KONGUNADU ARTS AND SCIENCE COLLEGE
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G.N.Mills Post, Coimbatore - 641 029, Tamil Nadu, India

DEPARTMENT OF PHYSICS

Under

DBT STAR COLLEGE SCHEME

LAB MANUAL

General Experiments

For B.Sc. Final year students

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CONTENTS

1. YOUNG'S MODULUS UNIFORM BENDING– KOENIG'S METHOD

AIM

To determine the young's modulus of the material of the given bar by measuring the elevation of its centre when equally loaded at the ends by Koenig's method.

APPARATUS REQUIRED

A uniform bar, two equal knife edges, plane mirrors, 50g and 100g weights with weight hangers, telescope and scale arrangement and metre scale.

FORMULA

Young's modulus of the material of the given bar

$$E = \frac{12\, M.\, g.\, l.\, a\, (2D+x)}{bd^3 s} \quad N/m^2$$

Where

l is the distance between knife edges (m)

D is the distance between the scale and remote mirror (m)

b is the breadth of the experimental bar (m)

d is the thickness of the experimental bar (m)

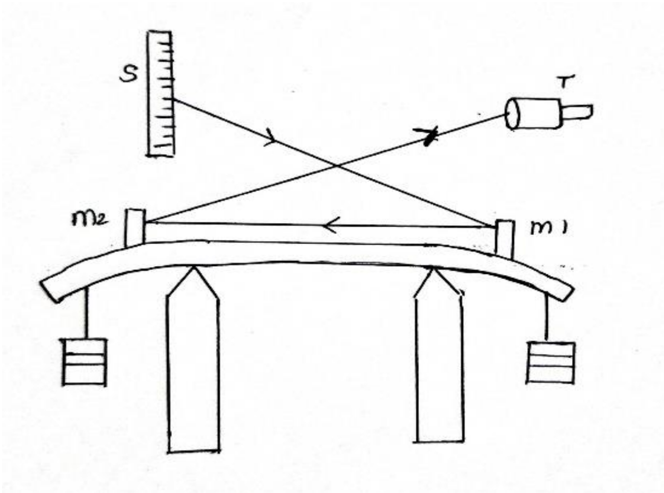
M is the load producing the mean shift (kg)

a is the distance between the knife edges and the weight hanger (m)

s is the mean elevation of the given bar (m)

x is the distance between knife edges (m)

DIAGRAM

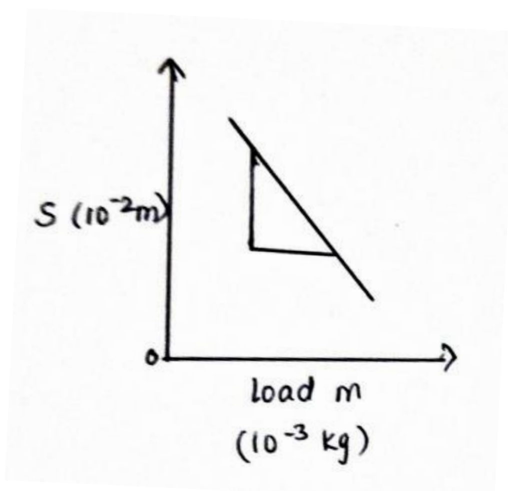


M_1, M_2 → **Mirrors**

S → **Scale**

T → **Telescope**

MODEL GRAPH



PROCEDURE

The given bar is supported symmetrically on two knife edges A and B in a horizontal level so that about 10 cm of the rod projects beyond each knife edge. Two stirrups C and D are arranged at distances about 5 cm from each end. The distance of the knife edge from the stirrups are made equal. Two weight hangers are suspended from these stirrups. Two plane mirrors M_1, and M_2 are mounted vertically on the knife edges. A telescope T and a scale S are arranged.

The telescope is adjusted to see a certain point P on the scale reflected in the mirror M_1. This image is formed by the ray of light from P getting reflected by M_2 and M_1 and entering the telescope. Taking the hanger itself as the dead load, the reading corresponding to the horizontal cross wire of the telescope is noted. Weights are added in units of m grams (50 grams for a wooden bar) in the hangers and every time the scale reading coinciding with the horizontal cross wire of the telescope is recorded. The weights are removed one by one and the readings are noted while unloading.

The distance between the knife edges (L), the distance between the each knife edge and the weight hanger near it (a), distance between the mirrors (x), the breadth (b) and thickness (d) of the bar are accurately measured.

TABULATION

1) To calculate the mean elevation of the given bar

S.No.	Load (10^{-3} kg)	Telescope Reading (10^{-2} m)			Shift (10^{-2} m)
		Loading	Unloading	Mean	

2) To find the thickness of the bar using screw gauge

LC = **ZE =** **ZC =**

S.No.	PSR (10^{-3} m)	HSC (div)	HSR = (HSC $\pm$ ZC) $\times$ LC (10^{-3} m)	TR =PSR+HSR (10^{-3} m)

3) To find the breadth of the bar using Vernier Caliper

LC =

S. No	**MSR (10^{-2} m)**	**VSC (div)**	**VSR = (VSC $\pm$ ZC) $\times$ LC (10^{-2} m)**	**TR = MSR+VSR (10^{-2} m)**

RESULT

Young's Modulus of the material of the bar by uniform bending using Koenig's method

(i) By experimental method =

(ii) By graphical method =

2. YOUNG'S MODULUS NON UNIFORM BENDING – KOENIG'S METHOD

AIM

To determine the Young's modulus of the material of the given bar by measuring the depression at the mid-point when centrally loaded by Koenig's method.

APPARATUS REQUIRED

A uniform bar, two equal knife edges, plane mirrors, 50g and 100g weights with weight hangers, telescope and scale arrangement and metre scale.

FORMULA

Young's modulus of the material of the given bar

$$E = \frac{3 M g l^2 (2D+x)}{2 bd^3 s} \ N/m^2$$

Where,

l is the distance between the knife edges (m)

D is the distance between the scale and remote mirror (m)

b is the breadth of the experimental bar (m)

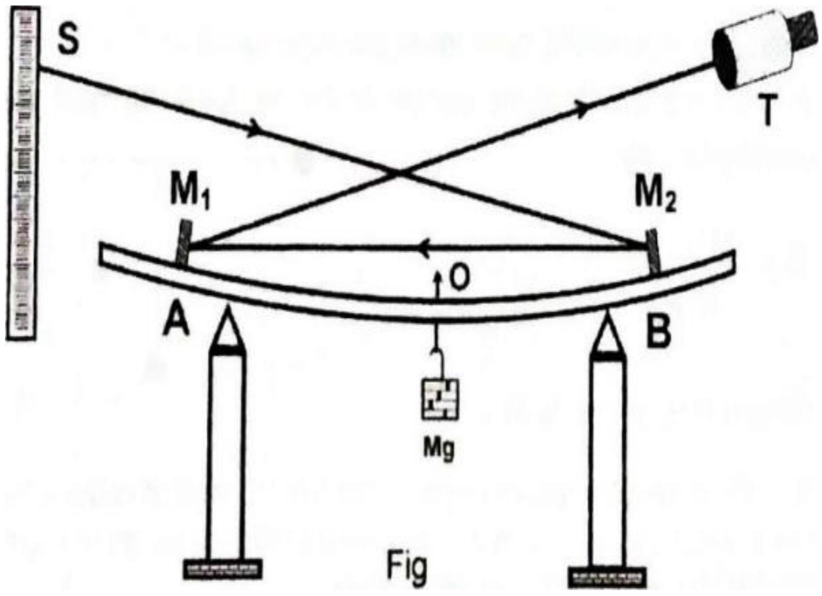
d is the thickness of the experimental bar (m)

M is the load producing the mean shift (kg)

s is the mean depression of the given bar (m)

x is the distance between the mirrors (m)

