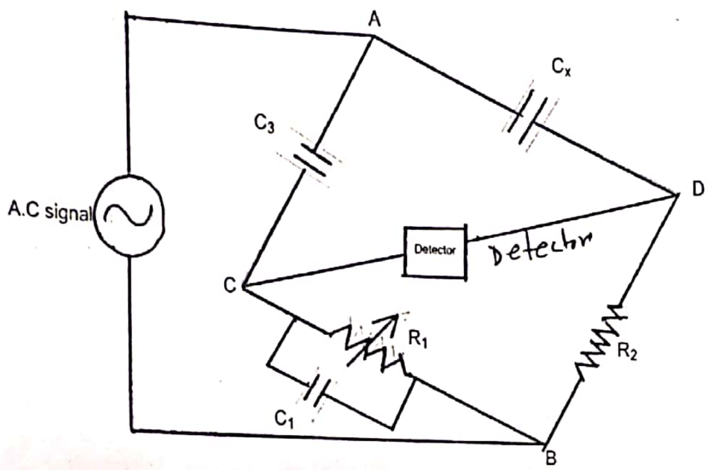
Experiment No:- 06

To find out an unknown capacitance --- a. c. bridge method.



Working Formula:

For balance condition of the bridge as shown in fig.1

is the impedance of BC

$Z_1Z_x = Z_2Z_3$ Z_2 " " " " BD

Z_3 " " " " AC

Z_x " " " " AD

Where $Z_1=(1\backslash R_1+jwc_1)^{-1}$

$Z_2= R_2,\ Z_3=1\backslash jwc_3,\ Z_x=1/jwc_x$

Equating the real and imaginary terms, we find that the unknown capacitance.

$Cx = C_3\ (R_1\backslash R_2)$

This is the working formula of this experiment

It can be seen from the circuit diagram of fig. the two variables chosen for the balance adjustment are capacitor C_1 and resistor R_2

Procedure:-

1. Switch on the trainer and connect the unknown capacitance in the arm marked C_x
2. Select some value of R_2
3. Vary R_1(500 Ω potentiometer) from the minimum position in a clockwise direction till balance of the bridge is obtained. At the balance condition sound in the LS (loud speaker) will be minimum. Three values of R_1 should be taken, for a given value of R_2 .
4. You vary the capacitor C_1 for fine balance adjustment.
5. Now change R_2 and take another three values of R_1.Find C_x take average of the two C_x values.

The full experiment is to be repeated for another two sets of C_x values.

Experimental D-----

Value of C_3 = 0.1μ F

<u>Table – 1</u>

Determination of unknown capacitance:

No of obs.	Capacitor No	Resistance R_2 (Ω)	ResistanceR_1 (Ω)	AverageR_1 (Ω)	Unknown capacitance C_x=C_3	Average C_x (μF)
1. 2. 3.	1					
1. 2. 3.	2					

Table -2

Verification of series law:

No of obs	Value of R_1 (Ω)	Value of R_2 (Ω)	Value of equivalent (μF)	Mean capacitance (μF)	Theoretical value (μF)
Series 1&2					
"					

Table -3

Verification of parallel law:

No of obs	Value of R_1 (Ω	Value of R_2 (Ω)	Equivalent of capacitance (μF)	Mean capacitance (μF)	Theoretical value (μF)
Parallel					

Discusssion :-

Expt. No. 306

LAB ELECTRONICS

INSTRUCTION MANUAL

SCHERING BRIDGE

OBJECTIVES

Measurement of Unknown value of Capacitance by using Schering Bridge (A.C Bridge)

~~In this trainer you will measure the unknown values of Capacitance.~~ $C_X = R_1 C_3 / R_2$

INTRODUCTION

The schering bridge, one of the most important AC bridges, is used extensively for the measurement of capacitors. It is particularly useful for measuring insulating properties, i.e., for phase angles very nearly 90^0. The basic circuit arrangement is shown in Fig.1, and inspection of the circuit shows a strong resemblance to the comparison bridge. Notice that arm 1 now contains a parallel combination of a resistor and a capacitor, and the standard arm contains only a capacitor. The standard capacitor is usually a high quality mica capacitor for general measurement work or an air capacitor for insulation measurements. A good-quality mica capacitor has very low losses (no resistance) and therefore a phase angle of approximately 90^0.

