VPCOE

VIDYA PRATISHTHAN'S
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LABORATORY MANUAL

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List of Experiments

1) Newton's Ring Experiment.
2) Plane diffraction grating for determination of unknown wavelength.
3) Ultrasonic Interferometer for the determination of compressibility of liquid.
4) Determination of band gap of a given semiconductor.
5) Solar cell characteristics, measurement of Voc, Isc, fill factor.
6) Laser based experiment.
   (determination of no of lines / cm of a grating)
7) Determination of absorption coefficient of sound of given material.
8) Half Shade Polarimeter.

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NEWTON'S RINGS EXPERIMENT

AIM:

To determine radius of curvature of a plano-convex lens using Newton's ring experiment.

PRIOR CONCEPTS:

Interference phenomenon, constructive and destructive interference pattern, fringe width, basic features of monochromatic source.

NEW CONCEPTS:

Proposition 1: Newton's rings for reflected light

Newton's ring in reflected light; the path difference between two rays is given by:

$$\Delta = 2\mu t\cos(r+\theta)+\lambda/2,$$

Where μ is refractive index of film, t is thickness of film, r is angle of refraction, θ is wedge angle and λ is wavelength of light.

For normal incidence and air film i=0, r =0, μ=1 , θ is very small, so cosθ=1.

Hence path difference becomes

$$\Delta = 2t+\lambda/2$$

Proposition 2: Diameter of rings

$$D_n = \sqrt{4n\lambda R},$$

Where R is radius of curvature of Plano-convex lens and n is natural number.

The diameter of dark fringe is directly proportional to square root of the natural number (n).

Proposition 3: Radius of curvature

$$R = D_n^2 /4n\lambda$$

LEARNING OBJECTIVES:

Intellectual skill:

1.To observe the phenomenon for interference pattern ie formation of Newton's ring for reflected rays.

2.To draw the conclusions form observation and relates them to propositions.

3.To understand calculation for determination of radius of curvature of plano convex lens.

Motor Skill:

1.To assemble the set up for Newton's ring pattern.

2.To draw ray diagrams for experimental set up.

3.To make observation and draw the graph

Theory: According to the theory, circular rings are formed due to interference of light rays reflected from the upper and lower surfaces of the air film formed between the convex surfaces of plano convex lens and plane glass plate. The incident ray is divided into two coherent rays by reflection from the upper and lower surfaces of the wedge shaped air film. The reflected rays interfere and produce bright and dark circular rings around the point of contact.

Newton's ring for reflected light the path difference between two rays is given by

$\Delta = 2\mu t \cos(r + \theta) + \lambda/2$

For normal incidence and air film i=0, r= 0, μ= 1 and θ is very small hence cosθ is very small. Hence path difference become $\Delta = 2\mu t + \lambda/2$

Diameter of ring:

The diameter of dark fringe is directly proportional to square root of natural number (n).

$D_n = \sqrt{4n\,\lambda R}$.

Seen the upper surface of wedge shaped film form in Newton's ring experiment is not plane, the diameter and also the width of rings are not increasing constantly.
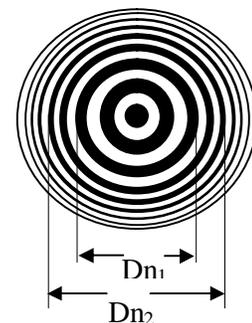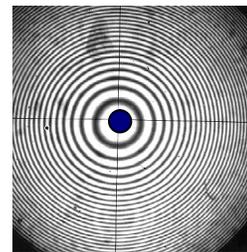
APPARATUS :
Traveling microscope, sodium lamp, plano-convex lens, optically plane glass plate, magnifying lens etc.

RAY DIAGRAM :
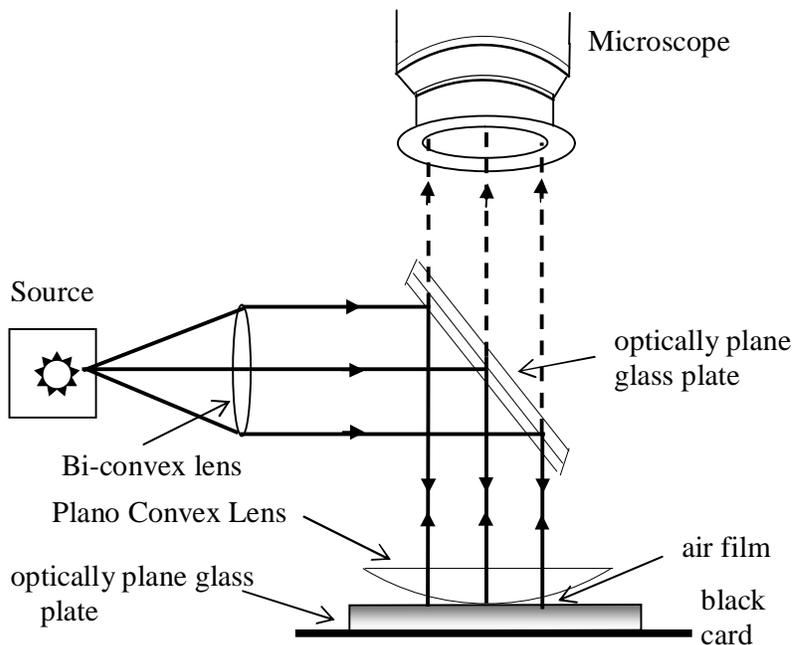
Diagram showing Newton's rings apparatus

Newton's rings observed in reflected system

PROCEDURE :

1. Find out the least count of traveling microscope using formula.

2. Observe Newton's rings(circular dark and bright rings) by means of traveling microscope.

3. Adjust the position of the microscope till the point of intersection of cross-wire coincides with the center of ring pattern.

4. Shift the traveling microscope to the left side till the vertical cross-wire become tangential at the center of the 12th dark ring.

5. Note the traveling microscope reading i.e. main scale reading (M.S.R.) and Vernier scale reading (V.S.R.) as given in the format.

6. Shift the microscope in the reverse direction till the vertical cross-wire becomes tangential to the 10th, 8th, 6th, 4th, 2nd dark ring and note down M.S.R. and V.S.R. every time.

7. Rotate the traveling microscope screw in the same direction, cross over the center of the rings and note down the M.S.R. and V.S.R. readings for 2nd, 4th, 6th, 8th and 10th dark ring to the right side.

