EXPERIMENT-1

DISPERSIVE POWER OF A PRISM

AIM: To determine the dispersive power of a material of prism using Spectrometer

APPARATUS: Spectrometer, Prism, Mercury Vapor Lamp etc.

FORMULA: The dispersive power of the prism is given by

$$w = \frac{\mu_b - \mu_g}{\mu_{av} - 1}$$

Where, $\mu_{av} = \frac{\mu_b + \mu_g}{2}$

$$\mu_b = \frac{\sin\left(\frac{A + D_B}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$\mu_G = \frac{\sin\left(\frac{A + D_g}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

A = angle of the prism

D_g = angle of minimum deviation for green colour

D_b = angle of minimum deviation for blue colour

THEORY:

A spectrometer is used to measure the necessary angles. The spectrometer consists of three units: (1) collimator, (2) telescope, and (3) prism table. The prism table, its base and telescope can be independently moved around their common vertical axis. A circular angular scale enables one to read angular displacements (together with two verniers located diametrically opposite to each other).

In the experiment, we need to produce a parallel beam of rays to be incident on the prism. This is done with the help of a collimator. The collimator has an adjustable rectangular slit at one end and a convex lens at the other end. When the illuminated slit is located at the focus of the lens (See Fig. 1), a parallel beam of rays emerges from the collimator. We can test this point, with the help of a telescope adjusted to receive parallel rays. We first prepare the telescope towards this purpose as follows:

Setting the eyepiece:

Focus the eyepiece of the telescope on its cross wires (for viewing the cross wires against a white background such as a wall) such that a distinct image of the crosswire is seen by you. In this context, remember that the human eye has an average "least distance of distinct vision" of about 25 cm. When you have completed the above eyepiece adjustment, you have apparently got the image of the crosswire located at a distance comfortable for your eyes. Henceforth do not disturb the eyepiece.

Setting the Telescope:

Focus the telescope onto a distant (infinity!) object. Focusing is done by changing the separation between the objective and the eyepiece of the telescope. Test for the absence of a parallax between the image of the distant object and the vertical crosswire. Parallax effect (i.e. separation of two things when you move your head across horizontally) exits, if the cross-wire and the image of the distant object are not at the same distance from your eyes. Now the telescope is adjusted for receiving parallel rays. Henceforth do not disturb the telescope focusing adjustment.

Setting the Collimator:

Use the telescope for viewing the illuminated slit through the collimator and adjust the collimator (changing the separation between its lens and slit) till the image of the slit is brought to the plane of cross wires as judged by the absence of parallax between the image of the slit and cross wires.

Optical leveling of the Prism:

The prism table would have been nearly leveled before uses have started the experiment. However, for your experiment, you need to do a bit of leveling using reflected rays. For this purpose, place the table with one apex at the center and facing the collimator, with the ground (non-transparent) face perpendicular to the collimator axis and away from collimator. Slightly adjust the prism so that the beam of light from the collimator falls on the two reflecting faces symmetrically (Fig. 2) when you have achieved this lock the prism table in this position. Turn the telescope to one side so as to receive the reflected image of the slit centrally into the field of view. This may be achieved by using one of the leveling screws. The image must be central whichever face is used as the reflecting face. Similarly, repeat this procedure for the other side.

Finding angle of minimum deviation (D_{m})

Unlock the prism table for the measurement of the angle of minimum deviation (D_m). Locate the image of the slit after refraction through the prism as shown in Fig. 3. Keeping the image always in the field of view, rotate the prism table till the position where the deviation of the image of the slit is smallest.

At this position, the image will go backward, even when you keep rotating the prism table in the same direction. Lock both the telescope and the prism table and to use the fine adjustment screw for finer settings. Note the angular position of the prism.

In this position the prism is set for minimum deviation. Without disturbing the prism table, remove the prism and turn the telescope (now unlock it) towards the direct rays from the collimator. Note the scale reading of this position. The angle of the minimum angular deviation, viz, D_m is the difference between the readings for these last two settings.

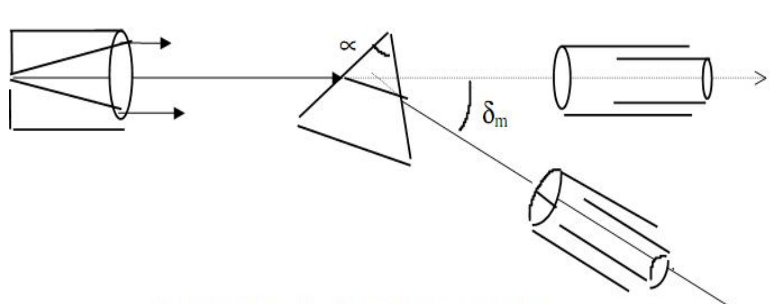


Fig 3. Minimum deviation geometry

OBSERVATION TABLES:

For angle of the prism 2A=120^0

A=60^0

For angle of minimum deviation:

Colour of the spectrum	Vernier A			Vernier B			Avg D
	Direct Reading (R)	Minimum Deviation(D)	D_m = (R-D)	Direct Reading(R)	Minimum Deviation(D)	D_m = $(R-D)_m$	

Dispersive power (w):- Angular rotation for a given wavelength is called dispersive power of the material of a prism

Readings:- $\therefore \mu_b = \frac{\sin\left(\frac{A+D_B}{2}\right)}{\sin\left(\frac{A}{2}\right)}$, $\mu_G = \frac{\sin\left(\frac{A+D_g}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$\therefore w = \frac{\mu_b - \mu_g}{\mu_{av} - 1}$ Where $\mu_{av} = \frac{\mu_b + \mu_g}{2}$

PRECAUTION:

1. Take the readings without any parallax errors
2. The focus should be at the edge of green and blue rays

RESULT: - The dispersive power of a material of prism using spectrometer is

w =

EXPERIMENT-2
NEWTON'S RINGS

AIM: To observe Newton rings formed by the interface of produced by a thin air film and to determine the radius of curvature of a Plano-convex lens.

APPARATUS: Traveling microscope, sodium vapour lamp, Plano-convex lens, plane glass plate, magnifying lens.

FORMULA: The radius of curvature of a convex lens is given by

$$R = (D^2_{m-p} - D^2_m) / 4p\lambda$$

Where,

D = diameter of the fringe in m

λ = wavelength of a given monochromatic light

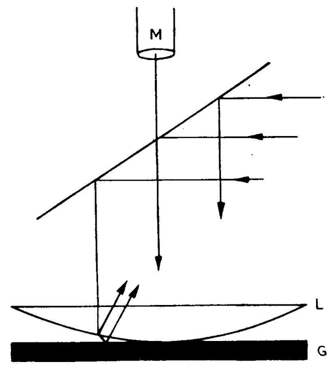
m & p = order of the fringe

THEORY:

The phenomenon of Newton's rings is an illustration of the interference of light waves reflected from the opposite surfaces of a thin film of variable thickness. The two interfering beams, derived from a monochromatic source satisfy the coherence condition for interference. Ring shaped fringes are produced by the air film existing between a convex surface of a long focus Plano-convex lens and a plane of glass plate.

When a Plano-convex lens (L) of long focal length is placed on a plane glass plate (G) , a thin film of air I enclosed between the lower surface of the lens and upper surface of the glass plate.(see fig 1). The thickness of the air film is very small at the point of contact and gradually increases from the center outwards. The fringes produced are concentric circles. With monochromatic light, bright and dark circular fringes are produced in the air film. When viewed with the white light, the fringes are coloured.

A horizontal beam of light falls on the glass plate B at an angle of 450. The plate B reflects a part of incident light towards the air film enclosed by the lens L and plate G. The reflected beam (see fig 1) from the air film is viewed with a microscope. Interference takes place and dark and bright circular fringes are produced. This is due to the interference between the light reflected at the lower surface of the lens and the upper surface of the plate G.



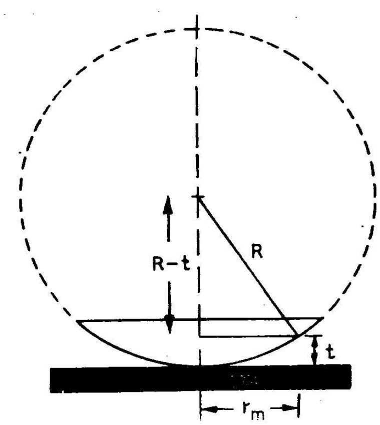
For the normal incidence the optical path difference Between\ the two waves is nearly 2μt, where μ is the refractive index of the film and t is the thickness of the air film. Here an extra phase difference π occurs for the ray which got reflected from upper surface of the plate G because the incident beam in this reflection goes from a rarer medium to a denser medium. Thus the conditions for constructive and destructive interference are (using μ = 1 for air)

2 t = n for minima; n = 0, 1, 2, 3… … … … **(1)**

and $2t = \left(n + \frac{1}{2}\right)\lambda$ for maxima; ; m = 0,1,2,3… … …**(2)**

Then the air film enclosed between the spherical surfaces Of R and a plane surface glass plate, gives circular rings Such that (see fig 2)

$$r_n^2 = (2R-t)\,t$$



Where r_n is the radius of the n^{th} order dark ring.

Fig.2

(Note: The dark ring is the n^{th} dark ring excluding the central dark spot).

Now R is the order of 100 cm and t is at most 1 cm. Therefore R>>t. Hence (neglecting the t2 term), giving

$$2t \approx \frac{r_n^2}{R}$$

Putting the value of "2 t" in eq (1) gives $2\lambda \approx \frac{r_n^2}{R}$

With the help of a traveling microscope we can measure the diameter of the mth ring order dark ring = Dn Then $r_n = \frac{D_m}{2}$ and hence,

$$R = \frac{D_n^2}{n} \frac{1}{4\lambda}$$

For diameter of the m+ p th ring

$$R = D^2_{(m+p)} / 4(m+p)\lambda$$

Thus,

$$R = (D^2_{m-p} - D^2_m) / 4p\lambda$$

So if we know the wave length λ , we can calculate R (radius of curvature of the lens).

PROCEDURE:

1. Clean the plate G and lens L thoroughly and put the lens over the plate with the curved surface below B making angle with G (see fig 1)

2. Switch in the monochromatic light source. This sends a parallel beam of light. This beam of light gets reflected by plate B falls on lens L.

3. Look down vertically from above the lens and see whether the center is well illuminated. On looking through the microscope, a spot with rings around it can be seen on properly focusing the microscope.

4. Once good rings are in focus, rotate the eyepiece such that out of the two perpendicular cross wires, one has its length parallel to the direction of travel of the microscope. Let this cross wire also passes through the center of the ring system.

5. Now move the microscope to focus on a ring (say, the 20th order dark ring). On one side of the center. Set the crosswire tangential to one ring as shown in fig 3. Note down the microscope reading.

6. Move the microscope to make the crosswire tangential to the next ring nearer to the center and note the reading. Continue with this purpose till you pass through the center. Take readings for an equal number of rings on the both sides of the center.

