PHYSICS LAB MANUAL

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Experiment No. 1

OBJECT: - To determine the wavelength of sodium light by Fresnel's Biprism method.

APPARATUS:-

Optical bench with uprights, a sodium lamp, Fresnel's biprism, a convex lens and micrometer eyepiece.

FORMULA USED:-

In the case of biprism experiment the mean wavelength

$$\boxed{\lambda = \beta \frac{2d}{D}}$$

Where β = fringe width

2d = distance between the two virtual sources **D**

= distance between the slit and the eyepiece

Where β is measured and distanced between the vertical source is given by

$$2d = \sqrt{(d_1 . d_2)}$$

Where d_1 = distance between the two image formed by the convex lens in the first position.

d_2 = distance between the two image formed by the convex lens in the second position

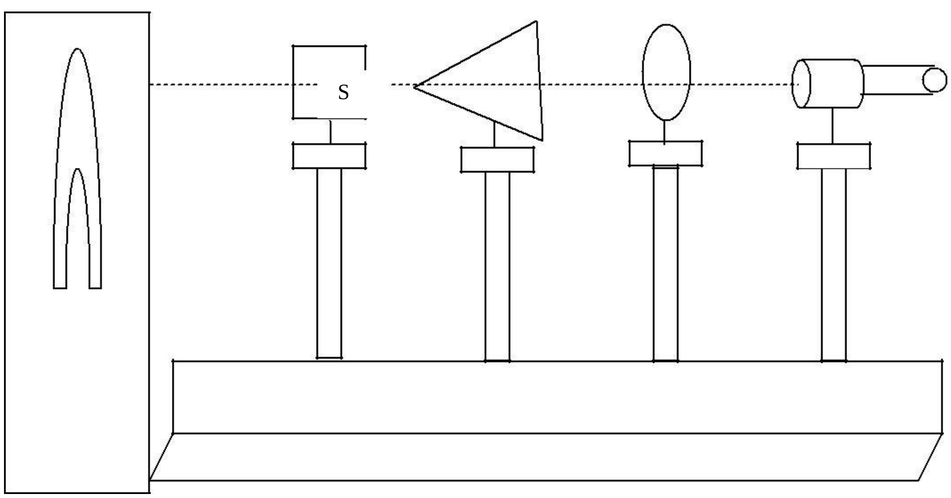

Fig. 1 Experimental arrangement of Biprism

PROCEDURE:-

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(1) Adjustment

(i) The height of the slit biprism and eyepiece is adjusted at the same level.

(ii) The biprism upright is placed near the slit. The slit is made narrow and vertical. It is illuminated with sodium light. Looking through the biprism two images of the source will be seen. The eye is moved side ways when one of the images will appear to cross the edge of the biprism from one side to the other. If the refracting edge of the biprism is parallel to the slit, the images as a whole will appear to cross the edge. Otherwise when adjustment is faulty, either the top or the bottom of the image will cross the edge first. The biprism is adjusted by rotating it in its own plane to effect the sudden transition of the full image.

(iii) The eyepiece is placed near biprism and the biprism upright is moved perpendicular to the biprism till fringes or a patch of light is visible. If the fringes are not seen the biprism is rotated in its cross plane.

(iv) If fringes are not clear reduce the slit width slightly.

(v) The vertical cross wire is adjusted on one of the bright fringe at the center of the fringe system and the eyepiece is moved away from the biprism. In doing, if fringes give a lateral shift, it must be removed in the following way. From any position, the eyepiece is moved away from the biprism and at the same time a lateral shift is given to the biprism with its base screw so that the vertical cross-wire remains on the same fringe on which it was adjusted. The eyepiece is now moved towards the biprism and this procedure is repeated few times till the lateral shift is removed.

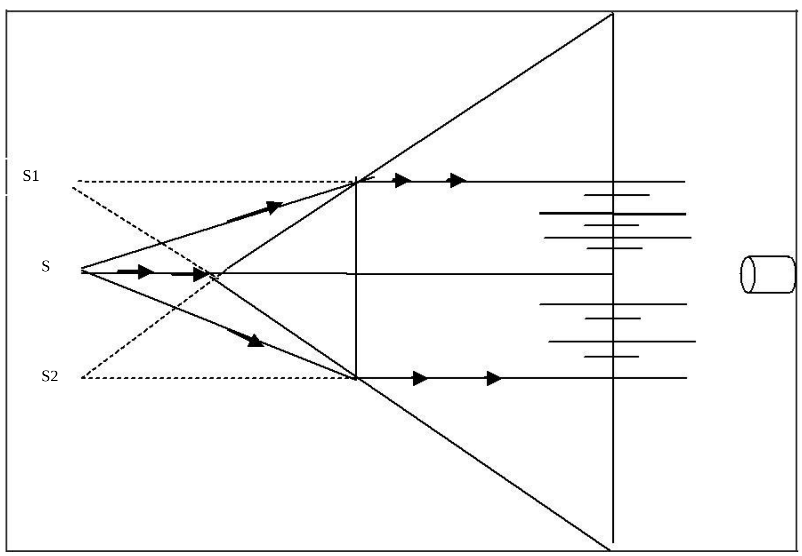


Fig. 2 Determination of fringe width

2. Measurement of β: (Fringe width)

1. The eyepiece is fixed about 100cm away from the slit.

2. The vertical crosswire is set on one of the bright fringes and the reading on the eyepiece scale is noted.

3. The crosswire is moved on the next bright fringe and the reading is noted. In this way observation are taken for about 20 fringes.

3. Measurement of D: (distance between source and screen)

1. The distance between the slit and eyepiece gives D.

4. Measurement of 2d: (distance between the two sources on screen)

1. For this part the distance between the eyepiece and slit should be kept slightly more than four times the focal length of lens. If necessary the position of the slit and the biprism should not be altered.

2. The convex lens is introduced the biprism and eyepiece and is placed near to the eyepiece. The lens is moved towards the biprism till two sharp images of the slit are seen. The distance d_1 is measured by the micrometer eyepiece.

3. The lens is moved towards the biprism till two images are again seen the distance between these two images give d_2.

4. At least two sets of observation for d_1 and d_2 are taken.

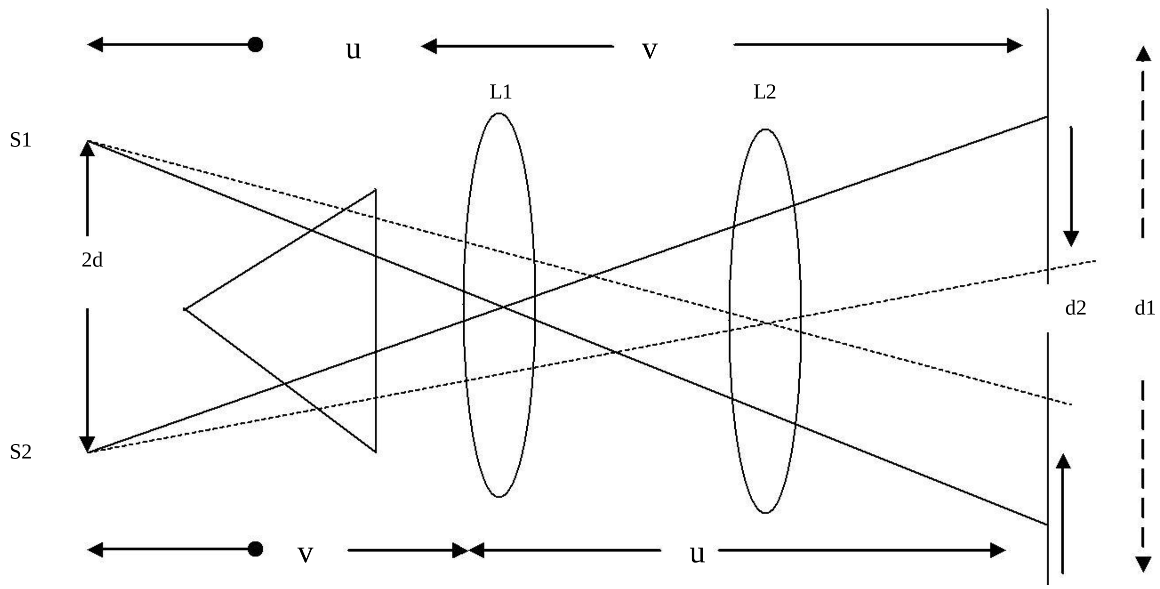


Fig. 3 Determination of distance between two sources

Observation of β: (fringe width)

No of division on the vernier scale =
Least count of Vernier =

No of fringe	Micrometer reading(a)			No of fringe	Micrometer reading(b)			Difference for 10 fringe	Mean for 10 fringe	Fringe width (mm) β = [Mean/10]
	MS	VS	Total (mm)		MS	VS	Total (mm)			
1				11						
2				12						
3				13						
4				14						
5				15						
6				16						
7				17						
8				18						
9				19						
10				20						

Measurement of D:

Position of the slit (a) = -----------cm
Position of the eyepiece (b) = -----------cm
Observation value of D (b-a) = -----------cm

Measurement of 2d:

Micrometer Reading												$2d = \sqrt{d_1 d_2}$	Mean 2d
Observation for d_1						Observation for d_2							
Position of I Image			Position of II Image			Position of I Image			Position of II Image				
MS	VS	Total	MS	VS	Total	MS	VS	Total	MS	VS	Total		

Calculation:

$$\lambda = \beta \frac{2d}{n} \qquad = \qquad \text{Å}$$

Result:

Standard value = ------------ Å

Percentage Error=-------------.

