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

Vivekanand College, Kolhapur (Empowered Autonomous)

Department of Physics

B.Sc. Part-III SEM VI Internal Examination (2023-24)
Paper- Classical Mechanics

Day: -
Date: -

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.

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

Section	Q. No.													03
	Marks													

प्र. क्र.
Q. No.

Internal Attendance
Classical Mechanics.
B.Sc. III
2023 - 24

Roll No.	Name	Sign
8205	Sushant Vilas Sutar	Sutar
8202	Rushi Chandrakant Dangare	Rushi
8203	Shrutika Sambhaji Khot	Shrutika
8204	Shreyashree Shantinath Demmana	Shemmana
8201	Misam Ashtak Pathan	Pathan

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous)
ESTD JUNE 1964
(अधिकार प्राप्त स्वायत्त)
कोल्हापूर

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

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	
Students Sign. :	
Seat No. :	8208
Seat No. in words :	
Suppliment No. :	
	47072
Centre	VCK

13/15

प्र. क्र.
Q. No.

Q1.

1. (c) scleronomous

2. (b) static.

3. (b) two

Q2.

2. ① Suppose a system contains 'n' number of particles. If one of its particle moves or displaces by a small distance δr_i, every other will displace by the same distance.
② When a body / system is in equilibrium, force acting on it is zero, hence displacement is also zero.

02	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

mathematically,

$$\sum_{i=1}^{n} F_{r_i} = \sum_{i=1}^{n} F\delta r_i = 0 \quad \text{——} \quad (1)$$

③ Let us introduce contraints in the above system. we will get.

$$F = F_{r_i} + F_{r_{i(c)}}$$

where $F_{r_{i(c)}}$ = constraint ~~force~~ applied.

④ Work = force × displacement.

∴ from eqⁿ (1), we get,

$$\sum_{i=1}^{n} F_{r_i} = \sum_{i=1}^{n} F\delta r_i + \sum_{i=1}^{n} F\delta r_{i(c)}$$

But we know, $\sum_{i=1}^{n} F\delta r_{i(c)} = 0$

$$\therefore \sum_{i=1}^{n} F\delta r_i = 0$$

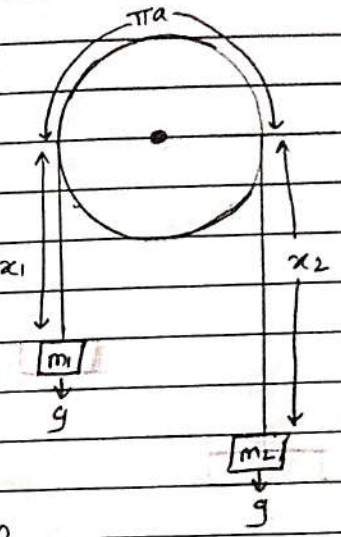
⑤ Hence, for a system which is in equilibrium, has actual work ~~zero~~. But virtually its particles move by infinitesimal small distances.

(अधिकारपत्रत स्वायत्त)
VIVEKANAND COLLEGE KOLHAPUR
ESTD JUNE 1964
Empowered Autonomous

Section	Q. No.													03
	Marks													

प्र. क्र.
Q. No.

Q3.



2. ① Consider masses m_1 & m_2 attatched to a string of length 'L' to radius of pulley 'a'.

② Consider the pulley with zero friction.

③ Total length of string is

$$L = x_1 + x_2 + \pi a \quad , [\dot{x}_1 = -\dot{x}_2 \quad \ddot{x}_1 = -\ddot{x}_2]$$

④ kinetic energy is given as.

$$K.E = \frac{1}{2} m_1 \dot{x}_1^2 + \frac{1}{2} m_2 \dot{x}_2^2$$

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

⑤ Potential energy is given as.

$$x_1, x_2 = L - \pi a - x_1$$

$$V = -m_1 g x_1 - m_2 g (L - \pi a - x_1)$$

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

⑥ Now, ~~total~~ according to Lagrangian.

$$L = T - V$$

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

ESTD JUNE 1964

04	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

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

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

$$\therefore (m_1 - m_2)g = \dot{x}\,(m_1 + m_2)$$

$$\boxed{\therefore \; x = \frac{(m_1 - m_2)\,g}{m_1 + m_2}}$$

This is the equation which does not contain 'T' (tension).

06

MAHARAJA COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

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

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	
Students Sign. :	Shaale
Seat No. :	8430
Seat No. in words :	Eight-Four-Three-Zero
Suppliment No. :	1
	47067
Centre	V.C.K

प्र. क्र.
Q. No.

Q1.

→ 1. c. Scleronomous.

→ 2. b. Statics

→ 3. ~~b. two~~ a. three

03

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

02	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

Q2.

→ 1 (A) Constraints:-

① The geometrical limitation or restriction to movement of a body is known as constraints

② Eg:- (i) A gas can only move inside a container.

B) Constraints can be classified by three ways

① With respect to time:-

a) Scleronomic constraint - Constraint that is independent of time.

Eg:- Simple pendulum.

b) Rheonomic Constraint - Constraint that is extensively depended on time.

Eg:- Simple pendulum whose length varies with time.

② With respect to distance:-

a) Holonomic Constraint:- Constraint in which any 2 particular particles remain at constant distance from eachother

Eg- 2 particles of rigid body

b) Non-Holonomic Constraint:- Constraint that are not holonomic are non holonomic.

Eg - 2 Particles of Gas in a enclosed container

③ With respect to work done:-

a) Conserved Constraint :- Constraint by which no work is done & energy remains constant.

Eg - Simple pendulum attached to rigid body.

ANANDMANAND COLLEGE ESTD JUNE 1964 (Empowered Autonomous)

Section	Q. No.														03
	Marks														

प्र. क्र.
Q. No.

b) Dissipative Constraint :- Constraint that completes a work and energy is not conserved.

Eg:- simple pendulum with variable length.

04

Q3.

1. Bead sliding on rotating wire in a force free space.

→ ① Let us assume a rotating wire & bead sliding on it in force free space.

② This system is holonomic conserved. ~~Scleronomic~~ system of constraints.

③ Here $\theta = \omega t$ ~~for~~ ①

i.e. $\dot{\theta} = \omega$

④ Let x, y be the cartesian & r, θ be the polar coordinates of this system.

$\therefore x = r \cdot \cos\theta = r \cdot \cos\omega t$

$\therefore y = r \cdot \sin\theta = r \cdot \sin\omega t$ (from ①)

⑤ Diff. w.r.t. t. we get.