8. Transfer the final readings from observation table A to observation table B and compete the calculations.

9. Plot a graph of the square of the diameter (D^2_n) Vs number of rings (n).

10. Calculate the radius of curvature of the plano-convex lens (R) from slope of the graph.
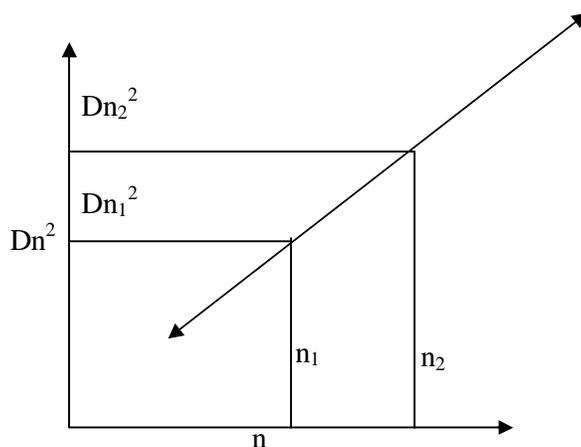
OBSERVATION:–

$$LC \text{ of traveling microscope} = \frac{\textit{Value of smallest division on main scale}}{\textit{Total no of divisions on vernier scale}} = \underline{\quad\quad} = \quad cm$$

Wavelength of given source = 5890 A° (A° - angstrom unit)

OBSERVATION TABLE (A):-

Sr. No.	Position	Ring number (n)	M.S.R. (A)	V.S.R. (B)	V.S.R. x L.C.	Final reading = A + (B x LC)
01	Left Side (L)	10				
02		08				
03		06				
04		04				
05		02				
06	Right side (R)	02				
07		04				
08		06				
09		08				
10		10				

OBSERVATION TABLE (B):-

Ring (n)	Microscope reading		Diameter (Dn) $\lvert L - R \rvert$	Diameter^2 (D_n^2)
	Left side (L)	Right side (R)		
10				
08				
06				
04				
02				

SAMPLE CALCULATION:

Formula for calculation of Radius curvature

$$\text{Radius of curvature (R)} = \frac{Dn_2{}^2 - Dn_1{}^2}{4\lambda (n_2 - n_1)}$$

Where $\lambda = 5890 \ \mathbf{A^0}$

From graph

$$\text{Slope} = \frac{Dn_2{}^2 - Dn_1{}^2}{(n_2 - n_1)}$$

Radius of curvature (R) = Slope /4 λ

RESULT:
  Radius of curvature of plano-convex lens is (R) = ---------------- cm.

CONCLUSION:
The spacing between the successive rings (increase/decreases) as we move away from central dark ring.

QUESTIONS:

1. Define interference phenomenon.
2. Enlist day to day observed phenomenon where interference takes place
3. What are conditions for interference of light?
4. Is this experiment can be used to measure refractive index of medium? Derive the mathematical relation.
5. In Newton's rings experiment the diameter of 5th dark ring is reduced to half of its value after placing a liquid between plane glass plate and convex surface. Calculate the refractive index of liquid.
6. What will be the nature of Newton's ring if sodium source is replaced by white light mercury source?

Experiment No:- 2
DIFFRACTION GRATING

AIM:

To determine the wavelength of light by means of a plane diffraction grating.

PRIOR CONCEPTS:

Diffraction of light, white light source, diffraction grating

NEW CONCEPTS:

Prop1: Fraunhofer diffraction

In Fraunhofer diffraction light source is at infinite distance from the diffracting object

Porp2: Spectrometer device

It is a device which is used for observing different basic phenemenon such as diffraction, refraction, dispersion.

Prop3: Grating element

The spacing between adjacent slits is known as grating element.

LEARNING OBJECTIVES:

Intellectual Skill:

1. To observe splitting of white light into seven colors.
2. To observe diffraction pattern of different order of spectrum.
3. To draw the conclusions form observation and relates them to propositions.

Motor Skill:

1. To arrange the set up for experiment.
1. To operate the spectrometer for parallel light position and generation clear single slit image.
2. To observe the phenomenon of diffraction of light and measure correct value of angle of diffraction.
4. To draw the ray diagram for experimental set up.

Theory:

The phenomenon of bending of light from the obstacle and their spreading into

geometrical shadow (of an object) is called diffraction.

Grating element: The spacing between the adjacent slits is known as grating element.

There are two types of diffraction.

1) Fraunhofer Diffraction: The distance between source and screen is infinite from

diffracting element.

2) Fresnel Diffraction: The distance between source and screen is finite from diffracting element.

Spectrometer device: It is the device which is used for observing different basic phenomenon such as diffraction, refraction, dispersion and hence to analyze the spectra of light.

APPARATUS:-
Spectrometer, plane diffraction grating, Hg source, magnifying lens, spirit level etc.

RAY DIAGRAM :-
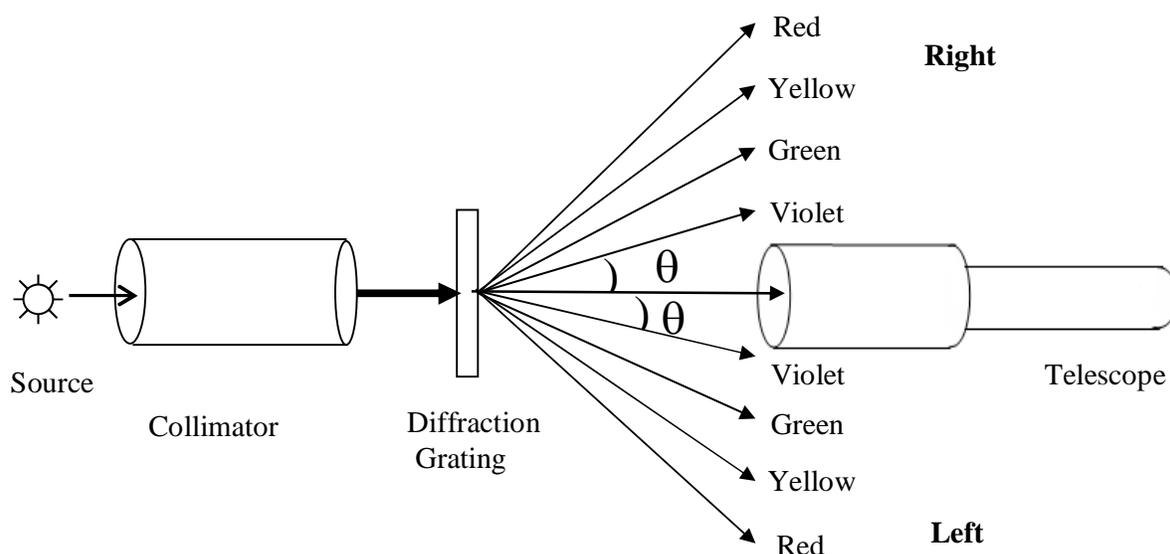
PROCEDURE :

1. Calculate the least count of spectrometer.

2. Adjust the collimator and telescope for parallel rays.

3. Illuminate the slit of the collimator by white light mercury source

4. Adjust the position of the telescope such that the image of the slit is obtained at the center of the field of view of telescope.