EXPERIMENT NO. 2

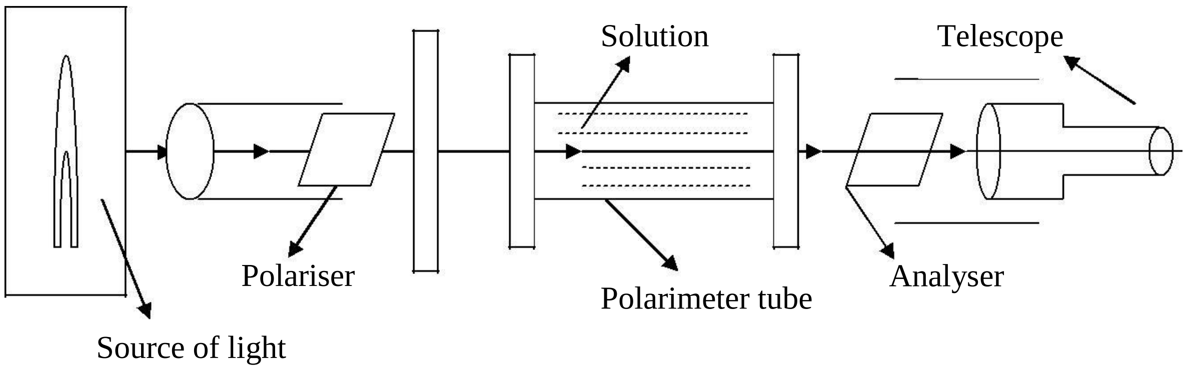
OBJECT:- To find the specific rotation of cane- sugar solution by a polarimeter at room temperature, using Half shade polarimeter.

APPARATUS:- Polarimeter, Polarimeter tube, cane-sugar, Physical Balance, Weight box, measuring cylinder, beaker and source of light.

FORMULA USED:- The specific rotation of cane- sugar solution is given by

$$S = \frac{\theta}{l.c} = \frac{\theta.v}{l.m}$$

where θ = rotation of the plane of polarization (in sugar)produced by the solution
v = volume of the sugar solution in cc
l = length of the polarimeter tube in decimeter
m = mass (in gms.) of sugar dissolved in water



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METHOD:-

1. The polarimeter tube is cleaned and filled with water such that no air is enclosed in it If there remains a small air bubble, then the bubble is brought in the bubble trap while placing the tube inside the polarimeter.
2. The tube is placed in its position inside the polarimeter and the polarimeter is illuminated with a white light source.
3. The analyser is rotated and adjusted in the position of tint of passage where yellow light is quenched and blue and red colures overlap and both halves of the field of view appear pink. The reading of the main scale and vernier scale is noted.
4. The Analyser is rotated by 180^0 where a similar situation appears and analyzer is again adjusted at the position of tint of passage. The reading on the main scale and vernier scale is noted.

5. About 10 gm of sugar is weighed and dissolved in water in the measuring cylinder to make 100cc of solution. Concentration of this solution is about 10%.
6. Water is removed and the solution is filled in the tube.
7. The tube is placed in polarimeter and observations are taken as in the case of water.
8. 50cc of the above solution is taken in measuring cylinder and water is added to make it 100cc. The Concentration of this solution is about 5%. Observations are repeated with this solution.
9. The above step is repeated and observations are taken for solution of about 2.5 % concentrates.

OBSERVATIONS:-

Length of the polarimeter tube = -------- dcm.

Mass of watch glass = -------- gms

Mass of Watch glass and sugar = --------- gms.

Mass of sugar = --------- gms.

Volume of the sugar solution = --------- cc

Temperature of the solution = ---------- ^{0}C

Concentration of the solution ($\frac{M}{V}$) = --------- gms/cc.

OBSERVATION FOR THE ANGLE OF ROTATION:-

Least count of instrument = ---------degree.

Analyser reading with pure water						
Clockwise X			Anticlockwise Y			Mean
MS	VS	Total	MS	VS	Total	$a = \frac{X+Y}{2}$

Concentration of solution in gm/cc	Analyser reading with sugar solution						Mean $b = \frac{X+Y}{2}$	$\theta = (b-a)$
	Clockwise X_1			Anticlockwise Y_2				
	MS	VS	Total	MS	VS	Total		

Calculation:

$$S = \frac{\theta}{l.c} = \frac{\theta.v}{l.m}$$

S1 =

S2 =

S3 =

Mean (S) = S1+S2+S3+S4 / 4

Result: The specific rotation of sugar = ---------------degree/dm/gm/cc

EXPERIMENT No.3

OBJECT: To determine the wavelength of spectral lines of mercury light by a plane transmission grating.

APPARATUS: Mercury lamp, Spectrometer, a spirit level, grating with stand, table lamp and a reading lens.

FORMULA USED: The wavelength of any spectral line can be obtained from the formula.

$$(a+b)\ \text{Sin}\theta = n\ \lambda$$

$$\boxed{\lambda = \frac{(a+b)\ \text{Sin}\theta}{n}}$$

Where, $(a+b)$ = grating element
θ = angle of diffraction
n = the order of spectrum

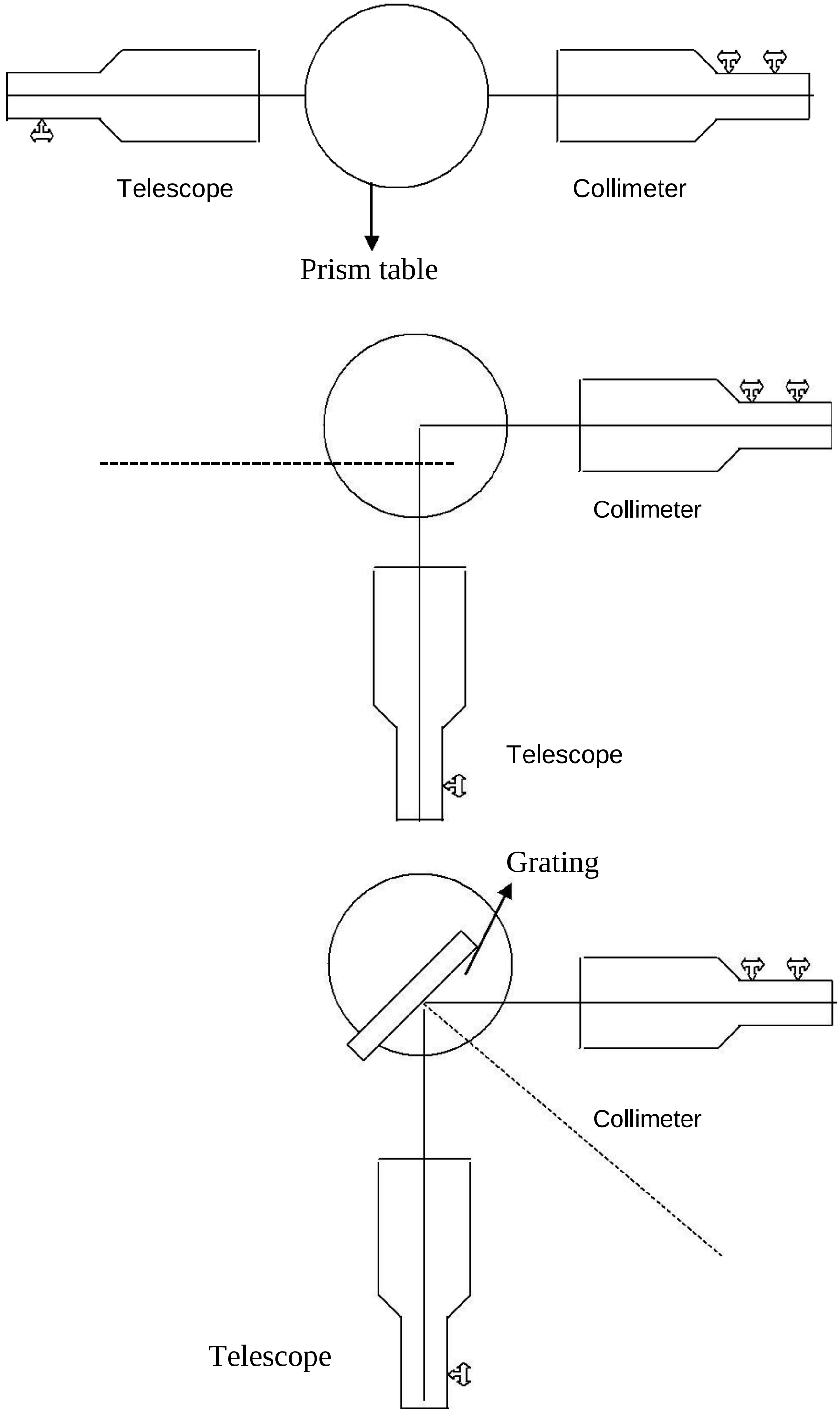
Procedure:

1. Set the spectrometer by adjusting the position of the eyepiece of the telescope so that the crosswire are clearly visible. Focus the telescope on a distance object for parallel rays. Level the spectrometer and prism table with spirit level.
2. Set the grating stand on prism table with help of two screws P and Q provided on the table. Take out the grating from the box carefully, holding it from the edge and with out couching its surface towards the telescope.
3. The telescope is rotated by 90^0 towards the left side of direct image and the diffraction grating is placed on the grating table.
4. The grating should be adjusted by rotating the grating table without touching the telescope such that the slit gets appeared at the crosswire of the eyepiece.
5. When the slit is seen clearly we rotate the grating table 45^0 towards right. So the diffraction gratings become normal to the incident light and ruled surface focus the telescope.
6. Now, the telescope should be again brought in its original position by rotating it 90^0 towards right.
7. Focus the telescope for different colours violet, green, red, etc. (VIBGYOR) by moving telescope slowly on either side from normal position. It was the first order spectrum.
8. Now, the second order spectrum may be viewed by further rotating the telescope in the same direction.
9. After taking the measurement for first order spectrum on both sides, i.e; by nothing v1 and v2 (main scale and vernier scale), we turn the telescope for the other side (say, right or left). It is now focused on the same colours or spectral lines and the reading of the crosswire on the scale is recorded.
10. Finally, the same procedure is repeated for other colours (spectral lines) as well as for other order of the spectrum.