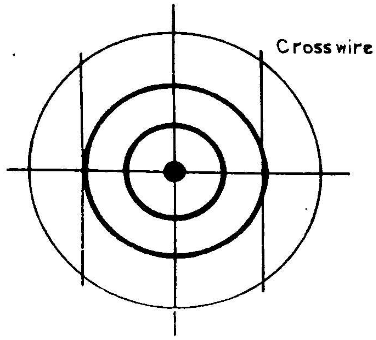


fig 3(Make **fig** sure that you correctly read the least count of the vernier in mm units)

OBSERVATION:

1. Least count of vernier of traveling microscope = ____________________m

2. Wave length of light = ________________________ m

Table 1: Measurement of diameter of the ring

S.No	Order of the ring (n)	Microscope reading						Diameter		$(D^2_{m-p} - D^2_m)$
		Left side			Right side					
		MS	VS	Net(m)	MS	VS	Net(m)	D(m)	D^2 (m^2)	
1	20									
2	18									
3	16									
4	14									
5	12									
6	10									
7	8									
8	6									
9	4									
10	2									

PRECATUION:

Notice that as you go away from the central dark spot the fringe width decreases. In order to minimize the errors in measurement of the diameter of the rings the following precautions should be taken:

(i) The microscope should be parallel to the edge of the glass plate.

(ii) If you place the cross wire tangential to the outer side of a perpendicular ring on one side of the central spot then the cross wire should be placed tangential to the inner side of the same ring on the other side of the central spot.(See fig 3)

(iii) The traveling microscope should move only in one direction.

RESULT:

The radius of curvature of a given planoconvex lens is = m

EXPERIMENT-3

MAGNETIC FIELD ALONG THE AXIS OF A COIL (STEWART GEE'S METHOD)

AIM: To measure the magnetic field along the axis of a circular coil and verify Bio-Stavart law

APPARATUS: Circular coil, Power supply, Switching keys, Magnetic needle, Sliding compass box etc.

FORMULA: The earth's magnetic field intensity is given by

$$B(x) = \frac{\mu_0 n I R^2}{2} \frac{1}{(R_2 + x_2)^{3/2}}$$

μ = permeability of the free space

n = number of turns

I = current given to the coil in A

R = radius of the coil in m

X = distance between the center and the magnetometer in m

THEORY:

For a circular coil of a turns, carrying a current I, the magnetic field at a distance x from the coil and along the axis of the coil is given by

$$B(x) = \frac{\mu_0 n I R^2}{2} \frac{1}{(R_2 + x_2)^{3/2}}$$

Where R is the radius of the coil. In this experiment, the coil is oriented such that plane of the coil is vertical and parallel to the north-south direction. The axis of the coil is parallel to the east-west direction. The net field at any point x along the axis, is the vector sum of the fields due to the coil B(x) and earth's magnetic field B_E (Fig 1)

$$\therefore \tan\theta = \frac{B(x)}{B_E}$$

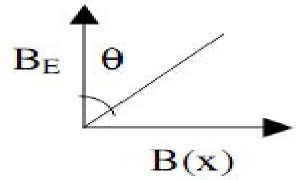


Fig 1.

PROCEDURE:

The apparatus consists of a coil mounted perpendicular to the base. A sliding compos box is mounted on aluminum rails so that the compos is always on the axis of the coil.

1. Orient the apparatus such that the coil is in the north-south plane
2. Adjust the leveling screws to make the base horizontal. Make sure that the compos is moving freely.
3. Connect the circuit as shown in the figure.
4. Keep the compos at the center of the coil and adjust so that the pointers indicate 0-0
5. Close the keys K and KR (make sure that you are not shorting the power supply) and adjust the current with rheostat, RH so that the deflection is between 50 to 60 degrees. The current will be kept fixed at this value for the rest of the experiment
6. Note down the readings $\theta_1 and \theta_2$. Reverse the current and note down $\theta_3 and \theta_4$
7. Repeat the experiment at intervals of 1 cm along the axis until the value of the fields drops to 10% of its value at the center of the coil. Repeat on both sides of the coil.
8. Draw following graphs:

   .B(x) as a function of x.

   . $\log(B(x))$ as a function of $\log\left(R^2 + X^2\right)$

Find slope and y-intercept from the graph and results with the expression for B(x).

OBSERVATIONS:

Parameters and constants

Least count for x measurement=

Least count for θ measurement=

No of turns of the coil, n=

Radius of the coil, R= 10 cm

Current in the coil, I= …

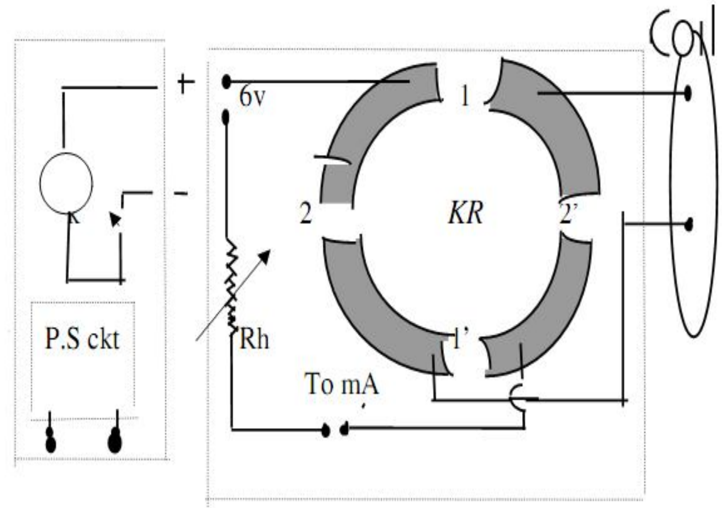


Fig 2.

Permeability of air, $\mu_0 = 4\pi \times 10^{-7} N/A^2$, Earth's magnetic field, $B_E = .39 \times 10^{-4} T$

TABLE -I

x_{cm}	θ_1	θ_2	θ_3	θ_4	θ **(average)**	$Tan\theta$	$\log(tan\theta)$	$\log(R^2 + X^2)$	$B(x) = B_E \tan\theta$ $(T)(10^{-4})$	**LogB (x)**
1										
2										
3										
4										
5										

TABLE- II

For other side of the scale…………

x_{cm}	θ_1	θ_2	θ_3	θ_4	θ **(average)**	$Tan\theta$	$\log(tan\theta)$	$\log(R^2+X^2)$	$B(x) = B_E \tan\theta$ $(T)(10^{-4})$	**LogB (x)**
1										
2										
3										
4										
5										

CALCULATION:

From the graph of B(x) vs. log (R^2+X^2), find the slope and intercept from regression analysis. Slope should be -1.5 according to Bio-Savart law, and intercept value should match with the value calculated using μ_o, n, I, and R

RESULT:

Experimental value of exponent (slope) =

Theoretical value of slope= -1.5

Experimental value of intercept=

Theoretical value of intercept=…..

EXPERIMENT-4

EVALUATION OF NUMERICAL APERTURE OF A GIVEN FIBER

AIM: The aim of the experiment is to determine the numerical aperture of the optical fibers available

APPARATUS: 1.numerical aperture kit 2. Laser diode.

FORMULA:

$$NA = SIN\ \alpha = D/\ (4L^2+D^2)^{½}$$

Where D = diameter of the fringe in m

L = distance between the zig and the screen in m

THOERY:

Numerical aperture of any optical system is a measure of how much light can be collected by the optical system. It is the product of the refractive index of the incident medium and the sine of the maximum ray angle.

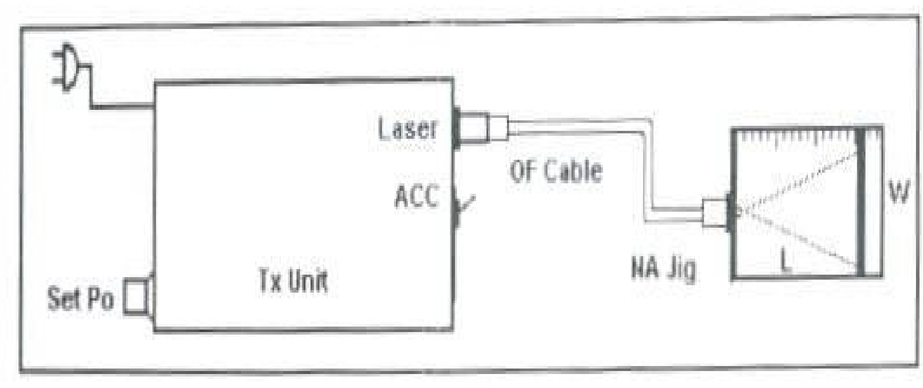
$NA = ni.\sin\theta_{max;}$ ni for air is 1, hence $NA = \sin\theta_{max}$

For a step-index fiber, as in the present case, the numerical aperture is given by $N=(N_{core}{}^2 - n_{cladding}{}^2)^{1/2}$

For very small differences in refractive indices the equation reduces to

$NA = n_{core}\ (2\Delta)^{1/2}$, where Δ is the fractional difference in refractive indices. I and record the manufacture's NA, $n_{cladding}$ and n_{core}, and θ.

BLOCK DIAGRAM:



PROCEDURE:

The schematic diagram of the numerical aperture measurement system is shown below and is self explanatory.

Step1: Connect one end of the PMMA FO cable to Po of TNS20EL TX Unit and the other end to the NA Jig, as shown.

Step2: Plug the AC mains. Light should appear at the end of the fiber on the NA Jig. Turn the Set Po knob clockwise to set to maximum Po. The light intensity should increase.

Step 3: Hold the white scale-screen, provided in the kit vertically at a distance of 15 mm (L) from the emitting fiber end and view the red spot on the screen. A dark room will facilitate good contrast. Position the screen-cum-scale to measure the diameter (W) of the spot. Choose the largest diameter.

Step: 4 Compute NA from the formula NA = $\sin\theta_{max} = W/(4L^2 + W^2)^{1/2}$. Tabulate the reading and repeat the experiment for 10mm, 20mm, and 25mm distance.

Step5: In case the fiber is under filled, the intensity within the spot may not be evenly distributed. To ensure even distribution of light in the fiber, first remove twists on the fiber and then wind 5 turns of the fiber on to the mandrel as shown. Use an adhesive tape to hold the windings in position. Now view the spot. The intensity will be more evenly distributed within the core.

OBSERVATIONS:

Sl. No	L (mm)	W(mm)	NA
1			
2			
3			
4			
5			

RESULT: Numerical aperture of the available optical fibers is Determined =

EXPERIMENT-5

DETERMINATION OF WAVELENGTH OF THE LASER SOURCE DIFFRACTION GRATINGS

AIM: To determine the wavelength of the given laser source.

APPARATUS: Laser source, diffraction grating, optical bench, screen, meter scale.

