Shri Swami Vivekanand Shikshan Sanstha Kolhapur's

Vivekanand College, Kolhapur (Empowered Autonomous)

Department of Physics

Notice

Date: Tuesday, 28th February 2025

All the students of B.Sc. – III are hereby informed that Continuous Internal Evaluation CIE Examination and Practical Examination is scheduled on 6th to 11th March 2025 in the Department of Physics at 10 AM.

Instructions:

1) Nature of question paper for B.Sc. – III: 03 MCQ's (03 Marks), 01 Short Answer Questions (04 Marks), 01 Long Answer Questions (08 Marks), total = 15 Marks.
2) Students should present before 15 minutes of the examination.
3) Answer sheets will be provided by the Department.
4) Strictly mention the Full Name and Roll number on Answer Sheet correctly.
5) All students should remain present for the Internal Examination as the examination will not be conducted afterwords in any case.

Sr. No.	Date	Name of the Paper	Time
1.	06/03/2025	Semiconductor Device and Instrumentation (Paper XIII) Topic: Semiconductor Devices	11:00 am to 12:00 am
		Classical Mechanics (Paper XIV) Topic: Lagrangian Dynamics	01:00 pm to 02:00 pm
2.	07/03/2025	Elements of Modern Physics (Paper XV) Topic: Laser	11:00 am to 12:00 am
		Solid State Physics II (Paper XVI) Topic: Elementary Band Theory	01:00 pm to 02:00 pm
3.	10/03/2025	Practical Examination	10:30 am to 05:30 pm
	11/03/2025		
	12/03/2025		

Head

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DEPARTMENT OF PHYSICS
VIVEKANAND COLLEGE, KOLHAPUR
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"Education for Knowledge, Science and Culture"
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Shri Swami Vivekanand Shikshan Sanstha, Kolhapur

Vivekanand College, Kolhapur (Empowered Autonomous)

Department of Physics

B.Sc. Part-III SEM VI Internal Examination (2024-25)
- Paper- Classical Mechanics
- Topic-Lagrangian Formulation
- Paper code: DSC1001F2

Day: - Thursday
Date: - 06/03/2025

Time: - 01.00 pm- 02.00 pm
Total Marks: 15

Sr. No.	Name of the students	Roll. No.	Sign	Marks
1.	Samruddhi S. Ranmale	8209		14
2	Sakshi R. Birange	8201	S.R.Birange	14
3	Ritu R. Nishad	9206	Rishad.	14
4	Riya D. Patil	8207		15
5	Seema S. Hiremath			14
6	Rutuja Sawantkar	8210		14
7	Atharv M. Kognalikar	8204		15
8	Gaurav A. Dadarne	8202		12
9	Saad Sanjay Hasbe	8430		13
10.	Tanishq Mude	8205		14
11.	Surekha T. Desai.	8203		14
12.	Sahil Chetan Patnekar	8208		13

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ESTD JUNE 1964

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Department of Physics

B.Sc. Part-III SEM VI Internal Examination (2024-25)
Paper- Classical Mechanics
Topic-Lagrangian Formulation
Paper code: DSC1001F2

Day: - Thursday
Date: - 06/03/2025

Time: - 01.00 pm- 02.00 pm
Total Marks: 15

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: (03)

1. If the constraints are independent of time then they are ..... constraints.

(a) rheonomous (b) holonomic
(c) scleronomous (d) non-holonomic

2. The principle of virtual work deals only with the case of .....

(a) kinematics (b) statics
(c) dynamics (d) aero-dynamics

3. For a rigid body moving parallel to fixed plane surface, the number of degrees of freedom is.....

(a) three (b) two
(b) four (d) one

Q.2 Attempt any one (04)

1. What are constraints? Classify constraints with examples.
2. State and explain the principle of virtual work.

Q.3 Attempt any one (08)

1. Set up Lagrangian for motion of a bead sliding on rotating wire in a force free space. Obtain expression for centripetal acceleration.
2. Obtain equation of motion of a system of two particles of unequal masses connected by inextensible string passing over a smooth pulley.

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Atharv Haripxasad Kognolikar

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- शिक्षणमहर्षी डॉ. बापूजी साळुंखे

15/15

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	47075
Centre	VCK

प्र. क्र. Q. No.	
Q.1	
1)	c) Scleronomus 1
2)	b) Statics 1
3)	a) three 1

03

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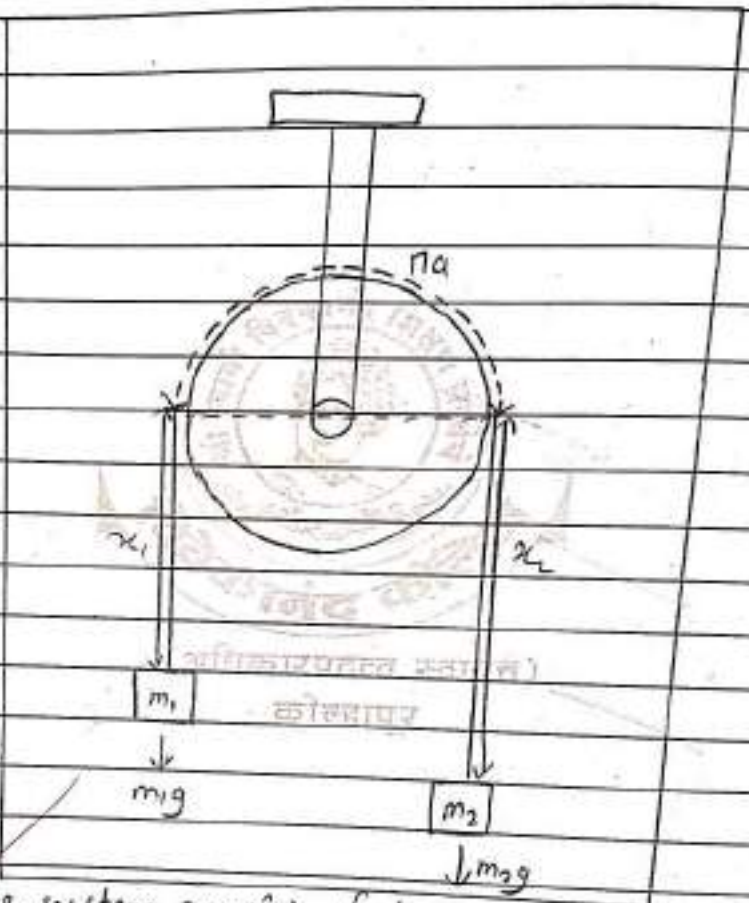
02 Section | Q. No. | Marks

प्र. क्र.
Q. No.

Q.3

a)



Suppose the system consist of two masses m_1 and m_2 suppo
over a pulley of radius 'a' with connecting to the flexible
string of length 'l'.

The configuration of the system is specified by two
co-ordinates i.e. x_1 and x_2

The eqⁿ for the constraints is given by,

$x_1 + x_2 + \pi a = l$

$\dot{x}_1 = -\dot{x}_2$ and $\ddot{x}_1 = -\ddot{x}_2$

The kinetic energy is given as,

$\therefore T = \frac{1}{2} m_1 \dot{x}_1^2 + \frac{1}{2} m_2 \dot{x}_2^2 = \frac{1}{2}(m_1 + m_2)\dot{x}_1^2$

$\therefore T = \frac{1}{2}(m_1 + m_2)\dot{x}_1^2$

The potential energy is given as,

$V = -m_1 g x_1 - m_2 g(\pi l - \pi a - x_1) = -(m_1 - m_2) g x_1 + V_0$

~~$= m_1 g x_1$~~ $V = -(m_1 - m_2) g x_1 + V_0$

~~where~~ $V_0 = g x_1 (l - \pi a) =$ constant.

Here, when the height is increases through the pulley the potential energy gets decreases. Hence there is negative sign.

The langragian solution for this case is,

$L = T - V$

$= \frac{1}{2}(m_1 + m_2)\dot{x}_1^2 + (m_1 - m_2) g x_1 - V_0$

04 Section Q. No. Marks

प्र. क्र. Q. No.

If there is only one generalized co-ordinate x then the eqn becomes,

$$L = \frac{1}{2}(m_1+m_2)\dot{x}^2 + (m_1-m_2)gx - V_0$$

Then, $\frac{\partial L}{\partial \dot{x}} = (m_1+m_2)\dot{x}$ and $\frac{\partial L}{\partial x} = (m_1-m_2)g$

The langrangian eqn for this case is given as,

$$L = \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{x}}\right) - \frac{\partial L}{\partial x}$$

$$= \frac{d}{dt}\left[(m_1+m_2)\dot{x}\right] - (m_1-m_2)g = 0$$

$$\frac{d}{dt}(m_1+m_2)\ddot{x} - (m_1-m_2)g = 0$$

$$\therefore \ddot{x} = \frac{m_1-m_2}{m_1+m_2}g$$

This is required expression for accelaration.

Q.2

1) Constraints :-

The limitations or geomatrical restrictions on a motion of particle is known as constraints.

Types of constraints :-

1) a) Scleronomic :-

If the constraints relation do not explicitly depend on time. Then it is called Scleronomic constraints.

e.g. → In the case of rigid body.

b) Rheonomic :-

If the constraints relation depends explicitly on time. Then it is called as rheonomic constraints.

02 Section | Q. No. | Marks

प्र. क्र. Q. No.

e.g :- The bead sliding on rotating wire in force fre space.

2) a) Holonomic :-

If the $r_1, r_2, \ldots, r_n$ is the position of co-ord -s at system and 't' is denotes time. Then the condition of all the constraintsee is expressed in the form of $(r_1, r_2, \ldots, r_n, t) = 0$. This is holonomic constraints

e.g. :- In case of rigid body of which any two particular points have fixed distance between them. They are holonomic. This condition is $(r^2 - r_j^2) - (l)^2$

b) Non - holonomic :-

If the all constraints does not expressed in the condition as holonomic then they are non - holonomic constraints.

e.g. :- The constraints involving in the motion of molecules in gas container is non - holonomic.

a)

3) Conservative :-

If constraints do not do any work, then the total mechanical energy of system is conserved while processing the constraints motion.

e.g. :- Simple pendulum with rigid body.

b) Discpective :-

If constraints do work, then total mechanical energy is not conserved.

e.g. :- Simple pendulum with variable length.