THEORY

The balance conditions require that the sum of the phase angles of arms 1 and 4 equals the sum of the phase angles of arms 2 and 3. Since the standard capacitor is in arm 3, the sum of the phase angles of arm 2 and arm 3 will be $0^0+90^0 = 90^0$. In order to obtain the 90^0 phase angle needed for balance, the sum of the angles of arm 1 and 4 must equal 90^0. Since in general measurement work the unknown will have a phase angle smaller than 90^0, it is necessary to give arm 1 a small capacitive angle by connecting capacitor C_1 in parallel with resistor R_1. A small capacitive angle is very easy to obtain, requiring a small capacitor across resistor R_1.

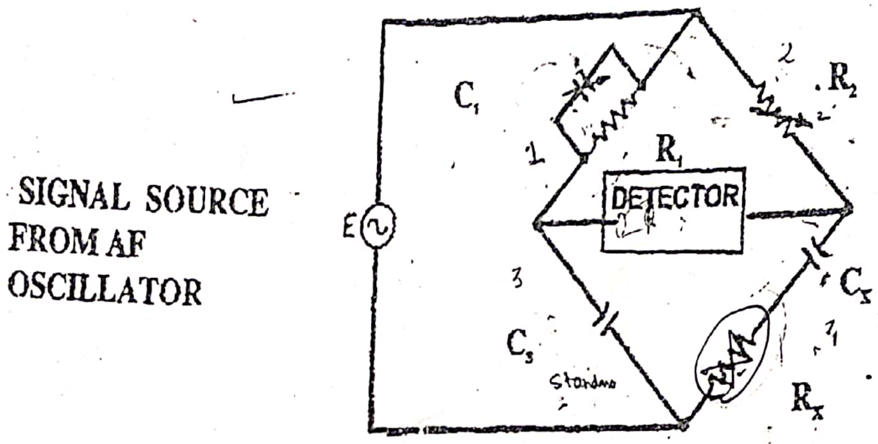


Figure 1 SCHEMATIC DIAGRAM

The balance equations are derived in the usual manner, and by substituting the corresponding impedance and admittance .

values in the general equation, we obtain

$$Z_x = Z_2 Z_3 Y_1$$

or

$$R_x - \frac{j}{wC_x} = R_2 \left(\frac{-j}{wC_3}\right)\left(\frac{1}{R_1} + jwC_1\right)$$

and expanding

$$R_x - \frac{j}{wC_x} = \frac{R_2 C_1}{C_3} - \frac{jR_2}{wC_3 R_1}$$

Equating the real terms and the imaginary terms, we find that

$$R_x = R_2 \frac{C_1}{C_3}$$

$$C_x = C_3 \frac{R_1}{R_2}$$

As can be seen from the circuit diagram of Fig. the two variables chosen for the balance adjustment are capacitor C_1 and resistor R_2. There seems to be nothing unusual about the balance equations or the choice of variable components, but consider for a moment how the quality of a capacitor is defined.

PROCEDURE:-

1. Switch on the trainer and connect the unknown capacitance in the arm marked Cx
2. Observe the sine wave at the output of 1KHz oscillator and patch the circuit by using the wiring diagram.

3. Observe the sine wave at the secondary of the isolation transformer on an oscilloscope.

4. Select some value of R_2.

5. Connect the oscilloscope between ground and the output point.

6. Vary R_1 (500 E Potentiometer) from the minimum position in a clockwise direction.

7. If the selection of R_2 is correct the balance point **NULL POSITION** (DC Line) can be observed on the oscilloscope. i.e., at balance the output wave form comes to a minimum voltage for a particular value of R_1 and then increases by varying R_1 in the same clockwise direction. If that is not the case select another value of R_2.