5. Set the diffraction grating on the prism table such that the grating surface is perpendicular to the prism table.

6. Move the telescope so as the first order diffraction pattern is visible on both sides of the line of direct vision .

7. Note the spectrometer reading as window A and window B. Calculate the angle of diffraction.

OBSERVATIONS :-

1) Source of light used $\qquad$ = ---------------

2) $LC\ of\ \ spectrometer\ \ \dfrac{\textit{Value of smallest division on main scale}}{\textit{Total no. of divisions on vernier}}$ = minute

3) No. of lines per inch on the grating N = 15000

4) Width of diffracting grating in cm = 2.54 cm

5) Grating element (d) = 2.54/15000= 1.6933 X 10^{-4} cm

6) Order of the spectrum (n) = 1

OBSERVATION TABLE (I):-

Color	Green				Yellow			
Readings	**X1**	**Y1**	**X2**	**Y2**	**X1**	**Y1**	**X2**	**Y2**
MSR (A)								
VSR (B)								
VSR x LC								
Final Reading A + (B x LC)								

OBSERVATION TABLE (II):-

Sr. No.	Color of light	Spectrometer Readings				Difference		Mean 2θ	θ	$Sin\theta$
		Left		**Right**		$2\theta_1 =$	$2\theta_2 =$			
		X1	**Y1**	**X2**	**Y2**	$\lvert X1\text{-}X2\rvert$	$\lvert Y1\text{-}Y2\rvert$	$(2\theta_1+2\theta_2)/2$		
01	Green									
02	Yellow									

SAMPLE CALCULATIONS : -

1) Formula for wavelength (λ):

$$(a+b) \sin \theta = d \sin \theta = n \lambda$$

$$\lambda_{(color)} = \frac{d \sin\theta}{n}$$

Where 'd' is grating element and 'n' is order of spectrum .

Find the wavelength (λ) for given colors.

RESULT :-

By using diffraction grating experiment the wavelength of different colors of light is found out experimentally and these are as follows.

1) $\lambda_{(green)}$ = ----------- A^0 2) $\lambda_{(yellow)}$ = ----------- A^0

CONCLUSIONS:

It is observed that angle of diffraction (increases/decreases) with increasing wavelength of light.

QUESTIONS

1. What do you understand by diffraction of light?
2. Discuss Fraunhofer and Fresnel diffraction.
3. What is diffracting grating?
4. How many colors are observed in spectrum? Write in sequence starting form lowest deviation color.
5. Is the spectrum observed in this experiment is different than that of obtained from prism?
6. What are the advantages of increasing the number of lines in grating?

ULTRASONIC INTERFEROMETER

AIM :
To determine the compressibility of liquid using ultrasonic interferometer.

PRIOR CONCEPT:
Propagation of sound waves , ultrasonic waves , standing wave pattern/ stationary wave

NEW CONCEPTS:

Proposition 1:Piezoelectric effect
Piezoelectric effect can be described as link between electrostatics and mechanics.
For a certain crystal an applied mechanical stress can develop a voltage and an applied voltage will change the shape of solid by certain amount.

Proposition 2: Ultrasonic transducer
A transducer is a device which is used to convert one form of energy to another. Ultrasonic transducer convert electrical energy to mechanical energy and vice versa.
Ultrasonic sound can be produced by transducers which operate by piezoelectric effect.

Proposition 3: Ultrasonic Interferometer
An Ultrasonic Interferometer is a simple device to determine the ultrasonic velocity in liquid with high degree of accuracy.

LEARNING SKILLS:

Intellectual Skill:
1.To understand working of ultrasonic interferometer.
2. To analyze and interpret the observation and relate them to proposition
Motor Skill:
1.To operate the ultrasonic interferometer properly.
2.To move micrometer slowly till anode current on the meter shows a maximum.

 Theory:
 The human ear is sensitive to sound waves of frequencies raining from 20 Hz to 20 kHz. This is known as audible limit. Sound waves of frequencies beyond the upper audible limit (f > 20 kHz) are called ultrasonic waves. Sound waves of frequencies less than 20 Hz are called infrasonic waves. Ultrasonic waves can propagate to all medium which has elasticity. There are different of ways by which ultrasonic wave can be generated. The selection method depends upon the frequency to be produced and required output. There are two important method for generating ultrasonic waves.
1)Magnetostriction effect: This is used to produce ultrasonic waves in the freq. range 20 kHz to 100 kHz.

2) Piezoelectric effect: This is used to produce ultrasonic waves in the frequency range greater than 100 kHz.

Ultrasonic Transducer:

A transducer is a device to convert one form of energy to another. Ultrasonic transducer converts electrical energy to mechanical energy and vice versa.

Ultrasonic Interferometer: Ultrasonic interferometer is a simple device to determine velocity of ultrasonic wave in liquid with high degree of accuracy.

APPARATUS:

Ultrasonic interferometer, high frequency generator, water, Co-axial shielded cable etc.

DIAGRAM :-

THE MEASURING CELL
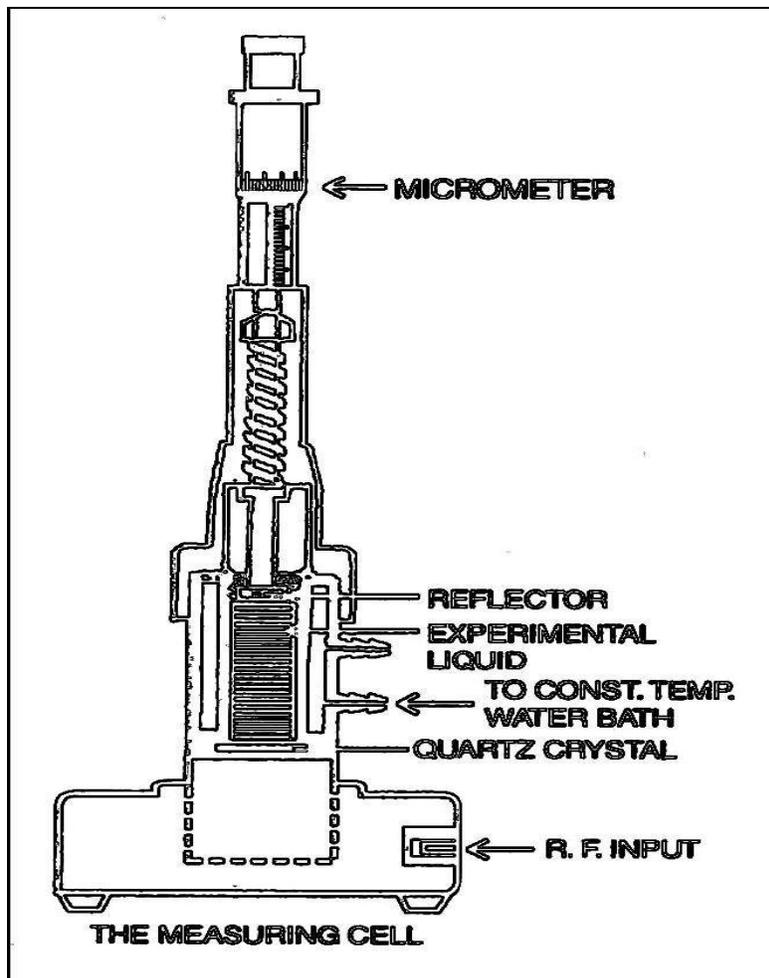
PROCEDURE :

1) Insert the micrometer cell in the square base socket and clamp it.