FORMULA: The wavelength of a laser is given by

$$\lambda = \text{Sin}\ \theta / Nm\ \ A^0$$

θ = angle of diffraction in deg

m = order of the diffraction pattern

n = the number of lines meter on the grating

N = 0.0984×10^6

THEORY:

If the waves have the same sign (are in phase), then the two waves constructively interfere, the net amplitude is large and the light intensity is strong at that point. If they have opposite signs, however, they are out of phase and the two waves destructively interfere: the net amplitude is small and the light intensity is weak. It is these areas of strong and weak intensity, which make up the interference patterns we will observe in this experiment. Interference can be seen when light from a single source arrives at a point on a viewing screen by more than one path. Because the number of oscillations of the electric field (wavelengths) differs for paths of different lengths, the electromagnetic waves can arrive at the viewing screen with a phase difference between their electromagnetic fields. If the Electric fields have the same sign then they add constructively and increase the intensity of light, if the Electric fields have opposite signs they add destructively and the light intensity decreases.

When laser light shines through two closely spaced parallel slits (Figure 2) each slit produces a diffraction pattern. When these patterns overlap, they also interfere with each other. We can predict whether the interference will be constructive (a bright spot) or destructive (a dark spot) by determining the path difference in traveling from each slit to a given spot on the screen.

Intensity maxima occur when the light arriv *In phase* with an integer number of wavelength Differences for the two paths: $d\sin\theta = m\lambda$ Where m = ±0, ±1, ±2 **…and** the interference Will be destructive if the path difference is a Half-integer number of wavelengths so that the Waves from each slit arrive *out of phase* with Opposite signs for the electric field.

$d\sin\theta = \left[m + \frac{1}{2}\right]\lambda$ Where *m* = ±0, ±1, ±2 **…**

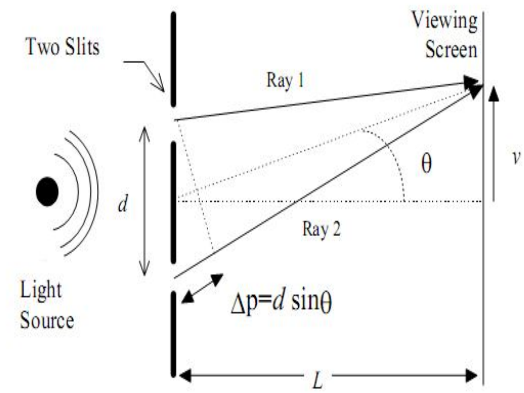
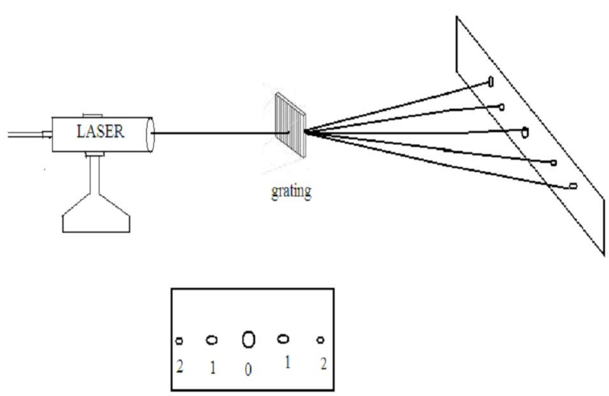


Figure 2: Interference of light from two slits. A maximum occurs when $\Delta p = m\lambda$ and a minimum when $\Delta p = (m+1/2)\lambda$, where *m*=0,1,2,…

Small Angle Approximation: The formulae given above are derived using the *small angle approximation*. For small angles θ (given in *radians)* it is a good approximation to say that $\theta \approx \sin\theta \approx \tan\theta$ (for θ in radians). For the figures shown above this means that $\theta \approx \sin\theta \approx \tan\theta = \frac{y}{L}$

BLOCK DIAGRAM:



PROCEDURE:

Arrange laser source diffraction grating and screen linearly at the same height on the optical bench. Keep the distance (D) between the grating and the screen at a fixed value. Switch on the laser source so that the laser is the incident normally on the surface of the grating. The laser is the incident normally on the surface of the grating. The laser is gets diffraction pattern on the screen. We can observe different diffraction orders of bright spots on the screen on either side of the central maxima. Now measure the distance x value gives the distance of that particular order of diffraction pattern from the central maxima. The wavelength of the given laser beam can be determined using formula,

$$\lambda = \sin\theta / Nm \text{ A}$$

Where,

$$\theta = Tan^{-1}(d/D)$$

Repeat the experiment for different values of D and note the corresponding d values for different diffraction orders and tabulate the readings.

OBSERVATION:

order	**Distance between the grating and the screen(D) 10^{-2}m**	**Distance between the central maxima and n^{th} order fringe(d) 10^{-2}m**			**$Tan^{-1}(d/D)$ degree**	**λ=sin□/N m × 10^{-2} m**
		Left	**Right**	**average**		

PRECAUTION:

Look through the slit (holding it very close to your eye). See if you can see the effects of diffraction. Set the laser on the table and aim it at the viewing screen. **DO NOT LOOK DIRECTLY INTO THE LASER OR AIM IT AT ANYONE! DO NOT LET REFLECTIONS BOUNCE AROUND THE ROOM.**

RESULT:

The wavelength of given laser is determined as = nm

EXPERIMENT -6

SONOMETER – TRANSVERSE LAWS

AIM: To verify the Laws of transverse vibration of stretched string by using son meter.

APPARATUS: Sonometer, tuning fork with different frequencies cork hammer, Weight hanger with suitable hanging weights, physical balance

FORMULA:

FIRST LAW: nl=constant

When T and m are constant

SECOND LAW: √T/l =constant

When n and m are constant

THIRD LAW: l√m=constant

When n and T are constant

Where "n" is the fundamental frequency

"T" is the tension on the string

"m" is the linear density (or) mass per unit volume length of string

"l" is the length vibrating segment of the string

PROCEDURE:

VERIFICATION OF FIRST LAW:

To verify the first law, the string of the sonometer is kept under a suitable tension. A tunning fork of known frequency (n) is excited and placed on the surface of the sonometer. A paper rider is placed on the string between the two bridges. The length of the wire is adjusted. So that the paper rider flutters vigorously and falls down. In this position the frequency of vibrating segment of the string is measured, keeping the tension as constant and using the some wire, the experiment is reapeated with different tuning forks. The first law is verified by showing the nxl is constant.

TABLE-1

Tension= Linear density=

s.no	Frequency n(Hz)	Resonating length of wire 10^{-2} m			nxl
		Trial-1	Trial-2	Mean	

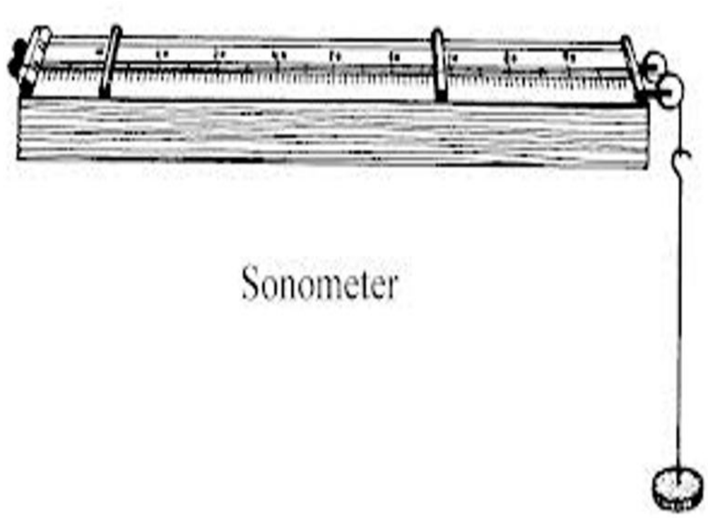
VERIFICATION OF SECOND LAW:

To verify the second law a tuning fork is taken and the string is kept under suitable tension (T). the fork is excited and placed on sonometer. The length (l) of the vibrating segment of the string is found as said above keeping the frequency of tunning fork as constant and using the same string, the experiment is repeated with different tensions. The second law is verified by showing the √T\l is constant.

Frequency= **Linear density=**

S.NO	Load M(g)	Tension T=Mg (g-wt)	Resonating length of wire			√T/l
			Trail-1	Trail-2	Mean l *cm*	

BLOCK DIAGRAM:



Sonometer

THIRD VERIFICATION LAW:

To verify the third law a string is kept under suitable tension. A tuning fork is excited and placed on the sonometer. The length of (l) of the vibrating segment of the string is determined as said above. A known length of the wire is taken and its mass is found in a physical balance from which mass per unit length (m) of the wire determined used the same tuning fork and the same tension. The experiment is repeated with different metal wire. The third law is verified by showing that $l\sqrt{m}$ is constant.

Tension= **Frequency=**

S.NO	Material of The wire	Mass per Unit length	Resonating length of wire			$l\sqrt{m}$
			Trial-1	Trial-2	Mean	
1	Steel					

2	**Copper**					
3	**Brass**					

PRECAUTIONS:

* The pully should by frictionless

* The tuning fork should be pressed on the sonometer board.

RESULT:

The law of transverse vibration of stretched strings are verified

EXPERIMENT 7

B-H CURVE

AIM: TO determine the hysteresis loop and to determine the loss of a ferrite specimen.

APPARATUS: Ferrite specimen in the shape of a to rid a step down transformer with voltage, Tapping resistors (0.1, 1.0,10,680 ohm), capacitor (4.7f) and CRO.