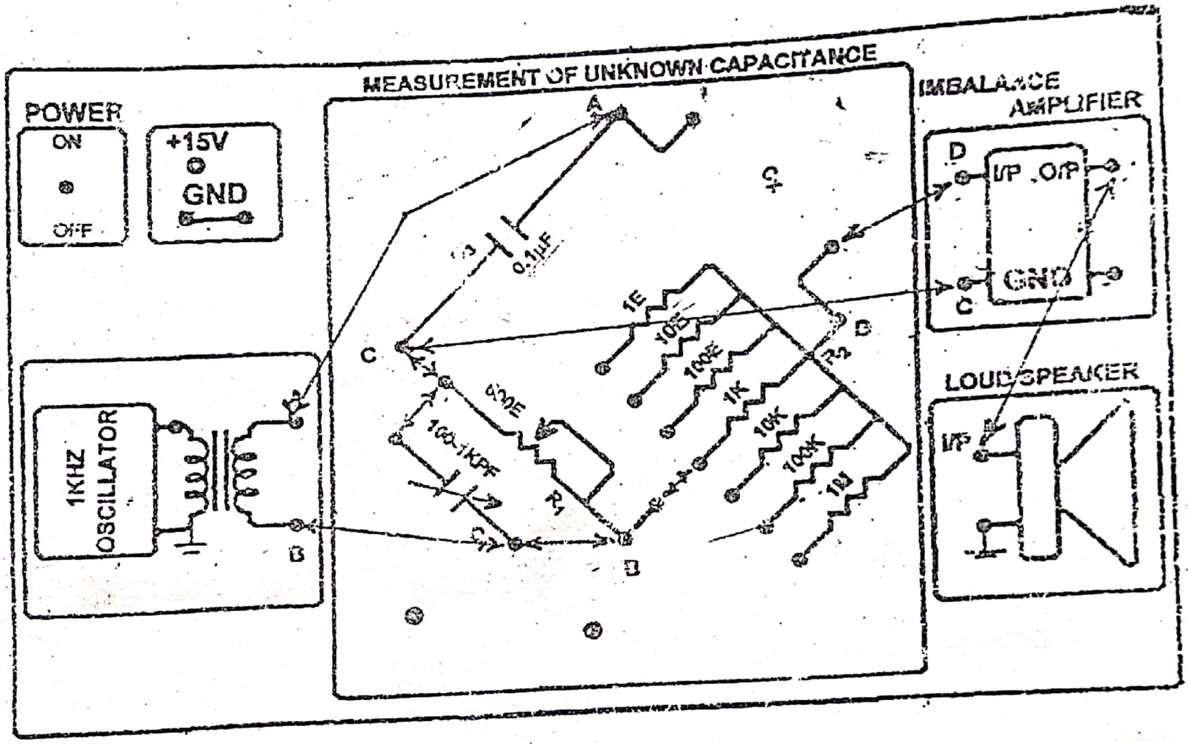
8. You vary the capacitor C_1 for fine balance adjustment.

9. The balance of bridge can also be observed by using Loudspeaker Connect the output of the bridge to the input of the detector.

10. Connect the Loudspeaker at output of the detector. Alternately adjust R_1 and proper selection of R_2 for a minimum sound in the Loudspeaker.

WIRING DIAGRAM

SCHERING BRIDGE



↔ INDICATING PATCHING CONNECTING

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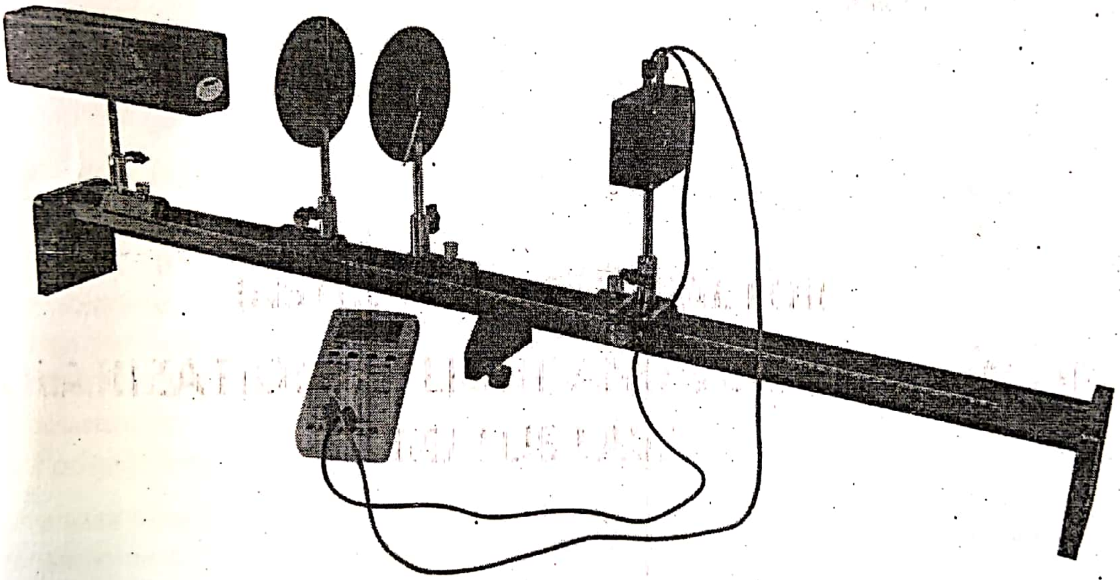
INSTRUCTION MANUAL FOR POLARIZATION OF LIGHT AND VERIFICATION OF MALUS LAW



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PRINCIPLE

Linear, polarized light passes through a polarization filter. Transmitted light intensity is determined as a function of the angular position of the polarization filter.