Prash S. Savtekar

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प्र. क्र. Q. No.	
Q.1	
1)	c) Sclerenomous
2)	b) Static
3)	a) Three

07

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02 Section | Q. No. | Marks

प्र. क्र. Q. No.

Q 2)

Constraints

= The limitation or geometrical restriction on a motion of particle or system of particle is known as constraints.

Types :-

1) Scleronomic : If constraints relation do not explicitly depend of time eg. In the case of rigid bodies

2) Rheonomic : If constraints relation depends on explicitly of time.

Example : The bead sliding on rotating wire.

3) Holonomic : The $x_1, x_2, \ldots x_n$ is position of co-ordinates of system & 't' denotes time. The condition all the constraints is expressed in a eqn $f(x_1, x_2, \ldots x_n, t) = 0$. This is holonomic.

Section	Q. No.													03
	Marks													

Example :- In case rigid body of which any two particular point distance betw are fixed . The condition is
$(r_i - r_j)^2 - c_{ij}^2$

4) Non-Holonomic :- If the all conditional constraint is not as expressed than its a non-Holonomic.

Example :- the constraints involving in The motion of molecules in gas. container is non-Holonomic.

5) conservative :- If constraints do not do any work then total mechanical energy of systems is conserved while necessary of constraints energy.

04

Example :- simple pendullum with rigid body.

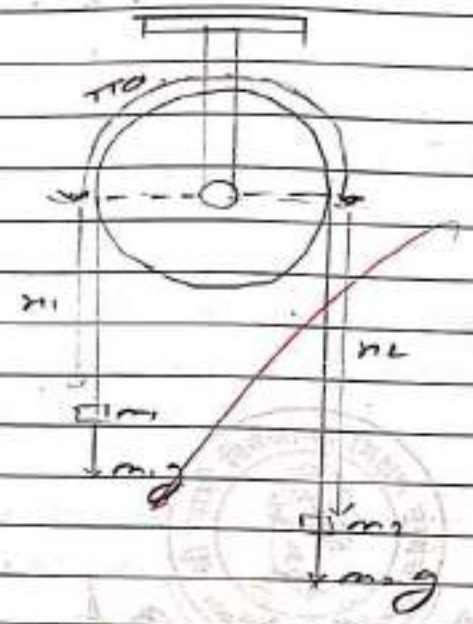
6) dissipative :- If constraints do work then mechanical energy is not conserved.

Example :- simple pendullum with variable length.

04	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

Q 3)



1) This system consists masses m_1 & m_2 suspended over a frictionless pully of radius 'a', & connected to inextensible string of constant length = l.

2) The configuration can be easily specified by two co-ordinates, x_1 & x_2.

3) The eqn constraints to such system

$$x_1 + x_2 + \pi a = l$$

$$\therefore \dot{x}_1 = -\dot{x}_2 \quad \& \quad \ddot{x}_1 = -\ddot{x}_2$$

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प्र. क्र.
Q. No.

The kinetic energy is given by.

$T = \frac{1}{2} m_1 \dot{r}_1^2 + \frac{1}{2} m_2 \dot{r}_2^2 = \frac{1}{2}(m_1+m_2)\dot{r}^2$

The potential energy is given by.

$V = -m_1 g r_1 - m_2 g (L - \pi L + r_1)$

$= -(m_1 - m_2) g r_1 + V_0$

where $V_0 = -m_2 g (L - \pi L) = \text{constant}$.

Thus, the light particle moves away from pulley the potential energy is decreases. It is negative.

The Lagrangian solving for this case is

$L = T - V$

$= \frac{1}{2}(m_1+m_2)\dot{r}_1^2 + (m_1 - m_2) g r_1 + V_0$

02 Section | Q. No. | Marks

प्र. क्र. Q. No.

If there is only one generalised co-ordinate x, then there will be only one Lagrange's eq'n becomes,

$$L = \frac{1}{2}(m_1+m_2)\dot{x}^2 + (m_1-m_2)gx - V_0$$

Then $\frac{\partial L}{\partial \dot{x}} = (m_1+m_2)\dot{x}$

$$\frac{\partial L}{\partial x} = (m_1-m_2)g$$

Now, Lagrange eqn from the case is,

$$\frac{d}{dt}\left[\frac{\partial L}{\partial \dot{x}}\right] - \left(\frac{\partial L}{\partial x}\right) = 0$$

$$\frac{d}{dt}\left[(m_1+m_2)\dot{x}\right] - (m_1-m_2)g = 0$$

07

$$(m_1+m_2)\ddot{x} - (m_1-m_2)g = 0$$

$$\boxed{\ddot{x} = \frac{m_1-m_2}{m_1+m_2}g}$$

This is required eqn for acceleration

Sakshi Raju Binanje

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14/15

प्र. क्र. Q. No.			
Q1	Q1	c] Sclerenomous	1
	Q2	b] Static	1
	Q3	b] two	1

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03

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

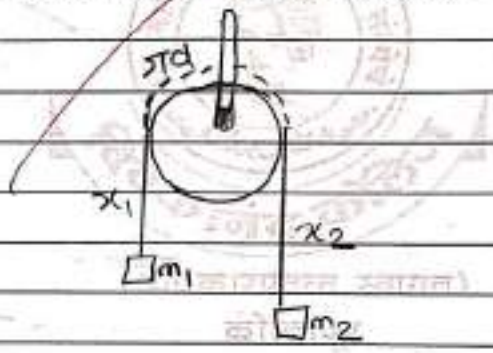
02	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

Q3 2 Atwood's machine.

If system is massless then it a Holonomic and Conservative constraint type and If string is frictionless then it is Scleronomic Contraint.

Atwood's machine constructed as below diagram



There are two different masses m_1 and m_2 are connected to pulley with radius a and total length of string is l
the string of system can be specified by co-ordinate x_1 and x_2

The equation of constraint is given as

$$x_1 + x_2 + \pi a = l \quad \text{..... (I)}$$

we have

$$\dot{x}_1 = -\dot{x}_2 \quad \text{..... (II)}$$

$$\ddot{x}_1 = -\ddot{x}_2$$

Section	Q. No.													03
	Marks													

प्र. क्र.
Q. No.

The Kinetic energy of system is given as

$$T = \frac{1}{2}(m_1 \dot{x}_1^2 + m_2 \dot{x}_2^2)$$

$$T = \frac{1}{2}(m_1 + m_2)\dot{x}_1^2 \quad \ldots\ldots \text{III} \quad [\text{from eq}^n \text{II}]$$

The Potential energy of system is given as

$$V = mgx$$
$$= -m_1 g x_1 - m_2 g x_2$$
$$= -m_1 g x_1 + m_2 g (l - \pi a - x_1) \quad \ldots \text{from I}$$
$$V = -m_1 g x_1 + m_2 g x_1 - V_0$$

where $V_0 = -m_2 g(l - \pi a)$ constant.

Here,

Potential Energy decrease as height is increases. Hence negative sign is used.

$$\therefore \quad V = -(m_1 - m_2)x_1 g - V_0 \quad \ldots\ldots \text{IV}$$

case of langrages eq^n

$$L = T - V$$
$$= \frac{1}{2}(m_1 + m_2)\dot{x}_1^2 + (m_1 - m_2)x_1 g + V_0$$

04 Section | Q. No. | Marks

प्र. क्र. Q. No.

and

$$\frac{\partial L}{\partial \dot{x}} = (m_1 + m_2)\dot{x} \quad \text{..... (v)}$$

$$\frac{\partial L}{\partial x} = (m_1 - m_2)g \quad \text{..... (vi)}$$

The Langoages conditions

$$\frac{\partial}{\partial T}\left(\frac{\partial L}{\partial \dot{x}}\right) - \frac{\partial L}{\partial x} = 0$$

$$\frac{\partial}{\partial T}\left(\frac{\partial L}{\partial \dot{x}}\right) - \frac{\partial L}{\partial x} = 0.$$

from eqn (v) and (vi)

$$\frac{\partial}{\partial T}(m_1 + m_2)\dot{x} - (m_1 - m_2)g = 0$$

$$(m_1 + m_2)\ddot{x} - (m_1 - m_2)g = 0$$

$$(m_1 + m_2)\ddot{x} = (m_1 - m_2)g$$

$$\ddot{x} = \frac{m_1 - m_2}{m_1 + m_2} g$$

$$\boxed{\ddot{x} = \frac{m_1 - m_2}{m_1 + m_2} g}$$ ... eqn of accelaration of Atwood's machine

This is eqn of system of two particle of unequal masses connected by inextensible string passing over a smooth palley.

sakshi Raju Biraje

Constraints

- Constraint is limitation or restriction to the motion of body
- Constraint is elastic in nature.
- Constraint opposes the motion or momentum of body.

There are 6 types or dependence are classified on basis of time, velocity, energy.

Constraint

1) Scleronomous 2) holonomic 3) conservative
2) Rheonomous 2) non holonomic 2) non conservative

02	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

1) Scleronomous

Constraint relation which are independent on time that type of constraint are called as. Scleronomic constraint.

Ex Simple pendulum.

2) Rheonomous

Constraint relation which depend on time that type of constraint are called as Rheonomous.

Ex Simple pendulum whoes length change with time.

3) holonomic -

Constraint relation which independ upon velocity that time of holonomic constraint are called as holonomic constraint.

Ex - rigid body.

The body having containing any two points distance is constant. Distance

Section	Q. No.													
	Marks													03

bet^n any two tpe particle is constant. and body which is at normal temp or room temp is called rigid body.

4) Non Holonomic

Constant relation which depends upon velocity that constraint are called non - Holonomic

Ex - non rigid body.
Distance bet^n any two particle changes and not constant that body which is at high temp are called non rigid body

5) Conservative
In constaint, mechanical energy is ~~conves~~ conserved that mean energy of system is constant that type of constraint called as conservative constraint
04
Ex. simple pendulum.