DIAGRAM

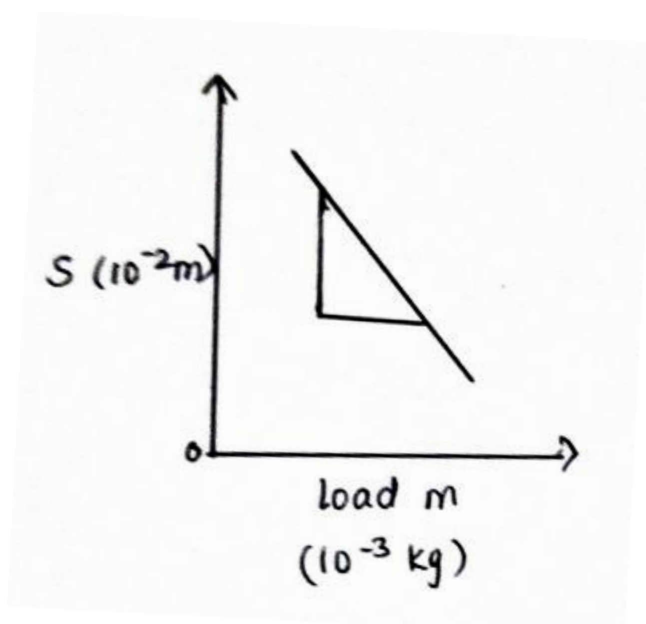


M_1, M_2 ⟶ Mirrors

S ⟶ Scale

T ⟶ Telescope

MODEL GRAPH



PROCEDURE

The given bar is supported symmetrically by the two knife edges A and B so that about 10cm of the bar projects beyond each knife edge A stirrup is slipped into the bar and adjusted to be exactly at the mid-point of the bar. A weight hanger is suspended from the stirrup. Two plane mirrors M_1 and M_2 are mounted vertically on the bar near knife edges. A telescope T and a vertical scale S are arranged as shown in Fig.

The telescope is adjusted to see a certain point P of the scale in the mirror M_1. This image is formed by the ray of light from P getting reflected by M_2 and M_1 and entering the telescope. Taking the hanger itself as the dead load and the reading corresponding to horizontal cross wire of telescope is noted. Weights are added in units of m grams (50 grams for a wooden bar) and every time the reading of the scale coinciding with the horizontal cross wire of telescope is recorded. The weights are removed one by one and the readings are noted while unloading. The distance between the knife edges (l), the breadth (b), and the thickness (d) of the bar are accurately measured.

TABULATION

1) To determine the mean depression of the given bar

S.No	Load (10^{-3} kg)	Telescope Reading (10^{-2} m)			Shift (10^{-2} m)
		Loading	Unloading	Mean	

2) To find the thickness of the bar using screw gauge

LC = **ZE =** **ZC =**

S.No.	**PSR (10^{-3} m)**	**HSC (div)**	**HSR = (HSC $\pm$ ZC) $\times$ LC (10^{-3} m)**	**TR =PSR+HSR (10^{-3} m)**

3) To find the breadth of the bar using Vernier Caliper

LC =

S.No	**MSR (10^{-2} m)**	**VSC (div)**	**VSR = (VSC$\pm$ZC) $\times$LC (10^{-2} m)**	**TR = MSR+VSR (10^{-2} m)**

RESULT

Young's Modulus of the material of the bar by non-uniform bending using Koenig's method

(ii) By experimental method =

(ii) By graphical method =

3. DISPERSIVE AND RESOLVING POWER OF GRATING

AIM

To determine the dispersive power and resolving power of a grating adjusted for normal incidence.

APPARATUS REQUIRED

Spectrometer, grating, reading lens, sodium vapour lamp and mercury vapour lamp.

FORMULA

Number of lines per meter of grating

$$N=\frac{\sin\theta}{m\lambda} \text{ lines/m} \qquad \ldots\ldots\ldots\ldots (1)$$

Where

m is the order of the spectrum

θ is the angle of diffraction

λ is the wavelength of sodium vapour lamp in metres

Wavelength of mercury spectral lines

$$\lambda = \frac{\sin\theta}{Nm} \text{ metres} \qquad \ldots\ldots\ldots\ldots (2)$$

Dispersive power of grating

$$\frac{d\theta}{d\lambda} = \frac{Nm}{\cos\theta} \qquad \ldots\ldots\ldots\ldots (3)$$

Where

dθ is the angular separation of two nearby spectral lines in radians

dλ is the difference in wavelength of two nearby spectral lines in metres

m is the order of the spectrum

θ is the mean angle of diffraction for a pair of lines

N is the number of lines per meter of grating in lines/m

Resolving power of grating $= \dfrac{\lambda}{d\lambda}$ .... (4)

PROCEDURE

After making the preliminary adjustments of the spectrometer the grating is mounted on the grating table and it is adjusted for normal incidence. The slit of the collimator is illuminated by light from the sodium vapour lamp. The telescope is illuminated to view the first order diffracted image and the reading of both the vernier scales for the left and right diffracted image is taken and the mean value of θ is determined. Number of lines/m of the grating is calculated using Eqn. 1.

The sodium vapour lamp is replaced by mercury vapour lamp and the slit is illuminated by mercury vapour lamp and the spectrum is viewed through the telescope. The vertical crosswire of the telescope is made to coincide successively with each one of the prominent lines of the first order spectrum and the readings are taken. Similarly, the corresponding readings of the same prominent lines for the first order spectrum on the other side are taken. The observations are tabulated.

TABULATION

1) To determine the number of lines/m of the grating

Order of the spectrum	Telescope reading				Diffrenence		Mean 2θ	θ	N=$sin\theta/m\lambda$ (lines/m)
	Left		Right		$V_A \sim V_A$	$V_B \sim V_B$			
	V_A	V_B	V_A	V_B					

2) **To determine the wavelength of the spectral lines in mercury spectrum**

Order of the spectrum	**Telescope reading**				**Diffrenence**		**Mean 2θ**	θ	$\lambda = \sin\theta/Nm$ ($\times10^{-10}$m)
	Left		**Right**		$V_A \sim V_A$	$V_B \sim V_B$			
	V_A	V_B	V_A	V_B					

3) **To determine the dispersive power of grating**

Spectral line	$d\theta$	**dλ 10^{-10}m**	$\frac{d\theta}{d\lambda}$	$\theta = \frac{\theta 1 + \theta 2}{2}$	$\frac{d\theta}{d\lambda} = \frac{Nm}{\cos\theta}$

RESULT

1) The number of lines per meter of the grating, N =
2) The wavelength of the mercury spectral lines $\lambda =$
3) Dispersive power and resolving power of grating has been calculated.

4. HARTMANN'S FORMULA- BRASS ARC SPECTRUM

AIM

To determine the wavelength of prominent spectral lines of brass arc spectrum using mercury spectrum as standard wavelength by Hartmann's formula.

APPARATUS REQUIRED

Brass arc spectrum, mercury arc spectrum, quadrant microscope and white light.

FORMULA

Wavelength of brass arc spectral lines

$$\lambda = \lambda_0 + [C / (d_0 - d)] \text{ m}$$

$$A = (d_2 - d_1) / (\lambda_2 - \lambda_1)$$

$$B = (d_3 - d_1) / (\lambda_3 - \lambda_1)$$

$$\lambda_0 = \lambda_1 - \{(d_3 - d_2) / (A - B)\} \text{ m}$$

$$d_0 = A(\lambda_2 - \lambda_0) + d_1 \text{ m}$$

$$C = \{(d_0 - d_1)(d_3 - d_2)\} / (A - B)$$

Where

d is the microscope reading for different spectral lines of the brass arc spectrum

λ_0, C, d_0 are Hartmann's constants

PROCEDURE

To determine the exact wavelength of brass lines on the photographic plate, the position of the photographic plate is kept in such a way that both the brass arc and mercury arc spectral lines are within the field of view. The measurement of the relative positions of the brass lines on the plates is carried out by means of a travelling microscope under which the plate is mounted on a movable carriage which is movable backwards or forward. The vertical cross wire of the quadrant microscope is focused at each spectral line of the brass and mercury arc spectrums and the readings are taken for both the spectrums simultaneously.