Step 1

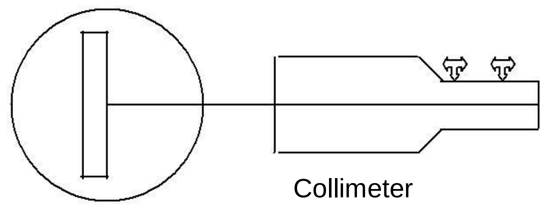
Step 2

Step 3

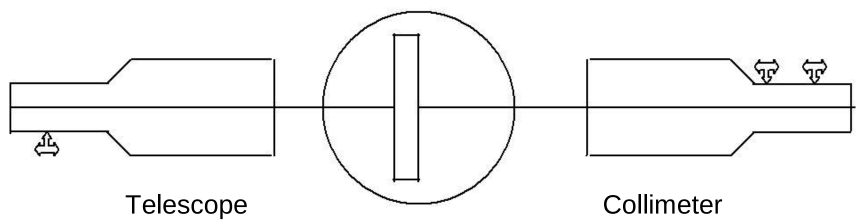


Adjustment of grating for normal incidence (step 1-3)

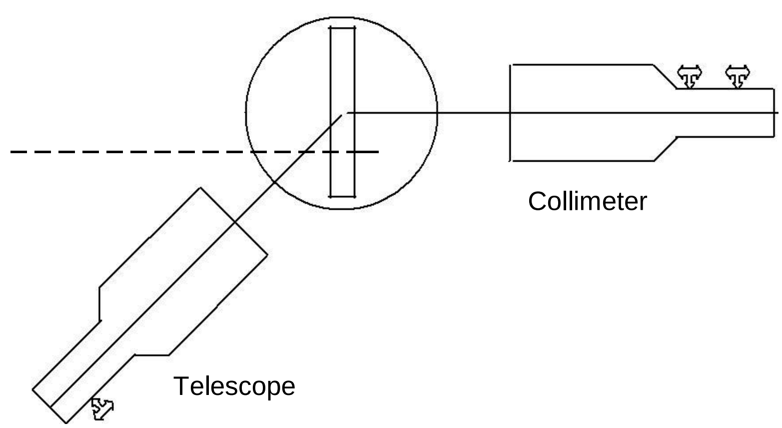
Step 4



Step 5



Step 6



Observation:

Table for determination of angle of diffraction:

Least count of spectrometer =

Number of lines per inch on the grating N =

Grating element (a+b) ------------------------ $\frac{2.54}{N}$

Reading of telescope for direct image $=90^{0}$

Reading of telescope after image $= 180^{0}$

Order of spectrum	Colour of light	Kind of vernier	Spectrum on left side reading of telescope (a)			Spectrum on right side reading of telescope (b)			2θ=(a-b)	Mean θ in degree
			MS	VS	Total	MS	VS	Total		
First	Violet	V_1								
		V_2								
	Green	V_1								
		V_2								
	Red	V_1								
		V_2								
Second	Violet	V_1								
		V_2								
	Green	V_1								
		V_2								
	Red	V_1								
		V_2								

Calculation:

Grating element (a+b) --------------------------= $\frac{2.54}{N}$

N = 15000

[redacted]

First Order:

Violet ---------------Å

Green ---------------Å

Red ------------------Å

RESULT:

Violet ---------------Å

Green ---------------Å

EXPERIMENT NO. 4

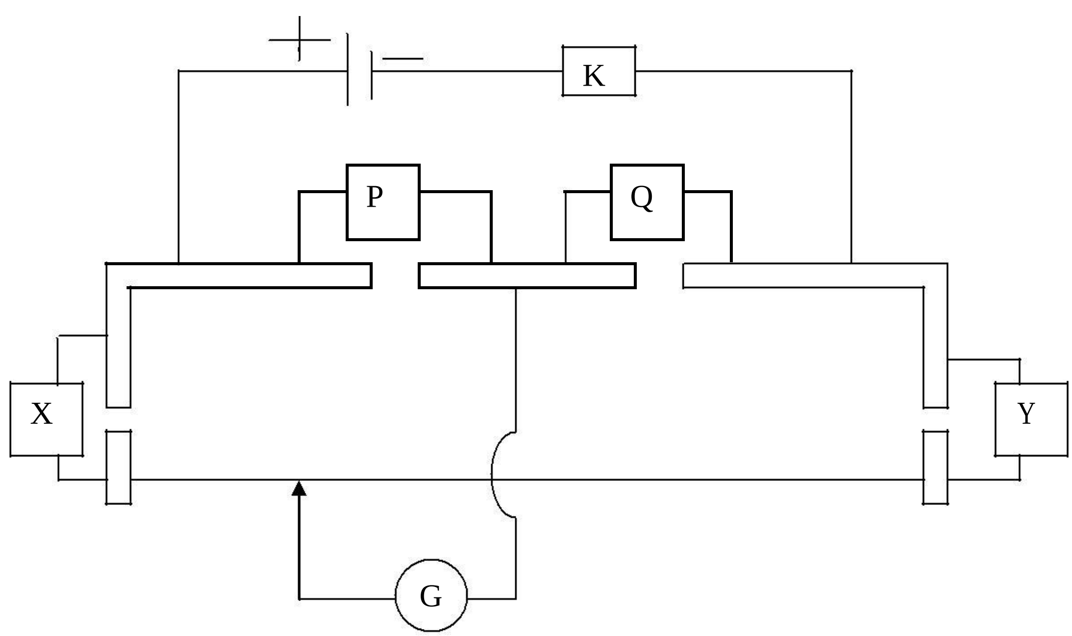
OBJECT: To determine Specific resistance of the material of given wire using Carey foster's bridge.

APPARATUS: Carry foster's bridge, two equal resistances, copper strip, a fractional resistance box, a cell, connecting wire, a sensitive galvanometer, a jockey and one way key.

PRECAUTION:

1. The thick copper strip and the end of the wire should be cleaned.
2. The unknown low resistance, fractions resistance box and equal resistance P and Q should be connected to the bridge by thick equal and small copper leads.
3. The plugs of the resistance box should be tight.
4. The values of equal resistance P and Q should be very small i.e. between 1 to 5 ohms.
5. The jockey should be touched gently and should not be kept pressed on the wire when shifting it from one point to the other.
6. The difference between X and Y should not be more then the resistance of the bridge wire.

Theory: `The arrangement of Carey Foster's bridge is similar to Wheatstone bridge. As shown in figure P and Q are two ratio arms x along with the resistance of the wire and Y along with the resistance of the wire from the other two arms.



Method: **Low resistance by calibrating the bridge – wire:** Let x be the unknown resistance and d_1, d_2 shifts obtained with resistance Y_1 and Y_2 the know resistance box then

$$X - Y_1 = - d_1 \rho$$

$$X - Y_2 = - d_2 \rho$$

$$(X-Y_1)/(X-Y_2)=d_2 /d_1$$

$$d_2 X - d_2 Y_1 = d_1 X - d_1 Y_2$$

$$X (d_2 - d_1) = d_2 Y_1 - d_1 Y_2$$

$$\boxed{X = \frac{d_2 Y_1 - d_1 Y_2}{d_2 - d_1}}$$

Specific resistance of the wire $\rho = \frac{X\pi r^2}{l}$

where, r is the radius and l is the length of wire

It is, therefore, not necessary to find out the value of ρ for the determination of an unknown low resistance. This method has the advantage that it does not require calibration of the bridge wire.

Procedure:

1. Draw the diagram showing the scheme of connections as in fig 1. Mark the gaps 1,2,3 and 4 on the bridge. Now clean the ends of the connecting wire and copper strip with sand paper. Connect the two equal resistance P and Q (say 1 ohm) in inner gaps2 and 3. Connect the copper strip in gap 1 and the fractional resistance box in gap 4. Connect one terminal of the galvanometer to the central terminal b and the other to a jockey. Connect the cell through a key K between the point A and C. Now test the connection by putting in the key K and touching the jockey at the end ‘a’ and then at ‘b’ end of the potentiometer wire, if the direction of deflection is in opposite direction in each case, then the connections are correct.

2. Now the keeping X and Y both equal to zero, find the balance point.Interchang X and Yand again find the balance point. The shift in the balance point gives the value of the corrections δl to be applied in all observations.

3. Replace the copper strip by X the unknown low resistance and find the shift in the balance point keeping Y equal to 0, 0.1, 0.2, 0.3, etc.