$\dot{x} = \dot{r} \cdot \cos\omega t - r\omega \sin\omega t$

$\dot{y} = \dot{r} \cdot \sin\omega t + r\omega \cos\omega t$ ②

⑥ Therefore, K.E. of particle is given by,

$$T = \frac{1}{2} m (\dot{x}^2 + \dot{y}^2)$$

$$T = \frac{1}{2} m \left[(\dot{r}\cos\omega t - r\omega \sin\omega t)^2 + (\dot{r}\sin\omega t + r\omega\cos\omega t)^2 \right]$$

(from ②)

VIVEKANAND COLLEGE KOLHAPUR ESTD JUNE 1964 Empowered Autonomous

04	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

After solving, we get

$$T = \frac{1}{2} m(\dot{r}^2 + r^2\omega^2) \quad \text{——— (3)}$$

(7) Thereforce, lagragian's Equation for this.

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{r}}\right) - \frac{\partial T}{\partial r} = Q_r = 0$$

- As, it is a force free space, $Q_r = 0$

$\therefore$ from eqn (3), we get.

$$\frac{\partial T}{\partial \dot{r}} = \dot{r} m \quad \text{——— (4)} \qquad \& \quad \frac{\partial T}{\partial r} = r\omega^2 m \quad \text{——— (5)}$$

$$\frac{d}{dt}(m\dot{r}) - (m r \omega^2) = 0 \quad \text{——— (from (4) \& (5))}$$

$$\therefore m\ddot{r} - m r\omega^2 = 0$$

$$\cancel{m}\ddot{r} = \cancel{m} r\omega^2$$

$$\boxed{\therefore \ddot{r} = r\omega^2}$$

here, $\ddot{r}$ is centripetal acceleration of a bead sliding on rotating wire in a force free space

06

VIVEKANAND COLLEGE KOLHAPUR
ESTD JUNE 1964
Empowered Autonomous

Internal Attendance
Semiconductor device

B.Sc. III
2023 - 24

Roll No.	Name	Sign.
8205	Sushant Vilas Sutar	Sutar
8202	Rushi Chandrakant Dongare	Rushikesh
8203	Shreutika Sambhaji Khot	Shreutika
8204	Shreyashree shantinath Demmana	Demmana
8201	Misam Ashtak Pathan	Pathan

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

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

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	
Students Sign. :	Sharp
Seat No. :	8430
Seat No. in words :	Eight-four-Three-zero
Suppliment No. :	
	47052
Centre	VCK.

12/15

प्र. क्र.
Q. No.

Q1.

→ 1. c) Pentavalent

→ 2. b) Closed

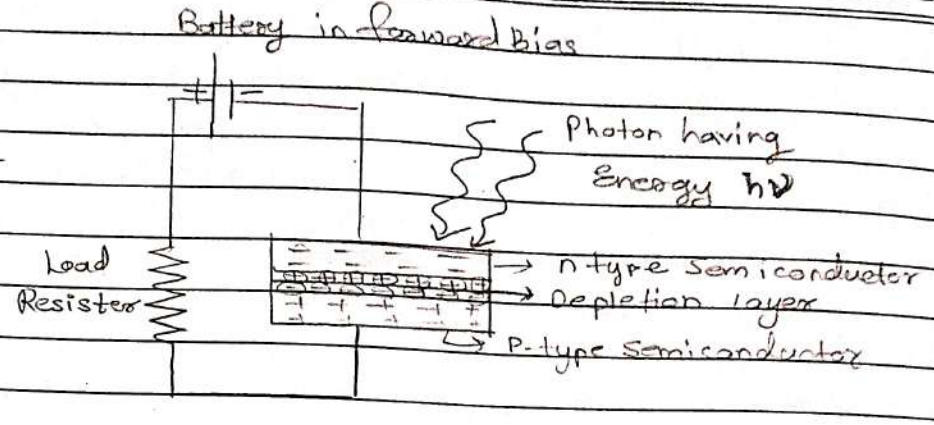
→ 3. a) Photo Electric

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

02	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

Q2. 1. Solar Cell :-



① Solar cell works on the principle of photo voltaic cell.
② A large number of solar cells make a solar panel
③ A P-N Junction diode is used for solar cell.
④ Construction:-
(i). A very thin layer of n-type semiconductor is produced on a thin p-type semiconductor
(ii) Two Electrodes are attached on the top of n-type & on the bottom of p-type.
(iii). A Battery is connected in forward bias,
(iv). A load resister is connected accros
⑤ Working:-
(i) P-N diode is connected with battery in forward bias as a result the width of depletion layer decreases as the like charges repel at battery terminals and width shortens.
(ii) A photon of energy hν is incidented which goes through n-type semiconductor & excteds and energizes holes & electrons present in the depletion layer.

PREMANAND COLLEGE Estd JUNE 1964 (Empowered Autonomous)

Section	Q. No.													03
	Marks													

प्र. क्र.
Q. No.

(iii) As a result the electrons in the depletion layer diffuses towards n-type semiconductor side & holes diffuses towards p-type semiconductor side.

(iv) Electrons and holes get separated and a barrier in potential is created.

(v) As a result when a load resistor is connected the current I is generated because of Potential difference of P-N diode.

(6) Therefore, In this way a Solar Cell produces electric current with the help of photons i.e Solar light.

6

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर
VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

Q3.

1. Semiconductors :-

→ (1) Semiconductors are devices that lie between conductors & insulators.

(2) They have a special properties of both insulating & conducting when varied with.

(3) In semiconductors conductivity increases as the temperature increases.

(4) Which is complete opposite of metals whose conductivity decreases with increase in temperature.

(5) Semiconductors can be ~~used~~ made with the help of Si & Ge.

04 Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

(6) There are primarily two types of semiconductors based on materials used :-
a) Intrinsic
b) Extrinsic

(7) Intrinsic semiconductor :-
i. These are also called i-type semiconductors these don't have any external impurity & contains purely Si or Ge atoms.
ii. But it shows very little electrical conductance therefore, inorder to use the semiconductors with other devices, intrinsic semiconductors are less preferred

(8) Extrinsic Semiconductor :-
(i) The Si or Ge semiconductors are doped with trivalent impurity to make p-type semiconductors which have holes as majority charge carries.
(ii) The Si or Ge semiconductors are doped with pentavalent impurity to make n-type semiconductor which have, electrons as majority charge carriers.