FORMULA: The energy loss per cycle of the hysteresis is given by

$$\text{Energy loss} = 0.5 N x S_v x S_H x \text{area of the loop}/RxL$$

Where,

N = No. Of turns of the sample=1430 turns

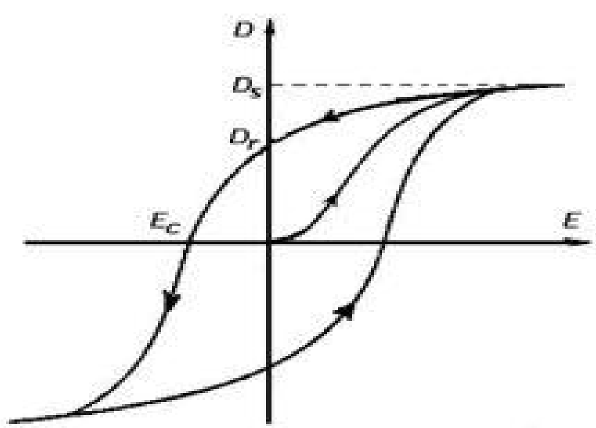
S_v and S_H represent vertical and horizontal sensitivity of CRO for that particular setting

At the gains in volts

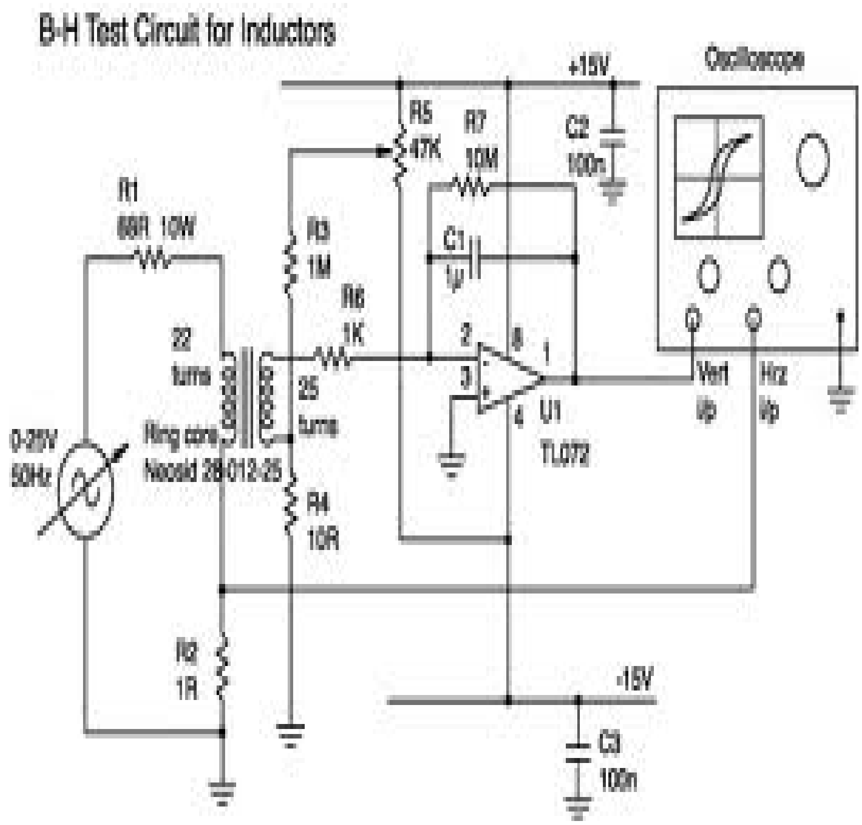
R = Resistance include in circuit in ohm

L = length of the specimen =0.033m

B-H LOOP:



BLOCK DIAGRAM:



PROCEDURE:

The circuit diagram for obtained B-H curve is the shown in the fig. since the induced voltage in the secondary coil is proportional to the derivative of the magnetic flux wave proportional flux should be obtained by integrating circuit containing a resistance and capacitor. When the integrated voltage is applied to the plates of CRO to give deflection proportional to the flux, then the current in impressed on the horizontal plates to give deflection proportional to it the result is B-H curve on the screen as shown in the fig.

It is traced on the graph on paper and its area is calculated for measuring horizontal Sensitivity the output voltage across the input resistance (R=0.1Ω) is directly give the X-plates as shown in fig and the corresponding length of the line on the CRO is measured. For the measuring vertical sensitivity the output voltage across the capacitor is given to the Y-plates and the length of the CRO is measured. The experiment is repeated for the different values of input resistance (R=1 Ω and10 Ω

TABLE:

S.NO	INPUT RESISTANCE (R)	SENSITIVITY		AREA OF THE LOOP	HYSTERESIS LOOP
		HORIZONTAL S_H (V)	VERTICAL S_V(V)		

RESULT:

The hysteresis loop of given specimen is determined

EXPERIMENT-8

DETERMINATION OF THICKNESS OF A THIN WIRE (AIR WEDGE METHOD)

AIM: To determine the thickness of the thin wire by forming the interference fringes using the air wedge set up.

APPARATUS: Traveling microscope, Sodium vapor lamp, Optically plane rectangular glass plates

Thin wire, Reading lens, Condensing lens with stand, Rubber band, wooden box with glass plate inclined at 45^0

FORMULA: Thickness of the thin wire,

$$t = l\lambda/2\beta$$

Where,

l = Distance between the edge of contact and the wire m

λ = Wavelength of sodium light m

β = Mean fringe width m

PRINCIPLE:

A wedge shaped air film is formed when a thin wire is introduced between two optically plane glass plates. When a parallel beam of monochromatic light is incident normally on this arrangement, interference occurs between the two rays; one is reflected from the front surfaces and the other at the back. These two reflected rays produce a pattern of alternate dark and bright interference fringes.

PROCEDURE:

Two optically plane glass plates are placed one over the other and are tie together by means of a rubber band at one end. The given thin wire is introduced in between the two glass plates, so that an air wedge is formed between the plates as shown in fig.14 this set up is placed on the horizontal bed plate of the traveling microscope.

The sodium vapor lamp is used as a source and is rendered parallel by means of a condensing lens. The parallel beam of light is incident on a plane glass plate inclined at an angle of 450 and gets reflected. The reflected light is incident normally on the glass plate in contact. Interference takes place between the light reflected from the top and bottom surfaces of the glass plate and is viewed through the traveling microscope. Therefore, the number of equally spaced dark and bright fringes are formed which are parallel to the edge of contact.

For the calculation of the single fringe width the microscope is adjusted so that the bright or dark fringe near the edge of contact is made to coincide with the vertical cross wire and this is taken as the nth fringe. The reading from the horizontal scale of the traveling microscope is noted. The microscope is moved across the fringes using the horizontal transverse screw and the readings are taken when the vertical cross wire coincides with every successive 3 fringes. The mean of this gives the fringe width ( ).The cross wire is fixed at the inner edge of the rubber band and the readings from the microcopies noted. Similarly reading from the microscope is noted keeping the cross wire at the edge of the material. The difference between these two values gives the value of '*l*'. Substituting the value and *l* in the equation then the thickness of the given thin wire can be determined.

BLOCK DIAGRAM:

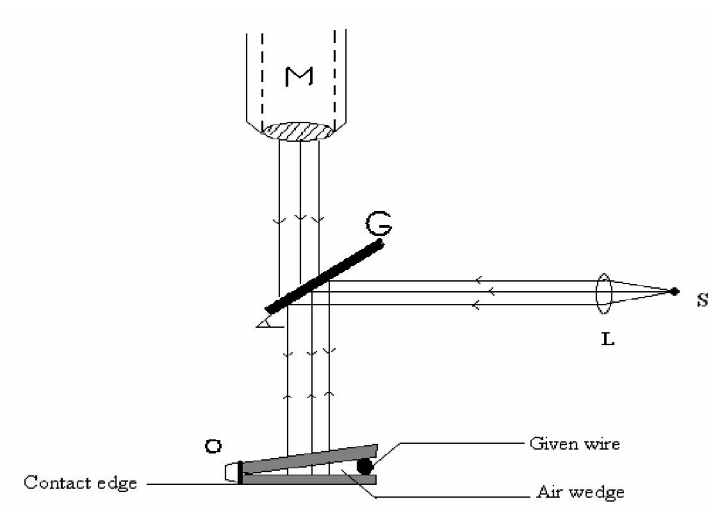


Figure:1

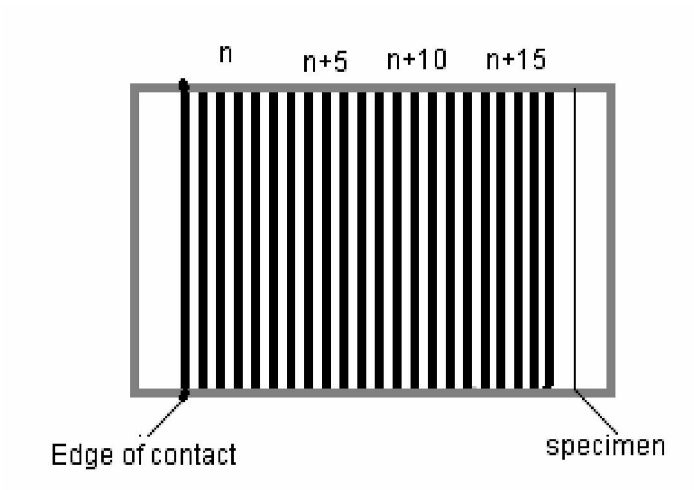


Figure:2

TABLE: To determine the fringe with by traveling microscope
Least count =0.001cm

Order of the fringe	MSR Reading			Width of 10 fringe	Mean Width of 1 fringeβ
	MSR	VSR	Total		
n					
n+5					
n+10					
n+15					
n+20					
n+25					
n+30					
n+35					

Meanβ= ------- x 10^{-2}m

CALCULATION:

Wavelength of the monochromatic light _ = 5893 Å

Distance between the edge of contact and the wire ***l*** = m

Fringe width _ = m

Thickness of the wire,t =

RESULT:

Thickness of the given thin wire t = ____________ x 10^{-2}m

EXPERIMENT-9

MELDE'S EXPERIMENT

AIM: To determine the frequency of AC mains by Meld's experiment.

APPARATUS: Electrically maintained tuning fork, A stand with clamp and pulley, A light weight pan, A weight box, Analytical Balance, A battery with eliminator and connecting wires etc.

FORMULA:

For Longitudinal mode

$$n = \frac{P}{L}\frac{\sqrt{T}}{m}$$

For Transverse mode

$$f = \frac{n}{2L}\sqrt{\frac{T}{m}}$$

THEORY:

STANDING WAVES IN STRINGS AND NORMAL MODES OF VIBRATION:

When a string under tension is set into vibrations, transverse harmonic waves propagate along its length. When the length of string is fixed, reflected waves will also exist. The incident and reflected waves will superimpose to produce transverse stationary waves in the string. The string will vibrate in such a way that the clamped points of the string are nodes and the point of plucking is the antinodes.

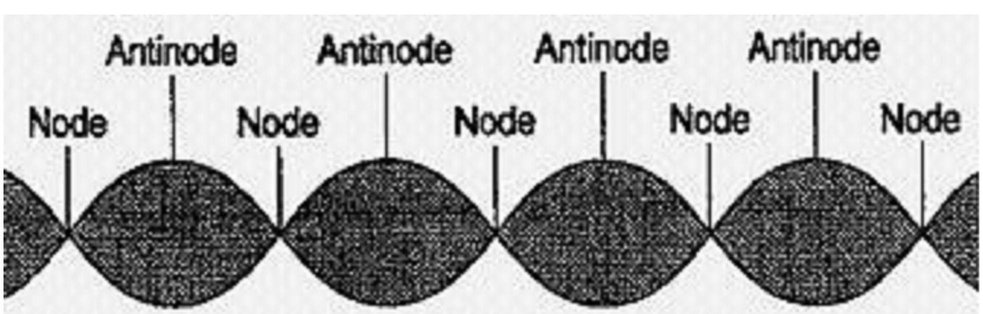


Figure A. The Envelope of a standing waves

A string can be set into vibrations by means of an electrically maintained tuning fork, thereby producing stationary waves due to reflection of waves at the pulley. The loops are formed from the end of the pulley where it touches the pulley to the position where it is fixed to the prong of tuning fork.