4. Calculate the radius of the given wire using screw gauge and length of the wire l. Measure only that length of the wire which is outside the binding terminals.

Observation:

Correction to applied δl = ----------- Cm

S.No.		Position of balance point with unknown resistance		Shift	Corrected shift
		Left gap l_1	Right gap l_2	$d = (l_1 - l_2)$	$(d - \delta l)$
1.					
2.					
3.					
4.					
5.					

Calculation: Value of X from observation

$$\boxed{X = \frac{d_2 Y_1 - d_1 Y_2}{d_2 - d_1}}$$

1and 2 ohms

2and 3 ohms

3 and 4 ohms

4 and 5 ohms

Mean value of X = ----------------ohms

Specific resistance of the wire $\rho = \frac{X\pi r^2}{l}$

Specific resistance ρ = -------------ohm cm

Result:

Experiment No.5

OBJECT: - To plot graph showing the variation of magnetic field with distance along the axis of a circular coil carrying current and evaluate from it the radius of the coil.

APPARATUS: - Stewart and Gee type galvanometer, Storage battery, rheostat, Millimeter, reversing key, one way key and connecting wires.

PRECAUTIONS: -

1. There should be no magnetic material or current carrying conductor in the neighborhood of the apparatus.
2. The coil should be adjusted in the magnetic meridian carefully and this should be tested by passing the current through it in one direction and then in the reverse direction. The deflection in two cases should be very nearly the same and must not differ by more than 2^o. Further, in this part of the experiment the current should be such that the deflection produced is nearly 45^o. This is because the instrument is most sensitive at $\theta = 45^o$.
3. After checking the setting of the coil in the magnetic meridian the current should be changed so that it may produce nearly 45^o deflection in the needle. By so doing the deflection near the inflection point is nearly 45^o and hence it can be located with greatest accuracy.
4. Initial reading of the pointer must be set zero. If there is any error it must be taken into account while recording the deflection.
5. **FORMULA USED: -**

$$\frac{2\pi n a^2 i}{10^7 (a^2 + x^2)^{3/2}} = H \tan\theta$$

Where, n = used number of turns of the coil

a = radius of the coil

i = current (in amp.)flowing through the coil

x = distance of the axil point from the centre of the coil

H = horizontal component of earth's field in the lab.

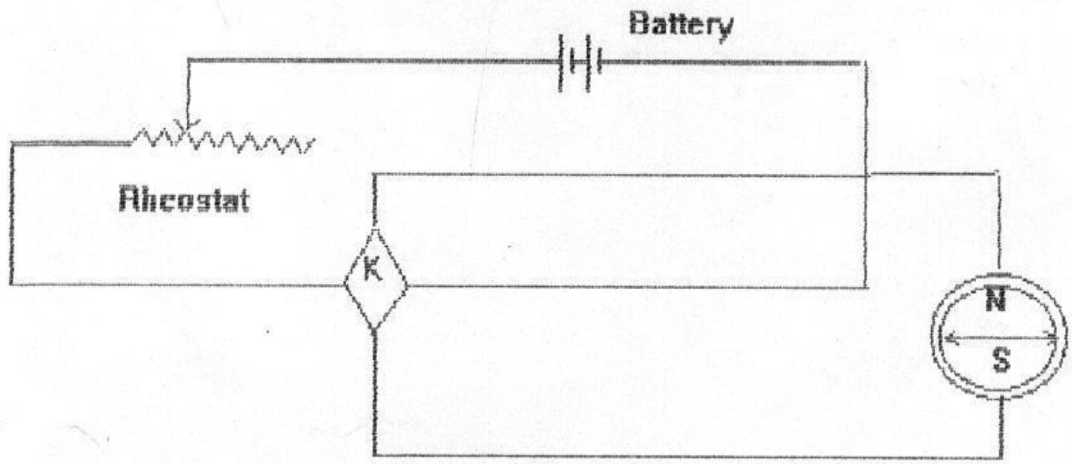
and θ = deflection produced in the magnetic field of the galvanometer when the coil has been placed in the magnetic meridian.

On plotting the graph between x and Tan θ a curve m as shown in figure is obtained. The distance between the points of inflection A and B is measured. This gives the radius "a "of the coil

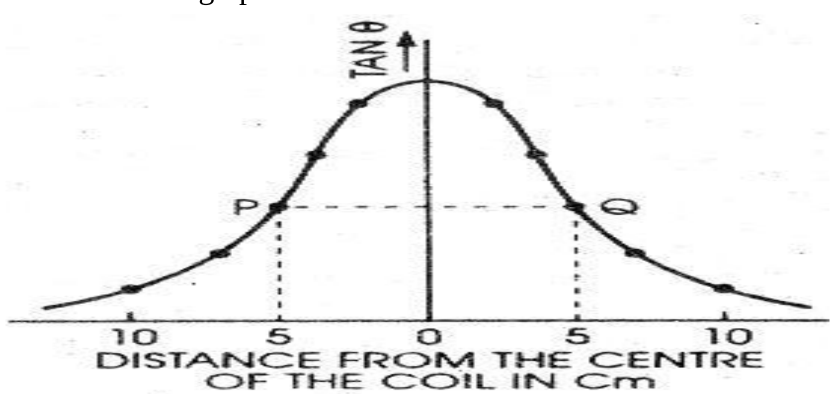
PROCEDURE: -

1. The coil of the galvanometer is set into magnetic meridian. For this the arms are moved this way or that till the magnetic needle of the compass box lies nearly at the centre of the coil. The bench is then rotated in the horizontal plane till the coil is set roughly in the magnetic meridian. In this case, on looking vertically downwards from above coil; the coil, the magnetic needle and its image formed in mirror kept below it in the compass box, all lie in the same vertical plane. The compass box is rotated till the pointer read zero on the circular scale.
2. Connections are made as shown in figure using say 50 turns of the coil and taking care that out of the four terminals provided on the commutator K any two diagonally opposite terminals are joined to the galvanometer and the other two to the battery through rheostat. The current is then passed by inserting the

plugs in one of the pairs of opposite gaps of the commutator.



3. The value of the current is adjusted by means of the rheostat such that nearly 45^{o} deflection is produced in the needle. This is because the instruments is most sensitive at $\theta = 45^{o}$. The direction of the current in the galvanometer is then reversed by putting the plugs in the other pair of opposite gaps of the commutator and the deflection in the needle is again observed. If the difference between the deflections in the cases is less than 2^{o} the adjustment is correct (i.e. the coil lies in the magnetic meridian). Otherwise the coil is further rotated along with the bench till the two deflections agree within this range.
4. The current is then changed to such a value that the deflection in the needle is about 75^{o} (the number of turns used may be changed to 50, if this much deflection is not possible by using 5 turns). The readings of both the ends of the pointer ($\theta_{1,}$ θ_2) are noted. The direction of the current is revesered and again reading of both ends of pointers ($\theta_{3,}$ θ_4) is noted. The mean of the four reading will give the mean deflection.
5. The compass box is initially at the center of the coil and has maximum deflection 75^{0}. Now compass box is shifted in steps of 2 cm an east side and the corresponding readings are noted till the deflection falls to nearly 15^{0}.
6. Similarly the compass box is shifted in west side from center of coil, by sliding the wooden bench in steps of 2 cm and the corresponding reading is noted.
7. The graph between the position of the compass box and tan θ is plotted when a curve, as shown in figure is obtained.
8. The distance between the two points of inflection at A and B is found out from the graph. This should be equal to the radius of the coil.
9. The circumference of the coil can be measured by a thread and its radius can be calculated to verify the value obtained from the graph.



OBSERVATIONS: -

S.No	Position of the needle on one of the scale. (Distance of Compass box from center of coil) x (cm.)	Deflection in the needle when it is on the											
		East side of the coil						West side of the coil					
		Current one way		Current reversed		Mean θ in deg. [redacted]	tan θ	Current one way		Current reversed		Mean θ in deg.	tan θ
		θ_1	θ_2	θ_3	θ_4			θ_1	θ_2	θ_3	θ_4		
1.													
2.													
3.													
4.													
5.													
6.													
7.													
8.													

Graph

Circumference of the coil as obtained by a thread and meter scale = ---- cm.

CALCULATION:-

Radius of the coil, as obtained from the graph = distance between the pointer A and B cm.

Radius of the coil, as obtained from measurement =

RESULT: - 1. The variation in the magnetic field with distance, along the axis of the given coil is as shown in the graph.

2. Radius of the coil = --------------- cm., as obtained from the graph and ----------------cm., as obtained from measurement.

Experiment No.5

Object: To determine the energy band gap of semiconductor material by four probe method.

Apparatus: Probes arrangement, Sample (Ge crystal), Oven, Four probe set up, Thermometer.

Precautions:

1. The surface on which the probe rest should be uniform.
2. Do not exceed the temperature of the oven above 180^0 for safe side.
3. Semiconductor crystal with four probes is installed in the oven very carefully otherwise the crystal may damage because it is brittle.
4. Current should remain constant throughout the experiment.
5. Minimum pressure is exerted for obtaining proper electrical contacts to the chip.

