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LAB MANUAL

Regulation : **2013**

Branch : ***B.E.* – All Branches**

Year & Semester : **I Year / II Semester**

GE6262- PHYSICS LABORATORY

Department of Physics

SYLLABUS

ANNA UNIVERSITY: CHENNAI

R - 2013

<u>PHYSICS LABORATORY</u>

II – Semester

<u>LIST OF EXPERIMENTS (Any 5 Experiments)</u>

1. Determination of Young's modulus by uniform bending method.

2. Determination of band gap of a semiconductor.

3. Determination of Coefficient of viscosity of a liquid –Poiseuille's method.

4. Determination of Dispersive power of a prism – Spectrometer.

5. Determination of thickness of a thin wire – Air wedge method.

6. Determination of Rigidity modulus – Torsion pendulum.

EX. NO.	DATE	NAME OF THE EXPERIMENT	SIGNATURE OF THE STAFF	REMARKS
1		**Young’s Modulus-uniform bending**		
2		**Viscosity of a liquid – Poiseuille’s method**		
3		**Dispersive power of a prism – Spectrometer**		
4		**Air wedge – Thickness of a thin wire**		
5		**Rigidity Modulus – Torsion Pendulum**		
6		**Band gap semiconductor**		

INSTRUCTION

I . YOUNG'S MODULUS

1. A uniform rectangular beam is placed on the two knife-edges in a symmetrical position. The distance between knife-edges is kept constant and is measured as *l*.

2. The weight hangers (dead load of the slotted weight) are suspended at points A and D on the beam at equal distance away from knife-edges. (i.e. the distance between AB and CD must be equal).

3. A pin is fixed at point O, exactly middle of the rectangular beam. The distance OB is equal to OC.

4. A microscope is arranged horizontally in front of scale and is focused at the tip of the pin. The microscope is adjusted such that the tip of the pin is coinciding with horizontal cross wire.

5. The equal dead weights (hanger) W_0 suspended on both side of the rectangular beam (at point A and D). The horizontal cross wire of the microscope is focused and coincides with the tip of the pin. The corresponding microscope reading (main scale reading and vernier scale reading) is noted from the vertical scale of microscope.

6. Then, additional load '*m*' (50 gm) is placed in the weight hangers on both sides simultaneously. Due to this load, there will be a small elevation on the rectangular beam and the height of the pin is increased.

7. The height of the microscope is adjusted in order to coincide the horizontal cross-wire with the tip of the pin. Once again, the main scale and vernier scale reading is noted from the vertical scale of microscope.

8. The experiment is continued by adding weights on both side of hanger for 2*m*, 3*m*, 4*m*, 5*m*…..etc. These reading correspondents to microscope reading on loading.

9. After adding all the weights, now the experiment to be carried out for unloading.

10. First, one weight (50 gm) is removed on both side, therefore there will be a depression in rectangular beam and the height of the pin is decreased. The microscope is adjusted again in order to coincide the horizontal cross-wire on the tip of the pin. The main scale and vernier scale readings are noted from the vertical scale of microscope.

11. Similarly, all the weights on both side of hanger are removed one by one and the corresponding microscope readings are noted. These readings are corresponding to microscope readings on unloading.

12. From these readings, the mean elevation of midpoint of the beam due to a load is determined.

2. VISCOSITY OF A LIQUID – POISEUILLE'S METHOD

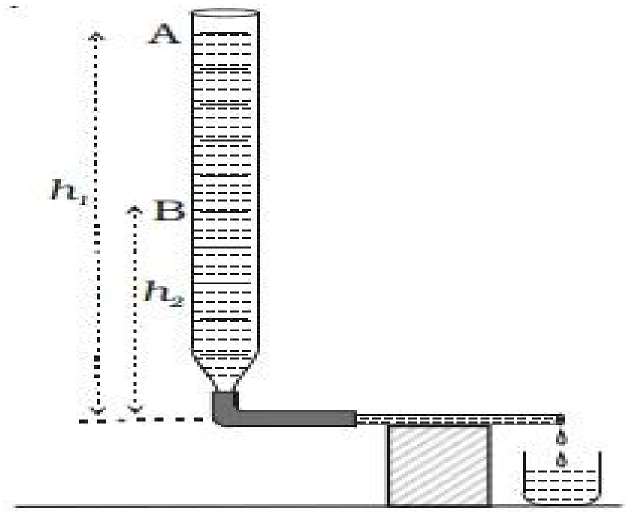

Fig. Determination of coefficient of viscosity by Poiseuille's flow

Poiseuille investigated the steady flow of a liquid through a capillary tube. He derived an expression for the volume of the liquid flowing per second through the tube.

Consider a liquid of co-efficient of viscosity η flowing, steadily through a horizontal capillary tube of length *l* and radius *r*. If *P* is the pressure difference across the ends of the tube, then the volume *V* of the liquid flowing per second through the tube depends on η

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3. SPECTROMETER

A) Adjustment of Spectrometer

The following adjustments should be done.

I) The optical axes of telescope and collimator should be perpendicular to the axis of rotation of the turn table and should meet at the same point.

This adjustment is done by the manufacturer.

II) Adjustment of the turn table:

1. The prism table is leveled with the help of three screws beneath the prism table. A spirit level is placed along the line joining the screws and the two screws are moved till the air bubble moves in the middle. Now place the spirit level along a line perpendicular to the previous line and adjust the third screw such that again the air

bubble appears in the middle. Here one thing should be remembered that first two screws should not be touched this time. The prism table is now leveled.

2. The second method which is generally used is **optical leveling** of the prism table. In this method the prism is placed on the prism table with its refracting edge at the centre of the prism table and one of its polished surface perpendicular to the line joining the two leveling screws P and Q as shown in fig 1(a).

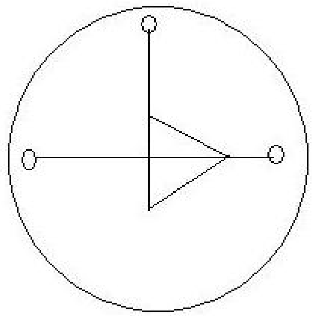


fig 1(a)

Now rotate the prism table in such a way that refracting edges AB and AC face towards the collimator and light falling on the prism is usually reflected from both the sides as in fig 1(b). The telescope is moved to the one side to receive the light reflected from the face AB and the leveling screws P and Q are adjusted to obtain image in the central field of view of the telescope. Again the telescope is moved to the other side to receive light reflected from face AC and remaining third screw R is adjusted till image becomes in central field of view of this telescope. The prism table is now leveled.