2) Fill the cell with water up to ¾ of its height.

3) Connect the co-axial cable of the high frequency signal generator to the base of the cell.

4) Switch on the oscillator and wait for one minute. Adjust the GAIN and ADJ knobs for greater deflection in the micrometer.

5) Move the top micrometer screw and note micrometer readings corresponding to the maximum current. Take at least six successive readings.

OBSERVATIONS :

1) **Frequency of crystal (n)** = **2 MHz**

2) **Density of liquid (ρ)** = **996.458 kg / m^3**

3) **Least count of micrometer** = --------------- **mm.**

OBSERVATION TABLE :-

Sr. No.	Position of micrometer	Difference in two successive positions d mm	Mean d mm	$\lambda = 2d$ mm
01				
02				
03				
04				
05				
06				

SAMPLE CALCULATIONS :

Formula :-
$$v = n\lambda \text{ (in m/sec)}$$

Where v is velocity, n is frequency and λ is the wavelength of sound.

$$\text{Compressibility } (\beta) = \frac{1}{\rho v^2}$$

Where ρ is density of liquid.

RESULT :

The Compressibility of liquid by using ultrasonic interferometer is found out to be β = ----------------- m^2 / N

QUESTIONS:

1. What is ultrasonic interferometer?

2. What is piezoelectric effect and magnetostriction effect ?

3. Which sound waves can be called ultrasonic ?

4. What is magnetostriction and piezoelectric effect?

5. Sound moves at 345 m/sec toward a rock wall , reflects and returns .The roundtrip takes 2 sec. How far away is the wall ?

6. Light and sound are both waves ; yet we can hear a car that is coming from behind the corner of a building before we can see the car. This is because
   a) Sound travels faster than light
   b) Since $\lambda_{sound} > \lambda_{light}$, sound diffracts more than light
   c) Sound is not reflected by buildings
   d) Sound and light interfere, with sound winning out

7. What are the types of sound waves?

Experiment No:- 04
Determination of Band Gap of a Semiconductor

AIM :

To determine the band gap of a semiconductor.

PRIOR CONCEPTS:

Energy bands in solids, conduction band, valence band, forbidden band.
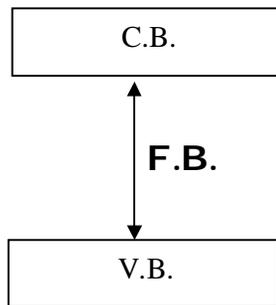
NEW CONCEPTS:

Proposition 1: Types of solids

Solids can be classified in three groups according to conductivity as-

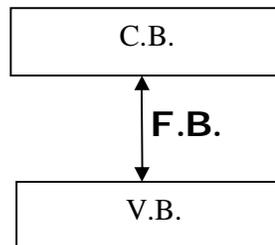Conductor, semiconductor, insulator.

Proposition 2: Forbidden gap

Forbidden gap is the gap between top of the valence band and bottom of the

conduction band; where no electron is present.

Forbidden gap is wide in insulator, narrow in semiconductor and is
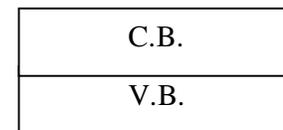
absent in conductor.

Concept Structure:

| C.B. |

F.B.

| V.B. |

1)Insulator

| C.B. |

F.B.

| V.B. |

2)Semiconductor

| C.B. |
| V.B. |

3) Conductor

Proposition 3: Forbidden Energy:

It is the minimum energy required by the electron in valence band to jump

to conduction band.

LEARNING OBJECTIVE :

Intellectual Skills:

1. To understand difference between forward bias and reverse biasing of diode.

Motor Skills:

1. To make proper reverse bias connections for a given diode.

2. To observe the change in reverse saturation current with change in temperature of diode.

Theory:

From the electrical conductivity point of view solids can be classified into three groups according to conductivity as- Conductor, Semiconductor and Insulator.

Conductor: Here valance band and conduction band are overlapped. Here large numbers of electrons are available for electric conduction. Forbidden gap is 0eV.

Insulator: Here valance band and conduction band are not overlapped. Forbidden gap is wide in insulator. Forbidden gap is greater than 5eV.

Semiconductor: The material whose conductivity is lies between insulator and conductor. Here forbidden gap is less than 5eV.

Two types of semiconductor:

1) Intrinsic Semiconductor: Extremely pure semiconductor is called intrinsic semiconductor

2) Extrinsic Semiconductor: Addition of some impurity to pure semiconductor is called Extrinsic Semiconductor. Such addition of impurity is called Doping.

Depending upon the dopants extrinsic semiconductor have two types:

a) n-type semiconductor: When pentavalent impurity (e.g. As, sb) is added in a Ge or Si semiconductor, such type of semiconductor is called as n-type semiconductor.

b) p-type semiconductor: When trivalent impurity (e.g. In, B) is added in a Ge or Si semiconductor, such type of semiconductor is called as p-type semiconductor.

Forbidden energy gap: The difference between the top of valance band and bottom of conduction band is called as forbidden energy gap or band gap.