OBJECTIVE:

1. The plane of polarization of a linear, polarized laser beam is to be determined.
2. The intensity of the light transmitted by the polarization filter is to be determined as a function of the angular position of the filter.
3. Malus' law must be verified.

CONTENT SPECIFICATIONS:

Laser, He-Ne 2.0 mW, 220 V AC	01
Optical bench Hexagonal, l = 1 m	01
Transversal Saddle	01
Fixed Saddle	03
Polarizer / Analyzer	02
Photo detector	01
Digital multimeter	01
Plug in lead red & Black 50cm	02

THEORY:

Light is a transverse wave. We define the direction of polarization by the direction of the electric field vector **E.** Light from common sources such as light bulbs is un-polarized or Laser source Linearly polarized, meaning that the plane of vibration of the electric field vector changes its orientation very rapidly and in a completely random fashion. However, when light interacts with matter, that the plane of vibration of the electric field may become fixed in a particular direction (linear polarization) or that the plane of vibration rotate or otherwise vary in a uniform (circular or elliptical polarization).

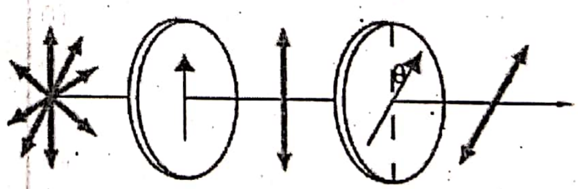


Figure 1

Let's evaluate how much light is transmitted when the transmission axis of a Polaroid is at an angle to the plane of polarization. The two cases, what would happen if the transmission axis is parallel or perpendicular to the polarization direction of the beam? In the former case all of the light is transmitted, in the latter case none of it is. In figure 1 shows what happens when the transmission axis of Polaroid makes an angle θ with the plane of polarization of an incident beam. In figure 1 an un - polarised beam of light is polarised by passing it through a Polaroid. The polarised beam is then passed through a second Polaroid, often called the analyser. The transmission axis of the analyser makes an angle θ with the plane of polarisation of the incident beam. The beam that emerges from the analyser is polarised in the same direction as the transmission axis of the analyser.

EVALUATION:

Let AA' be the Polarization planes of the analyzer in Fig. 3. If linearly polarized light, the vibrating plane of which forms an angle w with the polarization plane of the filter, impinges on the analyzer, only the part will be transmitted

$$E_A = E_0 \cdot \cos \theta$$

As the intensity I of the light wave is proportional to the square of electric field intensity vector E, the following relation (Malus' law) is obtained

$$I_A = I_0 \cdot \cos^2 \theta$$

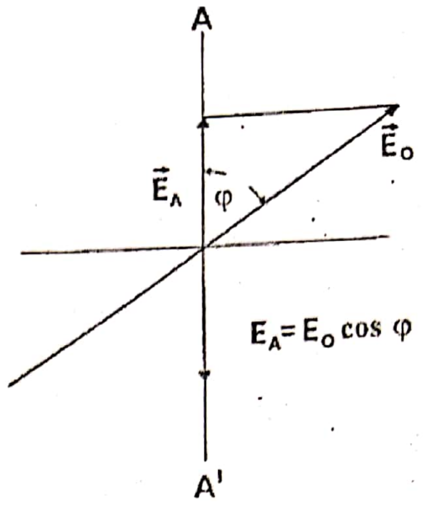
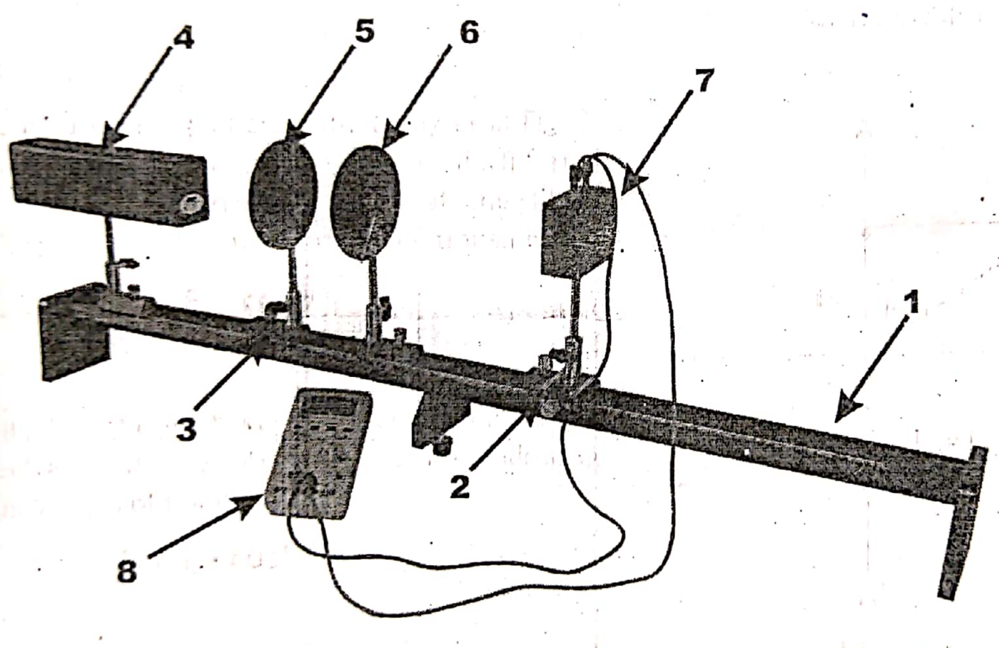


