटनेटकी कार्ययोजना करण्याची नितांत आवश्यकता आहे आणि ह्या नंतर, पुढे काम चालू करण्याविषयी परीक्षकांची परवानगी मिळविणे आवश्यक आहे.

४. सर्व निरीक्षणे कोष्टकवजा तक्त्यात भरावी. मधल्या सर्व गणना आणि निर्णय हे शक्य तितक्या सुवाच्चपणे आणि स्पष्टपणे नोंदविलेले असणे हे हितावह आहे.

५. प्रारंभिक किंवा अंतिम निरीक्षणात संख्यावाचक आकडे एकावर एक लिहू नयेत. जर लिहिलेला कोणताही आकडा नको असेल तर त्यावर एक रेघ ओढून पाहिजे असलेला आकडा त्याच्याजवळ लिहा.

६. प्रयोगशाळेतून बाहेर पडण्यापूर्वी आपले टेबल चांगल्या स्थितीत आहे याची खात्री करा.

INSTRUCTIONS TO CANDIDATES

1. Read the question carefully and perform the experiment as required.
2. If there be anything the apparatus that you do not know, ask the examiner or the laboratory assistant to help you,
3. Before doing any electrical experiment, it is obsolutely essential that you make a neat working sketch of all apparatus actually provided and of the necessary connection, and obtain the examiner's permission to proceed.
4. Express all observations in a tabular form.
   It is also desirable that all intermediate calculations and results should be entered as neatly and clearly as possible
5. No numerical figures should be written over either in the preliminary or final observations. If any figure is shought to be discarded it should be run through and the desired figure written near to it.
6. Please see that your table is in good order before you leave the laboratory.

(येथून लेखनास सुरवात करा.) (Begin writing here.)

Q.1] Write a note on Quantum nos. associated with vector atom Model.

Q.2] Explain spin-orbit interaction.

Q.3] What is Zeeman Effect & Explain Normal & Anamolus Zeeman Effect.

Q.4] Explain Zeeman Splitting of D_1 & D_2 lines.

VIVEKANAND COLLEGE KOLHAPUR (Autonomous) ESTD JUNE 1964

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

Q.1] Quantum no. associated with vector atom model :-

① Principle (or) Total Quantum no. (n) :-

This Quantum no. is associated with no. of sub-shells in the atom i.e. 0, 1, 2, 3, 4 etc. are given to s, p, d, f shells.

② Orbital Quantum No. (l) :-

Orbital Quantum no. is denoted by l. This quantum no. is associated to orbit of $e^{\ominus}$ i.e. orbital motion of $e^{\ominus}$ given by $\frac{lh}{2\pi}$. It ranges from $-l$ to $+l$ including zero

③ Spin Quantum No. (s) :-

Spin Quantum no. is denoted by s. This quantum no. is defines spin of $e^{\ominus}$ around its axis. It is given by $\frac{sh}{2\pi}$.

④ Resultant Quantum No. (J) :-

Resultant Quantum no. is the total resultant of spin quantum no. & orbital quantum no. It is given by $\frac{\sqrt{J(J+1)}\,h}{2\pi}$.

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

If ext. magnetic field is applied, then there are 3 more quantum no. associated with it.

(5) Magnetic spin quantum no. (m_s) :-

When ext. magnetic field is applied $e^{\ominus}$ revolves ~~around~~ spins around its own axis i.e. move in its own axis in magnetic field.

(6) Magnetic orbital quantum no. (m_ℓ) :-

When ext. magnetic field is applied then $e^{\ominus}$ moves in a orbit, which is given by m_ℓ. It ~~has~~ integer values.

(7) Total angular magnetic quantum no. (m_j) :-

Resultant of orbital & spin magnetic quantum no. is given by total angular magnetic quantum no. ~~If it has value~~ m_j = It depends upon values of ℓ & s.

Q.2] Spin - Orbit Interaction :-

When $e^{\ominus}$ revolves around nucleus it also rotates about its own axis. like Earth revolves around the Sun but it also revolves around its own axis.