(9) Semiconductors are used mostly in Electronic equipments like electrical Vehicles, Solar panels,

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

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

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	
Students Sign. :	Sahil P.
Seat No. :	8208
Seat No. in words :	
Suppliment No. :	
	47057
Centre	VCK. 12/15

प्र. क्र.
Q. No.

Q1.

1. (c) pentavalent

2. (b) closed

3. (b) photocatalytic

Q2.

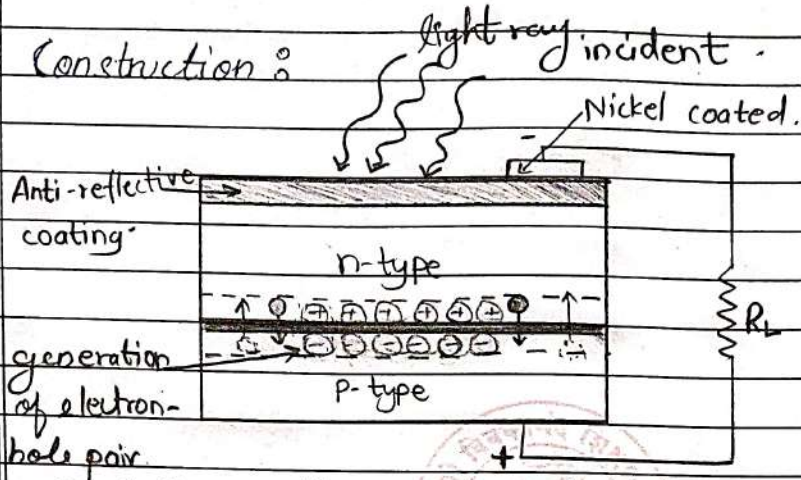
1. Solar cell is an electronic device which works with the help of light energy.

Principle : Solar cell work on the principle of photovoltic effect. When many solar cell are connected, it forms a Solar panel. According to this, when light of required intensity is incident on it, electric current start to flow through it!

02 Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

Construction :



① Solar cell is simply a p-n junction diode.
② The top layer has an antireflective coating so that all the incident light rays are used up efficiently/properly.
③ Here, p-region is slightly thicker than n-region.
④ ~~While~~ While, n-region is thinner than p-region.

Working :

① When light rays are incident on the surface, due to the energy of sun rays, electron ~~is~~ discharge takes place.
② This in turn creates electron-hole pair. For silicon, it activates at 0.7 eV. It is also important that light incident on it must have required intensity.

Section	Q. No.													03
	Marks													

प्र. क्र.
Q. No.

(4) As there is potential barrier, the conc^n of electron-hole pair increases up to a certain limit.
(5) When the limit is ~~crossed~~ fulfilled, electrons move towars p-region and holes towards the n-region.
(6) This inturn give rise to electric current.

6

Q3.

1. (1) Semiconductors are devices whose conductivity lies between ~~thes~~ Conductors and Insulator.
(2). Semiconductors have conduction band and valance band close to each other. (0 to 1eV)
(3) When temperature is increased, conductivity of semiconductor also increases.

(4) Semiconductors are divided into two types,
(a) Intrinsic semiconductors: These are pure semiconductors. ~~wit~~
(b) Extrinsic semiconductors: They have two type,
(1) p-type (semiconductors) When a trivalent impurity is introduced in a pure semiconductor. It has +ve charge. (Al, B, In)
(2) n-type (semiconductors): ~~They~~ When a pentavalent impurity is introduced. It has -ve charge (P, Sn)

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

04	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

(5) Properties of semi conductor ~~are~~ always depend on temperature.

(6) Semiconductors are used in p-n junction diode, photo cell, transistors, zener diode, etc.

3

TYAGARAJ MANDAL COLLEGE KOLHAPUR ESTD JUNE 1980 (Empowered Autonomous)

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

Vivekanand College, Kolhapur (Empowered Autonomous)

Department of Physics

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

Date: Total Marks: 15
Day: 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?

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

Internal Attendance

B. Sc. III

2023-24.

Roll No.	Name	Sign
8205	Sushant Vilas Sutar	Sutar
8202	Rushi Chandrakant Dongare	Rushi
8203	Shrutika Sambhaji Khot	Shrutika
8204	Shreyashree Shantinath Demmana	Demmana
8201	Misam Ashtak Pathan	Pathan

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

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

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	
Students Sign. :	S.R.Biradje
Seat No. :	8201
Seat No. in words :	
Suppliment No. :	
	47089
Centre	

13/15

प्र. क्र.
Q. No.

3

Q1) 1) a) pumping

2) a) Crystalline solid laser

3) b) Light amplification by stimulated emmission of Radiation

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

02	Section	Q. No.													
		Marks													

प्र. क्र.
Q. No. 1

- Ruby laser

1) Ruby laser is crystalline solid laser
2) It emitts visible light of deep red of 6943 A wavelength
3)

Construction

1) Ruby laser a cylindrical ruby crystal with ruby laser medium
2) There ~~are~~ one side is full reflecting silverized and other side is partially reflecting silverese
3) Helion xenon discharge tube is rotating rod one part of white light elbsorb by chromium and ~~pos~~ most of part of light used to heat apparatus, cooling is important

Construction of ruby laser diagram is as shown in below.

There are three major parts pumping, stimulati emmission and resonant.

VIVEKANAND... KOLHAPUR ESTD JUNE 1964 (Empowered Autonomous)

Section	Q. No.													03
	Marks													

प्र. क्र.
Q. No.