III) <u>Schuster's method for focusing the telescope and collimator:</u>

a) First of all prism is placed on the prism table and then adjusted for minimum deviation position. The spectrum is now seen through the telescope.

(Note: The turn table is rotated such that the light from the collimator may fall on the face AB and emerge through the face AC so that the spectrum is visible in the field of view of the telescope. Now, if the prism table is slightly rotated in the either direction till the refracted image of slit (spectrum) is obtained. The spectrum during the rotation of the table moves in one direction and it begins to retrace the path from a certain position when the rotation is still continued in the same direction. At this position, the rays suffer minimum deviation.)

b) The prism table is rotated slightly away from this position towards the collimator and spectrum is viewed focusing collimator on the spectrum.

c) Again rotate the prism table on the other side of minimum deviation position i.e. towards the telescope and focus telescope for best image of the spectrum.

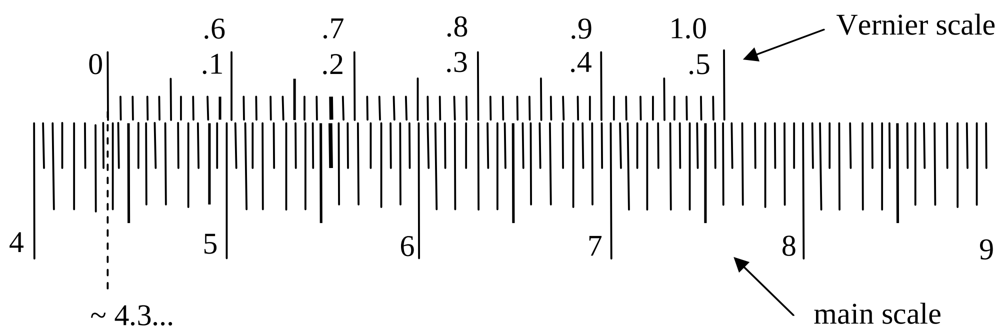
d) The process of focusing the collimator and telescope is continued till the slight rotation of prism table does not make the image to go out of focus. This means that both the collimator and the telescope are now individually set for parallel rays.

4. AIR WEDGE

- To understand that an optical interference method can be used to measure small distances.
- To measure the diameter of a wire by an optical interference method.
- To gain familiarity using a Vernier scale and determine the accuracy of your measurements.

The Vernier Scale

A Vernier scale is a small moveable scale placed next to the main scale of a measuring instrument. It allows us to make measurements to a precision of a small fraction of the smallest division on the main scale of the instrument.

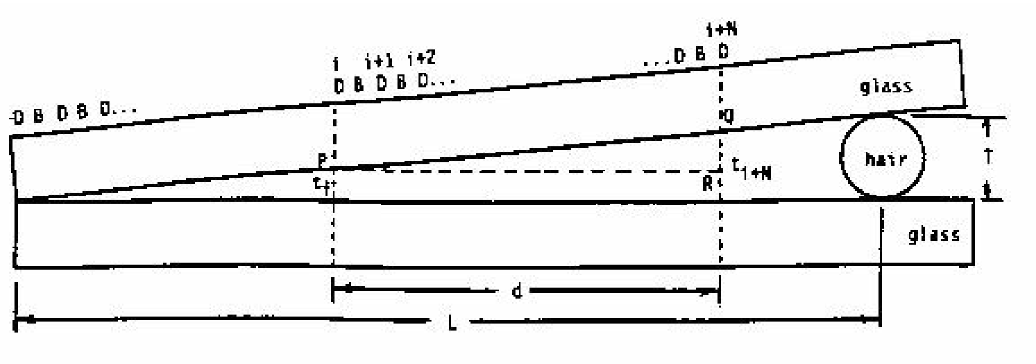


The following instructions describe how to correctly read the Vernier scale. Firstly, read the measurement on the main (lower) scale which is aligned with zero on the Vernier (upper) scale. You may find that using the magnifying lens and torch helps you to read the scale more easily.

In the example of Figure 1 this gives a value of just over 4.35 and less than 4.4. The accuracy of the measurement can be improved by reading the mark at which the lines on the Vernier and the main scale line up. In figure 1 this point has been indicated in bold for clarity and is at 0.18 or 0.68. Note the ambiguity between 0.18 and 0.68 as the Vernier scale has two sets of markings on it. The correct number to take depends on whether our first reading was above or below the 0.05 scale division on the main scale. In figure 1 it was above 4.35 so we take the 0.68 reading.

The final measurement is given by summing the two readings of 4.3 and 0.68, giving 4.368mm. (Note: this Vernier scale measurement has units of millimeters; the Vernier scales on spectrometers may be marked in degrees, minutes and seconds or degrees and fractions of a degree.)

In this experiment a wedge-shaped layer of air between two glass plates is produced by separating one end of the glass plates with a hair. (Refer to Figure 2.) When monochromatic light is shined on the plates from above, a series of bright and dark lines are seen. (In Figure 2 the bright and dark lines are indicated by the letters B and D, respectively.



A side view of the thin film of air. The distance between the lines and the thickness of the film are greatly exaggerated.

5. RIGITITY MODULUS – TORSION PENDULUM

PART 1: Determination of Rigidity modulus using Torsion pendulum alone

The radius of the suspension wire is measured using a screw gauge.

1. The length of the suspension wire is adjusted to suitable values like 0.3m,0.4m,0.5m,.....0.9m,1m etc.

2. The disc is set in oscillation. Find the time for 20 oscillations twice and determine the mean period of oscillation ' T_0 '.

3. Calculate moment of inertia of the disc using the expression

4. Determine the rigidity modulus from the given mathematical expression.

PART 2: Determination of rigidity modulus and moment of inertia using torsion pendulum with identical masses

The radius of the suspension wire is measured using a screw gauge.

1. The length of the suspension wire is adjusted to suitable values like .3m,0.4m,0.5m,.....0.9m,1m etc.

2. The disc is set in oscillation. Find the time for 20 oscillations twice and determine the mean period of oscillation ' T_0 '

3. The two identical masses are placed symmetrically on either side of the suspension wire as close as possible to the centre of the disc, and measure $\mathbf{d_1}$ which is the distance between the centers of the disc and one of the identical masses.

4. Find the time for 20 oscillations twice and determine the mean period of oscillation ' T_1 '.

5. The two identical masses are placed symmetrically on either side of the suspension wire as far as possible to the centre of the disc, and measure $\mathbf{d_2}$ which is the distance between the centers of the disc and one of the identical masses.