APPARATUS:

Thermometer, micro ammeter, battery, semiconductor diode, oven etc.
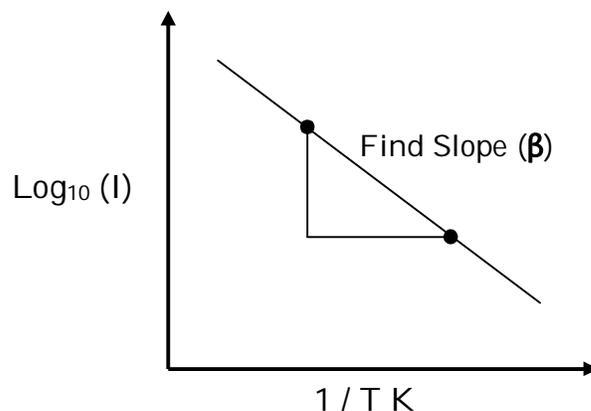
CIRCUIT DIAGRAM :
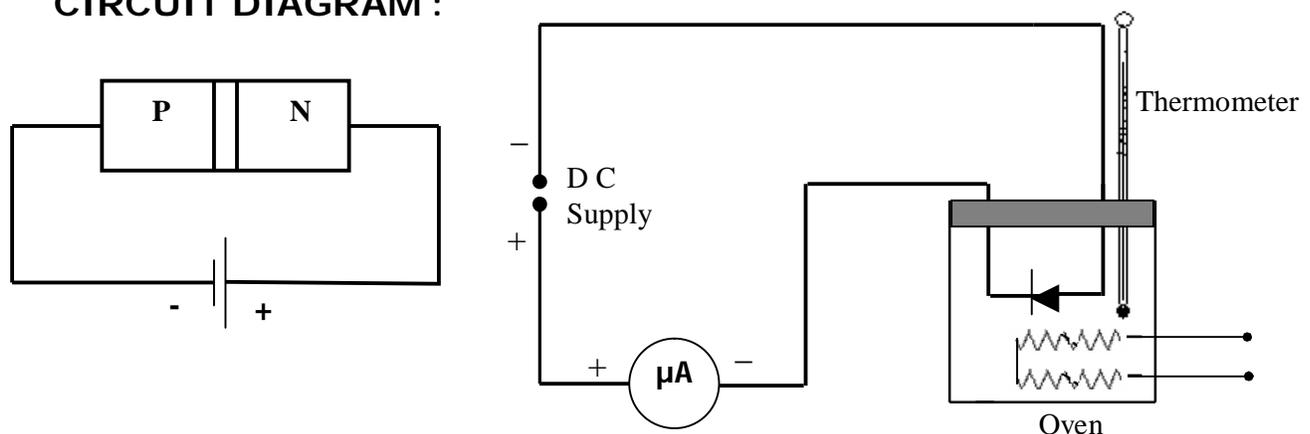
PROCEDURE :

1) Make the connections as shown in figure.
2) Insert the thermometer in the hole provided with oven.
3) Now put the power supply ON/OFF switch to 'ON' position and see that the jewel light is glowing.
4) Put the 'OVEN' switch to "ON' position and allow the oven temperature to increase up to 70 ^{0}C.
5) As soon as the temperature reaches 70 ^{0}C, switch off the oven.
6) Take the readings during the fall of temperature from 70 ^{0}C in step of 5 ^{0}C up to room temperature.
7) Tabulate your readings in the form as shown in the observation table.
8) Plot the graph between log I vs 1 / T K, the nature of graph is straight line.
9) Find the slop and calculate band gap Eg = 2kβ.

OBSERVATION TABLE :

Sr. No.	Temp T ^{0}C	Temp T K	1/T K	Current I (μA)	Log$_{10}$ I (μA)
01	70				
02	65				
03	60				
04	55				
05	50				
06	45				
07	40				

GRAPH:

Log$_{10}$ (I)

Find Slope (β)

1 / T K

SAMPLE CALCULATIONS :-

Band gap of a given semiconductor

$$Eg = 2k\beta$$

where β = m = Slope of graph

and k = Boltzmann constant = 8.63×10^{-5} eV/K

$$Eg = \text{----------------------} eV$$

> **Result :-**
>
> **Forbidden energy gap for semiconductor diode =** ------------eV.

QUESTIONS:

1. State the reason why energy band are formed in solid instead of energy loses.

2. How are the band structure of insulator and semiconductor similar? How are they different?

3. State the reason that can cause a solid to be metal (conductor) with respect
   to band structure.

4. The forbidden energy gap for silicon is 1.1eV and for germanium is 0.7eV which of the above material will have more conductivity? Why?

5. Define reverse saturation current (Is). How it depends on change in temperature.

6. If the germanium is doped with arsenic, is the result n-type or p-type semiconductor? Why?

7. How band structure is useful in classifying the solid according to its conductivity.

Experiment No:- 05
Study of Solar Cell Characteristics

Aim:

To find out the fill factor of solar cell.

PRIOR CONCEPTS:
Basics of Solar cell, basics of electric circuit, concept of electric power

NEW CONCEPTS:
Proposition1: Photovoltaic effect:
Light can be converted in to electrical energy if a pn junction is used.

Proposition2: Fill Factor
Fill factor is the ratio of actual maximum obtainable power (V_m X I_m) to the theoretical (not actually obtainable) power.

LEARNING OBJECTIVES:

Intellectual Skills:
1. To identify different circuit components.
2. To interpret the graph of current verses voltage for solar cell.

Motor Skills:
1. To make the connections as per the circuit diagram.
2. To take and tabulate observations carefully.
3. To plot the graph for characteristics of solar cell

Theory:
A solar cell is a photovoltaic device designed to convert solar energy into the electrical energy. A simple P-N junction can be used for this conversion. Solar cell is made from a high purity single crystal of silicon with minute amount of elements Boron and Phosphorous. A thin layer of P-type material is doped on a N-type substrate, forming a P-N junction.

When the incident sunlight falls on the upper p-region, it generates the electron-hole pairs. The thickness of the P-layer being very small, these electron and holes immediately reach the junction. This leads to increase in the number of holes on P side and electrons on N side. The accumulation of charges on the two sides of the junction produces a voltage.

Parameters of Solar cell:
1) Open Circuit Voltage(Voc): It is output voltage from solar cell when load impedance is very high.(i.e. $R_L \rightarrow \infty$)
2) Short Circuit Current (Isc): It is output current when load impedance is very small.(i.e. $R_L = 0$)
3) Fill Factor: It is ratio of maximum useful power to Ideal power.

Photovoltaic Effect: Light energy is converted into electrical energy if P-N junction is used.

APPRATUS:
Solar cell circuit, voltmeter, microammeter, multimeter etc.