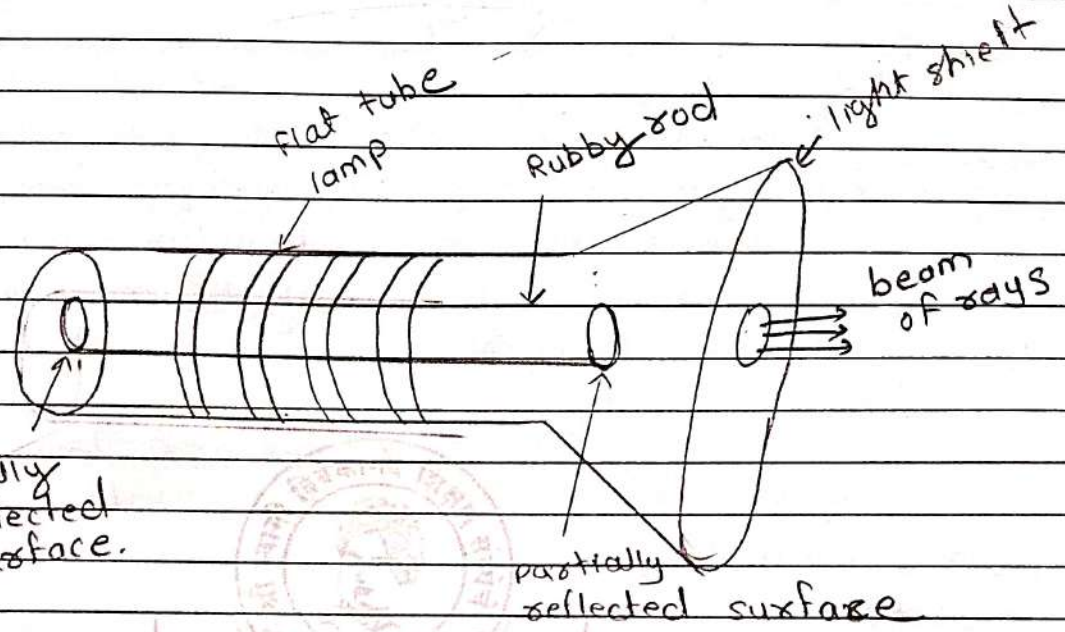


Diagram of Rubby laser

Working

1) Ruby material is consist of Alumihium oxide Al_2O_3 Among Al^{+3} some alumiminium ions are replaced by chromium ions Cr_2^{+3}

2) light from xenon lamp energy absorb by chromium ions. energy of chromium ions are increases due to absorbing energy. atom of ions are raisined from ground state to excited state level

VIVEKANAND COLLEGE KOLHAPUR (Autonomous) ESTD JUNE 1964

04	Section	Q. No.												
		Marks												

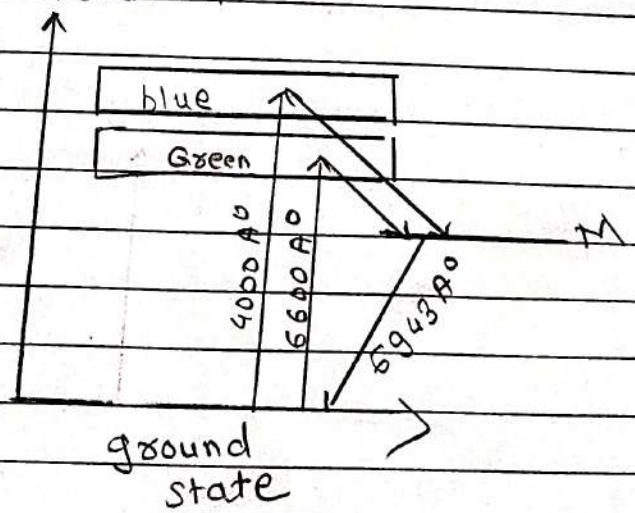
प्र. क्र.
Q. No.

Chromium ions who's get wavelength 4000 A° are get to one of energy state E_1 which is ~~blue~~ blue. and chromium ions who get wavelength of 6000 A° are get to one of energy state or level E_2 which is Green.

Blue and green states or levels are closer But life time at that state is 10^{-8} sec. which is very small.

non-radiation atoms or molecules take place on nearly lower energy level level at metastable state there life time of ions is nearly 3×10^{-3} sec.

Cr^{3+} ions decay ~~fo~~ By stimulating emmission to ground state. the ~~lif~~ light is reflected over the full reflecting surface and Light Amplification.



ESTD JUNE 1964

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

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	
Students Sign. :	S.R. Biranje
Seat No. :	8201
Seat No. in words :	
Suppliment No. :	1
	47103
Centre	

प्र. क्र.
Q. No.

As shown in diagram.

ruby lasser emmitts radiation of wavelength 6943 A°.

ruby laser radiation is not continuous because of pulse of radiation is small the lamp is not continuously emmitting the light.
pulse rate of ruby laser is 10^{-6} sec

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

02 Section Q. No. Marks

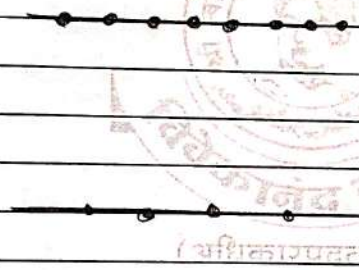
प्र. क्र. Q. No.

* Population Inversion in lasing action

- Population invension is used in laser action

- It is required to stimulasing emmission

Population inversion show in below



- ~~In~~ * Population inversion :-
The number of atoms or ions in higher energy level is larger than no. of atoms in lower or ground state lever (lower energy level is called as Population inversion.

Population inversion must be

i) The radiant density ~~constant~~ high freq^n should low have ~~short~~ wavelength high

Section	Q. No.													03
	Marks													

प्र. क्र.
. No.

2) The ration of spontaneous emmission and stimulated emmission should be too less

VIVEKANAND COLLEGE KOLHAPUR
ESTD
JUNE
1964
(Empowered Autonomous)
(अभिनव शिक्षण संस्था)
कोल्हापूर

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

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	
Students Sign. :	Sahil P.
Seat No. :	8208
Seat No. in words :	
Suppliment No. :	
	47097
Centre	

13/15

प्र. क्र.
Q. No.

Q1. (3)

1. (b) optical pumping

2. (a) Crystalline solid laser

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

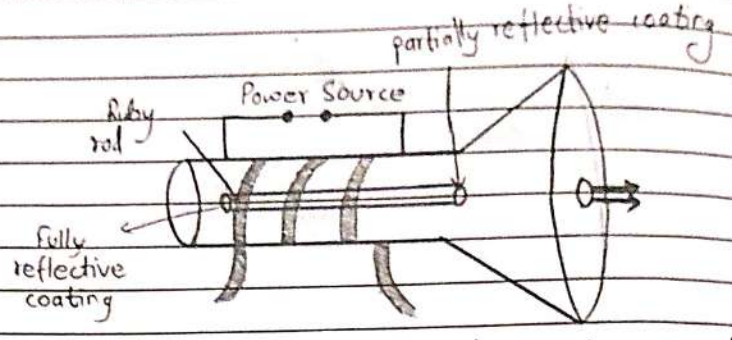
VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

02 Section Q. No. Marks

प्र. क्र. Q. No.