6. Find the time for 20 oscillations twice and determine the mean period of oscillation **' T_2 '**.

7. Find the moment of inertia of the disc and rigidity modulus of the suspension wire using the given formulae.

6.BAND GAP SEMICONDUCTOR

1. Wire up the circuit (provided separately). Sample 1 is a black case silicon based PNP transistor. You are measuring the base to emitter voltage as a function of temperature.

2. Put container of oil in the ice. Insert test tube with sample and digital thermometer probe in oil. Tip of probe should be near end of test tube. Use rod and clamp to hold in place.

3. Turn power supply voltage knob(s) to zero. Set current meter to measure a few mA. Set voltmeter to measure a few volts (2V). Turn on power supply and slowly turn fine volts knob to raise current close to 1 mA. The current must be kept within 1% of chosen value throughout experiment.

4. Get a few measurements of voltage and temperature as the sample cools off. Then move oil container, sample and probes to hotplate.

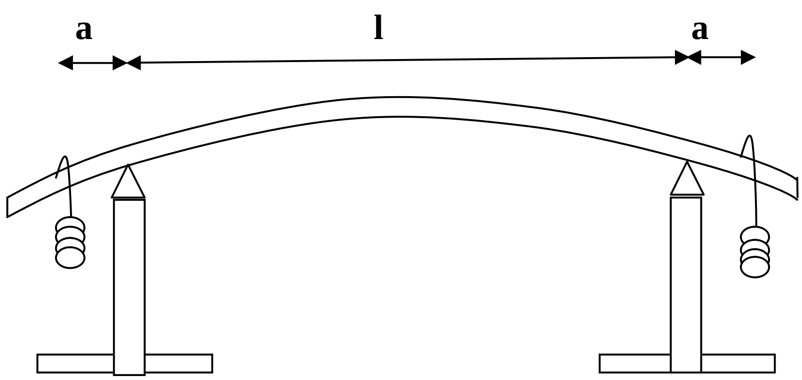
5. Turn on hotplate. Take temperature and voltage measurements at about 5 deg increments up to about 100 ˚C. NOTE: If a second digital thermometer is available put it in the oil. You may be able to get a reading or two with semiconductor temperature above 100˚C. Turn off hotplate before oil temperature reaches 150˚C.

6. Remove test tube and put container of oil in ice water to cool off. You may need to use gloves or towel to hold container.

7. Repeat process with sample 2. Use 2ma for current. This is a metal case germanium based PNP transistor. You are measuring base to emitter voltage.

8. Repeat process with sample 3. Use 1ma for current. This is a silicon based diode. You are measuring voltage across diode.

DIAGRAM - Young's Modulus by Uniform Bending



To find the breadth of the beam using Vernier Caliper (b):

LC = 0.001cm **OR = MSR + (VSC x LC)**

S.No.	MSR $x10^{-2}$ m	VSC division	VSR = (VSC X LC) $x10^{-2}$ m	OR = MSR + VSR $x10^{-2}$ m
1				
2				
3				
4				
5				
			Mean (b) =	$x10^{-2}$ m

Note:

MSR – Main Scale Reading
VSR – Vernier Scale Reading
OR – Observed Reading
VSC – Vernier Scale Coincidence
LC – Least Count

EX. NO : 1
DATE :

YOUNG'S MODULUS BY UNIFORM BENDING

AIM:

To determine the young's modulus of the material of the beam by uniform bending method.

APPARATUS REQUIRED:

A uniform rectangular beam, knife edges, weight hangers with slotted weights, Vernier microscope, pin, Screw gauge, vernier caliper.

FORMULA:

The Young's modulus of the material $E = \frac{3\,M\,g\,a\,\ell^2}{2\,b\,d^3\,y}\ Nm^{-2}$

Where,

- **E** - Young's modulus of the material of the beam in $\mathbf{Nm^{-2}}$
- **M** - Load producing the elevation in **'Kg'**
- **g** - Acceleration due to gravity in $\mathbf{ms^{-2}}$
- **l** - Length of the beam between the two knife edges in **'m'**
- **a** - Distance between the point of application of load and nearest knife edge in **'m'**
- **b** - Breadth of the beam in **'m'**
- **d** - Thickness of the beam in **'m'**
- **y** - Elevation produced for a load in **'m'**

OBSERVATION:

To find the thickness of the beam using Screw gauge

LC = 0.01 mm **ZE = ± ----- mm, ZC=± ----- mm**

S.No	Pitch scale reading (PSR) x 10^{-3}m	Head scale Reading (HSC) Division	Observed reading = PSR+(HSC x LC) x 10^{-3}m	Correct reading = OR ± ZC x 10^{-3}m
1				
2				
3				
4				
5				
Mean Thickness of the beam (b) =				x 10^{-3}m

Note:

PSR – Pitch Scale Reading
HSR – Head Scale Reading
OR – Observed Reading
VSC – Head Scale Coincidence
LC – Least Count

To find the Elevation of the beam (y)

LC = 0.001 cm **TR = MSR + (VSC x LC) cm**

S.No	Load x 10^{-3} kg	Traveling Microscope Reading						Mean cm	Elevation 'y' for M kg x10^{-2} m
		Increasing load			Decreasing load				
		MSR cm	VSC div	TR cm	MSR cm	VSC div	TR cm		
1	W								
2	W+50								
3	W+100								
4	W+150								
5	W+200								
Mean elevation of the beam (y) =									x10^{-2} m

The given beam is symmetrically supported on two knife edges. Two weight hangers are suspended at equal distance from the knife edges. A pin is fixed vertically at C by some wax. The length of the beam (l) between the knife edges is set for 60 cm. A traveling microscope is focused on the tip of the pin such that the horizontal cross wire coincides with the tip of the pin.

The reading in the vertical traverse scale is noted for dead load. In equal steps of m Kg added to the weight hangers , the corresponding readings for loading are noted. Similarly readings are noted while unloading. The breadth and the thickness of the beam are measured with a vernier calipers and screw gauge respectively. From the data Young's modulus of the beam is calculated.