CIRCUIT DIAGRAM:
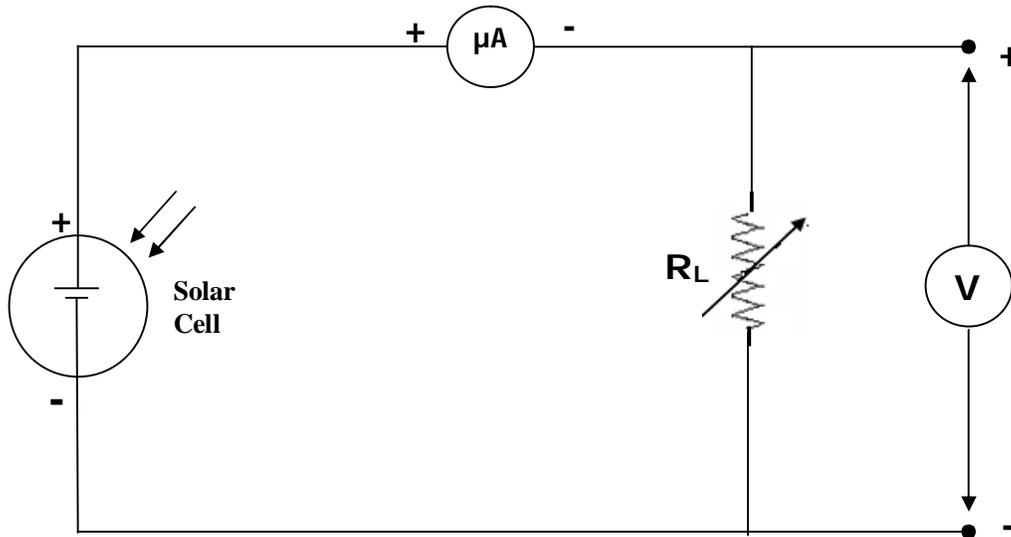
PROCEDURE :

1) Connect the circuit as shown in diagram.

2) Switch on the lamp.

3) Use digital multimeter as voltmeter and micro ammeter for measuring current.

4) Measure short circuit current (I_{SC}) for zero load (i.e. R_L = 0)

5) Measure open circuit voltage (V_{OC}) when R_L is maximum.

6) Now make R_L = 0, vary R_L and note corresponding values of voltage and current.

7) Plot I-V curve.

8) Draw a line making an angle 45^0 with X-axis to meet the curve at a point, find it's co-ordinate Im and Vm gives maximum power dissipation.

9) Calculate fill factor 'FF'.

OBSERVATION TABLE :

Sr. No.	V	I (µA)
01	0.0	--- (**Isc**)
02	0.2	---
03	0.4	---
---	---	---
---	---	---
---	--- (**Voc**)	00

GRAPH:
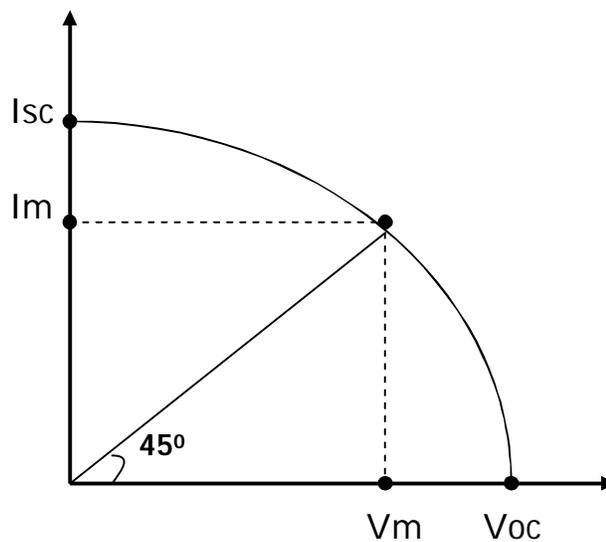
OBSERVATIONS (FROM GRAPH) :

1) Short circuit current   Isc   = ---------- µA

2) Open circuit voltage   Voc   = ---------- V

3) Maximum current   Im   = ---------- µA

4) Maximum voltage   Vm   = ---------- V

Solar Cell

CALCULATIONS :

Fill factor of a given solar cell (FF)   = $\dfrac{Im\ Vm}{I_{SC}\ V_{OC}} \times 100$

FF = ………%

Result :-

Fill factor of a given solar cell   = ---------- %

QUESTIONS:

1. What is solar cell?

2. What is photovoltaic effect?

3. Explain the difference between photovoltaic effect and photoelectric effect?

4. What are the advantages of solar cell?

5. Which materials are used for manufacturing of solar cell ?

6. Compare: production of electricity through solar cell and through conventional energy source.

Experiment No :- 06
: **Study of Laser**:

Aim:
To determine the grating element of given plane diffraction grating using laser.

PRIOR CONCEPTS:
Characteristics of laser, diffraction of light, diffraction grating.

NEW CONCEPTS:
Proposition 1: Semiconductor laser:
A semiconductor diode laser is specially fabricated pn junction device that emits coherent light when it is forward biased.

Proposition 2: Grating element
The spacing between adjacent slits is known as grating element.

LEARNING OBJECTIVE:

Intellectual Skills:

1. To observe diffraction pattern of different order.
2. To draw the conclusions form observation and relates them to propositions.

Motor Skills:
1. To arrange the set up for the experiment.
2. To draw ray diagram for the experimental setup
3. To observe the phenomenon of diffraction of light and measure correct value of angle of diffraction.

Theory:
The acronym of LASER is Light Amplification by Stimulated Emission of Radiation. It is the process by which one get a strong, intense, monochromatic, unidirectional and highly coherent beam of light. The principal involved in the laser is the phenomenon of stimulated emission radiation which was predicted by Einstein in 1917. When an atom in excited state, make transition to lower energy state through emission of electromagnetic radiation. This emission can occur in two different ways.

1) Spontaneous Emission: Atom in the excited state emits radiation even in the absence of any incident radiation.
2) Stimulated Emission: In which an incident photon of appropriate frequency triggers an atom in excited state to emit radiation.

There are different types of laser like as

- **Solid state laser:** Ruby laser, λ: 6943A^0 , Power : 10mW,   Colour: Red
- **Gas laser**   **:** He- Ne laser, λ: 6328 A^0 , Power : 0.5 to 50mW,   Colour: Red
                                λ: 5430 A^0 , Power : 0.5 to 50mW,   Colour: Green
- **Semiconductor laser:** λ: 7800 A^0, Power : 2mW to 5mW, Colour: Red

APPRATUS:
Laser source, diffraction grating, stand, screen, etc.