When $e^{\ominus}$ spin takes place there occurs one mechanical momentum & one magnetic momentum. Spin is denoted

Section | Q. No. | Marks

प्र. क्र.
Q. No.

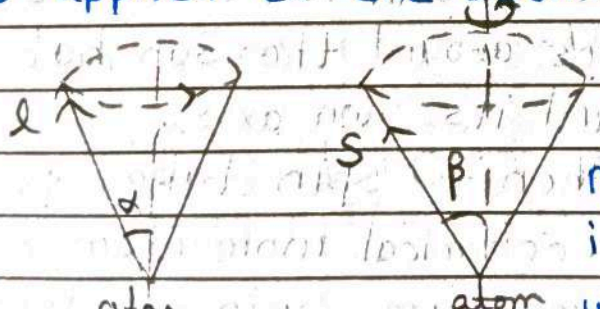
S & it has generally values in the range of $\frac{1}{2}$. Spin is given by $\frac{sh}{2\pi}$ & spin magnetic moment i.e. μ_s is given by,

$$\mu_s = 2s\left(\frac{e}{2M}\right)\frac{h}{2\pi}$$

When in orbit denoted by 'l'. This ranges from $-l$ to $+l$ including zero. Orbital is given by $\frac{lh}{2\pi}$. When it starts revolving it has 2 momentum firstly mechanical moment & another one is orbital magnetic moment.

i.e. $\mu_l = l\frac{eh}{4\pi M}$

When both spin & orbital motions happened, then there spin moment is different & orbital moment is different. Over the time there resultant is formed & is given by letter j. This happens when ext. magnetic field is applied to the atom.



as shown in fig. spin moment & orbital moment are given i.e. $L = l\cos\alpha$, $S = s\cos\beta$ where α, β are constants.

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

Q.2] Zeeman Effect :-

It is magneto-optic phenomena. When source of light is placed in a ext. magnetic field lines formed further splits into its components, this effect is known as "Zeeman Effect". Zeeman Effect is well known effect which has mostly two cases!

① Normal Zeeman Effect
② Anamolus Zeeman Effect

① Normal Zeeman Effect :-

When strong ext. magnetic field is applied to source, it further splits into 2 (or) 3 lines is called Normal Zeeman Effect. Normal Zeeman effect is due to strong magnetic field due to which resultant of l & s i.e. coupling bet^n them break-down & hence there is no resultant. j,

② Anamolus Zeeman Effect :-

When weak ext. magnetic field is applied it further splits into more than 3 lines, this is known as Anamolus Zeeman Effect. In this case since it is weak magnetic field, coupling of l & s remains

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No. 1

intact & resultant j will be there.

In Anamolus Zeeman Effect there is spliting of lines.

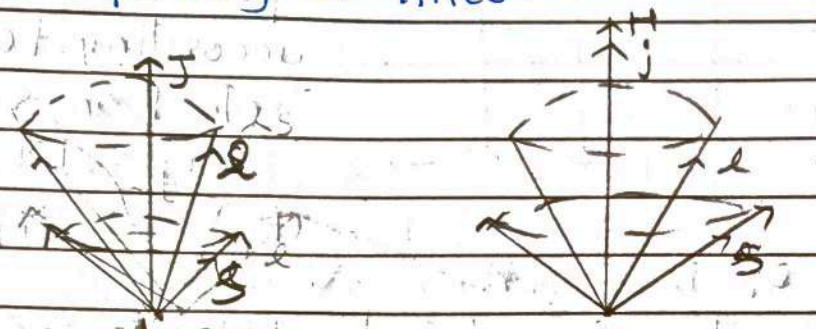


fig. (A) fig (B)