Formula used: The resistivity of the semiconductor crystal given by

$$\rho = \frac{\rho_0}{G\,(W/s)}$$

Where $\boldsymbol{\rho_0} = \frac{V}{I} \times 2\pi s$

G (W/S) is the correction factor and this obtained from table for the appropriate value of (W/S) W is the thickness of the crystal S is the distance between probe V and I are the voltage and current across and through the crystal chip. The energy band gap Eg of semiconductor crystal is given by

$$Eg\ 2k\ 2.3026 \log \frac{10_\rho}{\frac{1}{T}}\ eV$$

Where K is Boltzmann constant = 8.6×10^{-5} eV / deg and T is temperature in Kelvin

Theory: The Four Probe Method is one of the standard and most widely used methods for the measurement of resistivity of semiconductors. The experimental arrangement is illustrated. In its useful form, the four probes are collinear. The error due to contact resistance, which is especially serious in the electrical measurement on semiconductors, is avoided by the use of two extra contacts (probes) between the current contacts. In this arrangement the contact resistance may all be high compare to the sample resistance, but as long as the resistance of the sample and contact resistances are small compared with the effective resistance of the voltage measuring device (potentiometer, electrometer or electronic voltmeter),the measured value will remain unaffected. Because of pressure contacts, the arrangement is also especially useful for quick measurement on different samples or sampling different parts of the same sample.

Description of the experimental setup

1.Probes Arrangement

It has four individually spring loaded probes. The probes are collinear and equally spaced. The probes are mounted in a teflon bush, which ensure a good electrical insulation between the probes. A teflon spacer near the tips is also provided to keep the probes at equal distance. The whole –arrangement is mounted on a suitable stand and leads are provided for the voltage measurement.

2.Sample

Germanium crystal in the form of a chip

3.Oven

It is a small oven for the variation of temperature of the crystal from the room temperature to about 200°C (max.)

4.FourProbeSet-up,

The set-up consists of three units in the same cabinet.

Procedure:

1. Connect the outer pair of probes to current source through current terminal and the inner pairs to the probe voltage terminal.

2. Place the four probe arrangement in the oven and fix the thermometer in the oven through the hole.

3. Switch on the four probe set up and adjust the current to a desired value (say 8 mA) .Change the knob on the voltage side.

4. Connect the oven power supply. Rate of heating may be selected with the help of a switch low or high.

5. Switch on the power to the oven and heating will start.

6. Measure the voltage by putting the digital panel meter in voltage measuring mode and temperature (^{0}c)in thermometer.

Observations Table:

Distance between probes (S) = 0.200 cm

Thickness of the crystal (W) = 0.050 cm

Constant current (I) = 8.00mA

S.No	**Temperature (0^0)**	**Voltage (volts)**	**Temperature (T in K)**	**ρ (ohm cm)**	$\frac{1}{T}\times 10^3$	**$\log_{10}\rho$**
1.	20					
2.	30					
3.	40					
4.	50					
5.	60					
6.	70					
7.	80					
8.	90					
9.	100					
10.	110					
11.	120					
12.	130					
13.	140					
14.	150					
15.	160					
16.	170					
17.	180					

Table: G (W/S) function corresponding to (W/S) geometry of the crystal

S.No	W/S	G (W/S)
1.	0.100	13.863
2.	0.141	9.704
3.	0.200	6.931
4.	0.33	4.159
5.	0.500	2.780
6.	1.000	1.504
7.	1.414	1.223
8.	2.000	1.094
9.	3.333	1.0228
10.	5.000	1.0070
11.	10.000	1.00045

Calculation:

Find ρ corresponding to temperature in K using

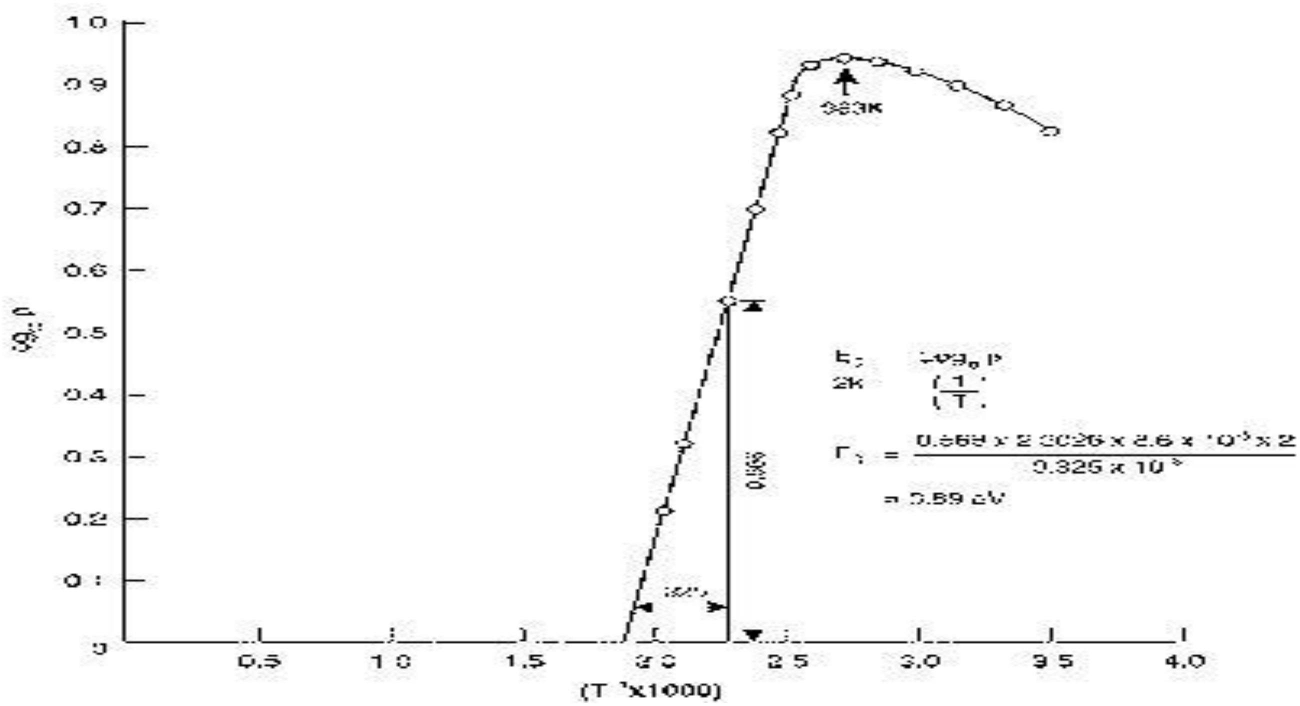
$\rho = \frac{\rho_0}{G(W/s)}$

Where $\boldsymbol{\rho_0} = \frac{V}{I} \times 2\pi s$ = ---------ohm cm

For different 'V' calculate ρ_0 and hence ρ in ohm cm

Find {W/S} and then corresponding to this value choose the value of function G (W/S) from the following table:

Now plot a graph for logρ versus $\frac{1}{T}\times\mathbf{10^{-3}}$ as shown in



Slop of the curve is $\frac{AB}{BC}$

Energy band gap Eg = 2K × $\frac{2.3026 \times \log 10\ \rho}{\frac{1}{T}}$

$= 2K \times 2.303 \times \frac{AB}{BC} \times \frac{1}{1000}$

$= 4.606 \times 8.6 \times 10^{-5} \times \frac{AB}{BC} \times \frac{1}{1000}$

` $= 0.396 \times \frac{AB}{BC}$ev

Result: 1. Resistivity of semiconductor crystal at different temperature are shown in the graph of log 10ρ versus $\frac{1}{T}\times 10^{-3}$

2. Energy band gap o semiconductor crystal Eg = --------eV

Standard Eg : Ge = 0.72 eV

Si = 1.1 eV

Percentage error:

Experiment No. 6

Object: To determine the Electro-Chemical Equivalent (ECE) of copper using a Tangent galvanometer.

Apparatus used: Copper voltmeter, Tangent galvanometer, Rheostat, one way key, Battery, Commutater, Stop watch, Sand paper and connecting wire.

Precautions: **1.** The maganometer box should be carefully leveled so that the magnetic needle moves freely in horizontal plane.

2. The coil should set in magnetic meridian.

3. All the magnetic materials and current carrying conductors should be at considerable distance from the apparatus.

4. The copper plate on which the deposit has to be made should be crapulously clean.

5. The deflection of the galvanometer should be kept constant with help of rheostat.

6. As far as possible the deflection should be kept as nearly equal to 45^0 as possible since under this circumstance the accuracy in measurement is at a maximum.

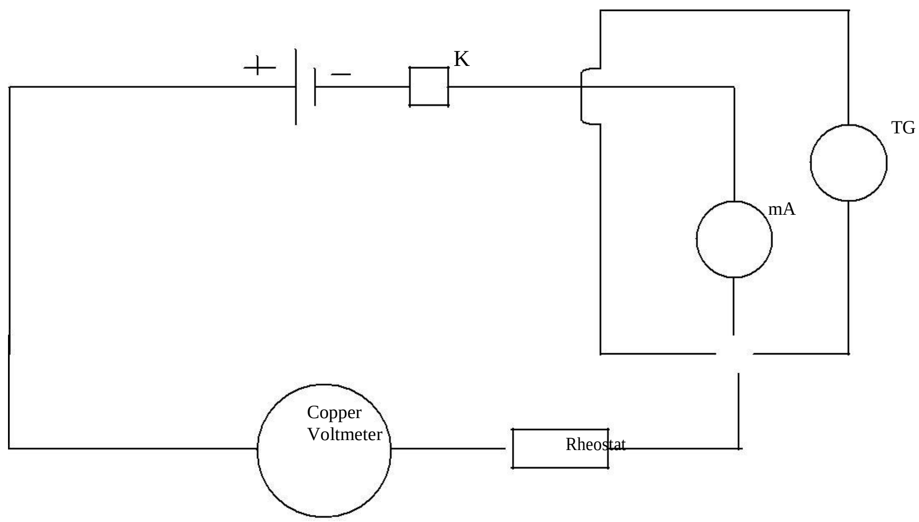


Fig 1

Formula used: Copper voltmeter it consists of a glass vessel containing 16 to 22% solution $Cuso_4$ with a few drops of sulphuric acid. The anode consists of pair of copper plates.