6) Non Conservative
mechanical energy is not conserved in system that called as non conservative constraint Ex simple pendulum with frictio

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Department of Physics

B.Sc. Part-III SEM VI Examination (2024-25)
Semiconductor devices and Instrumentation
Paper VI (Paper code: DSC-1001F1) Section I

Date : 06/03/2025 Total Marks: 15
Day : Thursday Time :- 11am to 12 noon

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 **(8)**

1. The ------ impurity should add to prepare n-type semiconductors.
   (a) trivalent (b) tetravalent
   (c) pentavalent (d) any one of above
2. The forward bias diode is used as ----- switch in circuit.
   a) open b) closed
   c) open/closed d) open and closed
3. Solar cell works on the principle of------- effect.
   (a) photoelectric (b) photocatalytic
   (c) photosynthesis (d) all of above

Q.2 Attempt any ONE **(08)**

1. Draw the diagram of Solae cell and explain its principle, construction and working.
2. Draw the diagram of Photodetector and explain its principle, construction and working.

Q.3 Attempt any ONE **(04)**

1. Explain semiconductors.
2. Explain current mechanism in semiconductor.

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Internal Examination Feb 2025

Shri Swami Vivekanand Shikshan Sanstha, Kolhapur's

Vivekanand College, Kolhapur

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Department of Physics

B. Sc. / M.Sc. Part – III, Semester – VI, PHYSICS Paper - XIII

Title of the Paper: Semiconductor devices & instruments

Name of Teacher: Dr. S. T. Inamdar

Attendance Sheet

Sr. No.	Name of the Student	06/03/25	Roll number				
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4)	Gaurav. A. Dadarne		8202	07			
5)	seema.s.Hiremath	Shm	8441	11			
6)	Rutesh S. Sawhekar	RSth	8210	11			
7)	Atharv H. Kognolikar	Ahk.	8204	15			
8)	Tanishq Mude		8205	12			
9)	Saad Sanjay Hasbe	Shasbe	8430	12			
10)	Sahil Patnekar	Sahil	Sahil	12			
11)	Surekha Desai.	Sdesai	8203	14			
12)	Samriddhi Ranmale	Rsmale	8209	09			
13)	Harshvardhan D. Patil		8232	06			
14)	~~Seema S. Hiremath~~	~~Shm~~	~~8441~~				
15)							
16)							
17)							
18)							
19)							
20)							

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Sakshi Raju Birange

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Centre	15/05

प्र. क्र. Q. No.	
Q.1]	c] Pentavalent
2]	b] closed
3]	a] Photoelectric

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02 Section	Q. No.													
	Marks													

प्र. क्र.
Q. No.

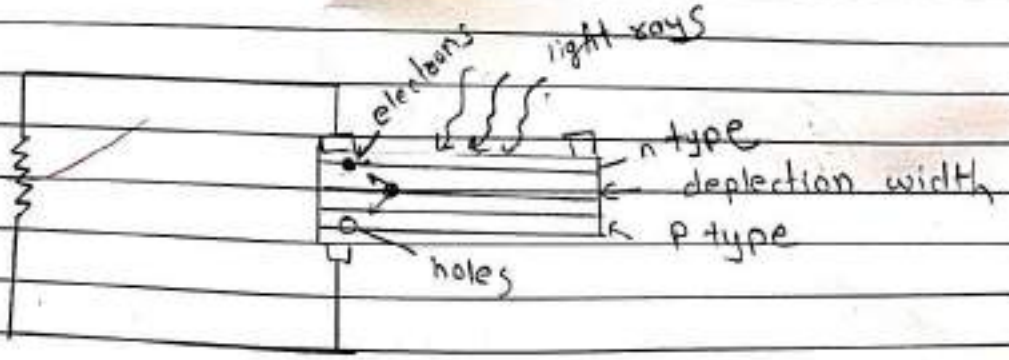
Solax cell

- Solax cell is a P-n Junction diode
- Solax cell also called as photovoltaic cell or PV c
- It is a device which convert light energy into electrical energy through photovoltaic effect
- Solax cell can be combine to form module called as Sonax pannels

* **Principle :-**

It is based on photovoltaic effect free electrons are produced in material when certain wavelength of light incident on the semiconductor.

* **Construction**



There is very thin layer of n type semiconductor relatively thicker layer of p type semiconductor

Section	Q. No.													03
	Marks													

प्र. क्र.
Q. No.

There are two contract electrodes front and back side of solar cell
N type semiconductor on top of solar cell and P type semiconductor back of solar cell.

* Working.

1] light is incident on semiconductor or solar cell photons are easily inter in material, there is very thin layer of N type Semiconductor

2] light energy in form of photons provides sufficient energy to the material to produce free electrons in the Juction.
There is formation of number of electron-hole pair in the junction

3] e free electron depletion layer quickly comes P n type semiconductor side and depletion layer quickly comes to type of semiconductor side because of tensial barrier.

4] As concentation concentation of Hole (P type) are highers. the current flow make a small battery voltage. It work as battery.

04 Section | Q. No. | Marks

प्र. क्र.
Q. No.

that How solar cell works
the battery form a set up of voltage are
called as voltage electric photovoltaic volta

It is a renewable type of energy source,
~~We~~ we we ~~in~~ daily so

X

Sakshi Raju Birange

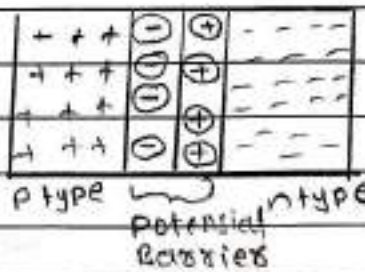
Semiconductors

material which conductivity lies bet^ conductors and insulators are called as semiconductors

two types of Semiconductors
intrinsic
Extrinsic

~~furth~~ Extrinsic semiconductor further divide in n type and p type of semiconductors

Current Barriers in Semiconductors, P-n Junction diode



02 Section | Q. No. | Marks

Section

प्र. क्र. Q. No.

प्र. क्र. Q. No.

∴ In Extrinsic semiconductor trivalent or pentavalent atoms are dopped to modified the intrinsic semiconductor.

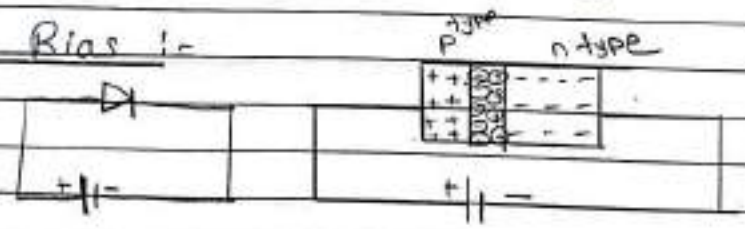
The layer of electrons form on P type of semiconductor and layer of as holes flow in direct^{n} of electrons similarly a layer of holes form on n type of semiconductor because of drift and diffision.

At equillibrium, layer of electrons and holes (P type) in the P-n function semiconductors are called as deflection layer.

Deflection layer stabilised and Potential Barial are formed.

There are two type of Biasing.

Forward Bias :-



In this Biasing positive terminal of battery is Connected to P type of diode

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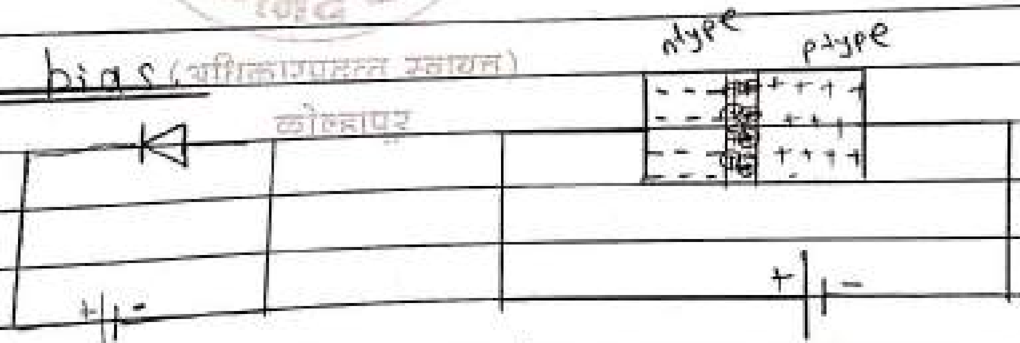
	Marks												03

and negative terminal of battery connected to n-type of diode

There is repulsion bet^n positive charge carrier and Positive (P-type) diode ~~and~~ similarly negative charge carrier n type diod and negative side of battary

Deplection width and potential barrier is decrease due to which circuit work as closed system and current is flow in the system. or circuit

Reverse bias



In this. Positive terminal of battary connected to negative charge carrier n type and negative terminal of battery connected to positive charge carrier.
There is attraction bet^n positive charge carrier and negative charge in battary similarly negative charge carrier and +ve sid of battary

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प्र. क्र. Q. No.

There is no charge flow in the Junction the potential barrier. The circuit is work as open circuit and no current is flow in the circuit in case of reverse biasing

Athare Hariprasad Kognolkar

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Suppliment No. :	01
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प्र. क्र. Q. No.	
Q.1	
a)	c) Pentavalent
b)	b) Closed
c)	a) Photoelectric

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02 Section | Q. No. | Marks

प्र. क्र. Q. No.