Figure 2



Experimental setups

DESCRIPTIONS:

1. Optical Bench, 2. Transversal saddle, 3. Fixed Saddle, 4. He-N Laser, 5. Polariser, 6. Analyser, 7. Photocell, 8. Digital multimeter

SET-UP AND PROCEDURE

1. The experiment is set up according to above Figure as He-Ne Laser at 0cm, polariser at 50cm, Analyser at 75 cm and photocell at 125cm.

   Note: Please mount the photocell in transversal saddle for adjustment.

2. Connect the photocell to digital multimeter and set its in 200 mV Range.

3. Now switch ON the laser and adjust the height for He-Ne Laser, Polariser, analyser and photocell at same level.

4. Now move the photocell with transversal saddle for total illumination at the center.

5. If the experiment is carried out in a non darkened room, the disturbing background current I_0 must be determined with the laser switched off and this must be taken into account during evaluation.

6. The laser should be allowed to warm up for about 30 minutes to prevent disturbing intensity fluctuations.

7. Keep the analyser at 90^0 positions, then rotated the polariser such that no laser light fall on the photocell.

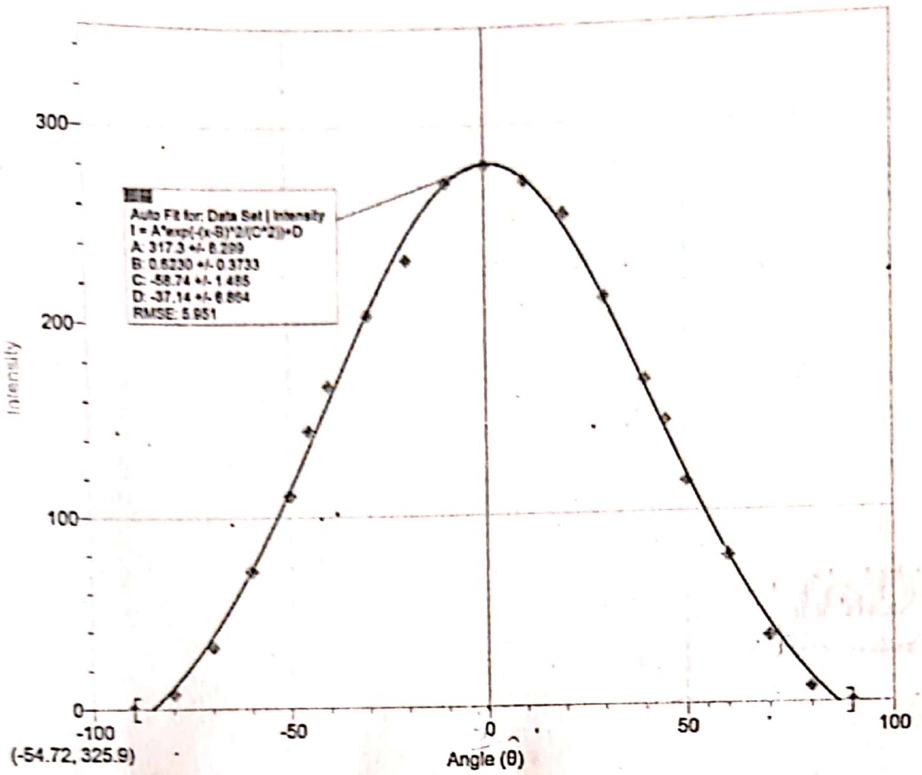
8. Now take the reading (µAmp) in steps of 10° between the polariser and analyser by rotating the analyser filter form $+90^0$ to -90^0.