Q2.

2. Construction :



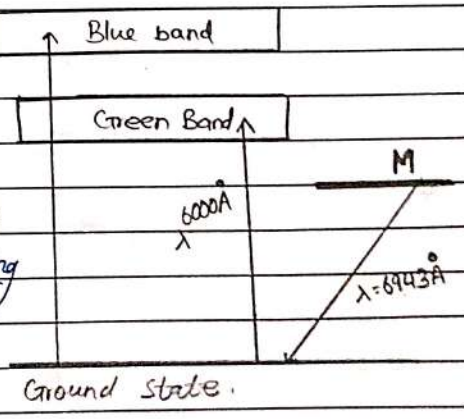
① A ruby rod is kept at the center of apparatus. At it's one end, it is ~~fully~~ coated by silver to make it fully reflective and at the other end, it is partially coated. This helps to concentrate the emitted ray into a single direction.

② Ruby laser is a optical laser and hilexal xenon laser. The energy provided is converted into light energy and some portion of energy get converted into heat. To cool this device, cool water is passed around the device. Energy produced is around a few kilowatt.

Working :

① Ruby crystal is made up of Al_2O_3 and some of Al are replaced by Cr^{3+} atoms.

② Chromium ions play a vital role in the working of this laser.



Section Q. No. Marks

प्र. क्र. Q. No.

③ When chromi of Al

④ When band.

⑤ The

⑥ When loses state

⑦ It s stat

⑧ Rub a pu perio

⑨ It

⑩ It

Section	Q. No.													03
	Marks													

प्र. क्र.
Q. No.

(3) When energy is provided to the ruby crystal, chromium ion absorbs radiation from a photon of 4000 Å and moves to exited state ie: Band Blue.

(4). When Cr^{3+} absorbs photon of 6000 Å, it moves to green band.

(5) The distance between these two bands is less.

(6) When energy is incident absorbed by on the exited green band, it loses a photon and goes in metastable stable state.

(7) It emitts 6943 Å of wavelength while coming to ground state.

(8) Ruby laser is not a continuous process. It is a pulsating laser because xenon lamp operates periodically.

(9) It has life time of 10^{-8} sec.

(10) It generates energy around 1KW.

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

Internal Attendance
Solid state Physics-2

B. Sc. III
2023 - 24

Roll No.	Name	Sign
8205	Sushant Vilas Sutar	Sutar
8202	Rushi Chandrakant Dongare	Rushikant
8203	Shrutika Sambhaji Khot	Shrutika
8204	Shreyashree Shantinath Demmana	Demmana.
8201	Misam Ashtak Pathan	Ypathan.

॥ ज्ञान, विज्ञान आणि सुसंस्कार यासाठी शिक्षण प्रसार ॥

– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	
Students Sign. :	
Seat No. :	8210
Seat No. in words :	
Suppliment No. :	
	47021
Centre	V.C.K.

प्र. क्र. Q. No.	
Q.1)	
1)	c) metallic
2)	a) conduction band.
3)	d) conductor

13/15

03

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

02	Section	Q. No.											
		Marks											

प्र. क्र.
Q. No.

Q 2) a) If a current carrying conductor specim placed perpendicular magnetic field intensity then an electrical field (E) induced the direction perpendicular both this phenomenon is known as hall effect

The effect used in determine
1) Nature of semiconductor
2) charge density
3) conductivity.

b) consider a slab subject to external elec field along x-axis & magnetic field applied along z-axis. Because this ex is used along y-axis

2) i.e potential difference in certain area to surface and bottom surface of slab which is 'Ey'

The voltage is called as hall voltage

If the potentiality of hall is +ve on top surface the current in is semiconductor

VIVEKANAND COLLEGE KOLHAPUR ESTD JUNE 1964 Empowered Autonomous

Q. No.													03
Marks													

5) If the polarity of hall voltage is -ve then current In due to flow of holes so the sample must be P-type semiconductor.

6) By reversing the polarity of hall voltage we can reverse the nature of By using fleming left hand rule, the current flows in negative of direction of x axis.

Electric Force = $F_e = eE$

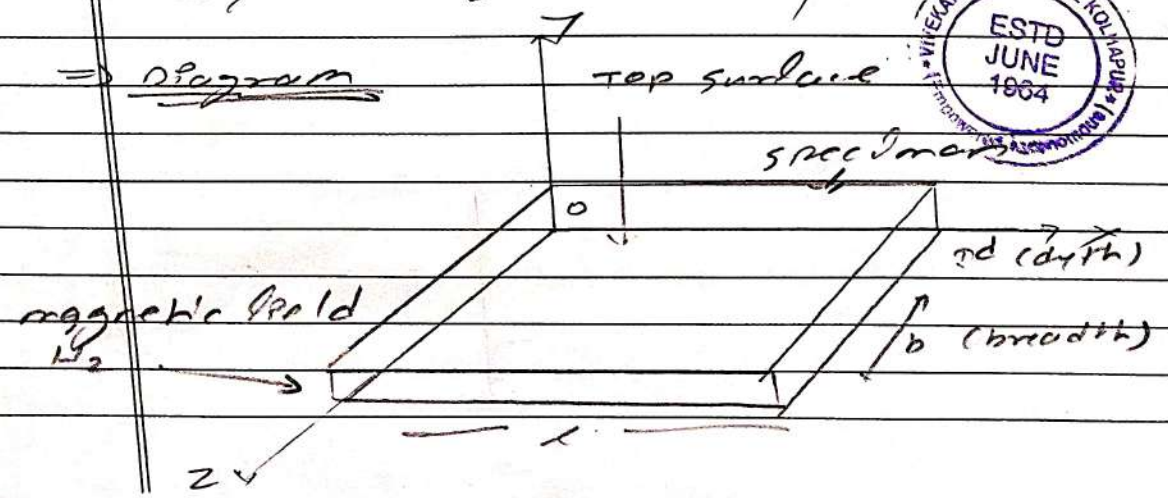
magnetic force = $F_m (\vec{v} \times \vec{H})$

Total force = Electric force + magnetic force

$= eE = \frac{e}{c} (\vec{v} \times \vec{H})$

06 $F_y = -e[E_x + \frac{1}{c} F_y \times \vec{v}]$

=> Diagram



VIVEKANAND COLLEGE KOLHAPUR ESTD JUNE 1964

Q. No.												03
Marks												

'Drude' proposed the electron theory for metal. According to this theory valence electron are more or inside the metal more freely like the atom or molecules of perfect gas. named as free electrons gas model by obey M-B statistics. The classical idea of Maxwell- Boltzmann called classical free electrons theory.