Q. 2

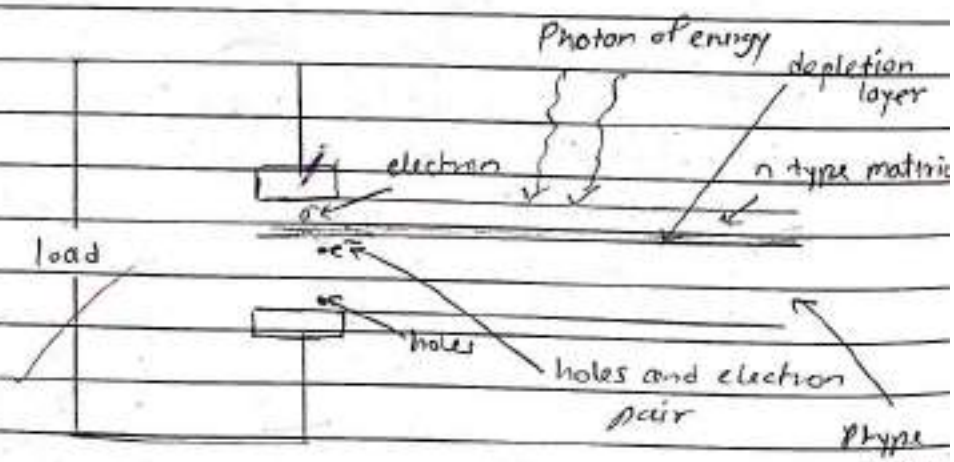
1) Solar cell :-

i) Solar cell is ~~ph~~ also known as photovaltic cell.
ii) It converts light energy into electrical energy.
iii) Solar cell is basically a p-n junction diode.
iv) The individual solar cells can combined and make the Solar panels.

Principle :-

Solar cell is works on the principle of ~~photoelectric~~ Photovoltic effect where we get free electrons when the light of partic wavelength is incident on the diode.

Contruction :-



Section	Q. No.													03
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i) Solar cell is basically a p-n junction diode.
ii) A thin layer of n-type semiconductor is grown up on the top of thiker layer of p-type semiconductor.
iii) The two electrodes are placed at front and back side of solar cell, which is placed at top of the n-type semiconductor and below the p-type semiconductor.
iv) A small load is connected for the current flow.

Working:-

i) When the light is incident on the solar cell, photon can be easily enter in the diode because of thin layer of n-type semiconductor.
ii) The light energy in the form of photon gives sufficient energy to the diode to create the electron-holes pairs.
iii) The free electron from the depletion layer comes quickly in the n-type region. Similarly the free holes in depletion layer comes quickly in p-type region.
iv) The newly generated electrons in n-type region and holes in p-type region does not cross the junction because of potential barrier.
v) As the concentration of electrons in n-type region gets higher and the concentration of holes in p-type region becomes higher, the diode behaves like a battery cell. It will give some voltage.
vi) This voltage set up is also known as photo voltage.
vii) If the load is connected as the current flowing through solar cell.

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प्र. क्र.
Q. No.

Q.3 The materials which lies between conductors and insulator is k as semiconductors.

J)

Semiconductors

- Intrensic semiconductors
- Extrensic Semiconducto
  - P-type Semiconductors
    - Doped with the trivalent Compound
  - n-type semiconducto
    - Doped with th Pentavalent Compound.

1) Intrensic semiconductors :-

i) Intrensic semiconductors are also known as undoped Semiconductor or i-type semiconductor.
ii) They are pure semiconductors and does not have any significant dopant.
iii) The conductivity of these semiconductors are based on the surrounding temprature.
iv) At the room temprature, the i-type semiconductors shows less conductivity it is not useful for electric devices.

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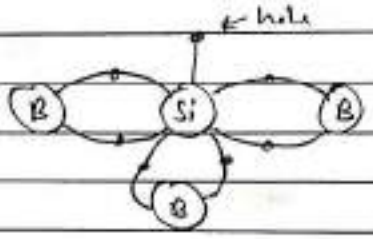
2) Extrensic semiconductors :-
i) These semiconductors are highly doped with the impurities.
ii) These semiconductors are not pure.
iii) The conductivity of these semiconductors is high.
iv) Because of high conductivity extrensic semiconductors are mostly used in electric ~~div~~ devices.

There are ~~ty~~ two types of extrensic semiconductors :-
1) P-type semiconductor
2) n-type semiconductor

1) P-type semiconductors :-



Silicon (Si)
When the tetravalent compound ~~Si is~~ is doped with the trivalent compound Boron (B). The three electrons of boron make covalent bond with three holes of silicon. ~~The~~ But the one hole remains alone. On the hole positive charge is present. Hence these semiconductors are called as

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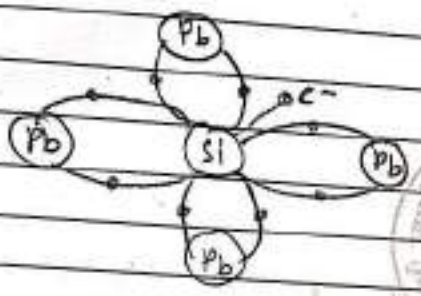
p-type semiconductors.

2) n-type Semiconductors :-



When the tetravalent compound Silicon (Si) is doped with penta-valent compound Pb lead (Pb) The four electrons make covalent bond with four holes of silicon. But the one electron remains alone. The electron moves freely. Hence it is called as n-type Semiconductor.

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प्र. क्र.
Q. No.

Q.1. The

1) The 'Pentavalent' impurity should add to prepare n-type semiconductor.

→ 1 & c) 'Pentavalent'

2) The forward bias diode is used as 'closed' switch in circuit.

→ 1 b) closed

3) ~~Solar cell~~ works ~~on~~ principle of 'Photoelectric' effect

→ a) Photoelectric

3) Solar cell works on the principle of 'photo~~catalytic~~'electric effect.

→ 1 ~~b) Photocatalytic~~ a) Photoelectric

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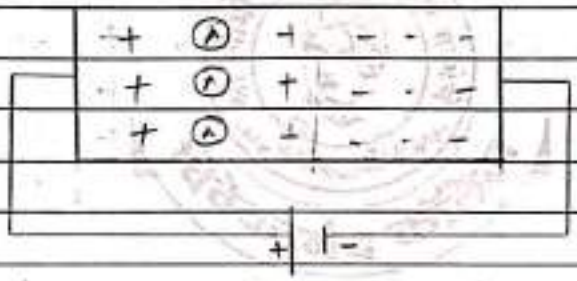
Q. 3.

2. Current mechanism in semiconductor →

The current mechanism in semiconductor is 'Forward and Reverse'.

① Forward direction →



The P- side of junction and n - side type of junction are having positive and negative charge and they have positive battery and negative respectively.
This is called of forward diode..

These are repulsion between the p - type of positive charge and positive terminal of battery.
And the n- type of negative charge having negative terminal of battery.

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Q. No.

Q.3.2.

Reverse diode junction direction →

The P-side type of charge and n-type side type of charge is negative and positive charge and they having negative and positive battery barriers respectively.

These are attraction between P-type of side and n-type of side ~~is~~ is negative charge and negative terminal of battery.

And the n-side type is positive charge and ~~negative terminal~~ positive terminal of battery.

3

04	Section	Q. No.													
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प्र. क्र.
Q. No.

Solar Cell

Q.2.

1.

Construction →

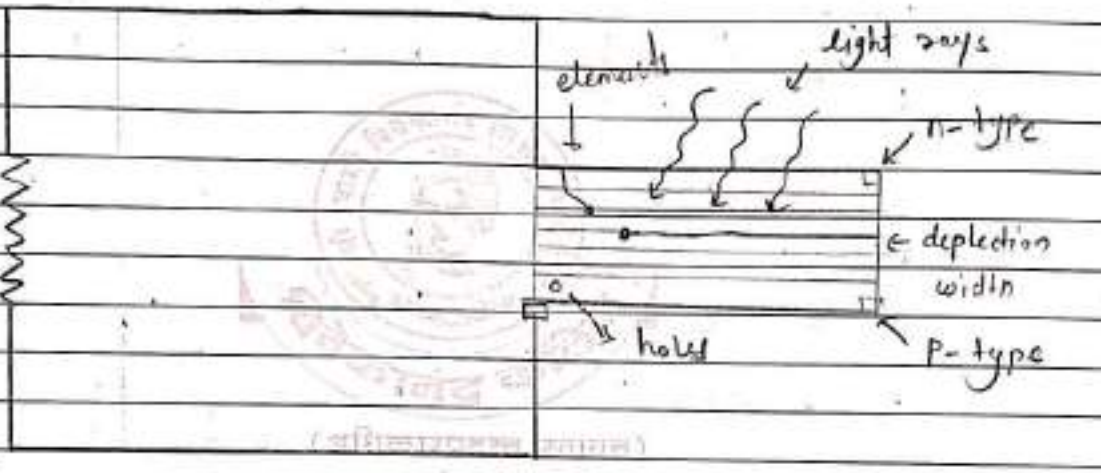

fig. Solar cell

1) There is very thin layers of n-type semiconductor relatively thicker layer of P-type semiconductor
2) There are two contact electrodes front & back side of solar cell.
3) N-type semiconductor is row of solar cell
4) And P-type semiconductor is back of solar cell.
5) Solar cell is made up by mainly two semiconductors these are n-type and P-type.
6) They having chargers positive and negative and positive and negative terminals.

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Department of Physics

B.Sc. Part-III SEM VI Internal Examination (2024-25)
Paper- Elements of modern Physics
Topic- Laser Physics
Paper code: DSC1001F3

Day: - Friday
Date: - 07/03/2025

Time: - 11.00 am- 12.00 pm
Total Marks: 15

Sr. No.	Name of the students	Roll. No.	Sign	Marks
1	Sakshi Bizanje	8201	SRBizanje	
2.	Sahil Patrekar	8208		
3.	Riya Patil	8207	RPatil	
4.	Ritu. R. Nishad	8206	Rishad.	
5	Seema. S. Hiremath	8441		
6	Samruddhi S. Ranmale	8209	Ranmale	
7	Ritesh S. Sawantkar	8210		
8	Atharv H. Kagwalikar	8204		
9	Harshvardhan D. Patil	8432		
10	Tanishq A. Mude	8205		
11.	Desai Surekha Tanaji	8203	Sdesai	
12	Saad Sanjay Hasbe.	8430	Shasbe	
13.	Gaurav H Dadarne	8202		

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Vivekanand College, Kolhapur (Empowered Autonomous)

Department of Physics

B.Sc. Part-III SEM VI (Paper XV)
Internal Examination
Laser Physics

Date: 07/03/2025 Total Marks: 15
Day: Friday Time: 10 -11 AM

Q.1] Select correct alternatives. **(03)**

1.The process of raising atoms from the lower energy states to proper higher energy states in laser formation is called.....

a) pumping

b) optical pumping

c) chemical pumping

2.Ruby laser is .....

a) crystalline solid laser

b) semiconductor laser

c) liquid dye laser

3.The word LASER is an acronym for.....

a) Light Amplification by Spontaneous Emissions of Radiation

b) Light Amplification by Stimulated Emission of Radiation

c) none of them

Q.2] Long answer questions. (attempt any one) **(08)**

1.What is pumping in laser formation? Explain in brief optical and electrical pumping.