CALCULATION:

Load applied at mid point **$m = 50 \times 10^{-3}$ kg**

Acceleration due to gravity **$g = 9.8\ ms^{-2}$.**

Breadth of the beam **b = -------------- $\times 10^{-2}$ m**

Thickness of the beam **d = ------------- $\times 10^{-3}$ m**

Distance between the point of application of load and nearest knife edge **$a = 10 \times 10^{-2}$ m**

Length of the beam between the knife edges l **= 60×10^{-2} m**

Young's modulus of the beam $E = \frac{3\, M\, g\, a\, \ell^2}{2\, b\, d^3\, y}\ Nm^{-2}$

RESULT:

Young's modulus of the material of the given beam **E =----------------- Nm^{-2}**

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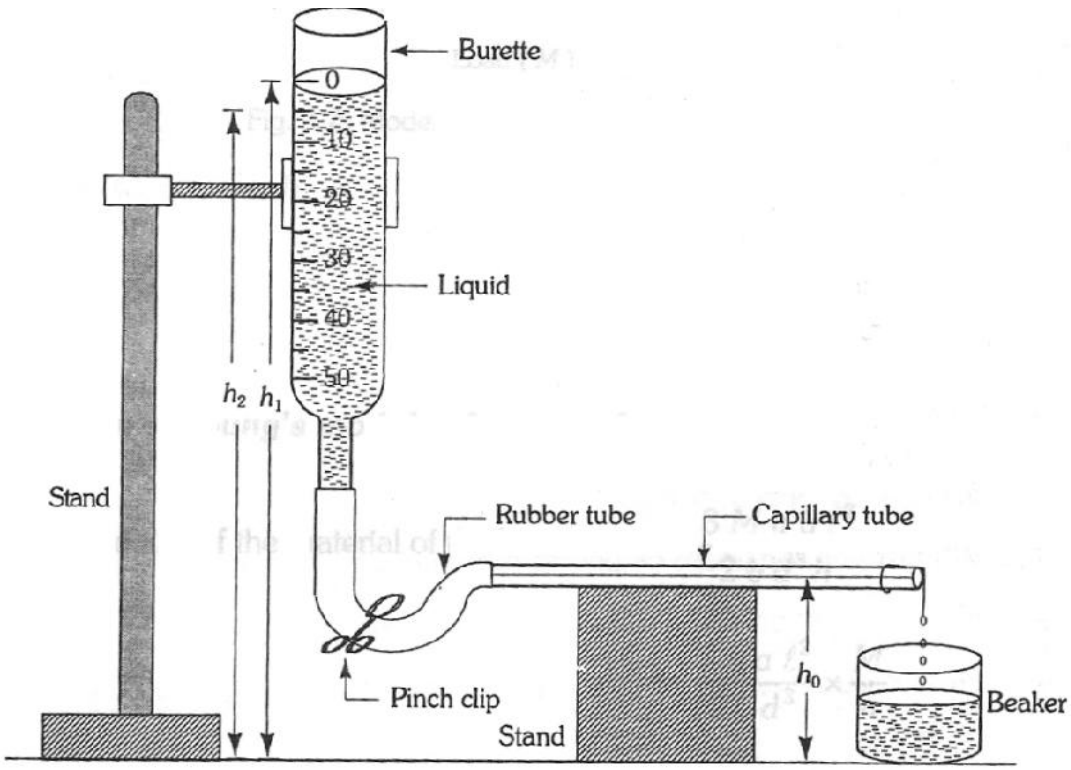
DIAGRAM - Coefficient of Viscosity of Water by Poiseuille's Method



EX. NO : 2
DATE :

COEFFICIENT OF VISCOSITY OF WATER BY POISEUILLE'S METHOD

AIM

To determine the coefficient of viscosity of the given liquid by poiseuille's flow method.

APPARATUS REQUIRED

Graduated burette, Burette stand, Capillary tube, Rubber tube, Pinch clip , Wooden stand, Beaker , Liquid, Stop watch, Meter scale, Traveling microscope.

FORMULA

Coefficient of viscosity of the liquid $$\eta = \frac{\pi \rho g r^4 h t}{8 l v} \quad Nsm^{-2}$$

Where,

ρ - Density of the given liquid in **kg / m^3**

g - Acceleration due to gravity in **ms^{-2}**

r - Radius of the capillary tube in **'m'**

h - Pressure head on the burette **'m'**

h_1 - Height of the initial level (0 cc mark) of liquid in the burette from the surface of the work table **'m'**

h_2 - Height of the final level (5cc mark) of liquid in the burette from the surface of the table **'m'**

h_o - Height of the axis of the horizontal capillary tube from the surface of the table in **'m'**

t - Time taken for 5 cc of liquid to flow in'**s**'

l - Length of the capillary tube **'m'**

v - Volume of the liquid in **m^3**

OBSERVATION:

Determination of the ' ht'

h_0 = ……….x 10^{-2} m

S. No	Burette reading	Time noted while crossing the level		Range	Time taken for the flow of 5cc of the liquid (t)	Height of the initial reading (h_1)	Height of the final reading (h_2)	Pressure head h = $[(h_1+h_2)/2]-h0$	ht
		Trial							
Unit	cc	Min	Sec	cc	sec	x10^{-2} m	x10^{-2} m	x 10^{-2} m	x10^{-2}ms
1	0			0-5					
2	5			5-10					
3	10			10-15					
4	15			15-20					
5	20			20-25					
6	25			25-30					
7	30			30-35					
8	35			35-40					
9	40			40-45					

Mean (ht) = x10^{-2}ms

PROCEDURE

Fix a clean dry burette in the stand which is as shown in figure. The well cleaned capillary tube of uniform cross section is attached to the lower end of the burette using rubber tube. The capillary tube is kept parallel to the work table (horizontal) using wooden stand, in order to get uniform flow of liquid

To stop any flow of liquid the pinch clip is fit to the rubber tube and close it. The burette is filled with the given liquid whose coefficient of viscosity is to be determined using a funnel above the zero mark. The liquid must be free from contamination in the form of precipitates or dirt etc. The pinch clip should be without any gravitational effect. The mass (m_1) of the clean and empty beaker (if the density of the liquid is not given) can be found using a physical balance and place it on the work table right below the free end of the capillary tube to collect the liquid. open completely and the liquid is allowed to flow in a streamlined manner (flowing freely) through the capillary tube drop by drop. The capillary tube should not be having any bubbles , if any it has to be removed completely first.

A short length of thread is tied at the free end of the capillary tube and makes it hanging from it so that the flowing liquid does not run along the surface of the tube, but falls inside the beaker in the form of drops through the tip of the hanging thread. Start the stop watch and note the time when the lower meniscus of the liquid crosses zero mark, 5, 10, 15 ………..40 cc in table. Using meter scale, the height h_1 from the surface of the table to the zero mark of the burette and the height h_2 from the surface of the table to 5cc mark of the burette for the first observation (when the liquid flows from zero mark to 5 cc mark).

The h_1 and h_2 values for other observations also should be recorded. The height h_0 from the surface of the table to the mid portion of the capillary tube can be measured. The time taken for the flow of 5 cc of liquid can be calculated. The pressure head (h) and also the product ht is also calculated. It is observed that the height (h) decreases, the time of flow of liquid (t) increases and the product (ht) is a constant.