In Anamolus Zeeman Effect, from fig. (B), we can say that resultant j is in the dirⁿ of ext. magnetic field H. Thus the formula of energy is given by,

$$dE = \frac{eh}{4\pi M} H_g m_j$$

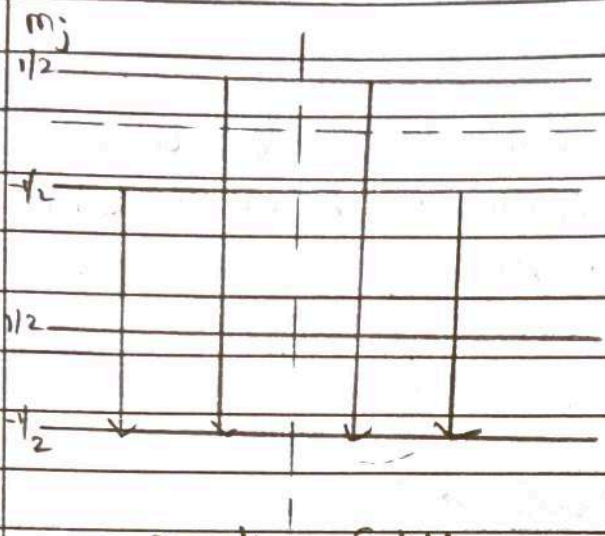
This is energy eqⁿ.

Q. 4] Explanation for Zeeman Splitting of D_1 & D_2 lines :-

D_1 lines are formed due to transition of $e^{\ominus}$ from $P_{1/2} \rightarrow S_{1/2}$. All this transitions are in the principle series. i.e. they follow it.

Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

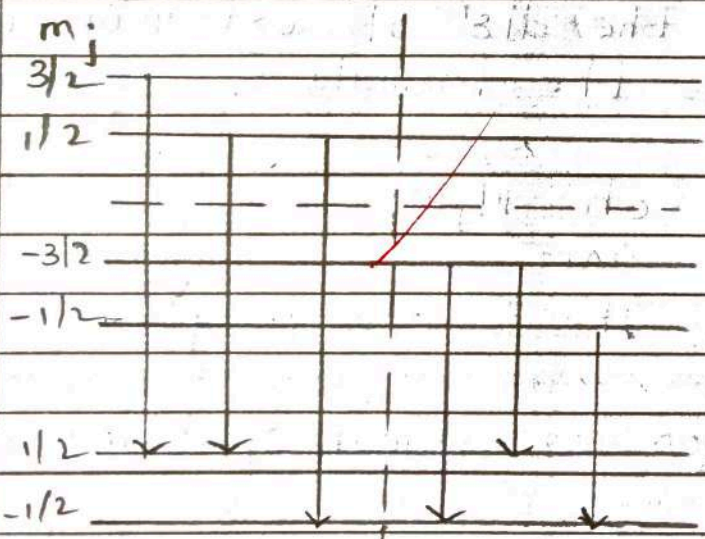


D_1 line Splitting

In D_1 transition 4 transitions took place & all are permitted transitions according to selection rules i.e. $\Delta m_j = \pm 1, 0$

$P_{1/2} \rightarrow S_{1/2}$ transition take place i.e. due to this P is splits into 2 further lines.

$J = L \pm S = \frac{0 \pm 1}{2} = \frac{1}{2}$ & $\frac{-1}{2}$.



In D_2 transition there are total 8 transitions which takes place but only 6 transitions are possible due to selection rule i.e. $\Delta m_j = \pm 1, 0$. 2 transitions are forbidden. $P_{3/2} \rightarrow S_{1/2}$ transitions took place.

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Autonomous)

Internal Examination 2022-23

PHYSICS-DSC -1001F2

B.Sc. – III, Sem – VI Solid State Physics I

Time: 30 Minutes

Marks: 20

Q. 1. LONG Answer Questions (Any one) **(10)**

1. Differentiate Crystalline and amorphous solids. Write a note on primitive and non-primitive cells.

2. Derive an expression for HCP packing fraction.

Q. 2. SHORT Answer Questions (Any two) **(10)**

1. Write down types of Bravis' lattices in two dimensions.
2. Write a note on Miller indices.
3. Explain Cubic and hexagonal structure.