2.Describe the construction and working of Ruby laser.

Q.3] Short answer questions. (attempt any one) **(04)**

1.What is meant population inversion in lasing action?

2.What are uses of lasers?

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ESTD JUNE 1964

Name:- Saad Sanjay Hasbe

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14/15

प्र. क्र.
Q. No.

Q1.

→ 1. a) Pumping.

→ 2. a) Crystalline solid laser.

→ 3. b) Light Amplification by Stimulated Emission of Radiation.

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02 Section | Q. No. | Marks

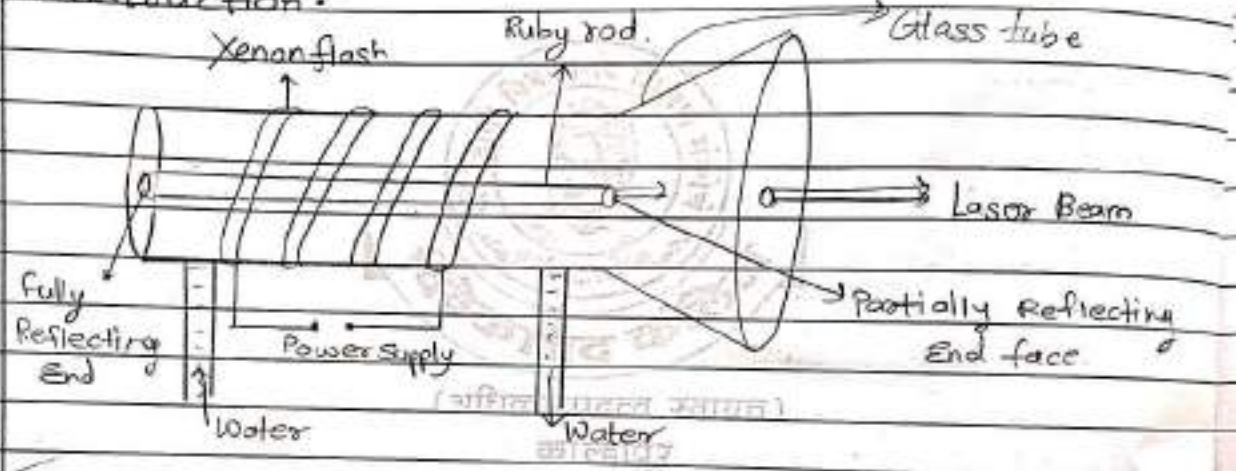
प्र. क्र. Q. No. 7

Q2. 2. Ruby laser :-

(1) A. Ruby laser is crystalline solid laser, first fabricated by Maiman in 1960.

(2) Optical pumping is used in Ruby inorder to generate laser.

A) Construction :-



(1) For Ruby laser, ruby rod is used which is cylinderical rod made up of Al_2O_3, but few Al^{3+} ions are replaced Cr^{3+} ions

(2) Chromium particles helps as a active particle

(3) Xenon flash lamp is spirally rotated around the rod & is connected with a power supply.

(4) The cavity in the rod, is where one end is coated with reflecting material and the other end is partially coated with reflecting.

(5) In the process the heat is generated because only few light from xenon lamp is used for pumping, all other light is used in heat

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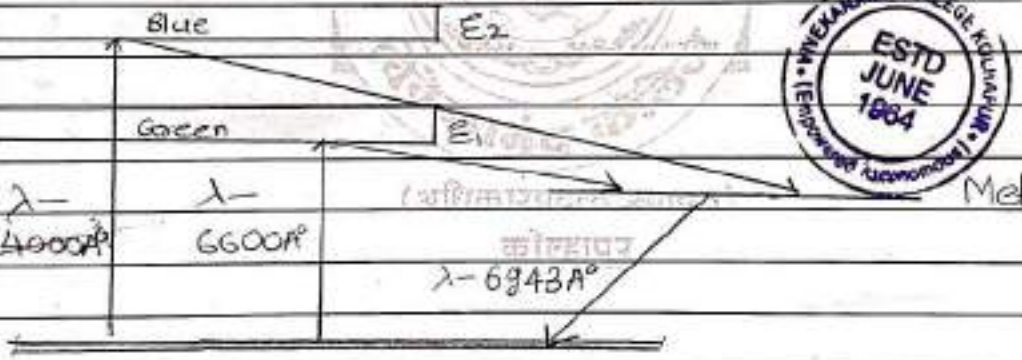
	Marks													

प्र. क्र.
Q. No.

generation, therefore it is necessary to cool down the Ruby lase, for which a water inlet & outlet circulates the water, acting as a coolent and regulate the temperature of system.

(5) The cone is built with the glass tube which helps to absorb the stray incoherent light

B] Working :-



(1) Once the photon from xenon lamp having energy hν hit the Cr^{+3} ions it excites the active particles

(2) This results into pumping of ions from ground state to higher energy state.

(3) If we provide a λ (wavelength) of 4000A° then the ions will excite to E_2 which have Blue colour.

(4) If we provide a wavelength of 6600A° then it will excite to E_1 which have green colour

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		Marks											

प्र. क्र.
Q. No.

5. But, the time span of ions in E_1 & E_2 is ver small (10^{-8} sec)
6. Therefore, a non-radiative transition state is obtained denoted as metastable transit wherein the ions stay for 3×10^{-3} sec period.
7. Here, the population inversion takes place
8. Therefore, by stimulation a precise coheren highly amplified beam of light is produced which is known as LASER (Light amplification by Stimulated Emission of Radiation)
9. The xenon flash lamp doesn't run continously ∴ it generates pulsed signal, of frequency 100Hz, & energy 10kV.

Name - Saad Sanjay Hasbe.

Supplement — 2

13431

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

Signature of Jr. Super.

विवेकानंद कॉलेज, कोल्हापूर. (अधिकारप्रदत्त स्वायत्त)

परीक्षेच्या ——— या विषयाच्या प्रयोग परीक्षा

Practical Examination in, ———

at the ——— Examination

उमेदवाराचा आसन क्रमांक ——— विभाग ———
(Candidate's Seat No.) (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 त्यानंतर पुढे काम चालू करण्याविषयी परीक्षकांची परवानगी मिळविणे आवश्यक आहे.
४. सर्व निरीक्षणे कोष्टकबद्ध तक्त्यात मांडावी. मधल्या सर्व गणना आणि निर्णय हे क्रम तिरक्या सुवाच्यपणे आणि स्पष्टपणे नोंदविलेले असणे हे हितावह आहे.
५. प्राथमिक 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. 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 by 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 absolutely 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.)

प्र. क्र. Q. No.
Q3. (4)

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→ 1. Population Inversion:

(1) In process of pumping when the ions from lower ~~excited~~ energy states get excited to higher energy states, then the accumulation of particles in higher energy state is knownas ~~pumping~~ population inversion.

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	Marks													

प्र. क्र.
Q. No.

② Population inversion is important condition for formation of laser.

③ In higher energy level the life span is very small therefore, the population inversion takes place in a non radiative metastable level where the life span is 3×10^{-3} sec.

④ There are few conditions in order to generate population inversion.

(i) The electron density (n) should be high.

(ii) The ratio of coefficient of spontaneous emission to coefficient of stimulated emission should be very less.

Akash S. Sawalkar

॥ ज्ञान, विज्ञान आणि संस्कार यासाठी शिक्षण प्रसार ॥
- शिक्षणमहर्षी डॉ. बापूजी साळुंखे

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12/15

प्र. क्र. Q. No.	
Q.1)	(3)
1)	a) pumping
2)	a) crystalline solid laser
3)	b) Light Amplification by stimulated Emission of Radiation.

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02	Section	Q. No.												
		Marks												

प्र. क्र. Q. No. (6)

Q 2) pumping :-

= Raising the atom in form lower energy state to high energy state this process is known as called the pumping.

= In pumping there have many types. like optical pumping, Electrical pumping, chemical pumping

1) Optical pumping :-

i) It absorbation of light of proper frequency is called as optical pumping.

ii) For example, In case of Ruby leaser.

iii) The pumping of chromium ion (Cr^{+3}) is done by absorbation of either.

a) photon of wavelength is 6600 A°

b) photon of wavelength is 4000 A°.

iv) The selection of some photon select or supression, of other ions. is crucial thing to do. This is optical pumping.

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	Marks													

प्र. क्र. Q. No.

2) Electrical pumping:

i) it is accomplished by mean of sufficiently intence, self-sustaning of electrical discharge.
ii) particularly is transition gaseous active media and pressure is about 1 to 10 torr.
iii) it take to place active the population inventation by using the gaseous active media method.
iv) This leaser is obtained by this method as are comanlly called Gas-discharge laser.
v) In electrical pumping the dischard may be pulsed & stationary. & quantal quansistationary.
vi) The current electrical discharge is about 100 to 1000 A/cm².
vii) The temprature of discharge is 1000 K. lows of the temprature discharge. At room Temprature is also used.
viii) The He-Ne is leser examples of gas-discharge laser and it obtained by Electrical pumping.

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03) Q. No.

Population Inversion :

i) when the stimulated emission of radiation is greather than spontaneous emission of radiation the population inversion happened.

ii) The number of atoms in higher energy state is has to be greater than number of atom in lower energy state.

iii) The radiation density and even the radiation frequency should be large.

iv) The lifetime of E_2 is has to be small than the E_2 population inversion happens.