RAY DIAGRAM:
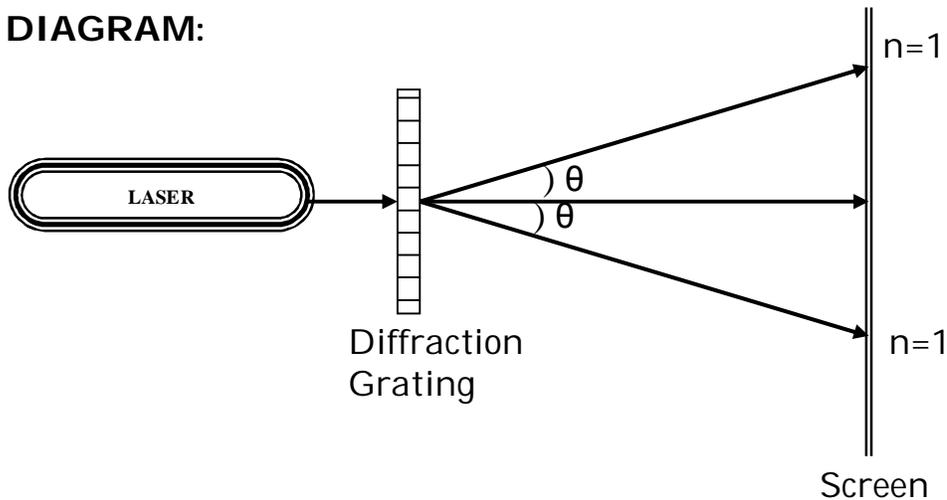
PROCEDURE:-

1) Fit the diode laser on stand.

2) Keep the grating in front of laser, focus laser on grating to form the well diffraction pattern on the screen.

3) Identify the central maximum and different order of spectrum on either side of central maximum.

4) Measure the distance of first order spectrum from the central maximum on either side.

5) Measure the distance between diffraction grating and the screen(x)

5) Repeat the measurements for different order of spectrums and tabulate the readings.

OBSERVATIONS:

1) Laser source used   =

2) Wavelength of Laser   = 6328 A°

3) Distance between diffraction
   grating and screen (x_1)   = ---------------
                     (x_2)   = ---------------

OBSERVATION TABLE:

Sr. No.	Order of spectrum (n)	Distance from central Maximum			Diffraction angle $\theta_1 = \tan^{-1}(y / x_1)$ $\theta_2 = \tan^{-1}(y / x_2)$	Mean θ
		Upper side (y_1) cm	Lower side (y_2) cm	y = $(y_1 + y_2) / 2$ cm		
01	1				θ_1 = ...	
02	1				θ_2 = ...	

SAMPLE CALCULATIONS: -

Formula for wavelength: d sinθ = $n\lambda$

Where 'd' is grating element and 'n' is order of spectrum

Grating element (d) = $n\lambda$ / sinθ

d = -------------- cm

RESULT:-

Grating element of given plane diffraction grating (d) = ----------- cm

QUESTIONS:

1. Write the acronym use for 'LASER'

2. Name the types of lasers   on the basis of material used for it.

3. Mention three characteristics of laser in detail.

4. How laser is different from ordinary source of light?

5. Explain working of semiconductor laser.

6. State applications of laser in information technology.

7. Calculate the power per unit delivered by laser pulse of energy 4.0×10^{-3} J and pulse length of 10^{-9} sec .When pulse is focused on small spot of radius 1.5×10^{-5} m.

: Absorption Coefficient of sound:

Aim:
To calculate the coefficient of absorption of sound for acoustical materials.

Prior Concept:

Natural sound waves, reflections of sound waves, sound as energy.

New Concepts:

Proposition 1: Absorption of sound

When a sound strikes a surface, part of it is transmitted and the remaining part is reflected. The property of a sound energy is converted in other form of energy is known as absorption.

Proposition 2: The coefficients of Absorption.

The coefficients of absorption 'a' of a material is defined as the ratio of sound energy absorb by its surface to that of the total energy incident on the surface.

Proposition 3: Absorption of Acoustical material

Materials having more capacity to absorb the incident sound are called 'absorbent' or acoustical materials'.

Learning Objectives:

Intellectual Skills:

1. To understand absorption and reflection of sound energy.

2. To understand reflection and absorption of sound energy and record the readings.

Motor Skills:

1. To develop skill to use decibel meter.

2. To observe reflection and absorption of sound energy and record the readings.

Theory:
Definition of Acoustic Absorption-Sound incident on a material is reflected, absorbed, and transmitted, as indicated. When such a material is installed on the walls of a room, its absorbing effect includes the transmitted sound as well as the pure absorption in the material. In this sense an open window is considered a "perfect" absorber, but is really a perfect transmitter. The coefficients deter-mined are based on this conception; that is, that what is not reflected is "absorbed." The open window is taken as the standard absorber with a coefficient of 1.00, or 100 per cent absorption. A material in the room with a coefficient of absorption of 0.50, means that it absorbs 50 percent as much sound as an open window of equal area.

Absorption coefficient of any material for sound is defined as the ratio of the sound energy absorbed by the material to the total sound energy incident on it.
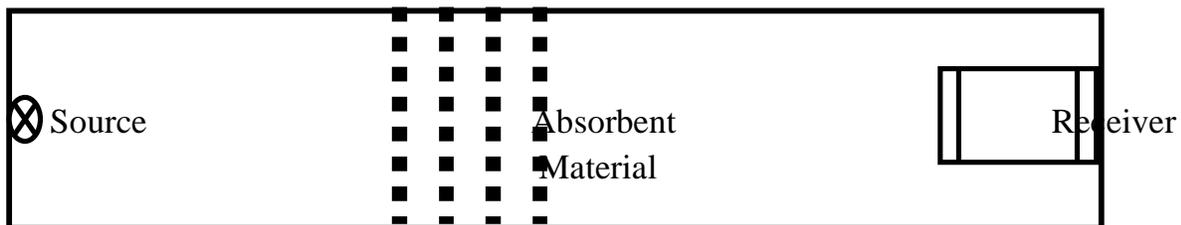Thus,

$$a = \frac{sound\ energy\ absorbed\ by\ the\ surface}{sound\ energy\ incident\ on\ the\ surface}$$

Materials having more capacity to absorb the incident sound are called 'absorbent' or acoustical materials'.

Apparatus:

Portable sound source, decibel-meter, different surfaces (Plastic, Thermocol, curtains, non perforated panels of wood, pressed wood fibres etc).

Diagram:

Procedure:
1. Measure the amount of sound energy received by the decibel-meter from source as shown in diagram.
2. For the measurement, keep the distance between sourse (S) and receiver (R) 1m.
3. Note down the reading in decibel (dB). Say S.
4. Mount material (sheet) on the panel.
5. Using sound source (S) and receiver (R) note down sound energy received after reflection from the surface. Repeat the observation for two more positions. Note down the readings and calculate the average value (S_1).
6. Now replace material sheet with thermocol sheet. Take three readings for this surface. Calculate the average value (S_2).
7. Using the formula calculate coefficient of absorption for Thermocol and Wood Material.

Observations:
Readings in decibel meter when sound energy is received directly = S = ………. dB.
Table for Sound Energy received after absorption from different surfaces.