Determination of the radius of the bore of the capillary tube:

The radius of the bore of the capillary tube is measured by using the traveling microscope must be done very carefully. The preliminary adjustment of the microscope and the least should be made. The capillary tube form the

CALCULATION:

Density of the given liquid **° = 1000 kg/m³**

Acceleration due to gravity **$g = 9.8\ ms^{-2}$**

Radius of the capillary tube **$r = 0.025 \times 10^{-2} m$**

Length of the capillary tube **$l = 50 \times 10^{-2}\ m$**

Volume of the liquid **$v = 5 \times 10^{-6} m^3$**

Mean value of ht **ht = ………… $\times 10^{-2}$ ms** experimental set up is detached and mount it over a stand in such a way that it is parallel to the work table. The microscope is adjusted to view the inner diameter of the capillary tube as shown in figure.

The vertical cross wire of the microscope is made to coincide with the left edge v_1 of the capillary bore and the reading should be noted in table from the horizontal scale of the microscope. Now the vertical cross wire is made to coincide with the right edge v_2 of the capillary tube and the reading should be noted. The horizontal cross wire is adjusted to coincide with bottom h_2 of the capillary bore and the reading should be noted. The diameter of the capillary bore is calculated by finding the difference between v_1 and v_2 and h_1 and h_2. The mean diameter (2r) and the radius (r) of the bore.

Determination of coefficient of viscosity of the liquid:

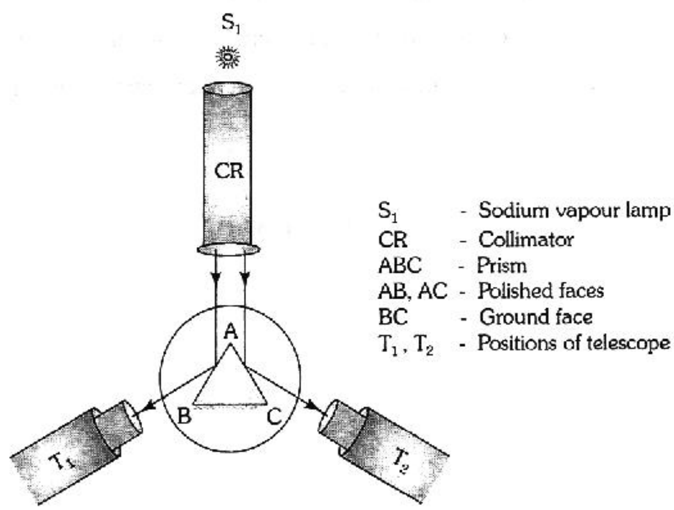
The length of the capillary tube (l) is measured using the meter scale. The relevant values can be substituted in the formula and the coefficient of viscosity of the liquid can be found.

RESULT:

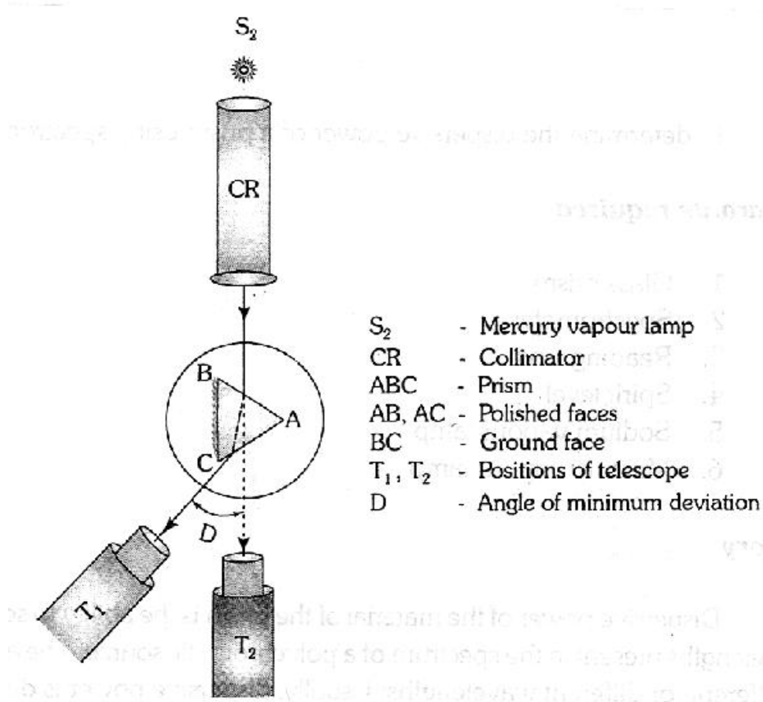
The coefficient of viscosity of the given liquid ¦ = **……………..Nsm^{-2}**

DIAGRAM - Spectrometer-Dispersive Power of The Prism

(1) Measurement of the angle of the prism (A):



2). To find the angle of minimum deviation 'D':



EX. NO : 3

DATE :

SPECTROMETER-DISPERSIVE POWER OF THE PRISM

AIM:

To determine the dispersive power of the prism using spectrometer.

APPARATUS:

Spectrometer, Flint glass prism, mercury vapour lamp, sodium vapour lamp, reading lens, spirit level.

FORMULA:

1. Refractive index of the prism, $\mu = \dfrac{\sin\left(A+D\right)/2}{\sin A/2}$

2. Dispersive power of the prism, $\mu = \dfrac{\mu_1 - \mu_2}{\mu_{12} - 1}$

Where,

$$\mu_{12} = \frac{(\mu_1 + \mu_2)}{2}$$

A - Angle of the prism in '**degree'**

D - Angle of minimum deviation in '**degree'**

μ_1 - Refractive index of the prism for first colour

μ_2 - Refractive index of the prism for second colour

PROCEDURE:

The preliminary adjustments of the spectrometer are made as usual. (Namely eye piece adjustment for distinct vision of the cross wires. Telescope adjustment for the distant object and collimator adjustment for parallel rays)

OBSERVATION:

To find the angle of the prism (A)

L.C = 1à **T.R = M.S.R + (VSCò L.C)**

Reflected image	VERNIER A deg			VERNIER B Deg			2A= R_1¼R_2 deg		A deg		Mean ‘A’ deg
unit	MSR	VSC	TR	MSR	VSC	TR	V_a	V_b	V_a	V_b	
Left											
Right											

Determination of the angle of minimum deviation ‘D’

L.C = 1à **TR = MSR + (VSCò L.C)**

Refracted ray readings	Vernier A			Vernier B			V_A R_1¼R_2 deg	V_B R_1¼R_2 deg	Mean D= $\frac{(V_A+V_B)}{2}$ deg	«
Lines of spectrum	MSR deg	VSC div	TR Deg R_1	MSR Deg	VSC Div	TR Deg R_2				
VIOLET										
BLUE										
BLUISH GREEN										
GREEN										
YELLOW										
RED										

The given prism is mounted vertically at the center of the prism table with its refracting edge facing the collimator, so that the parallel rays of light from the collimator fall almost equally on the two faces of the prism as shown in fig. The telescope is rotated to catch the reflected image from one of the faces of the prism and fixed in that position. By adjusting the tangential screw, the image is made to coincide with the vertical cross wire. The main scale and vernier scale readings are noted from both the vernier A and vernier B.