2) i) Laser of higher wavelength are used for surgeries of different part of body in hospital

ii) The small laser are used as pointer to business meeting

iii) The small laser is used in school for teaching purpose.

iv) It is used in various types like medical, optical, Electrical, mechanical, chemical.

Date:- 7/3/2025

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प्र. क्र. Q. No. Q.1

1)
→ a) Pumping

2)
→ a) crystalline solid laser.

3)
→ b) Light amplification by stimulated emission of radiation.

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प्र. क्र. Q. No. Q.2 (8)

2)

→ * construction and working of ruby laser:-

Ruby laser is solid crystalline laser which em red light.

* construction:-

1) It is consist of solid cylindrical crystal of ruby which is active material.

2) The resonate cavity formed by making on end fully reflecting and other partially reflecting by silvering.

3) The pumping is optical pumping and xen discharge tube is coiled round it.

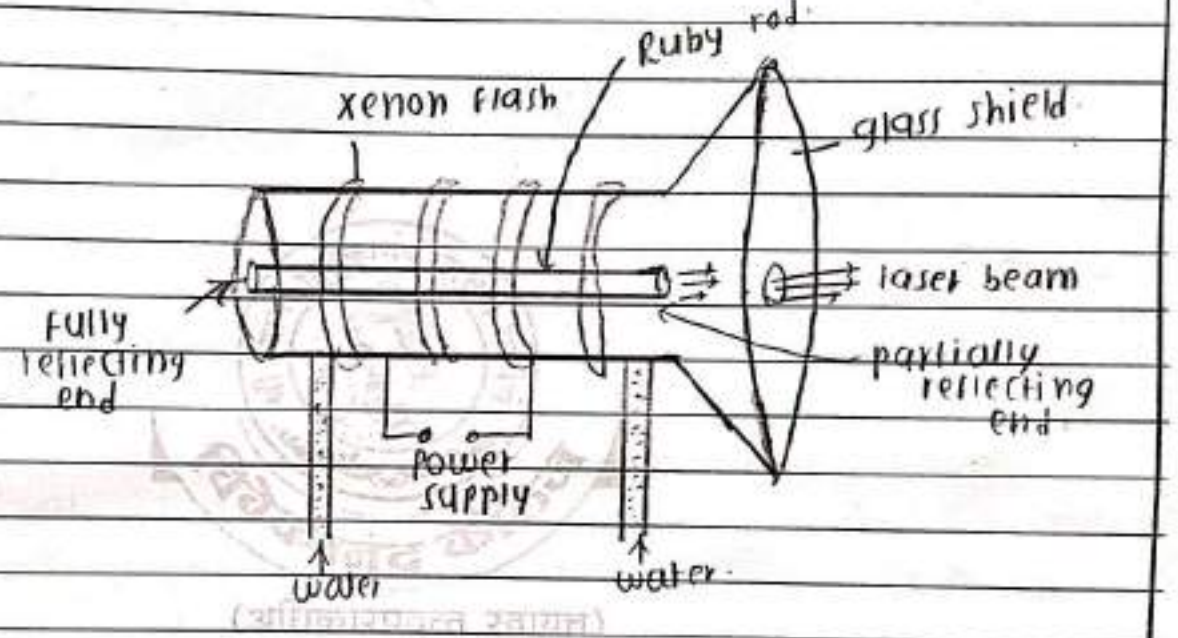
4) It can be charged to very few kilovolts and it operates at regular interval.

5) Few white light emits through discharge tube which is used for pumping and rest of it heating apparatus hence cooling is necessary.

6) cooling is done by circulating water aroun it.

Q. No.													
Marks													03

7) The glass shield is used to emit light in fine beam of laser.



(a) Fig:- Ruby laser

* working :-

1) Ruby laser is consist of aluminium oxides in which some of aluminium ions replaced by Cr^{+3} ions.

2) The chromium ions acts as central active ions in this laser.

3) The energy level of Cr^{+3} ions is as shown in Fig (b)

प्र. क्र. Q. No.

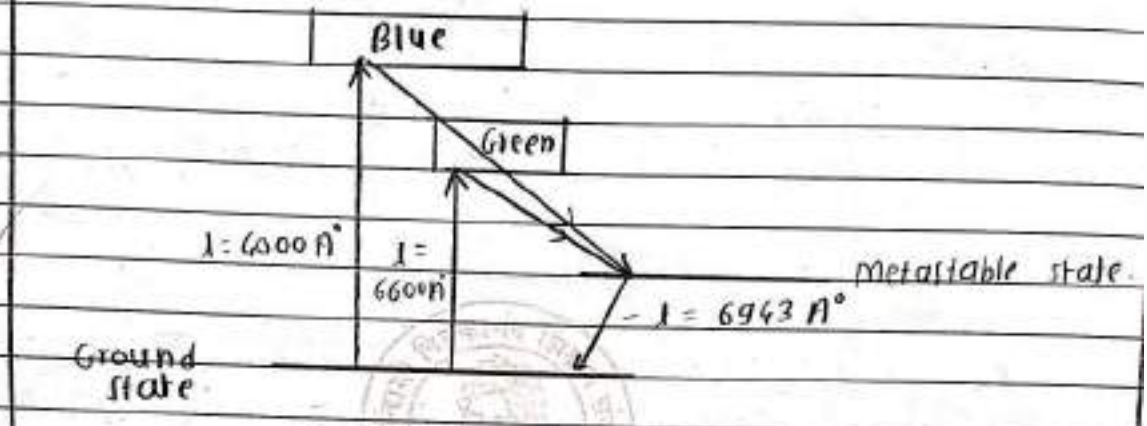


Fig (b) Energy levels

4) When xenon light absorbs by Cr^{+3} ions it makes transition to band de level as shown in fig

5) When Cr^{+3} ions absorbs wavelength of 6000 A° it makes transition from ground state to one of state of band state 1 (blue) and when it absorbs 6600 A° it's transition from ground state to band level 2 (green

6) But life time for this two levels is small and by non-radiative emission or radiation these ions drops to metastable state (M) and population inversion takes place.

7) The Cr^{+3} ions decay from band level and emits wavelength of 6943 A°. Light undergo multiple reflection and laser amplification takes place and small beam emitted through partially reflecting end.

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प्र. क्र. Q. No. Q.3 2)

(4)

→ * Uses of lasers :-

A) Based on narrow bandwidth :-

a) communication system :-

1) Laser is used as charge carriers on which message is mount.

2) Due to very narrow bandwidth, the number of channels of messages which can be simultaneously carried is very high.

3) Therefore, simultaneous transitions carried through laser on high scale is possible.

b) computers :-

1) computers uses radiation of signals to distinguish small differences, due to narrow bandwidth a number of small differences can be.

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प्र. क्र. Q. No.

distinguished and storage capacity of memory and information and can be increased.

B) Based on narrow angular speed or high directionality

a) chemistry :- Raman spectroscopy :-

1) crystal structure can be studied by obtaining scattering of atoms and molecules.

2) Due to high directionality, high intense beam of laser concentrated on sample, using small quantity of sample better spectrograph can be achieved in short period.

b) communication :-

1) Due to narrow angular speed it is used to communicate earth satellites, in rocketary.

2) Distance between earth-moon can measured.

c) Industry :-

1) To cut thin sheets of metal

2) To bore a narrow holes through metal at fast rate.

Q. No.

Marks 03

d) Medicine :-

Microsurgery are possible, harmful part can be destroyed without disturbing neighbouring part.

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Department of Physics

B.Sc. Part-III SEM VI Examination (2024-25)
Solid state physics
Paper XVI (Paper code: DSC-1001F4)

Date : 07 / 03 /2025 Total Marks: 15
Day : Friday Time :-1.00 pm to 2.00pm

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. Metals are good conductors of heat and electricity. This property is conferred by __ bonds.
   a) covalent b) ionic c) metallic d) hydrogen
2. For a metallic crystal, which band do the delocalized electrons occupy?
   a) conduction band b) valence band c) both, conduction and valence bands
   d) there are no delocalized electrons
3. What is the term for a material that has overlapping valence and conduction bands, allowing for easy electron flow?
   a) Insulator b) Semiconductor c) Superconductor d) Conductor

Q.2 Attempt any ONE **(08)**

1. Discuss Kronig- Penney model of metal
2. What is Hall effect? Obtain an expression for Hall coefficient. Also explain band theory of solids

Q.3 Attempt any ONE **(04)**

1. Distinguish between conductor, insulator and semiconductor.
2. Explain classical free electron theory of metals.

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प्र. क्र. Q. No.

13/15

Q.1

1) Metals are good condutors of heat and electricity. This property is canferred by metallic bond.