TABULATION

1) **Readings corresponding to the prominent spectral lines in mercury arc spectrum**

Order of the spectrum	Microscope reading $\times 10^{-2}$m	Standard wavelength $\times 10^{-10}$m

2) To determine the wavelength of spectral lines in brass arc spectrum

S.no	Microscope reading $\times 10^{-2}$m	Calculated wavelength $\lambda = \lambda_0 + C / (d_0 - d) \times 10^{-10}$ m	Standard wavelength $\times 10^{-10}$m

RESULT

The wavelength of prominent spectral lines of the brass arc spectrum is determined by using mercury spectrum as standard wavelength.

5. BANDGAP ENERGY OF A SEMICONDUCTOR

AIM

To determine the bandgap energy of a semiconductor material.

APPARATUS REQUIRED

Milliammeter, 2-volt battery, rheostat, water bath, thermometer and thermistor

FORMULA

Bandgap energy, $E_g = \left(\frac{2K}{q}\right) 2.303 \left(\frac{\log_{10} I_0}{\frac{1}{T}}\right)$ eV

Where

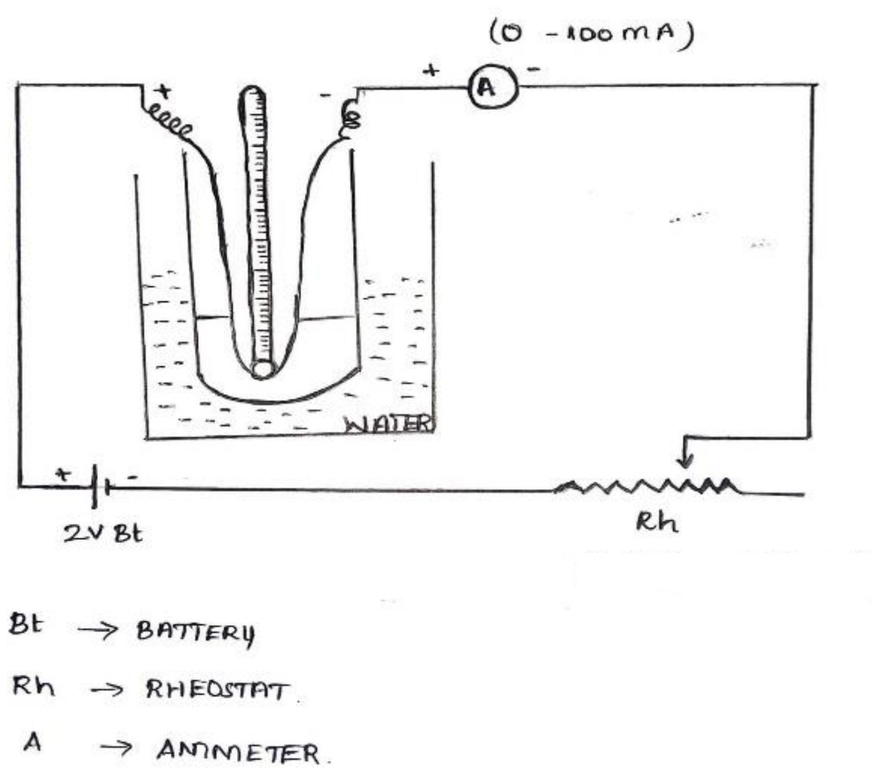
q is the charge of an electron (1.6×10^{-19}C)

K is the Boltzmann constant (1.380662×10^{-23}J/kg/K)

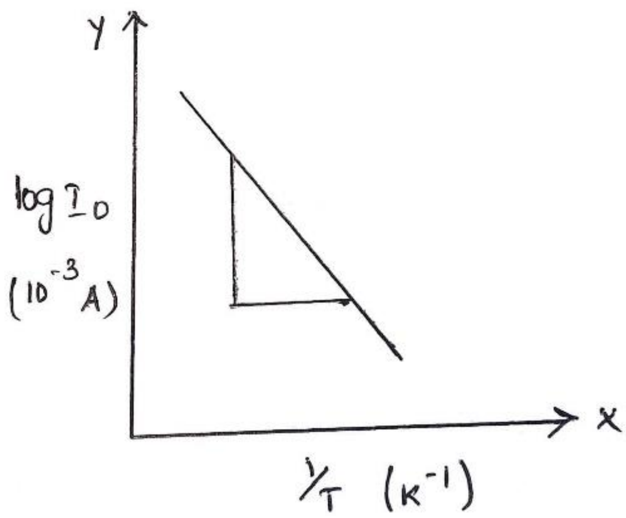
T is temperature in Kelvin

I_0 is current in mA

DIAGRAM



MODEL GRAPH



TABULATION

S. No	Temp (C)	Temp (K)	Current I_0 (mA)		Mean I_0 (mA)	1/T (K^{-1})	$\log_{10} I_0$	$\left(\frac{\log_{10} I_0}{\frac{1}{T}}\right)$
			Heating	Cooling				

PROCEDURE

Milliammeter, power supply, rheostat and thermistor are connected in series as shown in figure. The thermistor is placed in a test tube containing wax which is placed in a water bath. The temperature of the water bath is measured using a thermometer. The current in the circuit shown by milliammeter is noted for various temperatures. The water bath is heated slowly and when the temperature becomes maximum (steady state temperature), the milliammeter reading is noted.

The water bath is cooled (up to room temperature) and the milliammeter reading is noted for various temperatures of the water bath (for every 10°C fall in temperature) containing the thermistor. A graph is drawn by taking $\log_{10} I_0$ in Y-axis and 1/T in X-axis. The slope of the straight line is determined and substituted in the formula to calculate the average band gap energy graphically for the given semiconductor material. Also by using the formula the band gap energy is calculated.

RESULT

The band gap energy of the semiconductor material

1. By experimental method =
2. By graphical method =

6. MELTING POINT OF WAX USING THERMISTOR

AIM

To determine the melting point of solid like paraffin wax using thermistor.

APPARATUS REQUIRED

Milliammeter, 2-volt battery, rheostat, water bath, thermometer and thermistor

FORMULA

The current corresponding to the melting point of wax

$$I = \frac{I_A + I_B}{2} \text{ mA}$$

$$I_A = \frac{I_2 + I_3}{2} \text{ mA}$$

$$I_B = \frac{I_1 + I_4}{2} \text{ mA}$$

Where

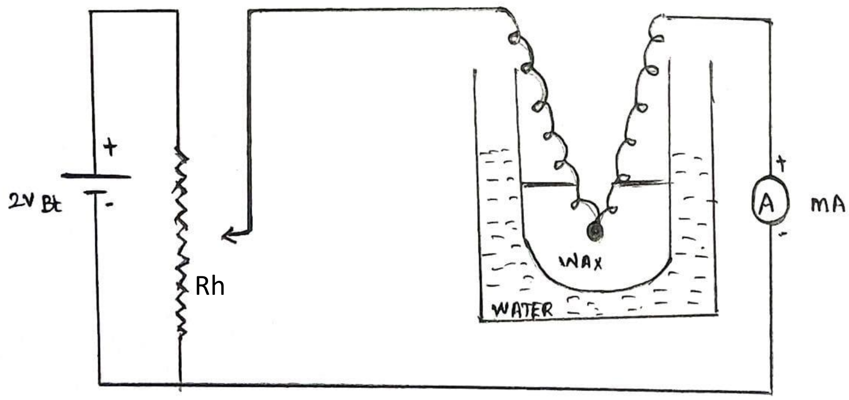
I_1 is the current when the wax just starts melting (mA)

I_2 is the current when the wax completely melts (mA)

I_3 is the current when the wax just begins to solidify (mA)

I_4 is the current when the wax completely solidifies (mA)