- There are some important assumptions.

1) metal structure consists positive ion core with valence electron moving freely along ion core.

2) This behaviours of free electron inside the metal just like atom or molecules of a perfect gas.

04

3) mutual repulsion and [illegible] electrons ignored.

4) Free electrons experience constant & uniformly electrostatic field due to ion core

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

04	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

5) Free electrons is negatively charge partical. while atom or molecules with mutualy neutral.

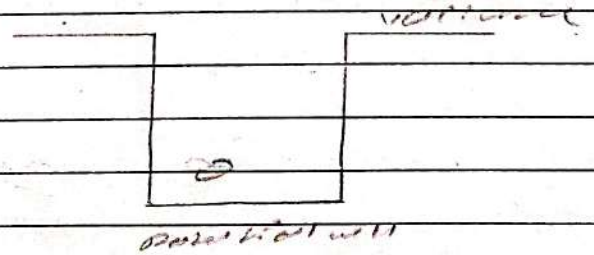
6) Total energy of free electrons is inside the metal is equal to K.E energy

7) valence electron is obey M-B statistics

8) Electrostatic attachment between free electrons and ion core is responsible for holding the electron within surface

9) Total negative energy of electrons is equal to positive energy of cors. this metal remaining and electricalet flow

10) moments of atom and free electrons inside the metal is equivalent to motion of free current potential well.



Potential well

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

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

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	Kalyani
Students Sign. :	
Seat No. :	8205
Seat No. in words :	
Suppliment No. :	1
	47019
Centre	VCK

प्र. क्र.
Q. No.

14/15

Q.1)

1. → c) metallic

2. → a) conduction band

3. → d) Conductor

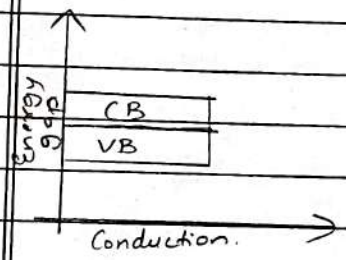
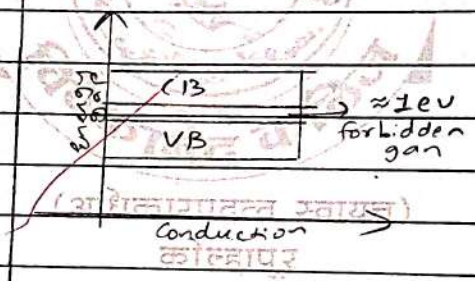
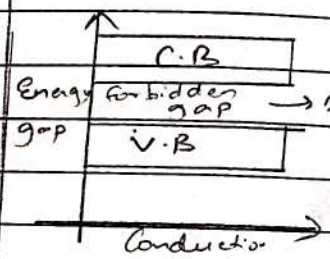
~~Q.2)~~

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर
VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

02	Section	Q. No.											
		Marks											

प्र. क्र.
Q. No.

Q.3.

1. →	Conductor	Semi-conductor	Insulator
1]	Valence band and conduction band overlaps which conducts current easily.	~~Valence~~ Conductivity lies between Conductor and Insulator.	Valence band an conduction band separated by larg distance, so condu is not possible
2]			
3]	Conductivity of Conductor is very high	Conductivity lies betn Conductor and Insulator.	~~Cond~~ There is no conduction of current.
4]	Conduction is due to flow of electron	Conduction is due to electron and hole.	No conduction
5]	Resistivity is very low	Resistivity is intermediate.	Resistivity is very high

Section	Q. No.													03
	Marks													

प्र. क्र. Q. No.			
6)	Temperature coefficient of resistivity is +ve.	Temperature coefficent of resistivity is -ve.	Temperature coefficient of resistivity is -ve.
7)	Eg- Copper, silicon	Eg- silver, galium	Eg- wood, plastic

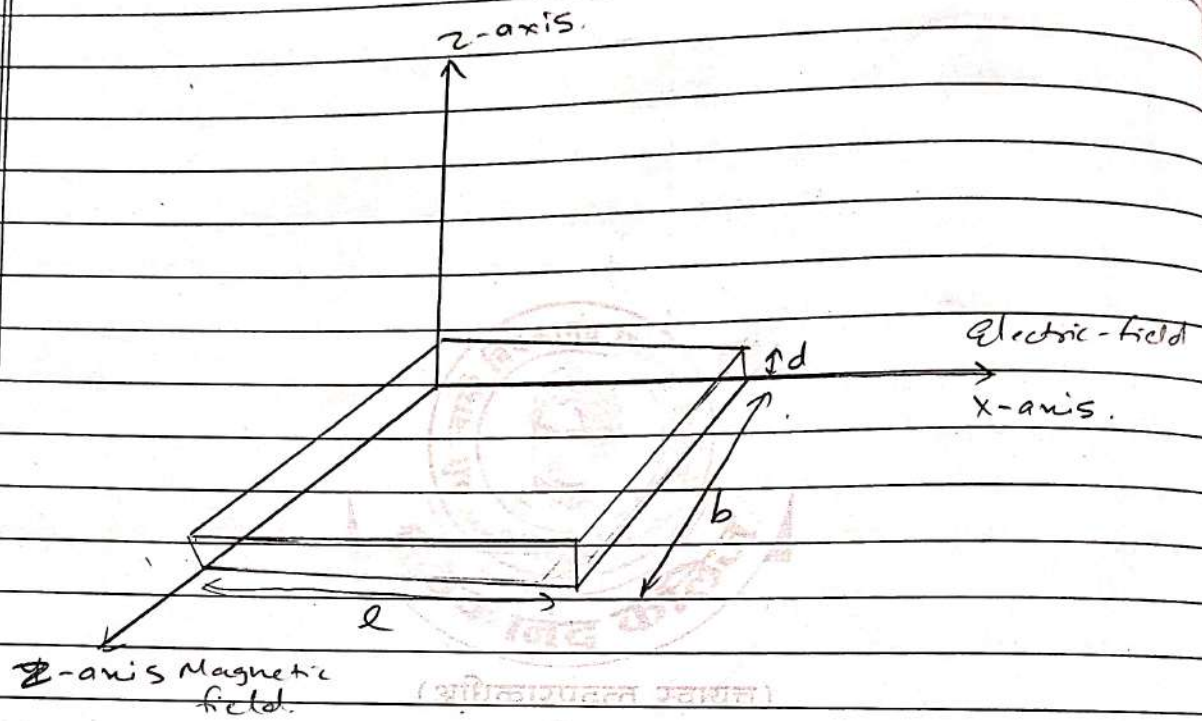
VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

(अधिकारप्राप्त स्वायत्त)
कोल्हापूर

04	Section	Q. No.											
		Marks											

प्र. क्र.
Q. No.