Similarly readings are taken for the image reflected by other refracting face of the prism. The difference between the two readings gives 2A, where A is the angle of the prism from this value, the angle of the prism is calculated.

The prism is mounted such that light emerging from the collimator is incident on one of the refracting face of the prism. Rotate the telescope slowly to catch the refracted image of any one of the colour which emerges from other refracting face of the prism.

The prism table is rotated in such a direction that the refracted image move towards the direct ray. The telescope is rotated carefully to the image in the field of view. At one stage, the image retraces its original path. This is the position of minimum deviation. At this stage fixes the telescope and adjusts the tangential screw to coincide the image of each colour with vertical cross wire. The corresponding readings are tabulated. The prism is removed and the direct ray reading is noted.

The difference between the direct ray and refracted ray reading for each color gives the angle of minimum deviation (D). By subtracting ‘A’ and ‘D’ values,’ μ’ for each and every colour can be calculated. By choosing any two colors and using dispersive formula, ‘ω’ can be calculated.

Determination of ’μ’

S.No	**Refractive index**		$«_{12} = \frac{(«_1 + «_2)}{2}$	μ
	$«_1$	$«_2$		

CALCULATION:

1. Refractive index of the prism, $« = \frac{\sin\ (A+D)/2}{\sin\ A/2}$

2. Dispersive power of the prism, $\mu = \frac{«_1 - «_2}{«_{12} - 1}$

Where $«_{12} = \frac{(«_1 + «_2)}{2}$

RESULT:

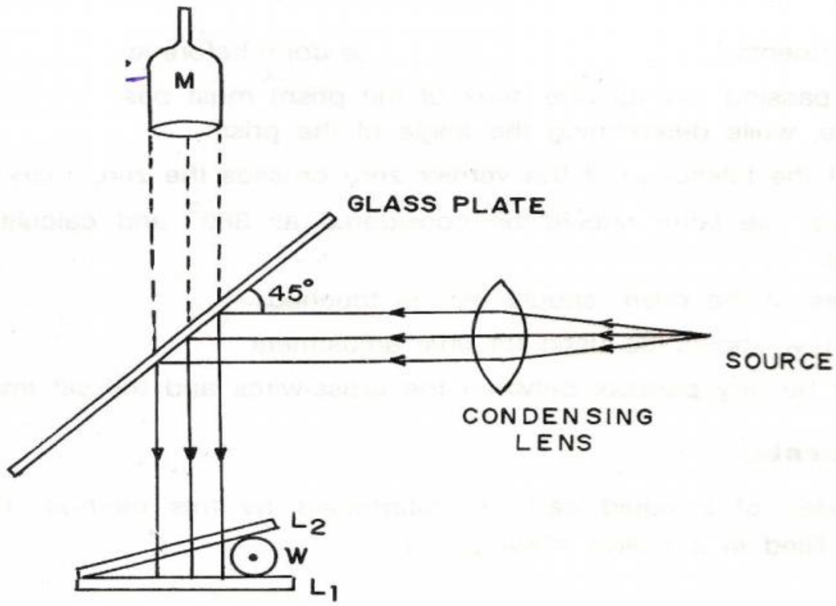
(1) Angle of the prism **'A' = ----------------------**

(2) Angle of minimum deviation **'D' = --------------------------**

(3) Refractive index of the material of the given prism **'«' = ----------**

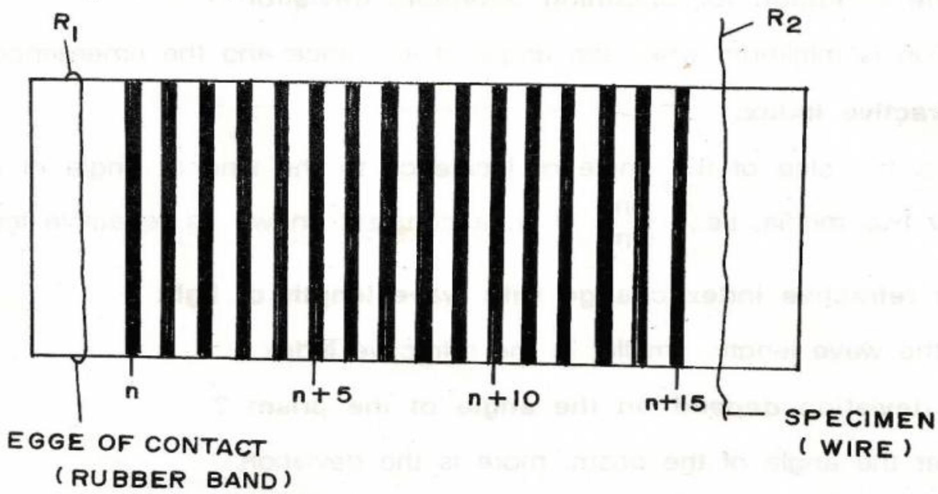
(4) Mean dispersive power of the given prism **'μ' = --------------------**

DIAGRAM - Air Wedge



Air-wedge arrangement

S	- Source (Sodium vapour light)
L	- Condensing lens (convex lens)
G	- Glass plate inclined at 45°
L_1, L_2	- Transparent plane glass plates
w	- Specimen (wire)



Interference - Fringe pattern

EX. NO : 4

DATE :

AIR WEDGE

AIM:

To determine the thickness of the thin wire by forming interference fringes using air-wedge arrangement.

APPARATUS:

Traveling microscope , Sodium vapour lamp , Two optically plane rectangular glass plates, Condensing lens ,Reading lens

FORMULA:

Thickness of the thin wire is given by,

$$t = \frac{a \; l}{2} \; m$$

Where,

λ - Wavelength of the sodium vapour lamp ($\lambda = 5893 X 10^{-10}$m) in **'m'**.

L - Distance between the specimen wire and the edge of contact, in **'m'**.

β - Mean width of one fringe, in **'m'**.