DIAGRAM

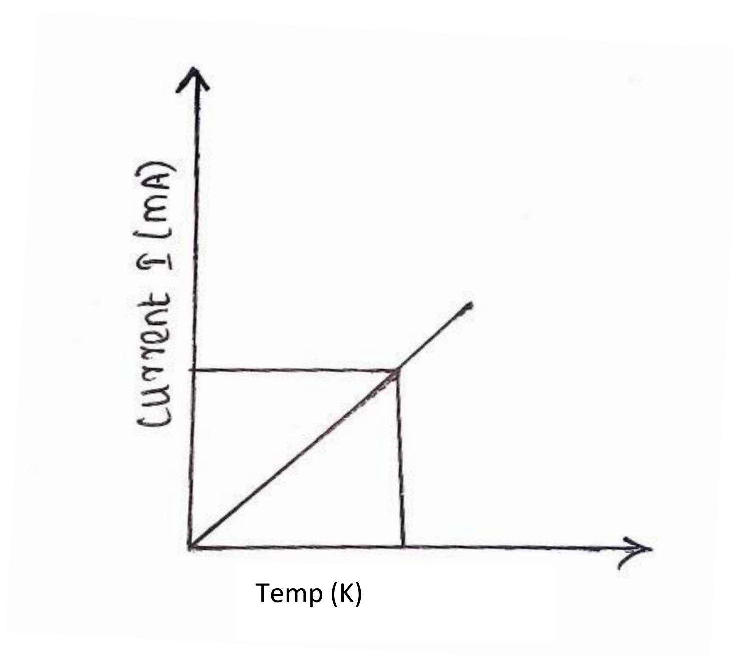


Bt ⟶ Battery

Rh ⟶ Rheostat

A ⟶ Milliammeter

MODEL GRAPH



TABULATION

S. No	Temp (^oC)	Temp (K)	Current (mA)		Mean I (mA)
			Heating	Cooling	

PROCEDURE

Milliammeter, power supply, rheostat and thermistor are connected in series as shown in figure. The thermistor is placed in a test tube containing wax which is placed in a water bath. The temperature of the water bath is measured using a thermometer. The current in the circuit shown by milliammeter is noted for various temperatures. The water bath is heated slowly and when the temperature becomes maximum (steady state temperature), the milliammeter reading is noted. The water bath is cooled (up to room temperature) and the milliammeter reading is noted for various temperatures of the water bath (for every 10 ^oC fall in temperature) containing the thermistor. The current when the wax begins to melt (I_1), when the wax is completely melted (I_2), when the wax begins to solidify (I_3) and when the wax is fully solidified (I_4) is noted down. From these values, the average value of current (I) is calculated. A graph is drawn between the current (I) and various temperatures (T). From the mean value of current I, a perpendicular is dropped to the temperature axis from which the melting point of wax can be determined.

RESULT

The melting point of wax using thermistor =

7. IMPEDANCE AND POWER FACTOR OF AN INDUCTIVE RESISTIVE CIRCUIT

AIM

To determine the impedance and power factor of an inductive resistive circuit and hence to calculate the inductance of the coil.

APPARATUS REQUIRED

Inductance coil, resistance box, Audio Frequency Oscillator (AFO), AC Milliammeter and AC Voltmeter.

FORMULA

Power factor = E_R/E

Impedance = V/I (Ω)

Inductance of the coil (L) = $\frac{\sqrt{Z^2 - R^2}}{2\pi f}$ henry

Where

$$E = \sqrt{E_L^2 + E_R^2}$$

E_L is the voltage across the inductance in volts

E_R is the voltage across the resistance in volts

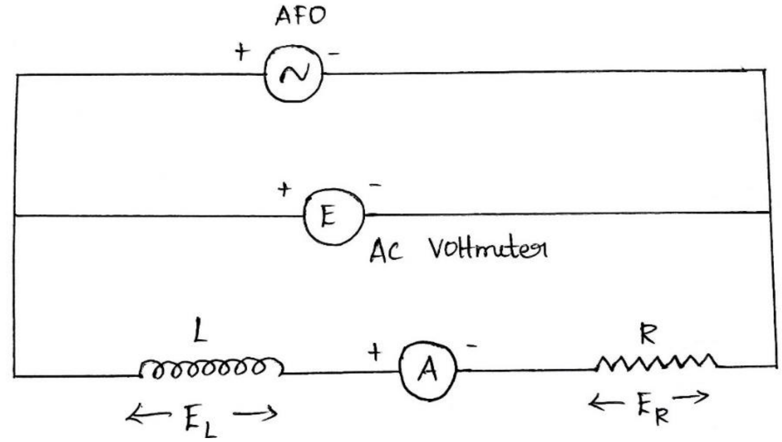
R is the resistance in ohms

Z is the impedance in ohms

f is the frequency in Hz

V is the Voltage in volts

CIRCUIT DIAGRAM



PROCEDURE

The inductive coil, resistance box, AFO and milliammeter are connected in series as shown the figure. With a small suitable resistance in the resistance box, a small voltage from AFO is applied in the circuit. The current in the circuit (I) is measured using the milliammeter and the voltage is measured using the voltmeter. The voltage across the inductance coil L and the resistance R is measured using a multimeter as E_L and E_R volts. The frequency applied from the AFO is varied and each time I, E_L and E_R are measured. The experiment is repeated by increasing the frequency up to 3 kHz in steps of 100 Hz.

TABULATION

To determine the inductance of the coil **R =**

S No	Frequency (Hz)	Voltage E (volts)	Current I (mA)	Impedance Z (ohms)	Voltage (volts)		Power Factor (E_R/E)	Inductance of the coil L (henry)
					E_L	E_R		

RESULT

The impedance and power factor of the inductive resistive circuit is determined and the inductance of the coil =

8. DETERMINATION OF SELF INDUCTANCE BY ANDERSON 'S BRIDGE METHOD

AIM

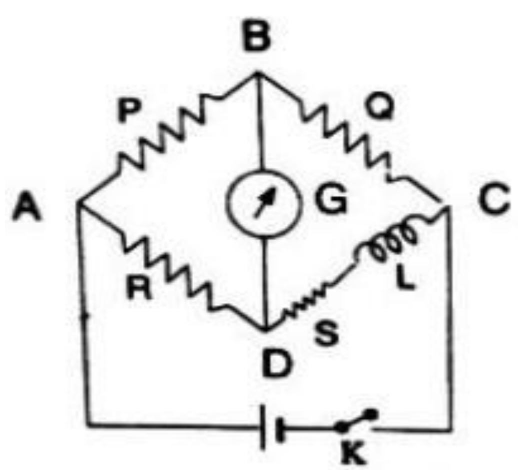
To determine the self-inductance of the given coil by Anderson's bridge method

APPARATUS REQUIRED

DC battery, AFO, self-inductance coil, standard capacitance box, headphone, resistance box, tap key and galvanometer.

CIRCUIT DIAGRAM

(a) DC balance



Bt

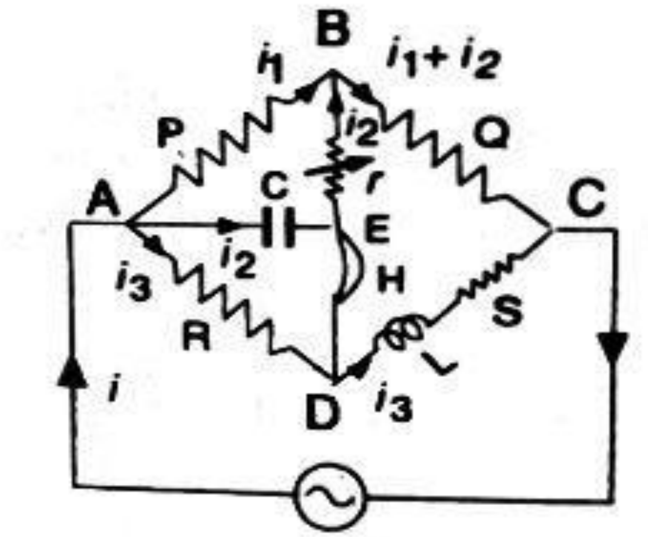
PQRS ⟶ Resistance box

Bt ⟶ Battery

C ⟶ Capacitance

G ⟶ Galvanometer

(b) AC balance



AFO

AFO ⟶ Audio Frequency Oscillator

L ⟶ Inductance coil

H ⟶ Head Phone

PROCEDURE

The experiment is performed in two stages.