Faraday's Law of Electrolysis

(i) According to first law mass deposited

$$M = Zit$$

Where Z is constant and is called the Electro – Chemical Equivalent of the substance.

$$Z = \frac{m}{It}$$

For tangent galvanometer $I = \dfrac{10rH \tan\theta}{2\pi n}$

$$\boxed{Z = \frac{2\pi n.m}{10rH \tan\theta \times t}}$$

Procedure:

1. Draw a neat diagram indicating the scheme of the connections as shown in fig.
2. Clean the cathode plate with a piece of sand paper and weigh it accurately.
3. Place the coil of T.G in magnetic meridian. Rotate the compass box to make the pointer read zero-zero.
4. Suspend an extra copper plate in the copper voltmeter for the cathode and complete the circuit containing an accumulator, rheostat and an ammeter.
5. Using copper test plate as cathode, allow a current to flow in circuit and read the

deflection. Now reverse the current with help of commutator and again read the deflection if the two deflections are the same then the coil are in the magnetic

meridian otherwise rotate slightly the coil till the two deflection are same. The pointer should read zero when no current is passed.

6. Using rheostat adjust the deflection (in the range 40-50).
7. Switch of the current and remove the test plate and place weighed plate as cathode.
8. Now switch on the current and immediately start stop watch. Take the deflection reading after every 5 minutes and keep it constant using rheostat. After about 20 minutes reverse the current and note the deflection .At the end of other half of time switch off the current and note down the reading of stop watch.
9. Remove the copper plate and immerse it in water and dry it and weigh it with chemical balance.
10. Measure the diameter of the coil and calculate radius by equating to $2\pi r$. Both external and internal circumference should be measured and then mean of the radius.

Observation:

Value of the field H = ----- 0.345 Oersteds
Radius of the coil (r) =--------------Cm
Numbers of turns in each coil (n) =
Mass of the copper plate before deposition of copper gm
Mass of the copper plate after deposition of copper -- gm
Mass of copper deposited = gm
Initial reading of stop watch = sec
Final reading of stop watch = sec
Total time taken =- sec

Table for the determination of θ:

S.No.	Time	Deflection of pointer for direct current		Deflection of pointer for direct current		Mean	tanθ
		Left pointer θ_1	Right pointer θ_2	Left pointer θ_1	Right pointer θ_2		
1.	5						
2.	10						
3.	15						
4.	20						
5.	25						
6.	30						

Calculation:

$$Z = \frac{2\pi n.m}{10rH\tan\theta \times t} = \text{------------------------}$$ gms / columb

Result: The E.C.E of copper = ---------------------------------------gms / columb

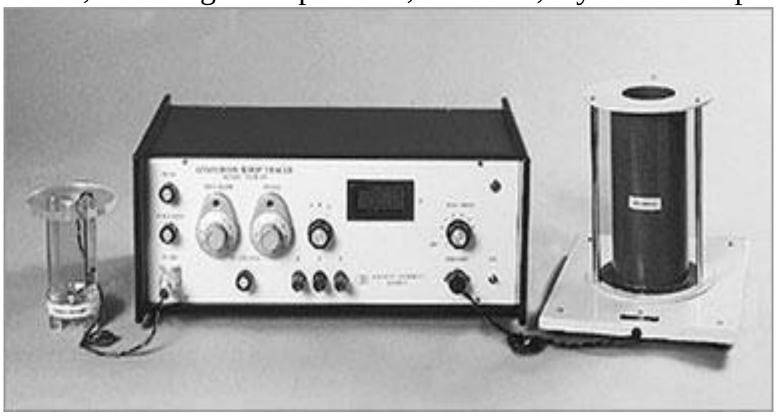
Standard value of E.C.E of copper = 0.000329g / columb

%error= -------------.

Experiment No.7

Object: To draw hysteresis curve (B-H curve) of a given sample of ferromagnetic material on a C.R.O. using a solenoid from this to determine the magnetic susceptibility and permeability of the given specimen.

Apparatus: C.R.O, ferromagnetic specimen, Solenoid, Hysteresis loop tracer



Formula used:

(a) Coercivity: $e_x = \frac{1}{2} \times$ Loop width = --------------------mm

$$H = \frac{G_0 \times e_x}{\{\frac{A_s}{A_c} - N\}}$$

(b) Saturation magnetization: $(e_y)_s = \frac{1}{2}$ × tip to tip height =-------- -mV

$$\mu_s = \frac{J_s}{4\pi} = \frac{G_0\ \mu_0\ gx\ (e_y)s}{gy\{\frac{A_s}{A_c} - N\}\times 4\pi}$$

(c) Retentivity: $(e_y)_r = \frac{1}{2}$ × (2 × Intercept)

$$\mu_r = \frac{J_r}{4\pi} = \frac{G_0\ \mu_0\ gx(e_y)\ r}{\{gy\{\frac{A_s}{A_c} - N\}\times 4\pi}$$

(d) Magnetic Permeability: μ = B / H = Slop of B – H curve

Procedure: 1. Calibration: When an empty pickup coil is placed in the solenoid field, the signal e_2 will only be due to the flux linking with coil area. In this case M = 0 Area ratio $A_s/A_c = 0$, N = 0 so that H = H_a.

Hence $e_y = 0$ and $e_x = H_a / G_0$

i.e; on C.R.O it will be only a horizontally straight line representing the magnetic field H_a.

From know values of H_a and corresponding magnitude of e_x we can determine G_0 and hence calibrate the instrument. The dimensions of a given sample define the values of demagnetisation factor N and the area ratio A_s / A_c pertaining the pickup coil. N can be obtained from manufacturers manual.

Now without sample adjust the oscilloscope at D.C. Time base EXT. Adjust the line in the center. Put the knob of Demagnetisation at zero and area ratio 0.40 and magnetic field 200gauss (rms).

e_x = 64mm, or
= 7.0 V (if read by applying on Y input of C.R.O)

For Area ratio 1 e_x = 160mm, or
= 17.5V

G_0 (rms) 200 / 160 = 1.25 gauss / mm
G_0 (peak to peak) = 1.25 ×2.82
= 3.53 gauss / mm

also G_0 (rms) = 200 / 17.5 = 11.43 gauss / volt

$$G_0 \text{ (peak to peak)} = 11.43 \times 2.82$$
$$= 32.23 \text{ gauss / volt}$$

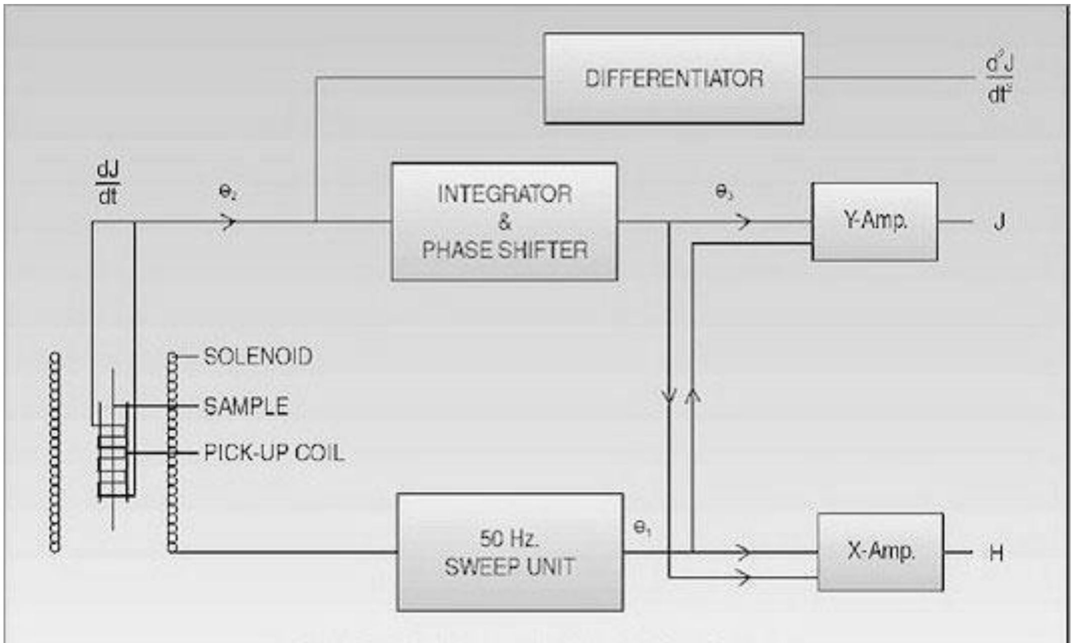


Fig. 1 Block diagram of Hysteresis Loop Tracer

2. Now adjust the knob of magnetic field in the hysteresis loop tracer to minimum value say 30Gauss. Note down the loop width in mm, Tip to tip height (mV) as shown in fig.