2) For metallic crystal, which band do the the delocalized electrons occupy ?
→ conduction band

3) → conductor

07

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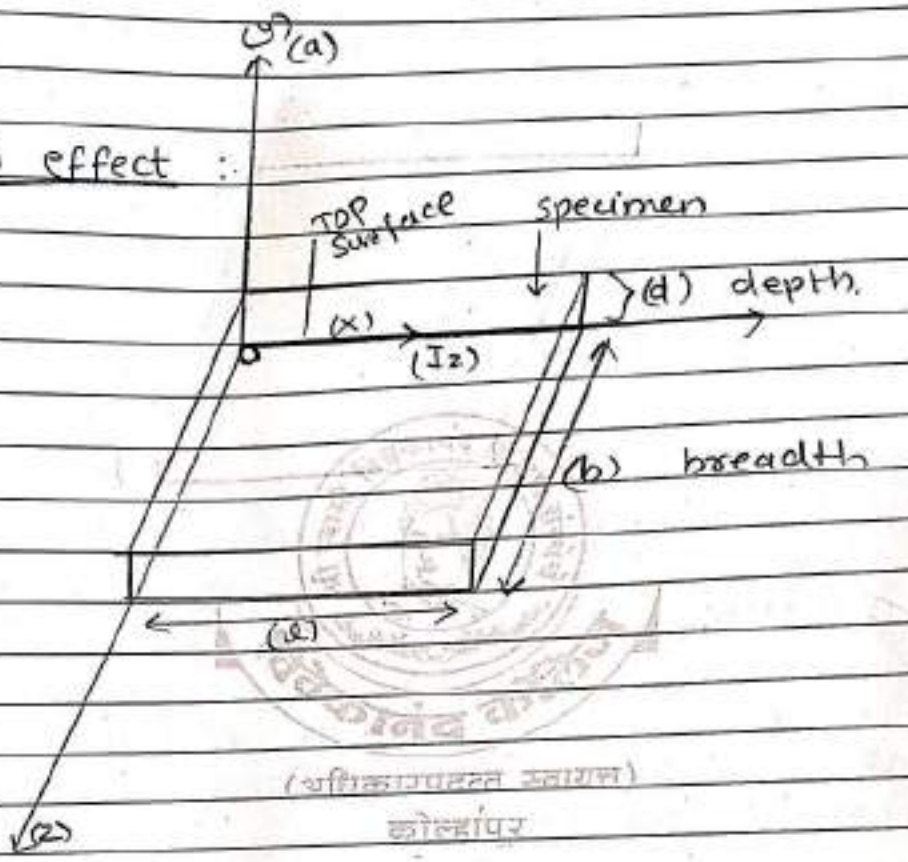
प्र. क्र. Q. No.

Q2] Ans (2)

Hall effect :



- Defination : if a current carrying conduc specimen is placed in transverse (⊥) magnetic field of intensity (H) then, eletric field (E) is induced in direction perpendicular to both this phenomenon is called / known as Hall effect.

- uses to determine -
1) Nature of semiconductor.
2) carries concentration or charge density

Section | Q. No. | Marks | 03

3) Mobility (μ) of charge carries or Conductivity (σ)..

- Electric force $= qE = -eE$.
- magnetic force $= Bqv = -\frac{e}{c}(\vec{v} \times \vec{H})$

$\therefore$ Total force = electric force + magnetic force

$$F_y = -eE_x - \frac{e}{c}(\vec{v} \times \vec{H})$$

$$\therefore \boxed{F_y = -e\left[E_x \frac{1}{c}(\vec{v} \times \vec{H})\right]}$$

- Expression for Hall voltage (E_y) & Hall coefficient (R_H) –

$\therefore$ Electric force = magnetic force

i.e $-eE_y = -\frac{e}{c}(V_x \times H_z)$

$$\therefore \boxed{E_y = \frac{1}{c} V_x H_z} \quad \text{—— (1)}$$

In ~~nonmagnetic~~ magnitude called as expression for Hall voltage per unit depth of Specimen.

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	Marks											

प्र. क्र. Q. No.

- Now let, n = no. of electron per unit volu
  $-e$ = charge on electron.
  V_x = velocity of electron on x-axis

I_x be current density
i.e no. of electron flowing per unit Area per unit time.

$\therefore$ $\boxed{I_x = n(-e) \cdot V_x}$

$\therefore$ $V_x = \frac{I_x}{-ne}$ from (I).

$\therefore$ $E_y = \frac{1}{c}\left(\frac{I_x}{-ne}\right) H_z$.

$\therefore$ $\frac{E_y}{I_x H_z} = R_H = \frac{1}{-nec}$

where R_H = Hall coefficient.

also, $ne = \rho$

$\therefore$ $\boxed{R_H = \frac{1}{-\rho_0}}$ $\rightarrow$ in electrostatic unit (e.s.

$\boxed{R_H = -\frac{1}{\rho}}$ $\rightarrow$ in electromagnetic unit (e.m

- The Hall coefficient is constant for given material.

- Dimension = $\boxed{\text{volt cm}^{-1}\ \text{Amp}^{-1}\ \text{gauss}^{-1}}$

also, measured in terms of emf.

06

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Q3) Distinguish between conductor, insulator & semiconductor.

Ans

(1).

	conductor	semiconductor	Insulator.
* Definition -			
•	A material that allows electric current pass through it very easily	A material that has conductivity in betn conductor and insulator.	A material that do not allow electric current to pass through them.
* Forbidden energy gap			
•	No energy gap i.e (V.B) (C.B) overlap with each other.	small energy gap	very larger energy gap.

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प्र. क्र. Q. No.	conductor	semiconductor	insulator
	* conductivity		
	• Higher conductivity	intermediate	very low
	* conduction		
	• due to free electron	due to both electron & hole.	No conductio
	* temperature coefficient resistivity		
	• (+ve) positive	(-ve) negative	(-ve) negative
	* Resistivity		
	• low	intermediate	very high
	* valence electron in outermost shell.		
	• less than 4 e^-	4 electrons	more / greater than 4 electron.

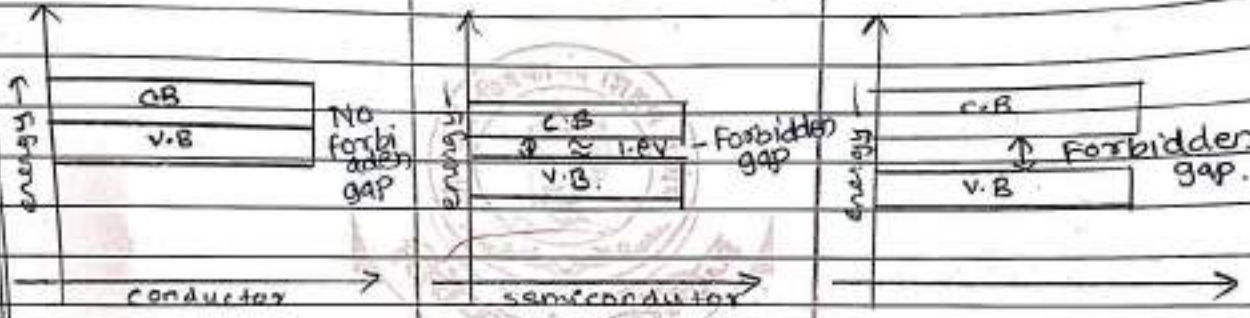
Section | Q. No. | Marks | 03

* Example.
  - copper
  - Silver

silicon
gallium

wood
air.

* Band diagram.



Atharv Hanjmasad Kagrolikar

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प्र. क्र. Q. No.	
Q.1	15/15
1)	c) Metallic
2)	a) Conduction band
3)	d) Conductor

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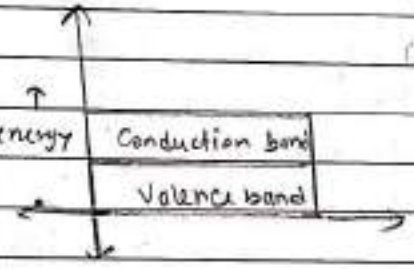
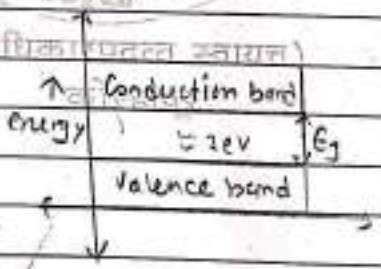
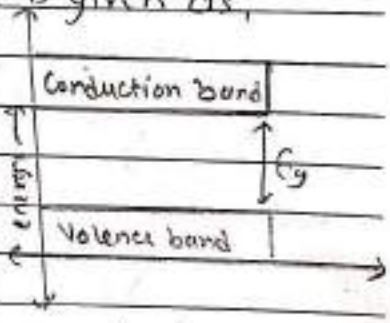
1)

Conductor	Semiconductor	Insulator
i) The material which gets current flow easily is called conductor	i) The material which lies between conductor and insulator in conductivity is known as semiconductor.	i) The material which cannot flow the current is known as insulator.
ii) The band diagram is given as, 	ii) The band diagram is given as, 	ii) The band diagram is given as, 
iii) There is no forbidden gap.	iii) There is small band gap	iii) There is too large band gap.
iv) There are ~~more~~ less than 4 electrons in outer-most shell	iv) There are four electrons in outer-most shell	iv) There are greater than four electrons in outer most shell.

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v) Here temprature coefficient of resistivity is positive.	V) Here temprature coefficient of resistivity is negative	v) Here temprature coefficient of resistivity is nega
vi) Here the conductivity of material is high.	vi) Here the conduct-ivity of material is intermidate.	vi) Here the cond-ivity of material is low.
vii) Here the resistivity of material is low.	vii) Here the resistivity of material is inter-midate.	vii) Here the resistivity of mate is high.
viii) Here, the conduction happens because of electrone.	viii) Here, the conduction happens because of hole and electrone both	viii) Here, the conduction ~~happ~~ ~~because of~~ does not happens.
ix) Example :- Copper	ix) Example :- Silicon	ix) Example :- Wood

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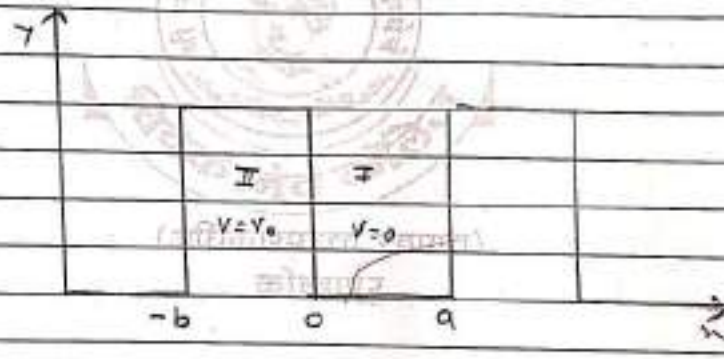
Q. No.