(a) **DC Balance**: Circuit connections are made as shown in diagram. The ratio of the resistances P and Q are fixed to a ratio 1:1. The resistance R is adjusted for balance .This gives the approximate value of resistance S of the coil .The experiment is repeated for making the P:Q ratio to be 10:1and 100:1. The accurate value of DC resistance of the coil S is found by Wheatstone's bridge relation

$$P/Q = R/S \quad \text{or} \quad S = R\,Q/P$$

(b) **AC balance**: An AC source (audio frequency oscillator) is connected between A and C. A variable non inductive resistance r is connected in series with capacitance C and this combination is connected parallel with arm AB. A headphone H is connected between B and D. The resistance r is adjusted until minimum sound is heard in the headphone. The value of L is calculated using the formula.

$$L = C [RQ + r (R+S)] \text{ henry}$$

TABULATION

DC Balance

P = **Q =**

S.No	Value of R(Ω)	Value of S (Ω)

AC Balance

P= **Q=** **R=** **S=**

S.No	Capacitance (farad)	Value of r (Ω)	L = C [RQ + r (R+S)] (henry)

RESULT

The self-inductance of the coil by AC method is determined and it is found to be

L=

9. NEWTON'S RINGS

AIM

To determine the radius of curvature of the given long focus convex lens by Newton's rings method and hence the refractive index of the material of the convex lens.

APPARATUS REQUIRED

Long focus convex lens, optically plane glass plate, sodium vapor lamp and travelling microscope.

FORMULA

Radius of curvature for face-I $R_1 = k_1 / m\lambda$ (metre) ………….(1)

Radius of curvature for face-II $R_2 = k_2 / m\lambda$ (metre) ………….(2)

Refractive index $$\mu = 1 + \frac{1}{f\left(\left(\frac{1}{R_1}\right)+\left(\frac{1}{R_2}\right)\right)}$$ ………….(3)

Where

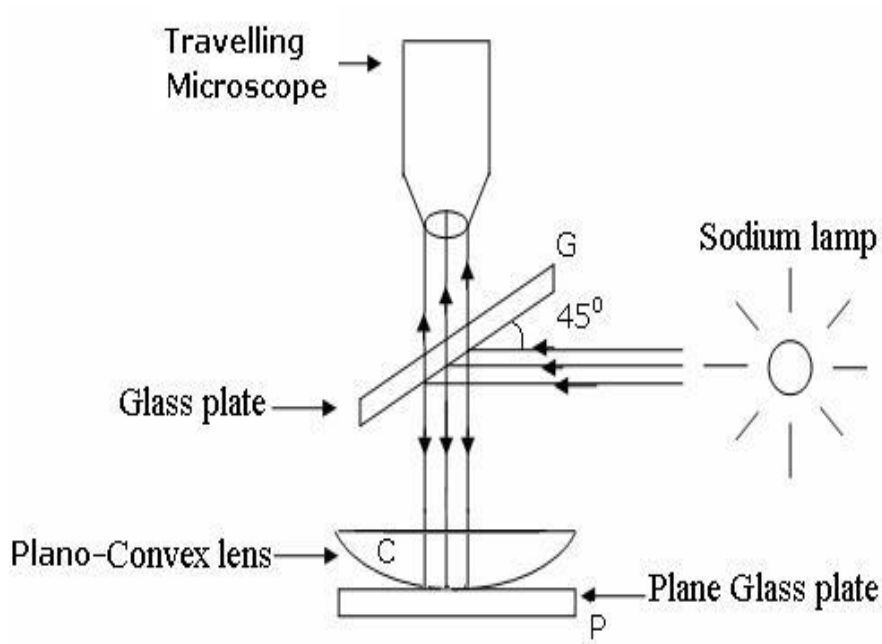
k_1, k_2 are the fringe width in meter

λ is the wavelength of sodium light

f is the focal length of given lens in meter

R_1, R_2 are the radii of Curvature for Face I and Face II respectively

DIAGRAM



PROCEDURE

The centre of the ring system is brought to the field of view of the microscope. The first few rings near the centre may be ill defined and hence it is difficult to fix the absolute order of the ring. So the first well defined dark ring near the centre is taken as the n^{th} dark ring. The microscope is moved to one side say right so that one of its crosswire is tangential to the $(n+30)^{th}$, dark ring. The reading of the microscope is noted. The microscope is then carefully moved by working its screw till the cross-wire is tangential to $(n+27)^{th}$ dark ring and the reading is taken. Similarly the readings corresponding to the $(n+24)^{th}$, $(n+21)^{th}$ etc, dark rings are noted. The microscope is always moved in the same direction to avoid any back-lash error. The difference between the microscope reading on either side for a given order gives the diameter of the particular order of ring. The radius of the ring and hence the square of the radius is calculated.

The values in the last column are obtained by the method of successive differences eg. $r^2_{n+15} - r^2_n$, $r^2_{n+18} - r^2_{n+3}$ etc. They are found to be a constant. The mean value of the last column is determined. Let it be k_1.

Now $k_1 = mR_1 \lambda$ where R_1 is the radius of curvature of the lens surface in contact with the glass plate and λ is the wavelength of the source of light. In the case of sodium light $\lambda = 5893 \times 10^{-10}$ metre. Hence the radius of curvature R_1 is calculated using equation 1.

The lens is then turned upside down and the radius of curvature R_2 of the other surface is also found in the same manner (Equation 2). The refractive index of the material of the convex lens is calculated using equation 3.

TABULATION

To determine the mean difference in radii between m rings

Order of the ring	Microscope reading ($\times 10^{-2}$ m)		Radius of Ring (r) ($\times 10^{-2}$ m)	r^2 ($\times 10^{-4}$ m^2)	$r^2_{n+m} - r^2_n$ ($\times 10^{-4}$ m^2)
	Right	Left			
n					
n+3					
n+6					
…					
…					
…					
n+30					

RESULT

(i) Radius of curvature for face I R_1 = -------------- (metre)

(ii) Radius of curvature for face II R_2 = -------------- (metre)

(iii) Refractive index of given convex lens by Newton's Ring method, μ = --------------

10. CAUCHY’S CONSTANT AND DISPERSIIVE POWER OF PRISM

AIM

To determine the Cauchy’s constant of the given prism and to calculate the dispersive power of prism for prominent spectral lines.

APPARATUS REQUIRED

Spectrometer, glass prism, mercury vapour lamp and sodium vapour lamp.

FORMULA

(i) Refractive index

$$\mu = \frac{\frac{\sin(A+D)}{2}}{\frac{sinA}{2}}$$

(ii) Cauchy's formula

$$\mu = A + \left(\frac{B}{\lambda^2}\right)$$

$$A = \mu - \left(\frac{B}{\lambda^2}\right)$$

$$B = \left(\frac{\mu_1 - \mu_2}{\left(\frac{1}{\lambda_1^2}\right) - \left(\frac{1}{\lambda_2^2}\right)}\right)$$

(iii) Dispersive power of a prism

$$\omega = \frac{\mu_1 - \mu_2}{\mu - 1}$$

where

$$\mu = \frac{(\mu_1 + \mu_2)}{2}$$

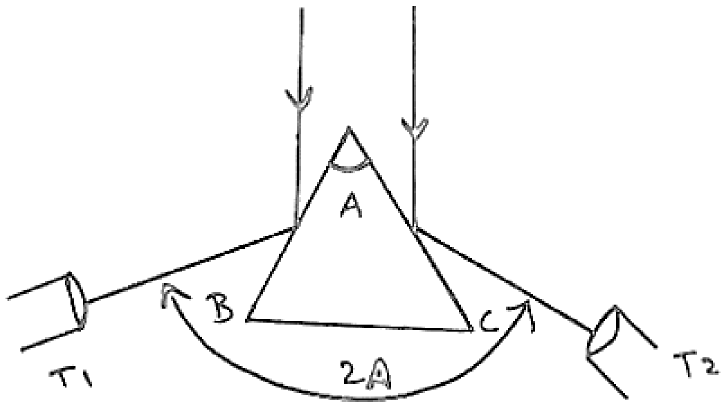
μ_1 and μ_2 are the refractive indices of the prism for two different wavelengths λ_1 and λ_2