3. Increase the magnetic field and note down the corresponding loop width, Tip to tip height (mV). In this way take about 7-8 readings.

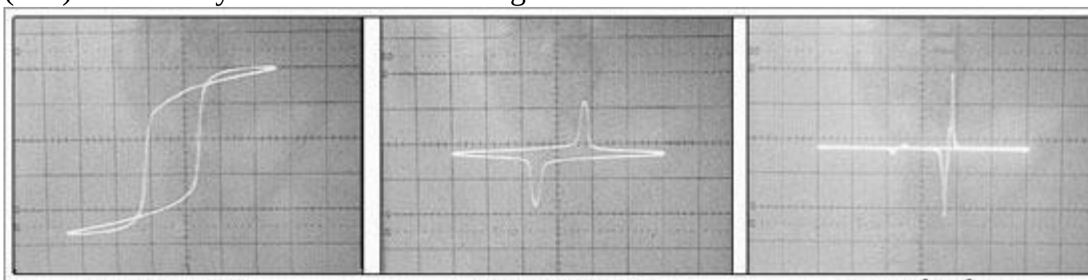
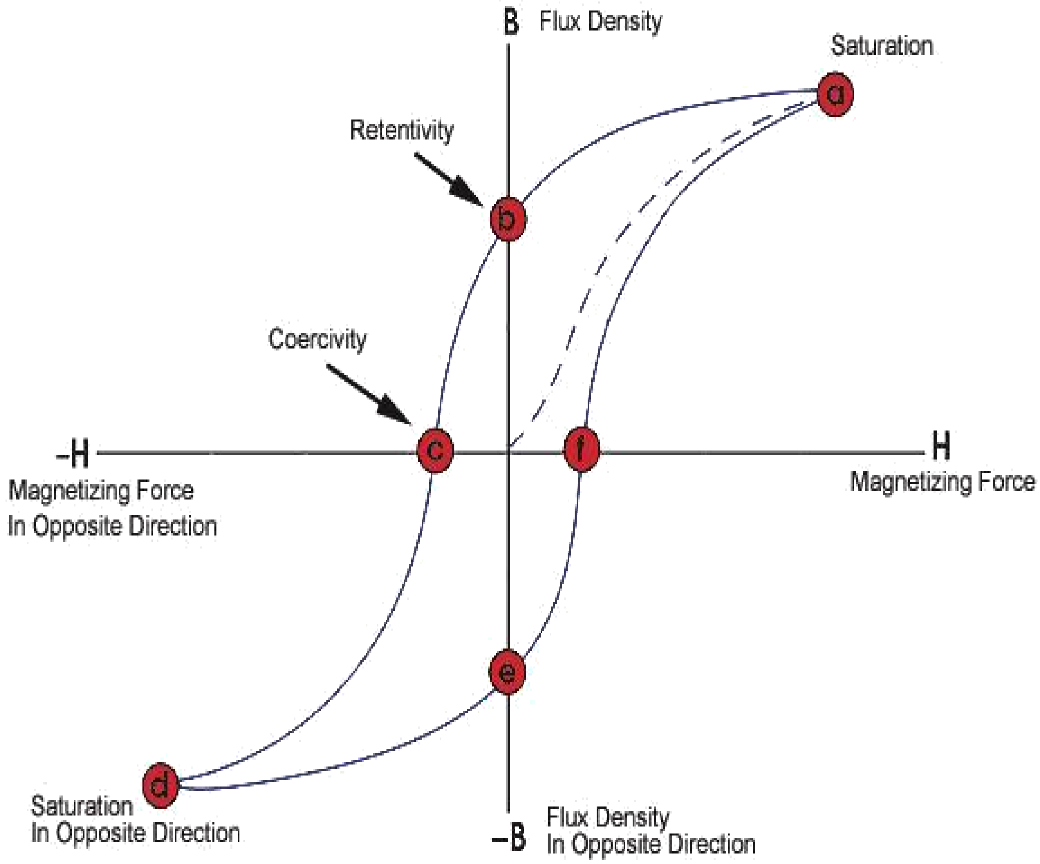


Fig. 2 : J-H Loop   Fig. 3 : dJ/dt Loop   Fig. 4 : d^2J/dt^2 Loop

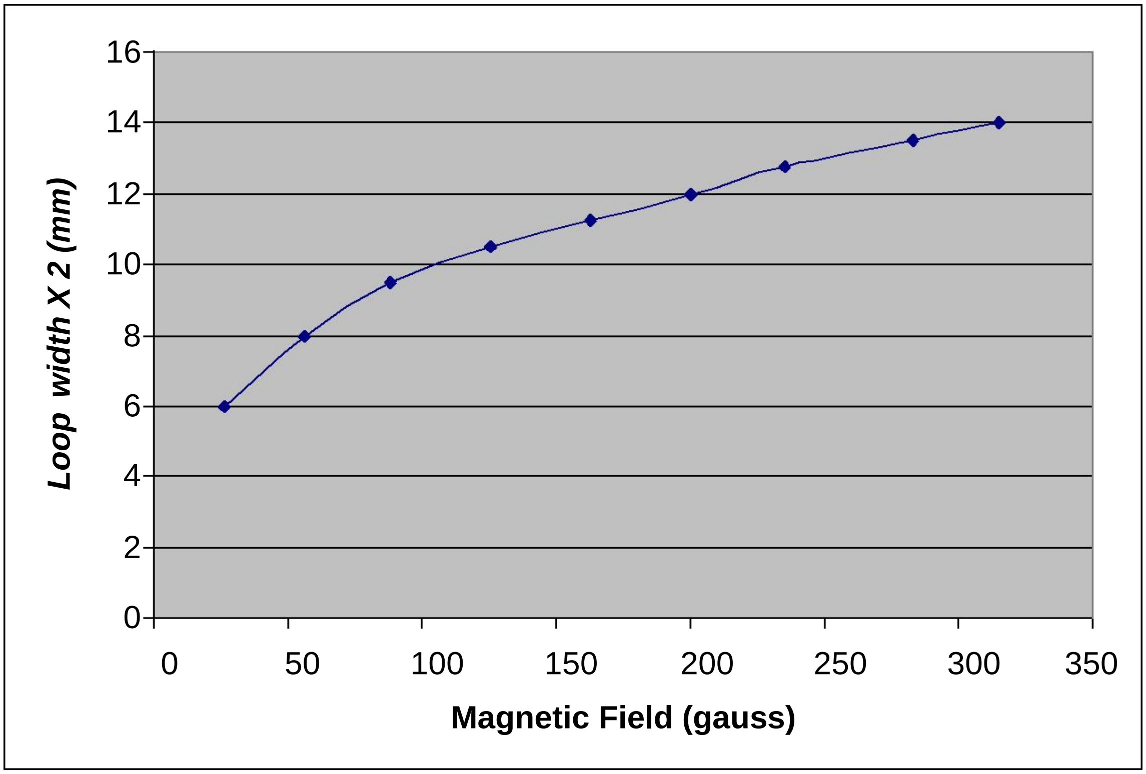


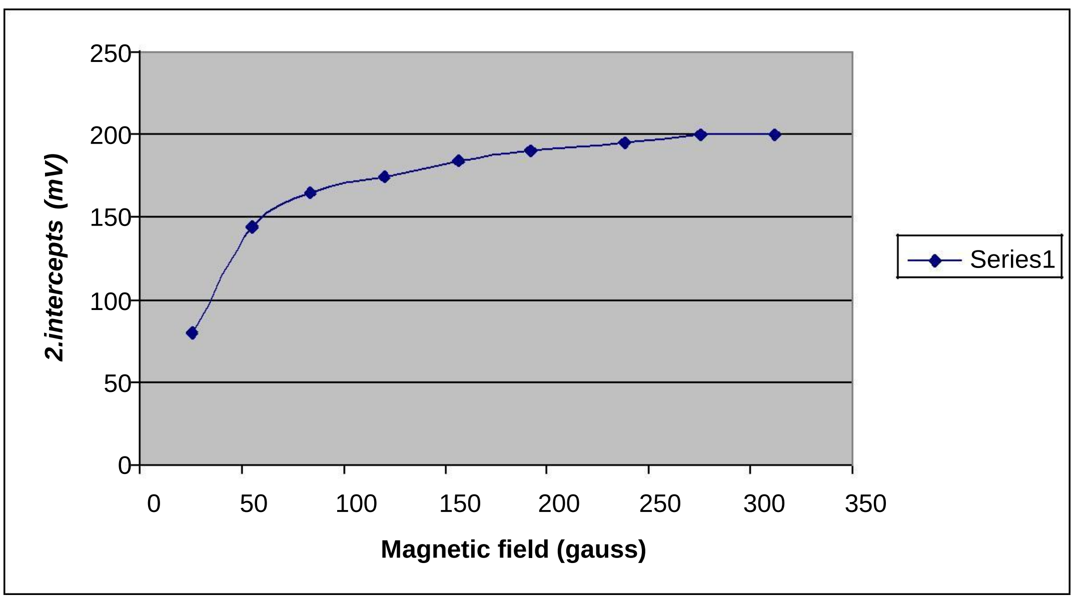
4. Plot the graph for loop width, intercept and saturation position against magnetic field.
5. From these values coercivity, retentivity, saturation magnetization magnetic permeability, can be calculated.