।। ज्ञान, विज्ञान आणि सुसंस्कार यासाठी शिक्षण प्रसार ।।
– शिक्षणमहर्षी डॉ. बापूजी साळुंखे 34608

Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

19/20

Signature of Supervisor

Suppliment No. :

Roll No. : 8214

Class : B.Sc-III, Sem-VI

Subject : Solid State Physics - I

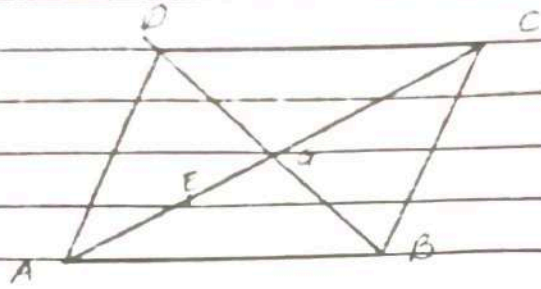
Test / Tutorial No. :

Div. :

Q.1) 2) HCP :-

The hexagonal close-packed structure, one of the common crystal type is made by stacking close packed planes in a simple sequence. There are two ways of arranging equivalent spheres to minimise the interstitial volume. One way leads to a structure with cubic Symmetry and it is the face centered cubic and other hexagonal symmetry and is called the hexagonal close-packed structure.

Spheres may be arranged in a single close-packed layer by packing each sphere in contact with six others. A second similar layer may be placed on top of this by placing each sphere in contact with three spheres of the bottom layer. A third layer can be added in two ways, in the cubic structure the spheres in the third layer are placed over the holes in the first layer not occupied by second layer; in the hexagonal structure the spheres of first layer and the packing may be said ABABAB....



ABCD is the base of hexagonal unit cell AD = AB = a. The sphere in the next layer has its centre F vertically above E and it touches the sphere whose centres are A, B and D.

AE is the $\frac{2}{3}$ of median AG.

$$AE = \frac{2}{3} \times \frac{\sqrt{3}}{2} a = \frac{a}{\sqrt{3}}$$

Hence, $FE = \frac{c}{2} = \sqrt{\left(a^2 - \frac{a^2}{3}\right)} = \frac{a\sqrt{2}}{\sqrt{3}}$

$$\frac{c}{a} = \frac{2\sqrt{2}}{\sqrt{3}} = 1.633$$

Packing fraction i.e. fraction of total volume filled

$$= \frac{\text{volume occupied by atoms}}{\text{volume of the unit cell}}$$

$$= \frac{2 \cdot 4/3 \pi R^3}{\frac{1}{2} \cdot \sqrt{3} a^2 c}$$

Since in ideal case of closest packing $a = 2R$.

$\therefore$ Packing fraction = ~~0.74~~ 0.74

Q.2) 2) Miller indices →

It is frequently necessary to consider planes passing through a space lattice since it is the planes which are determined by x-ray diffraction. In order to make the designation uniform for a chosen plane, the following procedure has been adopted.

1. Determine the intercepts of the plane along a, b, c in terms of lattice constants. The axis may be primitive or non-primitive.

2. Invert the intercepts, that is, write the numbers as their reciprocals.

3. If fraction result, multiply them by lowest common denominator.

The resulting integers are called miller indices of a plane and are conventially clubbed in [h, k, l]. The meaning of these indices is that a set of a parallel planes [h, k, l] cuts the a-axis into h parts, the b-axis into k parts and the c-axis into l parts.

3) Bravis lattice →

The various combinations of allowed rotation and reflection operations are found to give rise to 10 different two dimensional point groups.

The first refers to the rotation about the point and the point-group 4 contains 4-fold rotations. The second position refers to a mirror line normal to the x-axis and it refers also to other mirror lines related to this by a rotation operation. The third refers to the presence of other mirror lines related among themselves by symmetry but not covered up in the first set of mirror lines.