(i) For the transverse arrangement, the frequency is given by

$$f = \frac{n}{2L}\sqrt{\frac{T}{m}}$$

where 'L' is the length of thread in fundamental modes of vibrations, ' T ' is the tension applied to the thread and 'm' is the mass per unit length of thread. If 'p' loops are formed in the length 'L' of the thread.

(ii) For the longitudinal arrangement, when 'p' loops are formed, the frequency is given by

$$n = \frac{P}{L}\frac{\sqrt{T}}{m}$$

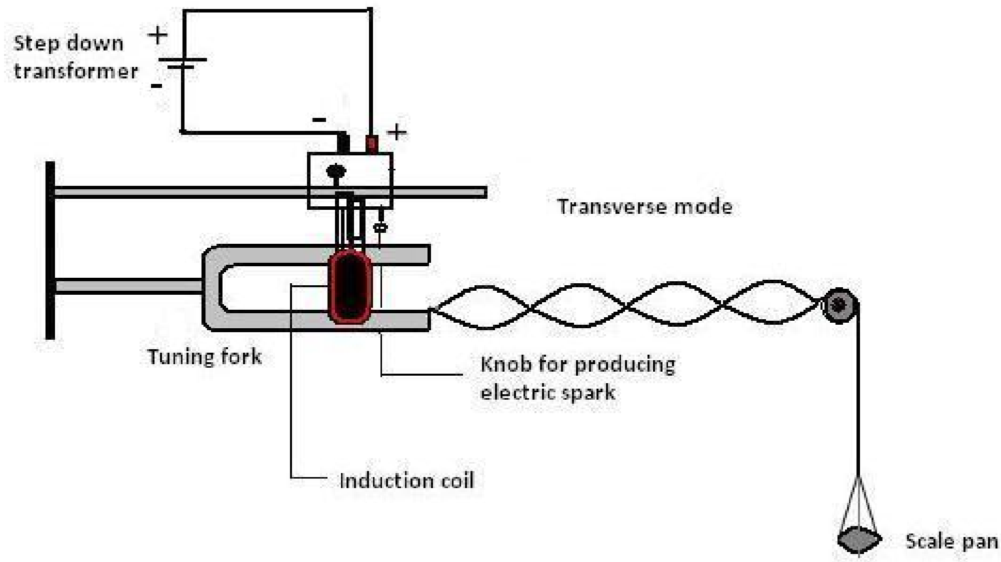
PROCEDURE:

1. Find the weight of pan P and arrange the apparatus as shown in figure.
2. Place a load of 4 To 5 gm in the pan attached to the end of the string
3. Passing over the pulley. Excite the tuning fork by switching on the power supply.
4. Adjust the position of the pulley so that the string is set into resonant
5. Vibrations and well defined loops are obtained. If necessary, adjust
6. The tensions by adding weights in the pan slowly and gradually. For finer adjustment, add milligram weight so that nodes are reduced to points.
7. Measure the length of say 4 loops formed in the middle part of the string. If 'L' is the distance in which 4 loops are formed, then distance between two consecutive nodes is L/4.
8. Note down the weight placed in the pan and calculate the tension T.

9. Tension, T= (wt. in the pan + wt. of pan) g
10. Repeat the experiment twine by changing the weight in the pan in steps of one gram and altering the position of the pulley each time to get well defined loops.
11. Measure one meter length of the thread and find its mass to find the value of m, the mass Produced per unit length.

BLOCK DIAGRAM:

For longitudinal arrangement



Mass of the pan, w =……… gm

Mass per meter of thread, m =……… gm/cm

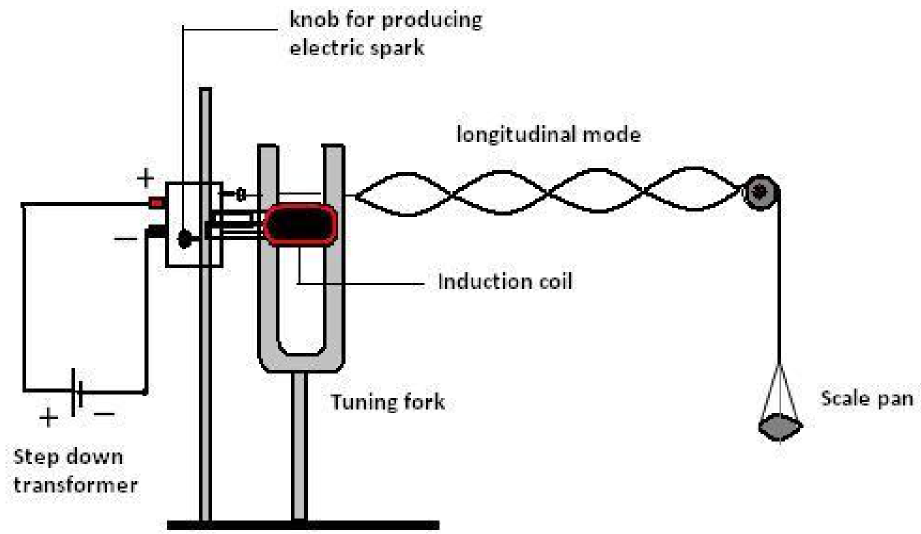
TABLE:1

sno	**Weight (W) gms**	**No. of loops (p)cms**	**Length of thread (L) cms**	**Length of each loop (L/P) cms**	**Tension (T) (W+w) gms**	**Frequency (n) Hzs**

Mean frequency= ---------------- Hzs

BLOCK DIAGRAM:

For transverse arrangement



Mass of the pan, w =……… gm

Mass per meter of thread, m =……… gm/cm

TABLE:2

Sno	**Weight (W) gms**	**No. of loops (p)cms**	**Length of thread (L) cms**	**Length of each loop (L/P) cms**	**Tension (T) (W+w) gms**	**Frequency (n) Hzs**

Mean frequency= ---------------- Hzs

PRECAUTIONS:

1. The thread should be uniform and inextensible.
2. Well defined loops should be obtained by adjusting the tension with milligram weights.
3. Frictions in the pulley should be least possible.

RESULT:

The frequency of the electric vibrator

1.In Transverse mode -------------cycles per second.

2.In longitudinal mode-------------- cycles per second.

EXPERIMENT-10

ELECTRICAL CONDUCTIVITY BY FOUR PROBE METHOD

AIM: To study of the temperature dependence of resistivity of a semi conductor (Four probe Method).

APPARATUS: Four probe apparatus (spring loaded four probes, germanium crystal in the form of a chip, oven for variation of temperature (to about 150^0C), thermometer, constant current power supply , oven power supply, high impedance voltmeter, milli-ammeter to measure, respectively, voltage and current through 4-point probes).

THEORY:

Resistivity of semiconductor:

The resistivity of germanium is measured with the help of four probes (Fig. I). The outer probes are used for passing a current through the germanium sample. The electric current carried through the two outer probes sets up an electric field in the sample. The electric current carried through the two outer probes, sets up an electric field in the sample, In Fig.II, the electric field lines are drawn solid and the equipotential lines are drawn broken. The two inner probes measure the potential difference between point B and C using a high impedance voltmeter.

For bulk samples where the sample thickness, w>>s, the probe spacing, the resistivity is calculated using the relation:

$$\rho_0 = (V/I)\, 2\pi s \text{ ------------ } (1)$$

Where

V= floating potential difference between the inner probes, unit: volt

I =current through the outer pair of probes, unit: ampere

S=spacing between point probes, unit: meter

ρ_0 =resistivity, unit: ohm meter

Fig III shows the resistivity probes on a die of material. If the side boundaries are adequately far from the die may be considered to be identical to a slice. For this case of a slice of thickness w and with a non conducting bottom surface the resistivity is computed by means of the divisor $G_7(w/s)$ as:

$$\rho = \rho_0 / (G_7(w/s)) = (V/I)(2\pi s / (G_7(w/s))$$

The values and graph for $G_7(w/s)$ are given in the lab manual. For $(w/s) \leq 0.5$, we may use the following value (obtained for the case of infinitely thin slice):

Equation

The temperature dependence of resistivity of a semiconductor:

The total electrical conductivity of a semiconductor sample is the sum of the conductivities of the valence and conduction band carriers, which are holes and electrons, respectively.

$$\sigma = e(n_e\mu_e + n_h\mu_h) \text{ -----------(4)}$$

Where

n_e, μ_e are the electron's concentration and mobility, and

n_h, μ_h are the hole's concentration and mobility,

μ_e , μ_h are the electron and hole mobilities.

In the intrinsic region the number of electrons is equal to the number of holes, $n_e = n_h = n_i$, so the conductivity becomes

$$\sigma = n_i\, e\, (\mu_e + \mu_h) \text{ ----------- (5)}$$

The detailed calculations reveal that the electron density (number/volume) depends on temperature as follows:

$$n_i = NT^{3/2} \exp(-E_g / 2kT) \text{ ---------(6)}$$

where N is some constant. The temperature dependence of the mobility in the intrinsic semi-conduction region is of the form:

$$\mu \;\alpha\; T^{-3/2} \text{ ----------- (7)}$$

Therefore

$$(\mu_e + \mu_h) T^{3/2} \approx constant$$

Use of this fact gives

$$\sigma = \text{constant} \times \exp(-E_g / 2kT) \text{ -------------- (8)}$$

The resistivity is reciprocal of conductivity. Therefore, for intrinsic semiconductor, it is (from Eq.(8))

$$\rho = A \exp(E_g / 2kT) \text{ ---------- (9)}$$

where A is some constant. The resistivity of a semiconductor rises exponentially on decreasing the temperature taking logarithm, we get

$$\log_{10}\rho = C + (1/2.3026)\,(E_g / 2kT) \text{ ---------(10)}$$

where $C=\log_{10}A$ is another constant. For convenience Eq. (10) is rewritten as

$$\log_{10}\rho = C + (1/2.3026)(E_g/2k)\times 10^3/T \text{ ------------ (11)}$$

Thus a graph between log of resistivity, $\log_{10}\rho$, and reciprocal of the temperature , $10^3/T$

Band gap energy:

The slope of the straight line graph between log of resistivity, $\log_{10}\rho$, and reciprocal of the temperature, $10^3/T$,

$$\text{Slope}=(AC)/(BC)=(1/(2.3026\times 10^3))(E_g/2k).$$

Therefore,

$$E_g=2.3026\times 10^3\times 2k\times(\text{Slope}).$$

We use $k=8.617\times 10^{-5}\,eVK^{-1}$ to get E_g in eV unit.