Q.2.
2.]



When current carrying conductor is placed in Magnetic field of intensity (H) then Electric field is induced which is perpendicular to both of them, This is Hall effect.

Hall effect is used ~~for~~ to determine.
(i) Nature of conduction
(ii) Charge density
(iii) Conductivity

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

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

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	
Students Sign. :	
Seat No. :	8205
Seat No. in words :	
Suppliment No. :	2
	47043
Centre	VCK

. क्र.
. No.

When Electric field is subjected on x-axis and Magnetic field is supplied on z-axis then induced emf is produced i.e potential difference is produced on top and bottom ~~side~~ surface of conductor. This voltage is called as Hall voltage. If polarity of hall voltage ~~on top surface~~ is +ve on top surface then electron flows ~~in x~~ and is known as n-type semiconductor. If polarity of hall voltage is negative then it is due to flow of hole then it is p-type semiconductor. Thus Nature of semiconductor can be known. By fleming's left hand the ~~laurence~~ laurentz force is negative direction of y-axis.

Electric force $= -eE$ —— (1)

Magnetic force $= \frac{-e}{c}(\vec{V} \times \vec{H})$ —— (2)

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

02 Section	Q. No.												
	Marks												

प्र. क्र.
Q. No.

Total force = Electric force + Magnetic force

$$= -eE + \left(-\frac{e}{c}(\vec{V} \times \vec{H})\right)$$

$$= -e\left(E_x + \frac{1}{c}(\vec{V}_z \times \vec{H})\right) \quad \text{—— (3)}$$

In equilibrium, Electric force balances with Magnetic force to stops flow of electron. thus,

Electric force = Magnetic force.

$$-eE_y = -\frac{e}{c}(\vec{V} \times \vec{H})$$

$$E_y = \frac{1}{c}(\vec{V}_x \times \vec{H}_z) \quad \text{—— (4)}$$

Current density i.e number of electron per unit area per unit time is given as.

$$I_x = n(-e)V_x \quad \text{—— (5)}$$

06.

n : number of electron
e : charge of electron
V_x : Velocity of electron.

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

Q. No.

Therefore eq (5) becomes

$$V_x = \frac{I_x}{-ne} \quad \text{——— (6)}$$

Substituting this value is eq^n (4)

$$\boxed{E_y = \frac{1}{c}\left(\frac{I_x}{-ne}\right) \times H_z} \quad \text{——— (7)}$$

This expression is called as hall voltage per unit depth.

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

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

where R_H is Hall coefficient

$$\therefore R_H = \frac{-1}{nec}$$

$$R_H = \frac{-1}{\rho c} \quad (\because nec = \rho)$$

ESTD JUNE 1964

04	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

$$R_H = \frac{1}{\rho c}$$ --- In electrostatic unit

$$R_H = \frac{1}{\rho}$$ --- In magnetostatic unit

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

Band Theory.

The splitting of Energy level in continous manner is Known as Bang theory. Consider Individual ~~at~~ atom, ~~this~~ having energy level 1s, 2s, 2p, 3s which are filled with electron. When this atom is brought together with another atom they interact. Due to interaction higher energy level is affected. Energy level of higher shell changes without violating Pauli's exclusion ~~the~~ principle. Thus single energy level ~~is~~ split's into many energy level.

6

Thus Band which are occupied by valence electron called Valence Band. Similarly Band which ~~occupied by~~ are empty of occupied by conduction electron is Known as Conduction Band.

VIVEKANAND COLLEGE KOLHAPUR ESTD JUNE 1964 (Empowered Autonomous)

|| ज्ञान, विज्ञान आणि सुंसस्कार यासाठी शिक्षण प्रसार ||
– शिक्षणमहर्षी डॉ. बापूजी साळुंखे

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	Kalyani
Students Sign. :	Shaslo
Seat No. :	8430
Seat No. in words :	Eight-four-three-zero
Suppliment No. :	1
	47026
Centre	VCK

प्र. क्र.
Q. No.

13/15

Q1.

→ 1. c.) Metallic

→ 2 a.) Conduction band

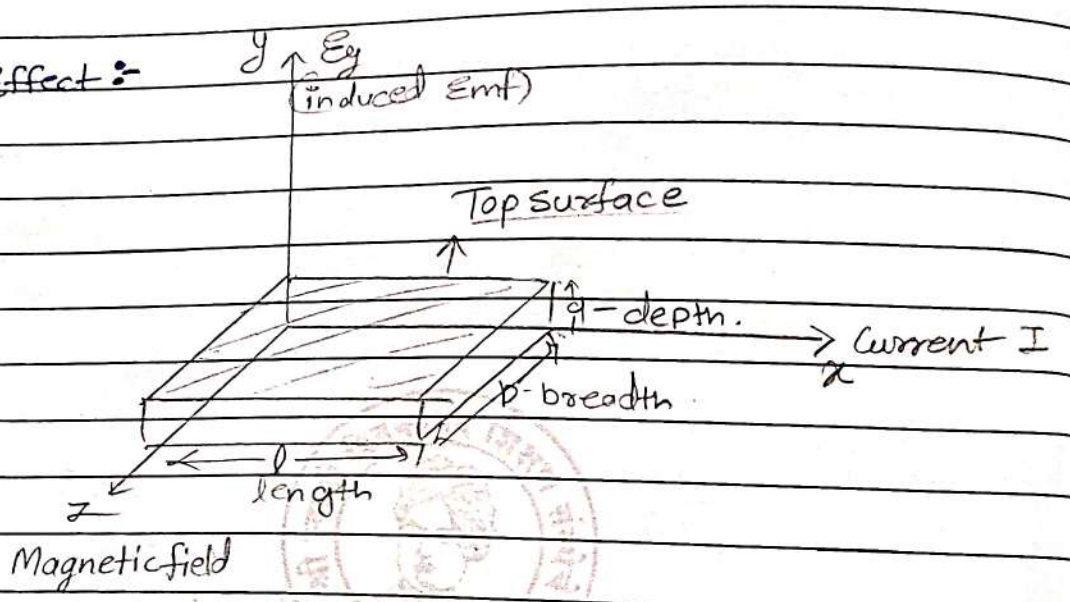
→ 3. d.) Conductor.