The requirement that a lattice should be invarient under a rotation operation $2\pi/n$ where $n = 1, 2, 3, 4, 5$ or 6. or under the mirror operation places restriction on the primitive translational vector a, b.

i) Oblique lattice
ii) Square lattice
iii) Hexagonal lattice

।। ज्ञान, विज्ञान आणि सुसंस्कार यासाठी शिक्षण प्रसार ।।
– शिक्षणमहर्षी डॉ. बापूजी साळुंखे 27636
Shri Swami Vivekanand Shikshan Sanstha Kolhapur's
VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Suppliment No. : 14/20

Roll No. : 8217

Class : B.Sc III, Sem VI

Subject : solid state physics – I

Test / Tutorial No. :

Div. :

Q.2

2) Miller indices :–

It is frequently necessary to consider planes passing through a space lattice since it is the planes which are determined by x-Ray diffraction. In order to make the designation uniform for a chosen plane, the following procedure has been adopted.

1. Determine the intercepts of the plane along a, b, c in terms of lattice constants. The axis may be primitive or non-primitive.

2. Invert the intercepts, that is, write the numbers as their reciprocals.

3. If fraction result, multiply them by lowest common denominator.

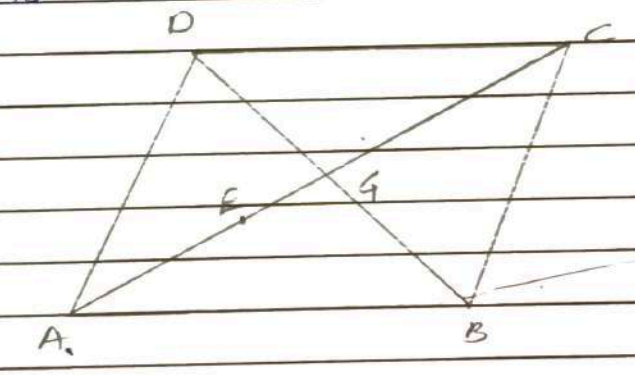
The resulting integers are called miller indices of a plane and are conventially closed in [h, k, l]. The meaning of these indices is that a set of a paralled planes [h, k, l] cuts the a-axis into n parts, the b-axis into k parts and the c-axis into l parts.

Q.1

2) Hexagonal close - packed structure :-

The hexagonal close - packed structure, one of the common crystal type is made by stacking close packed planes in a simple sequence. There are two ways of arranging equivalent spheres to minimise the interstitial volume. one way leads to a structure with cubic symmetry and it is the face centered cubic and other hexagonal symmetry and it is called the hexagonal close packed structure.

spheres may be arranged in a single close-packed layer by packing each sphere in contact with six others. A second similar layer may be placed on tip of his by placing each sphere in contact with three spheres of the bottom layer. A third layer can be added in two ways, in the cubic structure the spheres in the third layer are placed over the holes in the hexagonal structure the spheres of first layer and the packing may be said ABABAB ... -



ABCD is the base of hexagonal ~~unit~~ unit cell

$AB = AB = a$.

The sphere in the next layer has its centre E vertically above E and it touches the sphere whose centres are A, B and D.

AE is the 2/3 of median DG.

$$AE = \frac{2}{3} \times \frac{\sqrt{3}}{2} a = \frac{a}{\sqrt{3}}$$

Hence, $FE = \frac{c}{2} = \sqrt{\left(a^2 - \frac{a^2}{3}\right)} = \frac{a\sqrt{2}}{\sqrt{3}}$

$$\frac{c}{a} = \frac{2\sqrt{2}}{\sqrt{3}} = 1.633$$

Packing fraction i.e fraction of total volume filled

$$= \frac{\text{Volume occupied by atoms}}{\text{Volume of the unit cell}}$$

$$= \frac{2 \cdot 4/3 \pi R^3}{\frac{1}{2} \cdot \sqrt{3} a^2 c}$$

Since in ideal case of closet packing $a = 2R$.