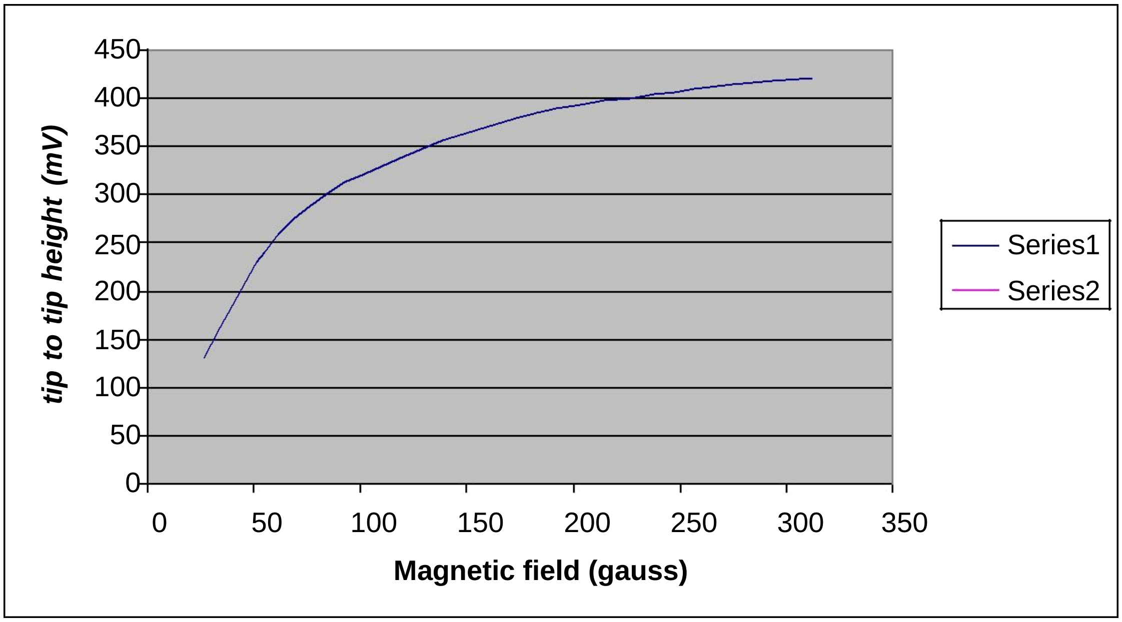
Observation: 1. Diameter of pickup coil (Given by manufacturer) = 3.21mm
2. Total gain of X and Y amplifier $g_x = 100$
3. Gain of Y amplifier $g_y = 1$
4. Length of sample = 39mm
5. Diameter of sample = 1.17mm
6. Area ratio = $\frac{A_s}{A_c}$ = 0.133 × 30 = 3.99
7. Demagnetisation factor N = 0.0029 × 30 = 0.087

Observation table:

S.No	Magnetic field (Gauss)	Loop width (mm)	Tip to tip height (mV)	2 × Intercept (mV)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				


Loop width X 2 (mm)
0
2
4
6
8
10
12
14
16
0
50
100
150
200
250
300
350
Magnetic Field (gauss)


2.intercepts (mV)
0
50
100
150
200
250
0
50
100
150
200
250
300
350
Magnetic field (gauss)
Series1



fig

Calculation:

From the graph

Loop width = --------------- mm
Tip to tip height = --------- mV
2× intercept = -------------- mV

(a) Coercivity: $e_x = \frac{1}{2} \times$ Loop width = --------------------- mm

$$H = \frac{G_0 \times e_x}{\{\frac{A_s}{A_c} - N\}}$$

(b) Saturation magnetization: $(e_y)_s = \frac{1}{2} \times$ tip to tip height =---------mV

$$\mu_s = \frac{J_s}{4\pi} = \frac{G_0\ \mu_0\ g_x\ (e_y)s}{g_y\{\frac{A_s}{A_c} - N\} \times 4\pi}$$

(c) Retentivity: $(e_y)_r = \frac{1}{2} \times (2 \times \text{Intercept})$

$$\mu_r = \frac{J_r}{4\pi} = \frac{G_0\, \mu_0\, gx(e_y)_r}{\{gy\{\frac{A_s}{A_c} - N\} \times 4\pi}$$

(d) Magnetic Permeability: $\mu = \frac{B}{H}$ = Slop of B – H curve

Result:

Experiment No. 8

OBJECT : To determine the coefficient of viscosity of water, by poiseuille's method.

APPARATUS: A Capillary tube of uniform bore and a constant level reservoir fitted on a board, a manometer, stop watch and graduated jar.

PRECAUTIONS:

1. The tube should be placed horizontally to avoid the effect of gravity.
2. The value of h should not be made large and should be so adjusted that the water comes out as a streamline flow.
3. The radius should be measured very accurately as it occurs in fourth power in the formula.
4. The Pressure difference should be kept small to obtain streamline motion

FORMULA USED: The coefficient of Viscosity of a liquid is given by the formula

$$\eta = \frac{\pi P r^4}{8Vl} = \frac{\pi h \rho g r^4}{8Vl} \quad \text{Poise or } Kg/(m - \text{sec})$$

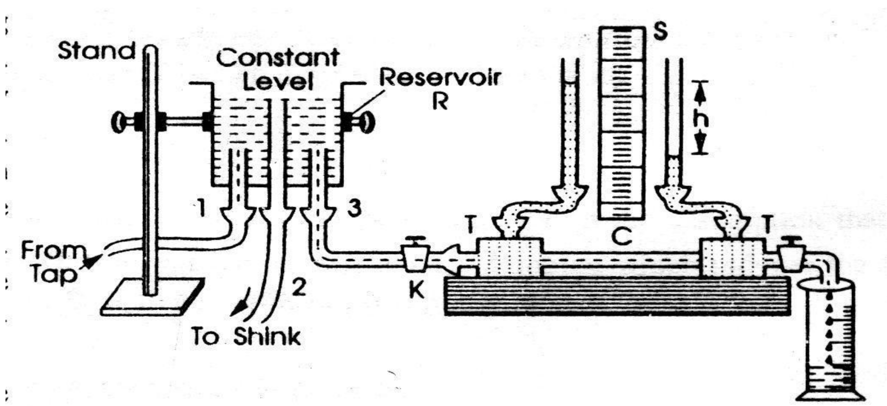
Where r = radius of capillary tube

V = volume of water collected per second

l = length of the capillary tube

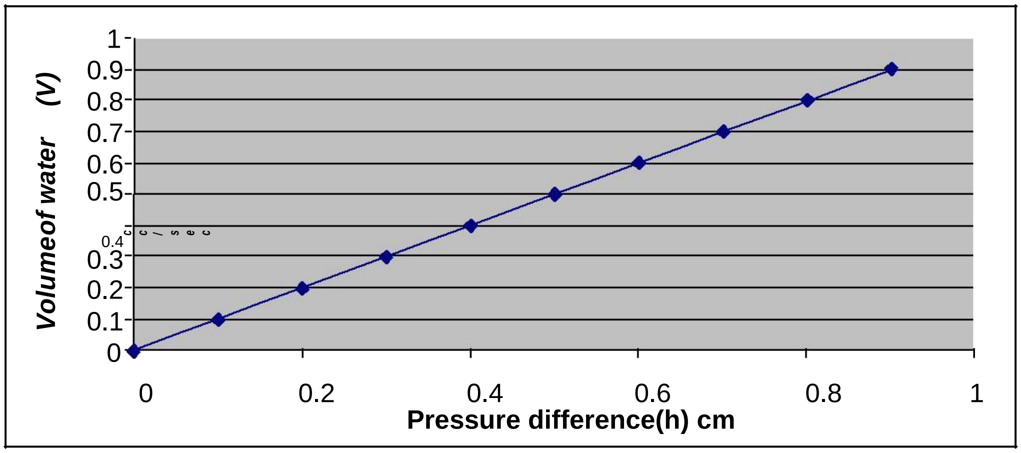
ρ = density of liquid ($\rho = 1.00 \times 10^3$ kg / m^3 for water)

h = difference of levels in manometer



PROCEDURE:

1. Allow the water to enter the constant level reservoir through tube (1) and leave through tube (2) in such a way that water comes drop by drop from the capillary tube. This is adjusted with the help of pinch cock K. It should be remembered that all the bubbles should be removed from the capillary.
2. When every thing is steady collect the 10ml water in a graduated jar and note down the time taken and thus calculate the volume V of the water flowing per second.
3. Note the difference of the level of water in manometer. This gives h.
4. Vary h by raising or lowering the reservoir. For each value of h, find the value of V.
5. Measure the length and diameter of the tube.
6. Plot graph h vs v & find its slop.



OBSERVATIONS:

Room Temperature= --------- ^{o}C

Sl.	Manometer Reading		Pressure Difference h (meter)	Measurement of V		V= $\frac{meter^3}{Sec.}$
	One end (meter)	Other end (meter)		Total volume of water Collected meter ^{3}	Time t Sec.	

Mean (h/v)=

Temperature of water = ^{0}C
Length of capillary tube = ------------cm. = ----------------- meter.
Radius of capillary tube(r) = ------------cm. = ----------------- meter.

CALCULATIONS:

The coefficient of viscosity η for water is given by;

$$\eta = \frac{\pi \rho g r^4}{8l}(h / v)$$

RESULT: The coefficient of viscosity of water at ^{0}c = ----------------Poise