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1864

02	Section	Q. No.												
		Marks												

प्र. क्र.
Q. No.

Q2. 2.A) Hall effect :-



① Statement :-
When a current carrying specimen (semiconductor or conductor) comes in influnce of transverse (or perpendicular) magnetic field of intensity 'H' then the induced emf is generated which is perpendicular to both, this effect is called Hall effect

② Hall effect can be used for :-
(i) Analysing nature of specimen.
(ii) Current density or charge concentration value
(iii). for finding mobility & conductivity ~~of the~~

③ Therefore, as induced emf is produced at the topside the charge carriers are attracted towards top surface.

④ If holes are attracted to top-surface then the semiconductor is n-type & If the electrons are attracted to the top ~~layer~~ the semiconductor is p-type.

ESTD JUNE 1964

Q. No.													03
Marks													

Hence, identification of type of semiconductor can be done with Hall effect.
This separation of charges generates potential difference accross the specimen which can be measured using voltmeter or multimeter.
Let F_e be the force of electric current
F_B be the magnetic force.

$$\therefore \quad F_e = qE = -eE$$

$$\& \quad F_B = q(\bar{V} \times \bar{B}) = \frac{-e}{c}(\bar{V} \times \bar{H})$$

Therefore, ~~the~~ by the fleming's left hand rule & laurentz force rule,

$$T.F. = F_e + F_B$$

$$= -eE_y - \frac{e}{c}(\bar{V}_x \times \bar{H}_z)$$

$$F_y = T.F. = -e\left(E_y + \frac{(\bar{V} \times \bar{H})}{c}\right)$$

This is the force generated by emf induced.
Therefore, as at the equilibrium, $F_e = F_B$ and induced force gets minimalised

$$\therefore \quad F_e = F_B$$

$$+\cancel{e}E = +\frac{\cancel{e}}{c}(\bar{V}_x \times \bar{H}_z) \quad \text{—— (1)}$$

Let, J_x be the current density.

$\therefore \quad J_x = n(-e).V_x$ —— here, $-e$ = charge on Elec
n = number of electron per unit volur

$$\therefore \quad V_x = \frac{J_x}{-ne}$$

V_x = Velocity along x

प्र. क्र. Q. No.

Put, value of V_x in eqn ①

$$\mathcal{E}_y = \left(\frac{I_x}{-ne}\right)\frac{1}{c} \times H_z$$

$\therefore$ Put $\frac{\mathcal{E}_y}{I_x \times H_z} = R_H$

$\therefore$ $R_H = \frac{\mathcal{E}_y}{I_x \times H_z} = \frac{1}{-nec}$

- This is Hall coefficient.

$\therefore$ $R_H = \frac{1}{-ne}$ ——— for Electromagnetic unit

& $R_H = \frac{1}{-nec}$ ——— for Electrostatic unit.

- Its dimension is Volt $Ampere^{-1}$ $Gauss^{-1}$ cm^{-1}

(11) The positive value of R_H indicates p-type semiconductor is used & negative value of R_H inditates n-type semiconductors.

B.) Band Theory of Solids:-

① In solids the band gap of energy is negligable i.e. the valence band & conduction band overlapse

② It allows electrons to pass through them and therefore, conduct electricity.

③ The coefficient of Temperature resistivity is positive which indicates as temp decreases conductivity increases.

④ Energy band theory is nothing but spliting of energy shell's without violating pauli exclusion rule.

⑤ The shell is splitted in bands namely conductance & valence band.

⑥ When electrons get excited they go to conduction band.

VIVEKANAND COLLEGE ESTD JUNI 19 (Empowere)

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

(अधिकारप्रदत्त स्वायत्त)
कोल्हापूर

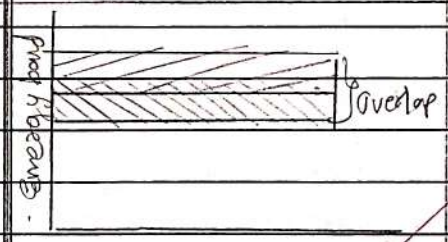
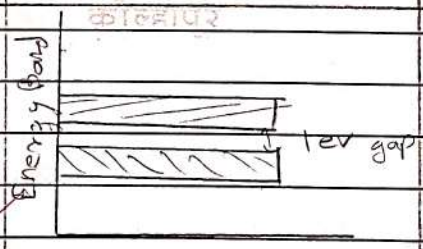
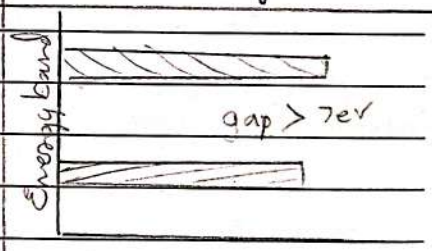
VIVEKANAND COLLEGE, KOLHAPUR.
(Empowered Autonomous)

SUPPLIMENT

Jr. Supervisor's Sign. :	
Students Sign. :	Shraddha
Seat No. :	8430
Seat No. in words :	
Suppliment No. :	2
	47036
Centre	

प्र. क्र.
Q. No.

Q3.
1 Distingusih Between.

Properties	Conductor	Semiconductor	Insulators.
Defination	The material which allows conduction through them	The materials that lies between conductor and insulators	The materials that donot allow conduction through them
Band Diagram.			
Forbidden Energy gap.	No gap as it overlapes	Small energy gap of about 1eV	large energy gap more than 7eV.
Conductivity	Very high	Intermediate	Very Very low (or no conductivity

ok

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964

02 Section	Q. No.											
	Marks											

प्र. क्र. Q. No.	Conductors	Semiconductors	Insulators.
Conduction due to.	Free electrons	free electrons & holes.	no conduction
Temperature Coefficient Resistivity	Positive	Negative	Negative
Number of Electrons in valence or outer most shell	less than four	four	Greater than four
Examples	Copper, Silver.	Silicon, Germanium	Wood, Rubber.

VIVEKANAND COLLEGE KOLHAPUR (Empowered Autonomous) ESTD JUNE 1964