$\therefore$ Packing fraction = 0.74

= 74%

Shri Swami Vivekanand Shikshan Sanstha's

Vivekanand College, Kolhapur (Autonomous)

Internal Examination 2022-23

PHYSICS-DSC -1001F2

B.Sc. – III, Sem – VI Solid State Physics II

Time: 30 Minutes

Marks: 20

Q. 1. LONG Answer Questions (Any one) **(10)**

1. Write a note on Reciprocal lattice and its properties, diffraction of X-rays by crystals.
2. Explain Powder method - Principle, Construction, Working and Application.

Q. 2. SHORT Answer Questions (Any two) **(10)**

1. Derive an expression Bragg's law in reciprocal lattice.
2. What are the types of X-ray diffraction methods.
3. Write a note on Rotating crystal method of x-ray diffraction.

।। ज्ञान, विज्ञान आणि सुसंस्कार यासाठी शिक्षण प्रसार ।।
- शिक्षणमहर्षी डॉ. बापूजी साळुंखे 27639
Shri Swami Vivekanand Shikshan Sanstha Kolhapur's
VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor

Suppliment No. :

Roll No. : 8211

Class : B.Sc III sem VI

Subject : Solid state physics II

Test / Tutorial No. : Internal exam

Div. :

Q. 2

1. Expression of Bragg's law in reciprocal lattice

The crystal lattice is a lattice in real oridnary space the reciprocal lattice is a lattice in Fourier space which is motivated by equation.

$$\therefore e^{i\pi Gr} = 1 \quad \text{——— (1)}$$

$\therefore$ G is termed reciprocal lattice vector

$\therefore$ The point of crystal lattice

$$\therefore r = ma + nb + pc \quad \text{— (2)}$$

m, n, P are integers.

Similarly, we define the reciprocal lattice points/ reciprocal lattice vector G in Fourier space as

$$\therefore G = h\vec{a}^* + k\vec{b}^* + l\vec{c}^* \quad \text{——— (3)}$$

h, k, l are integers

Scalar product

$$G.r = (h\vec{a}^* + k\vec{b}^* + l\vec{c}^*) . (ma + nb + pc)$$
$$= (hm + kn + lp) = \text{integers}$$

If we write Bragg diffraction condition in the form of

$$\sin\theta_{hkl} = \frac{\lambda/2}{d_{hkl}} = \frac{\lambda/d_{hkl}}{2}$$

3. Rotating crystal Method

Complete rotation method :- In this method series of complete revolutions occur.

- Each set of a plane in a crystal diffracts four times during rotation.
- four diffracted beams are distributed into a rectangular pattern in the central point of photograph.
- oscillation Method :- the crystal is oscillated at an angle of 15° or 20°.
- The photography plate is also moved back & forth with crystal
- The position of the spot on the plate indicates the orientation of the crystal at which the spot was formed.

Q.1

2. The methods described employ a single crystal.

Principle:-

If a monochromatic X-ray beam is allowed to fall on a small specimen of substance ground to a fine powder, the orientations of the minute crystal grains called the crystallites, being completely at random, a certain number of them will lie with a given set of lattice planes making the correct angle with the incident beam for reflection to occure.

Construction:-

The X-ray radiation from the source S is made monochromatic with the help of the filter F and it is collimated by passing through the fine slits S_1 and S_2 as shown in the fig. P is the specimen in the form of powder and O is the point where the direct beam coould have struck the film. Point A on the film corresponds at which a spectrum with glancing angle θ is formed MM' is one of the crystal planes with interplaner

spacing 'd' formed due to the arrangement of the crystal grains.

working :-

If we conside the diffracted beam from a large number of crystal grains which are randomly oriented, and consider the diffraction from the planes with the same interplaner spacing as the first one, the locus of the diffracted beams would lie on a cone with semivertical angle 2θ, since the angle between the inciden beam and the diffracted beam is 2θ.