Figures:

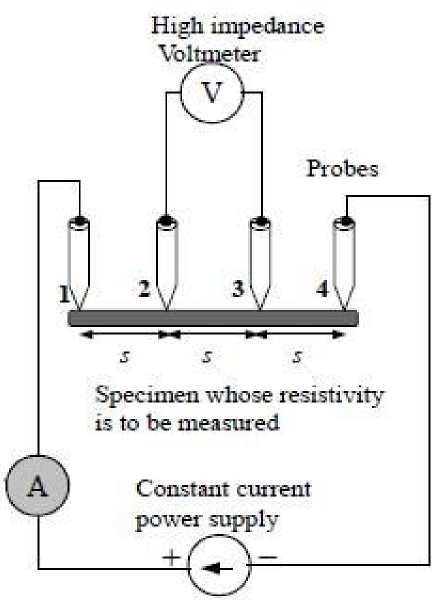


Figure:1

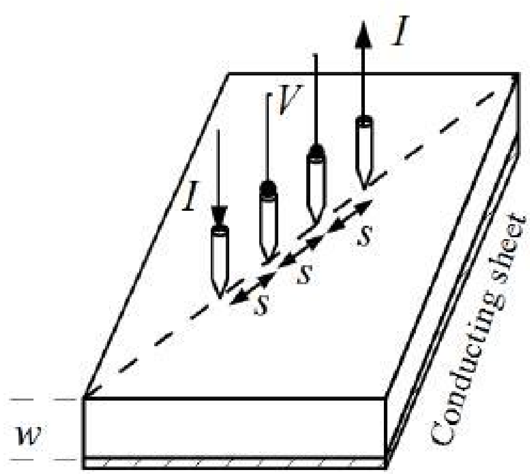


figure:2

PROCEDURE:

1. The settings of 4-point probes on the semiconductor chip is a delicate process. So first understand well the working of the apparatus. The semiconductor chip on probe set is costly.
2. Note the values of probe spacing(s) and the thickness (w) of the semiconductor chip. Note the type of semiconductor (germanium or something else).
3. Make the circuit as shown in fig. I & III. Put the sample in the oven (normally already placed by lab instructor) at room temperature.
4. Carefully, with the help of screw and delicate up/down movements, touch (Kelvin connection) the probes to the semiconductor chip.
5. Pass a mille ampere range current (say 2 mA) in the sample using constant current power supply)
6. The reading of the current through the sample is measured using millimeters provided for this purpose. The voltage is measured by the high impedance mille voltmeter connected to the inner probes. The readings can be taken alternately on digital meter provided for this purpose.
7. Note temperature of sample (oven) using thermometer inserted in the oven for this purpose.
8. The oven temperature is increased a little, and its temperature noted after reaching steady state. Again the constant current reading advised to be kept the same) and the corresponding voltage readings are taken.
9. Repeat the procedure for different temperatures. Note the data in the observation table.

10. For each temperature, calculate the resistivity by using the relation

$$\rho= \rho_0/(G_7(w/s))=(V/I)(2\pi s/(G_7(w/s))$$

11. Compute $\log_{10}\rho$ and $10^3/T$ and write it in the observation table.
12. Plot a graph between $\log_{10}\rho$ and $10^3/T$. it is a straight line. Find its slope.
13. Calculate the band gap using formula.

$$E_g=2.3026\times10^3\times2k\times(\text{Slope}).$$

Use $k=8.617\times10^{-5}eVK^{-1}$ to get E_g eVK^{-1} unit. Note that up to four-significant digits, $k=1.3806\times10^{-23}JK^{-1}$, and $1eV=1.602\times10^{-19}J$.

OBSERVATIONS:

1. Semiconductor chip material= Germanium (verify from your lab manual)
2. Spacing (distance) between the probes, s= --------------mm = -----------m
3. Thickness of the sample,w= ----------mm = ---------------m.

Table 1: voltage across the inner probes for a constant current at different samples temperatures

(a) Constant current passed through the sample = -----------mA

S.No	**Temperature T(K)**	**Voltage across inner probes *V* (m*V*)**	**$10^3/T(K^{-1})$ (calculated)**	**Resistivity $\rho(\Omega m)$ (calculated)**	**$\log_{10}\rho$ (calculated)**
1					
2					
3					
4					

CALCULATIONS:

1. For the given sample w/s =-------
2. The correction factor G_7 (w/s) =-----------
3. Calculation of $10^3/T$ (K^{-1}), $\rho(\Omega m)$ and $\log_{10}\rho$

   (i) Temperature *T*=-----------K. Therefore

   $10^3/T$ =----------- (K^{-1})

   (ii) Resistivity is

   $\rho = (V/I)(2\pi s/(G_7(w/s)))$ = -------------- Ωm

   $\log_{10}\rho$=---------.
4. Slope of the graph between 103/T (K^{-1}) and $\log_{10}\rho$ is

   Slope = AC/BC=—— =----------
5. Energy band gap

   $E_g = 2.3026\times10^3\times2k\times(\text{Slope})$

   $= 2.3026\times10^3\times2\times8.617\times10^{-5}\times$ (Slope) = --------------eV

PRECAUTIONS:

1. The surface of the semiconductor should be flat.
2. All the four probes should be collinear.
3. The adjustment of 4-point probes should be done gently, as the semiconductor chip is Brittle.
4. The voltage should be measured using inner probes only using a high impedance milli Voltmeter.

Temperature of the oven should not exceed the limits set by manufacturer of the prob and Chipset.

RESULT:

1. The temperature dependence of the resistivity of semiconductor (germanium) chip is as shown in the graph. The resistivity increases exponentially with the increase in 1/*T*. That is as at low temperatures resistivity is more and at high temperatures the resistivity is less.
2. The energy band gap for the given semiconductor (germanium) is = -----------eV.

EXPERIMENT-11

DIFFRACTION AT A SINGLE SLIT (LASER)

AIM: To determine slit width of single slit by using He-Ne Laser.

APPARATUS: He-Ne laser, Single Slit, Screen, Scale, tape etc.

THEORY:

If the waves have the same sign (are in phase), then the two waves constructively interfere, the net amplitude is large and the light intensity is strong at that point. If they have opposite signs, however, they are out of phase and the two waves destructively interfere: the net amplitude is small and the light intensity is weak. It is these areas of strong and weak intensity, which makeup the interference patterns we will observe in this experiment. Interference can be seen when light from a single source arrives at a point on a viewing screen by more than one path. Because the number of oscillations of the electric field (wavelengths) differs for paths of different lengths, the electromagnetic waves can arrive at the viewing screen with a phase difference between their electromagnetic fields. If the Electric fields have the same sign then they add constructively and increase the intensity of light, if the Electric fields have opposite signs they add destructively and the light intensity decreases.

Diffraction at single slit can be observed when light travels through a hole (in the lab it is usually a vertical slit) whose width, *a*, is small. Light from different points across the width of the slit will take paths of different lengths to arrive at a viewing screen (Figure 1). When the light interferes destructively, intensity minima appear on the screen. Figure 1 shows such a diffraction pattern, where the intensity of light is shown as a graph placed along the screen. For a rectangular slit it can be shown that the minima in the intensity pattern fit the formula

$$a\sin\theta = m\lambda$$

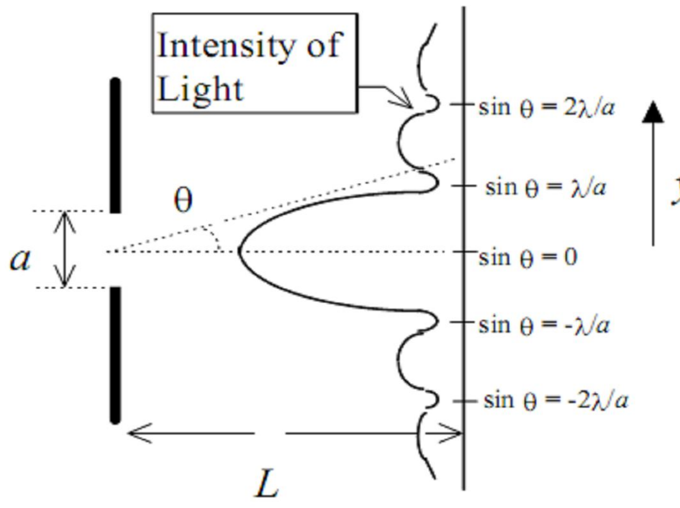


Figure 1: Diffraction by a slit of width *a*.
Graph shows intensity of light on a screen.

Where m is an integer (±1, ±2, ±3…..), *a* is the width of the slit, l is the wavelength of the light and θ is the angle to the position on the screen. The m^{th} spot on the screen is called the m^{th} order minimum. Diffraction patterns for other shapes of holes are more complex but also result from the same principles of interference.

PROCEDURE*:*

Diffraction at single slit

The diffraction plate has slits etched on it of different widths and separations. For this part use the area where there is only a single slit. For two sizes of slits, examine the patterns formed by single slits. Set up the slit in front of the laser. Record the distance from the slit to the screen, *L*. For each of the slits, measure and record a value for *y* on the viewing screen corresponding to the center of a dark region. Record as many distances, *y*, for different values of m as you can. Use the largest two or three values for *m* which you are able to observe to find a value for *a*. The He-Ne laser has a wavelength of 633 nm.

Table 1: Single slit

L = …….

λ= ………..

TABLE

Diffraction Order, m	Distance, y	y/L	Angle θ in *radians*	$\sin\theta$	a $\left(=\frac{m\lambda}{\sin\theta}\right)$

PRECAUTION:

Look through the slit (holding it very close to your eye). See if you can see the effects of diffraction. Set the laser on the table and aim it at the viewing screen. **DO NOT LOOK DIRECTLY INTO THE LASER OR AIM IT AT ANYONE! DO NOT LET REFLECTIONS BOUNCE AROUND THE ROOM.**

Pull a hair from your head. Mount it vertically in front of the laser using a piece of tape. Place the hair in front of the laser and observe the diffraction around the hair. Use the formula above to estimate the thickness of the hair, *a*. (The hair is not a slit but light diffracts around its edges in a similar fashion.) Repeat with observations of your lab partners' hair

RESULT:

The single slit width is____________________

EXPERIMENT-12
DIFFRACTION AT A DOUBLE SLIT (LASER)

AIM: To determine slit width of double slit by using He-Ne Laser.

APPARATUS: He-Ne laser, double Slit, Screen, Scale, tape etc.

THEORY:

If the waves have the same sign (are in phase), then the two waves constructively interfere, the net amplitude is large and the light intensity is strong at that point. If they have opposite signs, however, they are out of phase and the two waves destructively interfere: the net amplitude is small and the light intensity is weak. It is these areas of strong and weak intensity, which makeup the interference patterns we will observe in this experiment. Interference can be seen when light from a single source arrives at a point on a viewing screen by more than one path. Because the number of oscillations of the electric field (wavelengths) differs for paths of different lengths, the electromagnetic waves can arrive at the viewing screen with a phase difference between their electromagnetic fields. If the Electric fields have the same sign then they add constructively and increase the intensity of light, if the Electric fields have opposite signs they add destructively and the light intensity decreases.