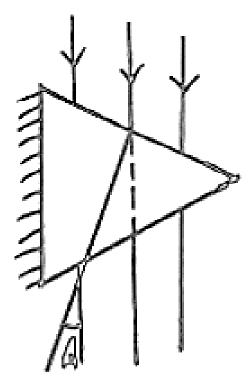
A is the angle of the prism

D is the angle of minimum deviation

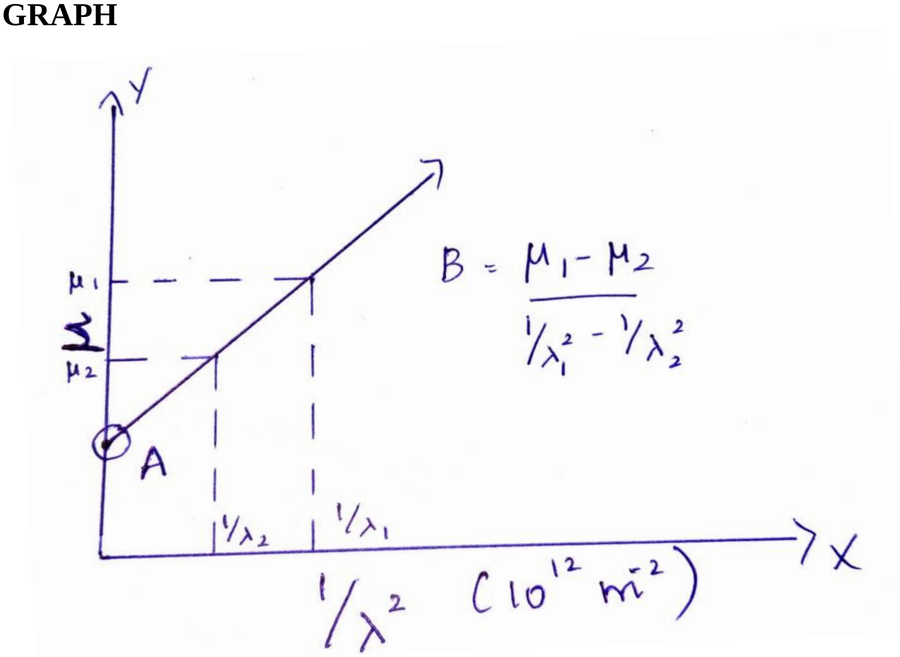
A and B are Cauchy's constants

DIAGRAM





MODEL GRAPH



PROCEDURE

(i) Cauchy's constants

The preliminary adjustments of the spectrometer namely the adjustment of the eye-piece for clear vision of cross wires and telescope and collimator for parallel rays are made. The prism table is adjusted to be perfectly horizontal using a spirit level. The slit is made narrow and illuminated by sodium vapour lamp and the angle of prism (A) is determined. The sodium vapour lamp is replaced by mercury vapour lamp. The direct ray reading is taken. It is convenient to have the vernier scales initially adjusted so that one of them reads 0° and the other 180°. The circular disc carrying the vernier scales is then fixed once for all so that the direct ray reading may remain the same throughout the experiment.

The spectrum of mercury light consists of number of discrete lines such as violet, blue, green, etc. The prism is set in the minimum deviation D position for the violet line and the angle of minimum deviation D is determined in the usual way. The refractive index of the prism for the violet line is calculated using the formula:

$$\mu = \frac{\frac{\sin(A+D)}{2}}{\frac{sinA}{2}}$$

The prism is adjusted successively to be in the minimum deviation position for the other lines in the mercury spectrum and in each case the angle of minimum deviation (D) and hence the refractive index (μ) is calculated. The wave lengths of the spectral lines are the standard wavelengths of the mercury spectrum. A graph is drawn with $1/\lambda^2$ on the x-axis and μ along the y-axis. The graph is found to be a straight line. The values of μ corresponding to $1/\lambda^2=0$ gives A. The slope of the line gives B.

(ii) Dispersive power

If μ_1 and μ_2 are refractive indices of the prism for two different wave length λ_1, and λ_2 the dispersive power is given by

$$\omega = \frac{\mu_1 - \mu_2}{\mu - 1}$$

The dispersive power is calculated for different ranges of wavelengths.

TABULATON

1) To determine the angle of prism, A

FACE	**V_A**	**V_B**
Reading of the image reflected from face I		
Reading of the image reflected from face II		
Difference between two faces (2A)		
Angle of Prism (A)		

2) To determine the refractive index of the given prism

Direct ray reading V_A= V_B=

Spectral lines	**Reading corresponding to minimum deviation**		**Difference between direct ray and minimum deviation reading**		**Angle of minimum deviation (D)**	$\mu = \dfrac{\sin\left(\dfrac{A+D}{2}\right)}{\sin\dfrac{A}{2}}$
	V_A	**V_B**	**$V_A \sim V_B$**	**$V_A \sim V_B$**		

3) To determine the Cauchy's constants A and B

Spectral lines	**Standard wavelength $\lambda \times 10^{-10}$ m**	$\frac{1}{\lambda^2} \times 10^{12}$ **m^{-2}**	**μ**	**Cauchy's constant**	
				$B = \left(\dfrac{\mu_1 - \mu_2}{\left(\frac{1}{\lambda_1^2}\right) - \left(\frac{1}{\lambda_2^2}\right)}\right)$ **m^2**	$A = \mu - \left(\dfrac{B}{\lambda^2}\right)$

4) To determine the dispersive power of the given prism

S. No	Spectral lines	μ_1	μ_2	$\mu = \frac{\mu_1 + \mu_2}{2}$	Dispersive power $\omega = \frac{\mu_1 - \mu_2}{\mu - 1}$

RESULT

(i) Angle of prism A =

(ii) Cauchy's constant for the given prism by experimental method

A =

B =

(iii)Cauchy's constant by graphical method

A =

B =

(iv)Dispersive power of the prism is calculated for different wavelengths

11. DETERMINATION OF UNKNOWN CAPACITANCE USING SCHERING BRIDGE

AIM

To determine the capacitance by using schering bridge.

APPARATUS REQUIRED

Capacitor box, resistance box, non-inductive resistance, audio frequency oscillator and head phone.

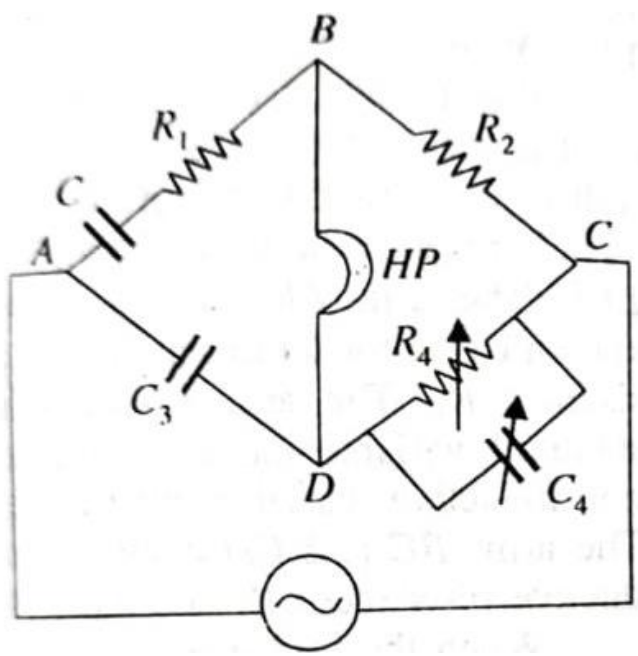
FORMULA

$C = (R_4.C_3)/R_2$ µF

C_2 is the capacitance of unknown capacitor

R_1, R_2 are variable non - inductive resistance

DIAGRAM



R ⟶ Resistance box

C ⟶ Capacitance box

AFO ⟶ Audio frequency osicallator

HP ⟶ Head phone

PROCEDURE

Schering Bridge is used for the accurate measurement of small capacitance. The unknown capacitance is connected in arm AB along with the associated resistance R_1 in series. The arm AD contains a standard capacitor C_3 having negligible resistance. Two remaining arms BC and CD contain non – inductive resistance R_2 and R_4 . A variable calibrated air capacitor C_4 is put in parallel with R_4 and the bridge is balanced by varying R_4 and C_4. The general balance condition of an AC bridge is