PROCEDURE:

The principle used in this experiment is interference (i.e., Superposition of two light waves). When a beam of monochromatic light falls normally on a glass plates, interference takes place between light reflected from

OBSERVATION:

To Determine the band width (β) LC=0.001 cm

S.No.	Order of the fringe	Microscope reading				Width of 5 fringes	Mean width of one fringe(β)
		MSR	VSC	VSR=(VSC X LC)	TR=(MSR +VSR)		
Unit		X 10^{-2}m	Div	X 10^{-2}m	X 10^{-2}m	X 10^{-2}m	X 10^{-2}m
1	n						
2	n+5						
3	n+10						
4	n+15						
5	n+20						
6	n+25						
7	n+30						
8	n+35						
9	n+40						
10	n+45						
						Mean(β) =	X 10^{-2}m

To determine the distance between the edge of contact and the specimen wire

Position	Microscope reading			
	MSR	VSC	VSR = (VSC x LC)	TR = (MSR + VSR)
unit	X 10^{-2}m	Div	X 10^{-2}m	X 10^{-2}m
Rubber band (edge of contact)				(R1)
Specimen wire				(R2)

$l = R_{2} \sim R_{1}$ .... X10^{-2}m the lower surface of the top glass plate and the upper surface of the lower glass plate resulting in the production of alternative bright and dark fringes.

An air-wedge is formed by keeping two planes rectangular glass plate kept contact in one end and it is tied by a rubber band. On the other side of the glass plate a thin wire whose thickness to be determined is introduced. This arrangement is placed on the horizontal bed of the traveling microscope

Now the light from the source is allowed to fall on the condenser lens. This lens renders back parallel beam of light. This parallel beam of light is allowed to fall on the glass plate which is kept at an angle of 45^0 to the horizontal plane. Now the light gets reflected. This reflected beam is allowed to fall on the two plane glass plates. Now the interference takes place between light reflected from top and bottom surface of the glass plates and the fringes consisting of alternate bright and dark bands through the traveling microscope.

The microscope is adjusted so that the bright and dark fringes near the edge of contact are made to coincide with the vertical cross wire of the telescope and it is taken as n^{th} fringe. The reading from the horizontal scale of the traveling microscope is noted. Now the microscope is slowly moved with the help of horizontal screw until the vertical cross wire coincides with the $(n+5)^{th}$ fringe and the corresponding reading is noted. Likewise the procedure is repeated up to 50 fringes (n+5, n+10, n+15….).From the observed reading mean width of one fringe (β) is calculated.

Now the microscope is moved towards the specimen wire and the reading (R_2) is noted. Similarly the microscope is moved towards the edge of contact and the reading (R_1) is noted. From the difference (R_2~ R_1) the length

CALCULATION

Wavelength of the sodium vapour lamp, **λ = 5893 X 10^{-10}m**

Distance between the specimen wire and the edge of contact ***l*** **= ……… X 10^{-2}m**

Mean width of one fringe, **β = ………. X 10^{-2}m**

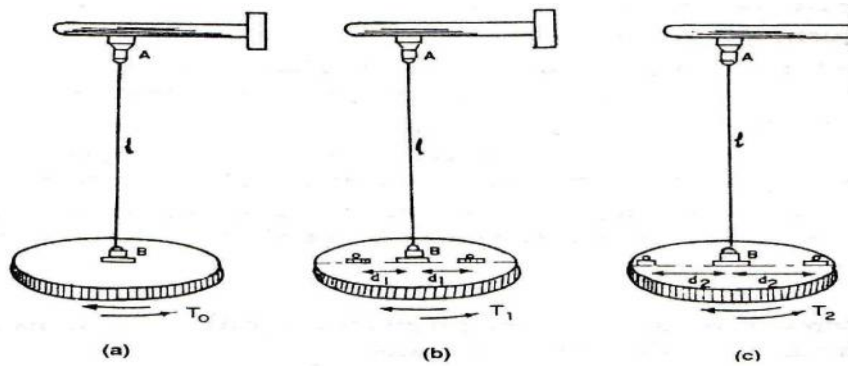
Thickness of the thin wire is given by,

$$t = \frac{a\,l}{2} \quad m$$

RESULT

Thickness of the thin wire (t) = _____________ in ‘m’.

DIAGRAM- Torsional Pendulum



Torsional pendulum

To find the radius (r) of the wire:

LC = 0.01 mm **ZE = ± ----- div**

ZC = ± (ZE x LC) =------ x 10^{-3}m

S.No	Pitch scale reading (PSR) x 10^{-3}m	Head scale reading (HSC) Div	Observed reading = PSR+ (HSC x LC) x 10^{-3}m	Correct reading = OR ± ZC x 10^{-3}m
1				
2				
3				
4				
5				

Mean=………………. x 10^{-3}m

EX. NO : 5

DATE :

TORSIONAL PENDULUM

AIM

To determine the moment of inertia of the metallic disc and the rigidity modulus of the material of the wire.

APPARATUS REQUIRED

Torsion pendulum, Two equal masses , Stop-clock , Screw gauge , Meter scale.

FORMULA

The moment of inertia of the metallic disc is given by

$$I = \frac{2m\ d_2^2 - d_1^2\ T_0^2}{T_2^2 - T_1^2} \text{ Kg m}^2$$

The Rigidity modulus of the material of the wire is given by,

$$\eta = \frac{8\pi I l}{T_0^2 r^4} \text{ N m}^2$$

Where,

- **M** - Mass of any one of the cylindrical masses in '**Kg'**.
- **r** - Radius of the suspended wire in **'m'**.
- ***l*** - Length of the suspension wire in **'m'**.
- **d_1** - Minimum distance between the suspension wire and the centre of mass of the cylinder in **'m'.**
- **d_2** - Maximum distance between the suspension wire and the centre of mass of the cylinder in **'m'.**
- **T_0** - Time period when no masses are placed in'**s**'.
- **T_1** - Time period when two identical masses are placed at the minimum distance in '**s**'.
- **T_2** - Time period when two identical masses are placed at the maximum distance in '**s**'.
- **I** - Moment of inertia of the disc in kg-m^2

OBSERVATION:

To determine the Time period:

Length of the suspension wire = …….. x 10^{-2} m

Position of the equal masses	Time for 20 oscillations			Time period (Time for one oscillation) sec	T^2 sec^2
	Trial-1 Sec	Trial-2 Sec	Mean sec		
Without masses					
With mass at minimum distance d_1= 2.5 x 10^{-2}m					
With mass at maximum distance d_2= 5.5 x 10^{-2}m					

PROCEDURE

One end of the long uniform metallic wire whose rigidity modulus to be determined is clamped. On the other lower end, a heavy metallic disc is attached by means of a chuck. The length of the suspension wire is fixed to a particular value say, 60 or 70 cm.