Two-slit Diffraction: When laser light shines through two closely spaced parallel slits (Figure1) each slit produces a diffraction pattern. When these patterns overlap, they also interfere with each other. We can predict whether the interference will be constructive (a bright spot) or destructive (a dark spot) by determining the path difference in traveling from each slit to a given spot on the screen. Intensity maxima occur when the light arrives in phase with an integer number of wavelength differences for the two paths:

$$d\sin\theta = m\lambda$$

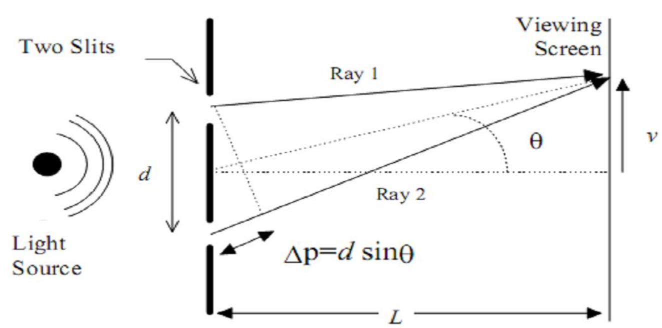


Figure 2: Interference of light from two slits. A maximum occurs when $\Delta p = m\lambda$ and a minimum when $\Delta p = (m + 1/2)\lambda$, where m=0,1,2,...

Where m = ±0, ±1, ±2 **…** and the interference Will be destructive if the path difference is a Half- integer number of wavelengths so that the Waves from each slit arrive out of phase with Opposite signs for the electric field.

dsinθ= [m+1/2]λ Where m = ±0, ±1, ±2 **…**

PROCEDURE:

Using the two-slit templates, observe the patterns projected on the viewing screen. Observe how the pattern changes with changing slit width and/or spacing.

For each set of slits, determine the spacing between the slits by measuring the distances between minima on the screen. (The smaller spacing's give are from the two slits patterns interfering, if they get too small to measure accurately, just make your best estimate.) You will need to record distances on the screen *y* and the distance from the slits to the screen, *L*.

Observations:

Table 1: Single slit
L = …….
λ = ………..

TABLE

Diffraction Order, m	Distance, y	y/L	Angle θ in *radians*	$\sin\theta$	a $\left(=\frac{m\lambda}{\sin\theta}\right)$

PRECAUTION:

Look through the slit (holding it very close to your eye). See if you can see the effects of diffraction. Set the laser on the table and aim it at the viewing screen. **DO NOT LOOK DIRECTLY INTO THE LASER OR AIM IT AT ANYONE! DO NOT LET REFLECTIONS BOUNCE AROUND THE ROOM.**

Pull a hair from your head. Mount it vertically in front of the laser using a piece of tape. Place the hair in front of the laser and observe the diffraction around the hair. Use the formula above to estimate the thickness of the hair, *a*. (The hair is not a slit but light diffracts around its edges in a similar fashion.) Repeat with observations of your lab partners' hair.

RESULT:

The double slit width is____________________

EXPERIMENT-13

ENERGY GAP OF A SEMICONDUCTOR DIODE

AIM: To determine the energy gap of a semiconductor diode

APPARATUS: Germanium diode, thermometer, copper vessel, regulated dc power supply, micro ammeter, heater& Bakelite lid.

PROCEDURE: Connections are made as per the circuit diagram. Pour some oil in the copper vessel.fix the diode to the Bakelite lid such that it is reversed biased.bakelite lid is fixed to the copper vessel, a hole is provided on the lid through which the thermometer is inserted into the vessel. with the help of heater, heat the copper vessel till temperature reaches up to 80^0c.note the current reading at 80^0c apply suitable voltage say 1.5v(which is kept constant) & note the corresponding with every 5^0c fall of temperature, till the temperature reaches the room temperature

A graph is plotted between 1/T (K) on x-axis and $\log_{10}R$ on y-axis is a straight line. Slope is measured by taking the values of two points where each one of them intersects on the straight line as shown in the fig.

The energy gap-slope x Boltzmann's constant/$\log_{10}e$.

The energy gap Eg=1.9833 x slope $\times 10^{-4}$ev

BLOCK DIAGRAM:

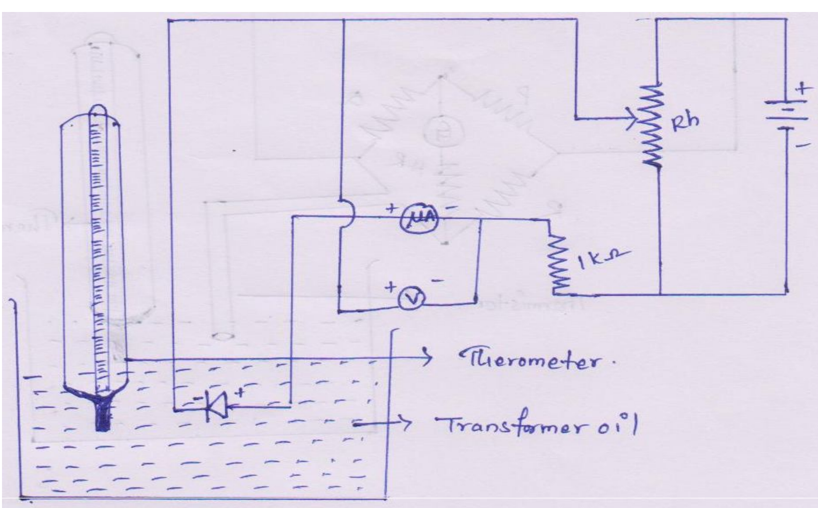
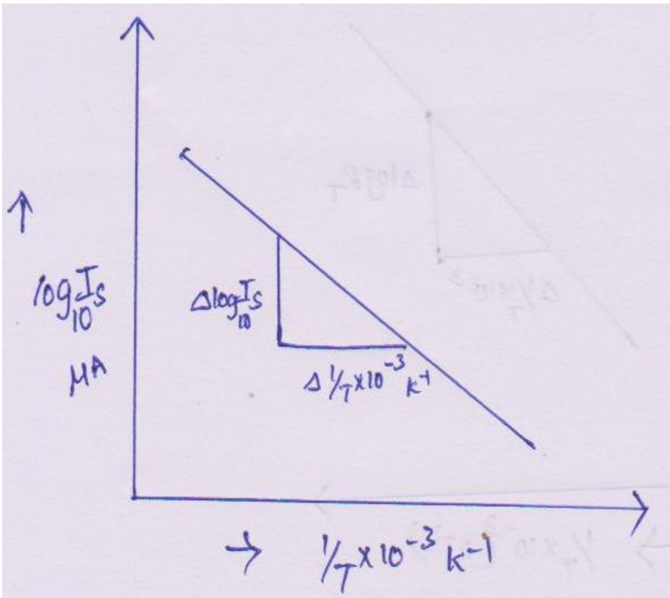


TABLE:

S.NO	Temparature		Current (µA)	$Log_{10}Is$(µA)	1/T x10^{-3} K^{-1}
	t ^{0}c	T=t+273K			
	100				
	95				
	90				
	85				
	80				
	75				
	70				
	65				
	60				
	55				
	50				
	45				
	40				

MODEL GRAPH:



RESULT:

The energy gap of semiconductor diode is Eg_____________________.

EXPERIMENT-14

THERMISTOR-CHARACTERISTICS

AIM: To determine the temperature coefficient of resistance of the given theThermistor.

APPARATUS: Thermistor, thermometer, electrical heater, galvanometer, connecting wires, post office box and battery.

FORMULA: Post office box works on the principle of wheat stone bridge.

$$P/Q=R/S$$

PROCEDURE:

The connecting is made as shown in the circuit diagram the thermistor is placed in the beaker containing Water. a thermistor and stirrer is introduced into the beaker. The room temperature $t_1{}^oc$ is noted.Here we determine the resistance of thermistor at different temperature by making use of the principle of Wheatstone bridge. This is said to be balanced when the current (i_g) through the galvanometer is zero. The Condition for the balance of the Wheatstone bridge is

$$P/Q=R/R_t$$

We keep P=Q for convenience and we adjust R to get null deflection in the galvanometer.

Now the value of the thermistor (R_t).Thus the resistance of the thermistor is found at different temperatures and the readings are tabulated as follows.

BLOCK DIAGRAM:

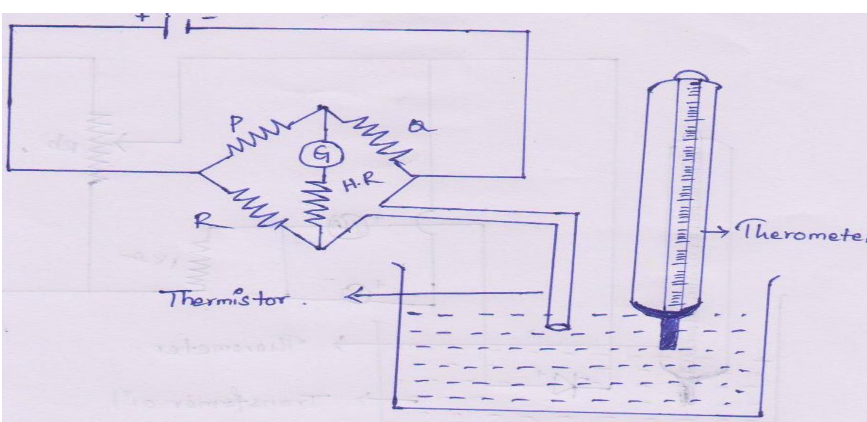


TABLE:

S.NO	TEMPARATURE T^o c	RESISTANCE OF THERMISTOR $R_{T\,\Omega}$	$Log_{10}R_{T\,\Omega}$	T=t+273 K	$1/T x10^{-3}$
1	95				
2	90				
3	85				
4	80				
5	75				
6	70				
7	65				
8	60				
9	55				
10	50				
11	45				
12	40				
13	35				

A graph is drawn by taking 1/T on x-axis and $logR_t$ on y-axis we have

$$R=R_0e^{\beta/t}$$

$$\log_e R=\log_e R_0+\log_e e^{\beta/t}$$

$$\log_e R= \log_e R_0+\beta/t$$

The above equation is in the form of

$$y = mx + c$$

$$m = \beta$$

$$2.3026 x \log_{10} R = \beta/t + 2.3026 x \log_{10} R$$

$$\log_{10} R = \beta/2.3026 \text{ x } t + \log_{10} R$$

$$\text{Slope} = \beta/2.3026$$

$$\beta = 2.3026 \text{ x slope}$$

from graph,

$$\text{slope} = \Delta\ (\log_{10} Rt)/\Delta 1/t$$

$$\beta = 2.3026 \text{ x } \Delta\ (\log_{10} Rt)/\Delta 1/t$$

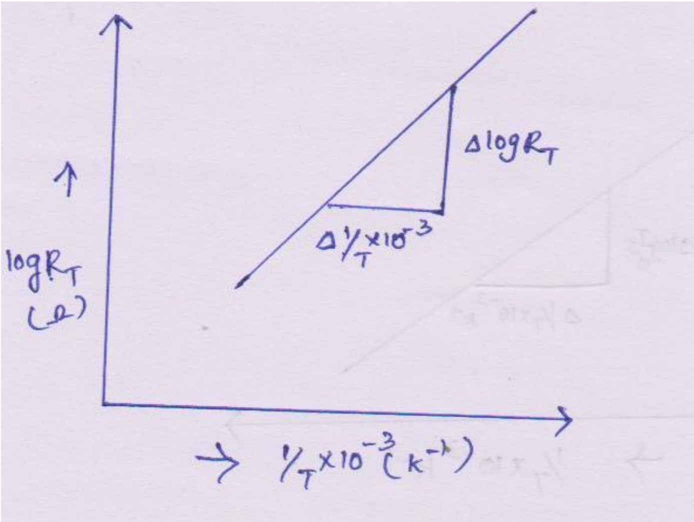
after finding β,we have

$$\alpha = -\beta/t^2 \quad \Omega/k$$

Where $T = 273 + t^0$

Energy gap $E_g = 2k\beta$ joule

MODEL GRAPH:



PRECAUTIONS:

1. Before starting the experiment the connections must be checked.

2. The current should not be passed for long intervals

RESULT:

1. Temperature coefficient of resistance of the given thermistor is __________

2. The sensitivity of the thermistor is found to be ______________________

3. The energy gap of the thermistor is Eg =___________________________

EXPERIMENT-15

DIFFRACTION GRATING – NORMAL INCIDENCE METHOD

AIM: To determine the wave length of a given source of light by using the diffraction grating in the normal incidence method.