Q.2 Kronig - Penny model :-



Consider an electron moving along X axis under periodic potential is defined as,

$V = 0$ for $0 < x < a$

$V = V_0$ for $-b < x < 0$

By using time independent schrodinger eqn,

$$\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}(E - V)\psi = 0 \quad \text{---(1)}$$

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For region I :-

$V = 0$

Eqn (I) becomes,

$$\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2} E\psi = 0$$

Put $\frac{2m}{\hbar^2} E = \alpha^2$

$$\frac{d^2\psi}{dx^2} + \alpha^2\psi = 0 \quad \text{---(II)}$$

For region (III) II :-

$V = V_0$

eqn (I) becomes,

$$\frac{d^2\psi}{dx^2} + \frac{2m}{\hbar^2}(E - V_0)\psi = 0$$

Put

$$\frac{d^2\psi}{dx^2} - \frac{2m}{\hbar^2}(V_0 - E)\psi = 0$$

Put $\frac{2m}{\hbar^2}(V_0 - E) = \beta^2$

$$\frac{d^2\psi}{dx^2} - \beta^2\psi = 0 \quad \text{---(III)}$$

The solution of eqn (II) and (III) is,

$$\psi = e^{ikx} V_{is}(x) \quad \text{---(IV)}$$

Differenciate eqn (IV) w.r.t. x.

$$\frac{d\psi}{dx} = e^{ikx}\frac{dU_k}{dx} + ikU_k e^{ikx}$$

Differenciate above eqn w.r.t. x.

$$\frac{d^2\psi}{dx^2} = e^{ikx}\frac{d^2U_k}{dx^2} + ike^{ikx}\frac{dU_k}{dx} + ikikU_k e^{ikx} + ik\frac{dU_k}{dx}e^{ikx}$$

$$\frac{d^2\psi}{dx^2} = e^{ikx}\frac{d^2U_k}{dx^2} + 2ike^{ikx}\frac{dU_k}{dx} - k^2U_k e^{ikx} \quad \text{(V)}$$

Put this value in eqn (II),

$$e^{ikx}\frac{d^2U_k}{dx^2} + 2ike^{ikx}\frac{dU_k}{dx} - k^2U_k e^{ikx} + \alpha^2 e^{ikx}U_k = 0$$

By dividing with e^{ikx} we get

$$\frac{d^2U_k}{dx^2} + 2ik\frac{dU_k}{dx} + (\alpha^2 - k^2)U_k = 0 \quad \text{(VI)}$$

When we put eqn (V) in eqn (III) we get,

$$\frac{d^2U_k}{dx^2} + 2ik\frac{dU_k}{dx} - (\beta^2 + k^2)U_k = 0 \quad \text{(VII)}$$

For solving the above eqn we have to take,

$$U_k = e^{mx}$$

$$\frac{dU_k}{dx} = me^{mx}$$

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$$\frac{d^2 v_{1c}}{dx^2} = m^2 e^{mx}$$

Put this all values in eqⁿ (VII), we get,

$$m^2 e^{mx} + 2ikme^{mx} + (\alpha^2 - k^2) e^{mx} = 0$$

or

$$m^2 + 2ikm + (\alpha^2 - k^2) = 0$$

$$m = \frac{-2ik \pm \sqrt{-4i^2k^2 - 4(\alpha^2 - k^2)}}{2}$$

$$= \frac{-2ik \pm \sqrt{-4k^2 - 4\alpha^2 + 4k^2}}{2}$$

$$= \frac{-2ik \pm \sqrt{-4\alpha^2}}{2}$$

$$= \frac{-2ik \pm 2\alpha}{2}$$

$$m = i(\alpha \pm k)$$

$m_1 = i(\alpha + k)$ $\qquad$ $m_2 = i(\alpha - k)$

The soln is given as,

$$u_1 = Ae^{m_1 x} + Be^{m_2 x} = Ae^{i(\alpha+k)} + Be^{i(\alpha-k)} \quad \text{— (VIII)}$$

Similarly,

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Q. No.

Similarly by eqn (VII) we get

$m_1 = (\beta + i\kappa)$ $\quad m_2 = -(\beta + i\kappa)$

The soln is given as,

$y_2 = Ce^{m_1 x} + De^{m_2 x} = Ce^{(\beta+i\kappa)} + De^{-(\beta+i\kappa)}$ — (IX)

Now by the condition,

At $x = 0$

$y_1 = y_2$

$Ae^{\circ} + Be^{\circ} = Ce^{\circ} + De^{\circ}$ — (X)

$\frac{dy_1}{dx} = \frac{dy_2}{dx}$

$i(\alpha+\kappa)A + i(\alpha-\kappa)B = (\beta+i\kappa)C - (\beta+i\kappa)D$ — (XI)

Then,

NAME: RITU - R. NISHAD DATE: 07-03-2025

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

(अधिकारमान्य स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	Kalyani
Student's Sign. :	Rishad.
Seat No. :	3206
Seat No. in words :	
Suppliment No. :	1+1
	47022
Centre	VCK

प्र. क्र. Q. No.		
Q1	Select correct Alternative.	
1	~~a) metallic~~ b) ionic	14/15
2	a) conduction band	
3	d) (conductor)	

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02 Section | Q. No. | Marks

प्र. क्र. Q. No.

Q3. Attempt any one.

2. Explain classical free electron of metals.

→ "Prude" proposed the theory of free electron of metals.

According to his theory particles can move inside metals like atoms & molecules move freely in perfect gas.

It obey M-B statistics

Max-well - Boltzman classical statistics of free electron theory.

- Metal structure consists of ion cores with positively moving among this ion cores.

- The behaviour of free electron moving with metal is similar of atom & molecules of perfect gases.

- Mutual repulsion between free electrons & atoms are ignored.

Section | Q. No. | Marks

03

प्र. क्र.
Q. No.

- Free electron experiences constant & uniform electrostatic field due to ion cores.
- Free electrons are positively charged particle while atoms & molecules are neutral.
- Total energy of free electron inside a metal is equal to kinetic energy.
- Valence electrons obey M-B statistics
- Electrostatic attraction b/w free electron & ion core is responsible for holding the electron with in the surface.
- The total negative charge of electron is equal to the positive charge of ion core.
- Metal remains electrically neutral.
- Movement of free e^- inside a metal is equal to motion of free particle in potential well

04 Section | Q. No. | Marks

प्र. क्र. Q. No.

Q2. Attempt any ONE

2. What is Hall effect ? Obtain an expression for Hall corfficient . Also explain band theory of solids.

→ In equilibrium the electric force balances the magnetic force so that the ~~force~~ flow of e^- stops i.e; resultant force

$$(F_y) = 0$$

$\therefore$ Electric force = magnetic force

$$-e E_y = -\frac{e}{c}(V_x \times H_z)$$

$$\therefore E_y = \frac{1}{c} V_x H_z \quad \text{in magnitude} \quad \text{---} (1)$$

This is expression for Hall voltage for unit depth of specimen

I_x be current density , i.e; no of e^- flowing per unit area per unit time

n = no. of e^- per unit volume

$-e$ = charge on e^-

x = velocity of e^- on x-axis

$$\therefore I_x = n(-e) \cdot V_x$$

$$\therefore V_x = \frac{I_x}{nc}$$

from eq ① we get

$$\therefore E_y = \frac{1}{C}\left(\frac{I_x}{-nc}\right) H_z$$

$$\therefore \frac{E_y}{I_x H_z} = R_H = \frac{1}{-nc}$$

where, R_H is called as Hall coefficent

Also, $nc = \rho$

$$\therefore R_H = -\frac{1}{\rho c}$$ — in e.s.u
Inelectostatic unit

$$R_H = -\frac{1}{\rho}$$ — in e.m.u
electromagnetic unit

The Hall coefficient is constant for given material

02 Section Q. No. Marks

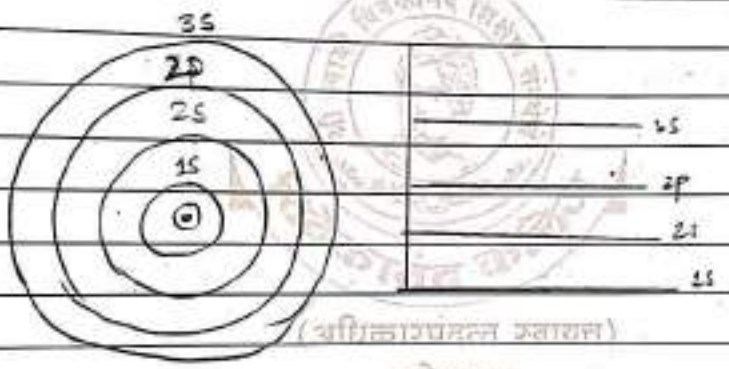
प्र. क्र. Q. No.

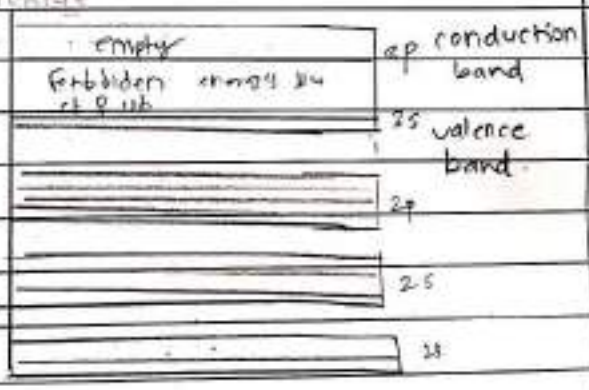
Dimension - volt cm^{-1} amp^{-1} $gauss^{-1}$

It is also measured in form of emf.

* **Band Theory of Solids.**

The splitting of energy levels in continous manner is called energy band.





When isolated atom is discreate energy levels to form 1S, 2S, 2P, 3S

Section | Q. No. | Marks | 03

Pg. No.

When they are brought together to form solid various interactions takes place considerably & consequently with neighbouring atoms.

The outer most shell changes slightly without violating pauli's exclusion principle.

The valence e^- occupies then outer most shell it is called valence band & when the outermost shell is empty then it is called conduction band.

These two regions valence band & conduction is called as energy band theory.

Eg:- $^{23}_{11}Na$

$1s^2, 2s^2, 2p^6, 3s^1$

Except $3s^1$ all the other subshells are filled.