The crystal structure can be obtained from the arrangement of the traces and their relative intensities. If a diffracted beam with glancing angle θ is found at point A, which is at a distance R from 'o', where the direct beam strikes the film and if L be the radius of the cylindrical camera then,

$$2\theta = \frac{arc}{radius} = \frac{R}{L}$$

$$\therefore \theta = \frac{R}{2L}$$

From Bragg's law

$$2d\sin\theta = n\lambda$$

differentiating this relation we get,

$$2(\Delta d \sin\theta + d\cos\theta\,\Delta\theta) = 0 \quad \because n \text{ and } \lambda \text{ are constants.}$$

$$\Delta d \sin\theta = -d\cos\theta\,\Delta\theta$$

$$\therefore \frac{\Delta\theta}{\Delta d} = -\frac{\sin\theta}{d\cos\theta} = \frac{\tan\theta}{d} = \infty \quad \theta = 90^\circ$$

" ज्ञान, विज्ञान आणि सुसंस्कार यासाठी शिक्षण प्रसार "
-शिक्षणमहर्षी डॉ. बापूजी साळुंखे
Shri Swami Vivekanand Shikshan Sanstha Kolhapur's
VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

SUPPLIMENT

Signature of Supervisor	
Suppliment No. : (17) / 20	Subject : Solid state physics II
Roll No. : 8214	Test / Tutorial No. :
Class : B.Sc - III, Sem VI	Div. :

Q 1.

2. Powder Method - Principle, Construction, Working and Application

The methods described above employ a single crystal. The powder method developed independently by Debye and Scherrer and by Hull, uses material in which individual crystal are very small and oriented at random. A narrow beam of monochromatic radiation falls upon the microcrystalline aggregate.

Amongst the vast number of small crystals there will always be some which are so oriented that given reflection hkl is possible the crystalline fragments which give these reflections must be so set that angle of incidence rays as axis.

The lines of powder photograph are identified by deducing the spacing of corresponding planes from positions of lines and finding by trial a crystal cell which will give

the same spacing. The case with which this can be done depend upon number of variables to be dealt with.

In cubic crystal there is only one variable. the length of unit cube edge. Hexagonal, rhombohedral, and tetragonal crystal have a two variables.

A length and an axial ratio are measured on vertical axis. In these graphs the values of axial ratio are measured on vertical axis. for each axial ratio value of $\sin\theta$ for various reflections are plotted on horizontal line to logarithmic line

An interesting feature which is shown best by powder photograph is that resolving power becomes very high when the reflected ray is thrown back through an angle 2θ, which is nearly $180°$

If the spacing d is varied in eqn $n\lambda = 2d\sin\theta$ we have,

$$\therefore \Delta d \sin\theta + d\cos\theta . \Delta\theta = 0$$

$$\therefore \frac{\Delta\theta}{\Delta d} = \frac{\tan\theta}{d}$$

The powder photograph method can be applied to any type of matter with crystalline arrangement, so it does not require single crystal. It has been most useful in the investigation of metal and alloy

Q2.

1. Expression of Bragg's law in reciprocal lattice

The crystal lattice is a lattice in real / Ordinary space the reciprocal lattice is a lattice in Fourier space which is motivated by equation

$$\therefore \quad e^{i\pi G r} = 1 \quad \text{—— (1)}$$

$\therefore$ G is termed reciprocal lattice vector

$\therefore$ The point of crystal lattice

$$\therefore \quad r = ma + nb + pc \quad \text{—— (2)}$$

m, n, p are integers.

Similarly, we define the reciprocal lattice Points / reciprocal lattice vector G in Fourier space as

$$\therefore \quad G = h\vec{a}^* + k\vec{b}^* + l\vec{c}^* \quad \text{—— (3)}$$

h, k, l are integers

Scalar product

$$G \cdot r = (h\vec{a}^* + k\vec{b}^* + l\vec{c}^*) \cdot (ma + nb + pc)$$

$$= (hm + kn + lp) = \text{integers}$$

If we write Bragg diffraction condition in the form of

$$\sin\theta_{hkl} = \frac{\lambda/2}{d_{hkl}} = \frac{\lambda/d_{hkl}}{2}$$

5