The disc is slightly twisted so that it executes ***torsional oscillations***. Care should be taken that the disc oscillates without wobbling. First few oscillations are omitted. A mark is made on the disc such that time taken for 20 oscillations (to and from motion) are noted using stop-clock. Two trials are taken. The average of these two trials gives the time period T_0.

Now equal masses are placed on either side of the disc close to the suspension wire. The distance d_1 from the centre of one of mass and the suspension wire is noted. Now the disc with masses at the minimum distance is made to execute torsional oscillations. Time for 20 oscillations is noted. Two trials are taken. From this mean period T_1 is calculated.

Now the two masses are placed at the extreme ends of the disc and the distance d_2 from the centre of the one of the masses and the point of suspension wire is noted. The disc is now subjected to torsional oscillations. Time for 20 oscillations is noted. Two trials are taken. From this time period T_2 is calculated.

Now the masses of any one of the cylinders are calculated. The radius of the wire is measured by means of screw gauge and the length is measured using meter scale. From this data the moment of inertia and the rigidity modulus of the material of the wire are determined.

CALCULATION

Mass of any one of the cylindrical masses **m = 50 X 10^{-3} kg.**

Radius of the suspended wire **r = X10^{-3}m**

Minimum distance between the suspension wire and the centre of mass of the cylinder **d_1 = 2.5 X 10^{-2} m**

Maximum distance between the suspension wire and the centre of mass of the cylinder **d_2 = 5.5 X 10^{-2} m**

Length of the suspended wire ***l*** **= X10^{-2}m**

Time period without masses **T_0 = sec**

Time period when two identical masses are placed at the minimum distance 'd_1' **T_1 = sec**

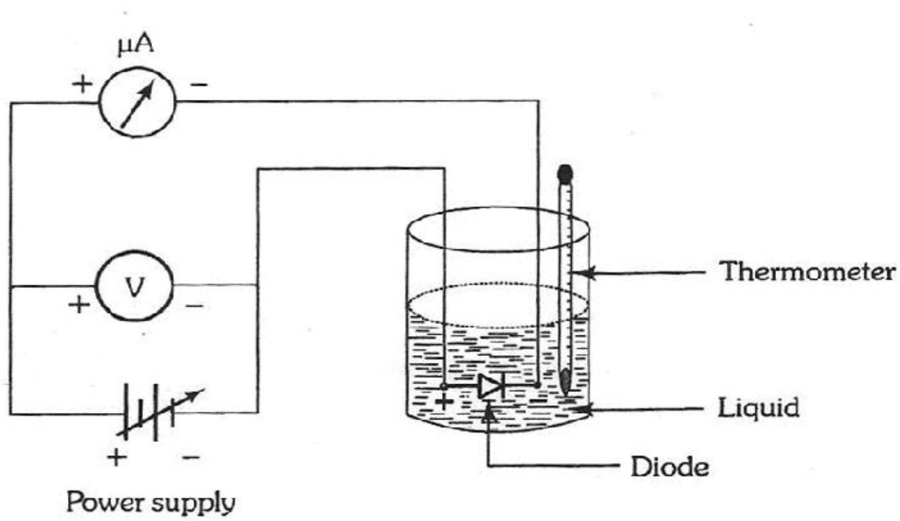
Time period when two identical masses are placed at the maximum distance 'd_2' **T_2 = sec**

RESULT

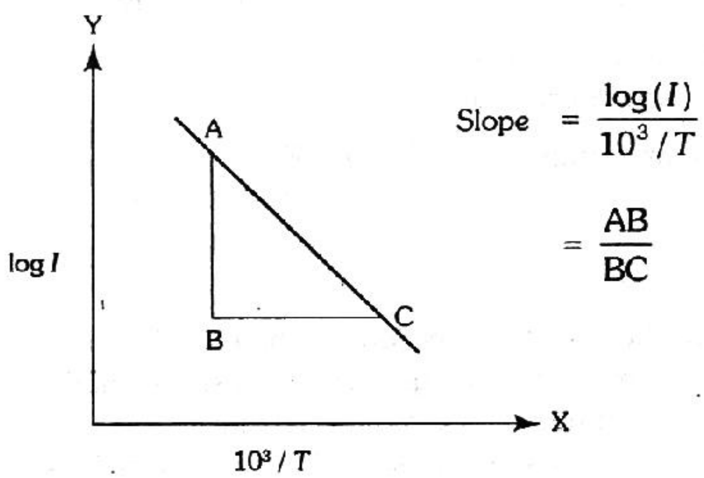
1. The moment of inertia of the metallic disc (I) = _____________kg m^2

2. The Rigidity modulus of the material of the wire (η) =_________ Nm^{-2}

DIAGRAM- **Band Gap of a Semiconductor**



GRAPH



EX. NO : 6
DATE :

BAND GAP OF A SEMICONDUCTOR

AIM:

To determine the band gap of a semiconductor.

APPARATUS REQUIRED:

Power supply, Voltmeter, Micro ammeter, Diode, Thermometer, Oil, Beaker.

FORMULA:

$$E_g = 2k\frac{\ln I}{T} \quad \text{eV}$$

Where

K - Boltzmann constant (1.38 x10^{-23} J/K)
I - Saturation current passing through the diode for a particular temperature **'μA'**
T - Temperature of the diode in '**K**'

PROCEDURE

Make the circuit connections as a shown in the figure. Note that the given semiconductor (Ge or Si diode) whose band gap is to be determined must be connected to the circuit through long wires soldered at its terminals such that it is reverse biased. Take oil or water in the beaker and immerse the reverse biased diode with leads in the liquid inside the beaker. Insert the thermometer in the beaker such that its mercury bulb is just at the height of the diode.

Heat the liquid up to 70°C using the heating system. Switch off the heating system and allow the liquid to cool on its own. Switch on the regulated power supply and by adjusting its knob set the current 0.5 V through the diode . when the temperature of the diode in the liquid is 60°C ,note the current I flowing through the diode as shown in the micrometer.

OBSERVATION:

Determination of band gap

Tc Temperature in Celsius	T_k Temperature in Kelvin	Current in microampere I	Log I	$10^3/ T_k$

As the temperature of the diode falls, the current flowing through it decreases. Note the current as shown by the micro ammeter for every one degree Celsius fall of the temperature of the liquid until it falls to 50°C.

Draw graph with $10^3/T$ along x- axis and log I along y-axis. The graph will be a straight line. Determine the slope of the log I versus $10^3/T$ from the graph. Substituting the value of the slope and the Boltzmann's constant in the formula , calculate the band gap(E.g.) of the semiconductor.

RESULT:

Band gap of a semiconductor = ………….. eV