$$Z_1/Z_2 = Z_3/Z_4$$

$$Z_1 = R_1 + 1/j\omega C,$$

$$Z_2 = R_2,\ Z_3 = 1/j\omega C_3$$

$$\text{and } 1/Z_4 = 1/R_4 + 1/(1/j\omega C_4)$$

Equating the real and the imaginary parts we get,

$$R_1 = R_2.C_4/C_3 \quad \text{……….} (1)$$

$$1/C = R_2/C_3R_4 ,$$

$$C = R_4/R_2\ C_3 \quad \text{……….} (2)$$

C can be calculated using equation (2). The bridge can be used for the measurement of dielectric constants particularly liquids.

TABULATION

To determine the capacitance of the unknown capacitor

$R_1 =$, $R_2 =$, $C =$

S.No	Known capacitance C_3 (μF)	Resistance R_4 (Ω)	Capacitance C_4 (μF)	Unknown capacitance $C = R_4/R_2 .C_3$ (μF)

RESULT

The value of capacitance calculated by Schering bridge C =

12. DETERMINATION OF UNKNOWN CAPACITANCE BY DE SAUTY'S BRIDGE

AIM

To determine the capacitance by using De Sauty's bridge

APPARATUS REQUIRED

Capacitor box, non-inductive resistance, audio frequency oscillator and headphone.

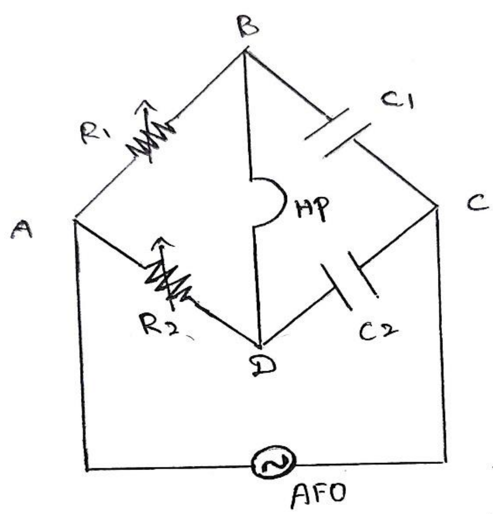
FORMULA

$C_2 = R_1 / R_2 \times C_1$ μF

C_2 is the capacitance of unknown capacitor

R_1 and R_2 are variable non inductive resistors

CIRCUIT DIAGRAM



R ⟶ Resistance box

C ⟶ Capacitance box

AFO ⟶ Audio frequency oscillator

HP ⟶ Head phone

PROCEDURE

Connections are made as in figure. C_1 and C_2 are the two capacitances to be compared. R_1 and R_2 are variable, non- inductance resistances. Audio frequency oscillator is connected between A and C and headphone between B and D.

When the bridge is balanced

$$Z_1/Z_2 = Z_3/Z_4 \text{ (OR)}$$

$$Z_1/Z_3 = Z_2/Z_4$$

Here , $Z_1 = R_1$; $Z_2 = 1/ j\omega C_1$; $Z_3 = R_2$; $Z_4 = 1/jwC_2$

$$R_1/R_2 = (1/j\omega C_1)/(1/j\omega C_2)$$

(or)

$$C_2/C_1 = R_1/R_2$$

$$C_2 = C_1R_1/R_2 \qquad \ldots\ldots\ldots\ldots(1)$$

If C_1 is known capacitance, then the unknown capacitance C_2 can be calculated from equation (1). R_1 and R_2 are suitably varied each time until the sound in the headphone is inaudible.

TABULATION

To determine the capacitance of the unknown capacitor

S. No	Capacitance of known capacitor C_1 (μF)	Resistance R_1 (Ω)	Resistance R_2 (Ω)	Capacitance of unknown capacitor $C_2 = C_1R_1/R_2$ (μF)	Mean C_2 (μF)

RESULT

The value of capacitance calculated by De Sauty's bridge C=

13. DETERMINATION OF HIGH RESISTANCE USING

BG - LEAKAGE METHOD

AIM

To determine the value of high resistance by the method of leakage using a ballistic galvanometer.

APPARATUS REQUIRED

Battery, tap key, ballistic galvanometer, stopwatch, high resistance, commutator and condenser.

FORMULA

High resistance by experimental method

$$R = \frac{t}{\left(2.303\, C \log_{10}\left(\frac{\theta_0}{(\theta_0 - \theta_t)}\right)\right)} \text{ ohms}$$

By Graphical method

$$R = \frac{1}{((2.303\ C \times \text{slope}))} \text{ ohms}$$

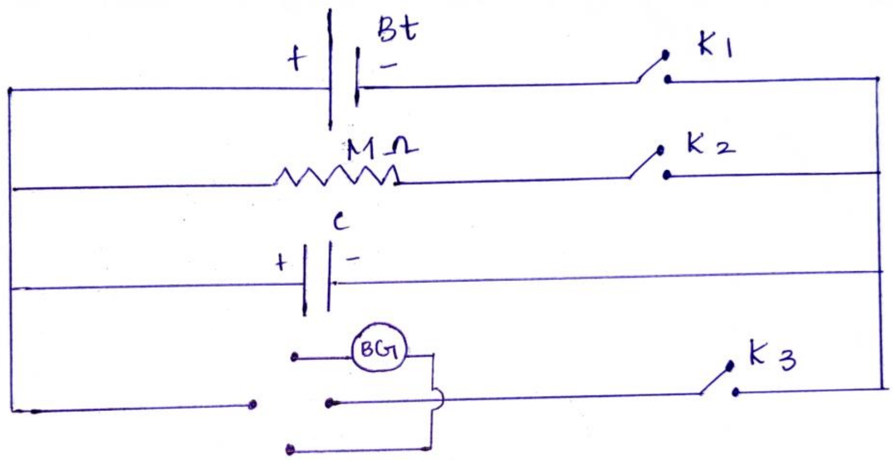
Where

θ_0 is the initial charge

θ_t is the charge remaining in the capacitor

C is the capacitance of the capacitor

CIRCUIT DIAGRAM



$K_1, K_2, K_3 \rightarrow$ Tap keys

$C \rightarrow$ Capacitance

$M\Omega \rightarrow$ Mega ohms

$Bt \rightarrow$ Battery

$BG \rightarrow$ Ballistic Galvanometer

PROCEDURE

Connections are made as shown in figure. The key k_1 is kept closed and the condenser is charged for a particular time interval and discharged through B.G. The capacitance value and the time of charging is adjusted to have the throw within the scale. The throw on either sides are noted and the mean value of the throw gives θ_0. Again, the condenser is charged for a definite interval of time and the key k_2 is closed for a small interval of time say 1, 2, 3 etc seconds so that the charge in the condenser is allowed to leak through the given high resistance for a given time. After this leakage time t seconds, key k_1 is opened and the condenser is discharged through the B.G. The throw is noted on either side by using the commutator and the mean value is calculated as θ_t. The experiment is repeated by changing the time of leakage. The readings are tabulated.

TABULATION

C =0.4μF R = 3 MΩ θ_R = θ_L= θ_0= (θ_R+ θ_L)/2

S.No	Leakage time t (s)	Throw in BG(θ_t) (10^{-2}m)		Mean throw θ_t(10^{-2}m)	$\log_{10}\left(\frac{\theta_0}{(\theta_0-\theta_t)}\right)$	$\frac{t}{\log_{10}\left(\frac{\theta_0}{(\theta_0-\theta_t)}\right)}$
		Left	Right			

RESULT

Mean value of high resistance by leakage using Ballistic galvanometer is determined by

Experimental method R=

Graphical method R=

14. REFRACTIVE INDEX OF THE PRISM – STOKE'S FORMULA

AIM

To determine angle of the emergence i' corresponding to various angles of incidence i and to calculate the refractive index of prism using Stoke's formula.