Sound Energy absorbed Name of Material	Reading in Decibel- Meter			Average Reading
	1	2	3	
1) Thermocol (T)				S_1 = ………dB
2) Wood (W)				S_2 = ………dB

Sample Calculations:

The absorption coefficient (a) for

(i)   Thermocol Material:

$= a(T) = S_1 / S$

= ……………………… O.W.U or Sabine/m2

(ii)   Wood Material:

$= a(W) = S_2 / S$

= ……………………… O.W.U or Sabine/m2

RESULT:

The calculated values of absorption coefficients are,

For i) Thermocol Material = ………………… O.W.U or Sabine/m2

For ii) Wood Material   = ………………… O.W.U or Sabine/m2

QUESTIONS

1. What are the types of sound waves?

2. What are ultrasonic sound waves?

3. Explain the term absorption coefficient.

4. Which is ideal sound absorber?

5. What is OWU?

Aim:

To determine specific rotation of sugar solution by using half shade polarimeter.

Prior Concept:

Unpolarized light, plane polarized light Polarizer, analyzer, polarization, Polaroid, dichroism.

New Concepts:

Proposition 1: Optical Activity

When a beam of plane polarized light is incident on certain crystals , the plane of polarization rotates / turns about the direction of beam. This phenomenon of rotation plane of polarization is called optical activity.

Proposition 2: Optical active materials.

The crystals or chemicals shows optical activity phenomenon are called as optically active materials.

Proposition 3: Dextro-rotatory / Right handed materials:

A material which rotates the plane of vibration to the right are called as Dextro-rotatory / Right handed materials.

Proposition 4: Laevo-rotatory / Left handed materials:

A material which rotates the plane of vibration to the left are called as Laevo-rotatory / Left handed materials.

Learning Objectives:

Intellectual Skills:

1. To understand Dextro and Laevo rotation of plane polarized light.
2. To understand the concept of specific rotation of materials.

Motor Skills:

1. To observe the phenomenon of optical activity of plane polarized light and measure correct value of angle of rotation.
2. To see and adjust the just merged potion of the colors.
3. To operate the polarimeter and record the readings.

Theory:

When a beam of plane polarized light is incident on certain substances like sugar solutions, quartz crystal etc the plane of vibration is rotated. The amount of rotation depends upon the distance travelled in the medium. This phenomenon of rotation plane of polarization is called optical activity.

The crystals or chemicals shows optical activity phenomenon are called as optically active materials. Some crystals rotate the plane of vibration to the right are called as dextrorotatory and if left called levorotatory.

The rotation produced by a 1mm thick crystal is called specific rotation. It has been observed that specific rotation is nearly proportional to inverse Square of the wavelength. The violet light is rotated nearly 4 times as much as red light.

The specific rotation of a solution at a given temperature and wavelength is defined as the rotation of plane of vibration of plane polarized light produced by one decimeter length of solution when the concentration of the solution is 1 gm per cc.

Apparatus: Polarimeter, a balance, measuring cylinder, beaker, source of light, different concentration of sugar solution, polarimeter tube etc.

Diagram:
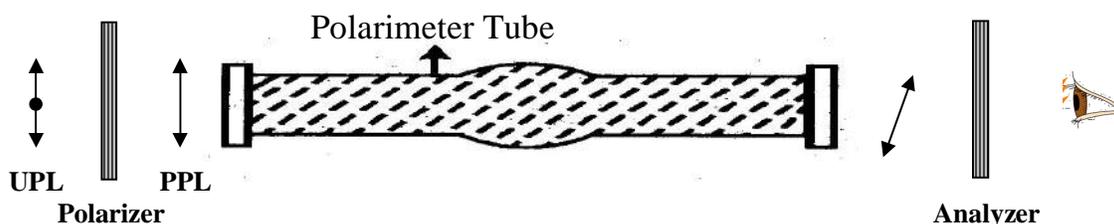
Principle:
When plane polarized light is passes through optically active liquid then it change the plane of polarization of light.

Procedure:

1. Place the polarimeter tube so that the aperture of the tube is in the front of light.

2. Look through the eyepiece so that the two halves of the half shade device are clearly visible .

3. Fill the polarimeter tube with distilled water taking care of that either there is no air bubble in the tube or if it is there, it remains at the centre part of the tube.

4. Place the tube in the polarimeter and observe through the eyepiece E. In general we find two semi circles of different colours. By rotating the analyser eyepiece system, the colour pair gets changed. Let us select a pair of different colour, say red and blue.

5. By rotating the analyser scale, the colour pair can be interchange. By rotating the analyser scale, the two colours can be mixed so that circular field of view appears gray instead of two semicircle of

   red and blue.

6. Record the reading of analyser scale at this position.

7. Prepare a sugar solution by dissolving 10 gm., 8gm, 6gm, and 4gm of sugar in 100ml of distilled water separately.

8. Fill the polarimeter tube with 10gm concentration of sugar

   solution. Adjust the analyser scale until the field of view appears gray.

9. Note down the analyser reading .

10. Repeat the same procedure for other sugar concentrations i.e. 8gm,6gm,and 4gm. Adjust the analyser scale until the field of view appears gray everytime.

11. Calculate the values of angle of rotation q for different sugar concentrations with respect to distilled water.

12. Plot the graph of angle of rotation q against mass of sugar n. Graph is straight line, find out its slope.
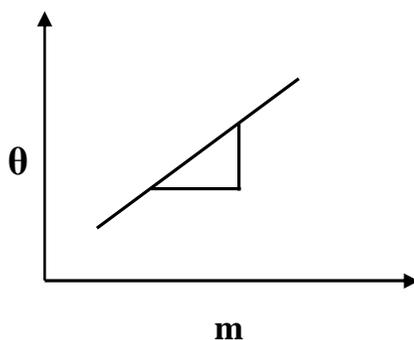
Obsrevations:

Length of polarimeter tube   = 20cm

Least count of analyzer scale =_____

Observation Table:

Sr. No.	Liquid Used	Mass of Sugar in gram (m)	Analyzer Reading	Angle of Rotation (θ)
1	Distilled water	---	(reference reading)	---
2	Sugar solution	4		
3	Sugar solution	6		
4	Sugar solution	8		

Graph:

Sample Calculations:

Formula Used: The specific rotation of the [plane of polarization of sugar dissolved in water can be determined by the following formula,

$$S = \frac{1000 \times \theta}{l \, m}$$

Where θ = rotation produced in degrees.

l = length of the tube.

m = mass of sugar in gms dissolved in water.

V = volume of sugar solution

RESULT:

Specific rotation S = _____ ^{0}/gm cm

QUESTIONS

1. What is unpolarized light?

2. What is plane polarized light?

3. What is optical activity?

4. Give examples of optical active materials?

5. Explain dextro and laevo rotatary phenomenon.

6. Explain the term specific rotation.