APPARATUS: Spectrometer, diffraction grating, mercury vapour lamp, spirit level.

FORMULA: The wavelength of the light is given by the relation

$$\lambda = 2\sin(\theta/2)/nN \ A^0$$

where ,

λ = wave length of spectral line

θ = diffraction angle

n = number of order of the spectrum

N = grating constant

PROCEDURE:

Normal incidence:

The slit of the Spectrometer is illuminated with mercury vapour lamp. The telescope is placed in the line with the axis of collimeter and the direct image of the slit is observed. The slit is narrowed and the vertical axes wires are made to coincide with the center of the image of the slit. The reading of one of the venire is noted. The prism table is clamped firmly and the telescope is turned through exactly 90^0 and fixed in position. The grating is held with the ruling vertical and minted in its holder on the prism table such that the plane of the grating passes through the center of the table and the ruled surface towards the collimeter.the prism table is released and related until the image of the slit of the grating. The prism table is fixed after adjusting point of intersection of the cross-wire is on the image of the slit. Then the venire is related and the ruled side of the grating faces the collimeter.the telescope is brought back to the direct reading position. now the light from the collimeter strikes the grating normally.

Measurement:

The telescope is rotated so as to catch the first order diffracted spectral image on the one side say on the left with mercury light"VIBGYOR"spectrum can be seen. The point of cross-wire is set on the red line of the spectrum and its reading is noted. Then the corresponding to all the colours of the spectrum are noted.then the telescope is turned to the other side is right side and similarly. The readings corresponding to any one line gives the angle of diffraction for that line the first order spectrum.

The experiment is repeated for the record order spectrum the number of line per cm of the grating is noted and the wavelength λ of the spectral line is found by the relation

$$\lambda = 2\sin(\theta/2)/nN \ A^0$$

BLOCK DIAGRAM:

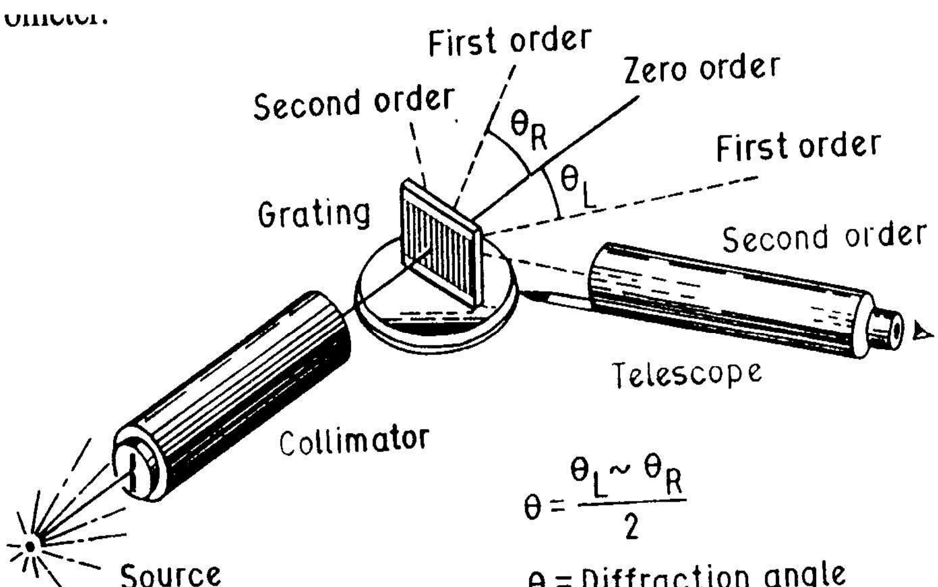


Fig. 5

TABLE:

S.NO	Spectral line	Telescope reading(degrees)				Angle of diffraction(deg)		Mean(deg) $\theta=\frac{\theta_1+\theta_2}{2}$	$\lambda=\frac{\sin(\theta)}{nN}$ A^0
		Left side		Right side		$V_1\sim V_1$	$V_2\sim V_2$		
		V_1	V_2	V_1	V_2				
1	Red								
2	Yellow								
3	Green								
4	Blue								
5	Violet								

Precautions:

1. Always the grating should be held by the edges of the surface should not be touched.

2. Light from the collimeter should be uniformly incident on the control surface of the grating.

3. Reading of the verniers are noted without any parallel error.

4. Optical adjustments should be made carefully.

The wavelength of the used is experimentally found for all colour.

Colours of line standard of values

RESULT:

The wavelength of light used is experimentally found all colours

Colours spectral line	Standard value A^0	Experimental value A^0
Red		
Yellow		
Green		
Blue		
violet		

EXPERIMENT-16

HALL EFFECT

AIM: To determine the hall-coefficient and charge carrier density of the given semi conductor material by hall-setup.

APPARATUS: Hall Effect demonstration kit, Hall probe, Electro magnet (1500gauss in 10mm gap), Al spacer, Indium arsenide (In As), semiconductor etc.

HALL EFFECT: When conventional current flow through a semi conductor from A to B. The motion of carriers (electrons and holes drift with velocity V_d) is shown in fig. the direction of magnetic induction B is out of the paper and towards you the force acting on charged particle is given by

$$F=q\,[VxB]$$

For both the carriers, the force is towards left. So the carriers move to the left as the charge carriers accumulate a potential difference develops such that the carriers are under zero force. These carriers prevent other carriers from joining them. Therefore particles are more in the left regions than in the right. As a result of these carriers the situation is equivalent to batteries like for n-type and for p-type materials. This voltage probe voltage across D,E is called Hall voltage and is given by

$$V_h= (R_h B_J I_n \times 10^{-8})/\, t \text{ Volts}$$

Where

R_h= (1/ne) is called hall-co-efficient in cm^3/coulomb

t = thickness of the sample in cm

B_J = magnetic field in gauss in z-direction

I_n =probe current in MA

10^{-8}= conversion factor

In practical, the y- direction contacts are not exactly opposite and the resistance of the material b/w these misaligned contacts develop R_i drop voltage. A part from this voltage, ethinghausen effect etc., will also contribute be the y-direction. This has to be null field before any meaningful are made.

EXPERIMENT:

Calibration of electro magnet:

1.Connect the gauss meter probe and correctly again it perpendicular to magnetic field and at the center of the pole pieces. Set pole pieces spacing to 10mm.

2.Keep the Nob in calibration position and set the probe current given on the gauss meter probe

3.Set different magnetic currents and read magnetic field in kilo gauss in 2k and 20k ranges

4.Plot magnetic field as a function of magnetic current, this is the calibration curve.

5.Repeat the measurement for 15mm to 20mm pole piece spacing and obtain similar calibration curves.

6.Remove the gauss meter keep it safe.

DIAGRAM:

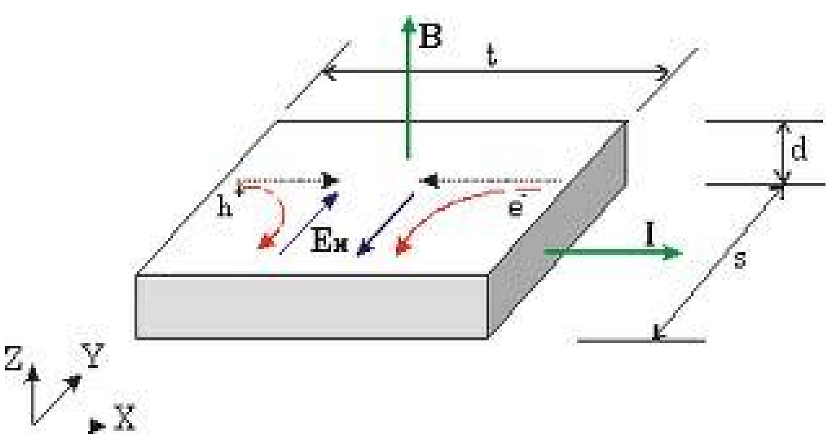


TABLE:1

Magnetic current	Magnetic field (kilo gauss)		Average in (gauss)
	Increasing	decreasing	

Determination of R_h by using the variation of probe voltages. A function of probe current for find B_J

(i) Connect electromagnet terminals to magnet terminals.

(ii) Connect all probe to the socket and align the probe perpendicular to the magnetic field and at the center of the gap.

(iii) Keep magnet current and probe current in minimum position (extreme anticlock wise position)

(iv) Plug in the instrument to 230v DC main supply.

(v) Gently rotate the probe and select the position of maximum probe voltage. (Do not disturb the position till all the measurements are completed).

(vi) Adjust zero control to read probe voltage when magnet current is zero (disconnect magnet current wire).

(vii) For different values of probe current note probe voltage. Plot the graphs for V_n ,V_s probe current.

The slope is given by,

$$(R_h B_J x\ 10^{-8})/ t$$

From the known values of B_J and t determine R_h

(Viii) Repeat the experiment for different magnet currents in the full range i.e., 0 to 2000mA.

take the average of R_h is obtained from the above plots and determine the value of carrier

concentration.

TABLE:2

Magnetic current		200mA		300mA		400mA	
P_c mA	P_r mV	P_c mA	P_r mV	P_c mA	P_r mV	P_c mA	P_r mV

PRECAUTIONS:

1) Align the probe exactly perpendicular to the applied magnetic field.
2) Keep the separations of pieces of electro magnet constant only by using Al spaces.

RESULT:

1) Hall coefficient of the semiconductor material is R_h = --------------- cm^3/ coulomb
2) The charge carrier density of the given semi conductor material (In As) is found to be h = ---------------cm^3