APPARATUS REQUIRED

Spectrometer**,** prism and sodium vapour lamp.

FORMULA

$$\tan\left(\frac{r-r'}{2}\right) = \frac{\tan\left(\frac{A}{2}\right)\tan\left(\frac{i-i'}{2}\right)}{\tan\left(\frac{i+i'}{2}\right)}$$

$A = r + r'$

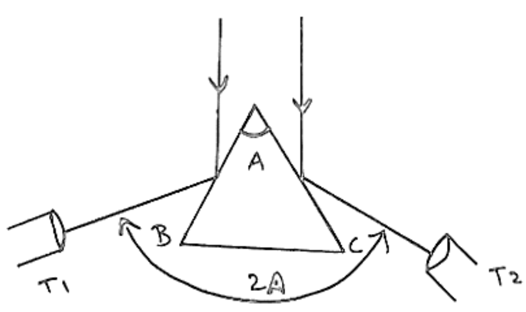
i is the angle of incidence

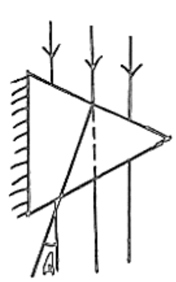
i' is the angle of emergence

r is the angle of refraction at the first face of the prism

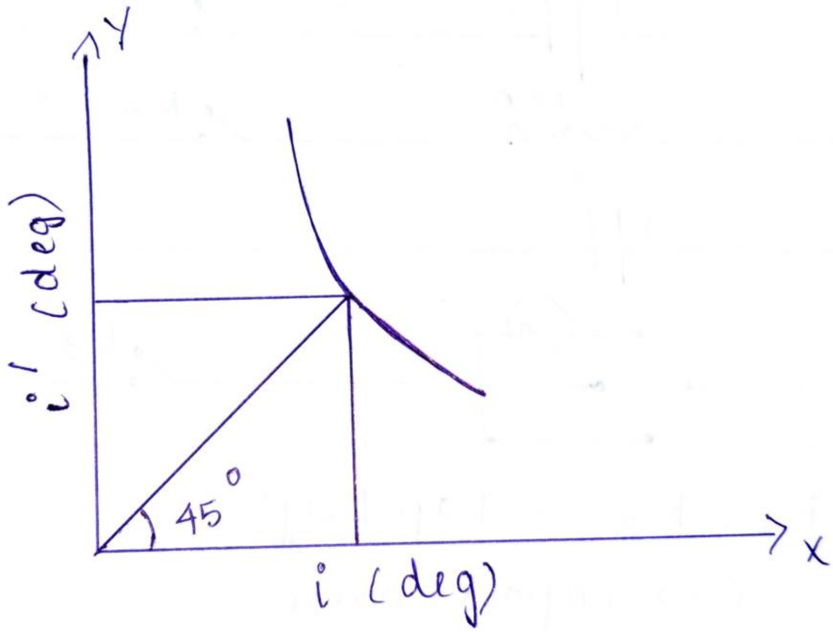
r' is the angle of refraction at the second face of the prism

DIAGRAM





MODEL GRAPH



PROCEDURE

The preliminary adjustments of the spectrometer are made. The spirit level is used to make the prism table perfectly horizontal.

The slit is made narrow and illuminated by sodium vapour lamp and the direct ray reading is taken. It is convenient to have the vernier initially adjusted. The circular disc carrying the vernier is fixed.

The prism is then mounted on the prism table so that the beam of light from the collimator is incident on one face and emerges on the other face. The prism table is slowly rotated until the reflected image from the face AB of the prism is seen in the telescope. Final adjustments are made until the vertical cross wire coincides with the fixed edge of the slit. The telescope is fixed in this position. To determine i', the prism is slowly rotated so that the refracted image move towards the minimum deviation position and then turns back until the vertical cross wire coincides with the fixed edge of the slit. To determine the angle of emergence i', the telescope is moved to get the reflected image from the face AB.

This reflected ray reading is taken. The difference between this reading and the direct ray reading gives θ.

The experiment is repeated for i equal to 45°, 50°, 55°, 60° and 65° and i' is calculated in each case. The refractive index of the prism in air and water is calculated using Stoke's formula.

TABULATION

1) To find the angle of prism

Reading of the reflected ray				$V_A \sim V_A$	$V_B \sim V_B$	Mean 2A	A
Left		right					
V_A	V_B	V_A	V_B				

2) To determine the angle of emergence of the prism

Direct ray reading V_A = V_B =

Angle of incidence i	Angle of rotation of telescope (180^0 -2i)	Reflected ray reading		Difference between direct and reflected ray reading		$i' = \frac{180^\circ - \theta}{2}$		Mean i'
		V_A	V_B	V_A	V_B	V_A	V_B	

3. To determine the refractive indices of the material of the prism

Angle of incidence I	Angle of emergence i'	$\tan(\frac{r-r'}{2})$	r	r'	$\mu = \frac{\sin i}{\sin r}$	$\mu' = \frac{\sin i'}{\sin r'}$

RESULT

The angle of emergence i' corresponding to various angles of incidence i are determined and i-i' curve is drawn. The refractive index of the material of the prism using stokes formula is

μ =

15. POLARIMETER – SPECIFIC ROTATION

AIM

To determine the specific rotation of sugar solution using polarimeter.

APPARATUS REQUIRED

Polarimeter, sugar solution and source of light.

FORMULA

Specific rotation of sugar solution is given by

$$S_t^{\lambda} = \frac{\theta V}{lm}$$

Where

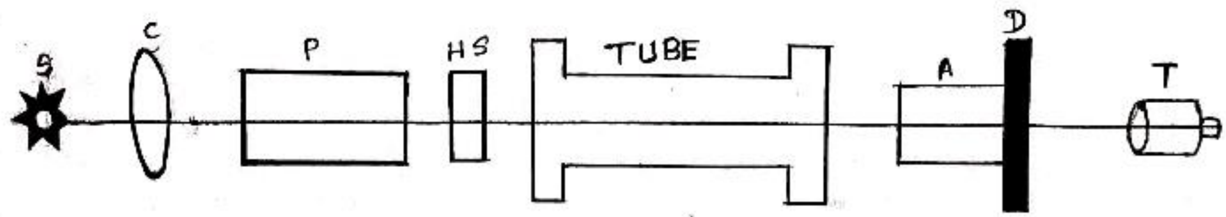
θ is the angle of rotation in deg.

V is the volume of water in m^3.

l is the length of the tube in metres

m is the mass of the sugar in kg.

DIAGRAM



S → Source **HS → Half shade plate**

C → Lens **A → Analyser**

P → Polarizer **T → Telescope**

PROCEDURE

The analyser is set at position (I) and the readings are noted. Then analyser is rotated by 180° (position II) and readings are taken. Position I is set when both halves are of equal intensity. The eyepiece of the analyser is rotated in clockwise and anticlockwise direction at both positions I and II.

Fill the tube with distilled water and note the analyser readings. Then fill the tube with sugar solution of different concentrations (without any bubbles in the tube) and take different readings.

(A)

(i) Mass of sugar (m) = ……. kg

(ii) Volume of the solution (V) = ……. m^3

(iii) Concentration of solution (m/V) = ……. kg/m^3

(B) Length of the polarimeter tube (l) = ……. m

Room temperature = …….. $^\circ C$

TABULATION

Value of 1 division of main scale = …….

No of divisions on vernier scale = …….

Least count of vernier scale = …….

S.No	Analyser reading with pure water (a)			Concentration of solution (g/cc)	Analyser reading with pure solution (b)			a-b (deg)
	MSR	VSC	Total		MSR	VSC	Total	

RESULT

The specific rotation of sugar solution =