Note: mV reading must be in fluctuation condition because the laser beam intensity not remains constant. Therefore take the reading for both minimum and maximum value for mV.

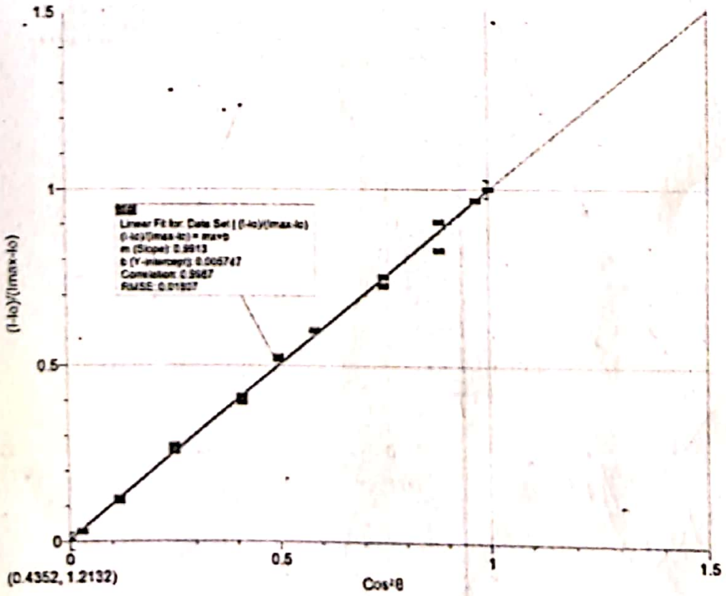
OBSERVATION TABLE:

V_0=0.0 mV

Angle (θ)	Cos²θ	Intensity (min)	Intensity (max)	V	(V-Vo)	(V-Vo)/(Vmax-Vo)
-90	0.000	0	0	0	0	0.000
-80	0.030	6	10	8	8	0.029
-70	0.117	23	41	32	32	0.114
-60	0.250	53	90	71.5	71.5	0.256
-50	0.413	86	136	111	111	0.397
-45	0.500	117	173	145	145	0.519
-40	0.587	143	193	168	168	0.601
-30	0.750	193	214	203.5	203.5	0.728
-20	0.883	223	240	231.5	231.5	0.828
-10	0.970	235	306	270.5	270.5	0.968
0	1.000	245	314	279.5	279.5	1.000
10	0.970	198	343	270.5	270.5	0.968
20	0.883	182	325	253.5	253.5	0.907
30	0.750	155	266	210.5	210.5	0.753
40	0.587	133	203	168	168	0.601
45	0.500	120	174	147	147	0.526
50	0.413	99	132	115.5	115.5	0.413
60	0.250	72	81	76.5	76.5	0.274
70	0.117	33	36	34.5	34.5	0.123
80	0.030	7	9	8	8	0.029
90	0.000	0	0	0	0	0.000



Corrected photo cell voltage as a function of the angular position θ of the polarization plane of the analyzer.



Normalized photo cell P.D as a function of $\cos^2\theta$

EXPERIMENT NUMBER: 7

AIM:

DETERMINATION OF YOUNG'S MODULUS BY FLEXURE METHOD:

THEORY:

Hooke's law states that within elastic limit, the stress generated within the body is proportional to the strain. If a light bar of breadth b and depth d is placed horizontally on two knife edges surface by a distance *l* and a load of mass m, applied a t the midpoint of the bar, produces a depression S of the bar, then Young's modulus Y of the material of the bar is given by

$$Y = \frac{g l^3}{4 b d^3} \cdot \left(\frac{M}{l}\right)$$

Where is the acceleration due to gravity.

Drawing a graph : draw a graph with load m in gm Along x axis and corresponding depression – in cm along y axis. The nature of this graph known as load depression graph, will be straight line passed through the origin. This verifies the Hooke's Law. Draw the two load depression graph for two values of *l*. Calculate [m/δ] from the graph, and determine Y from the mean value of [**m**/δ].

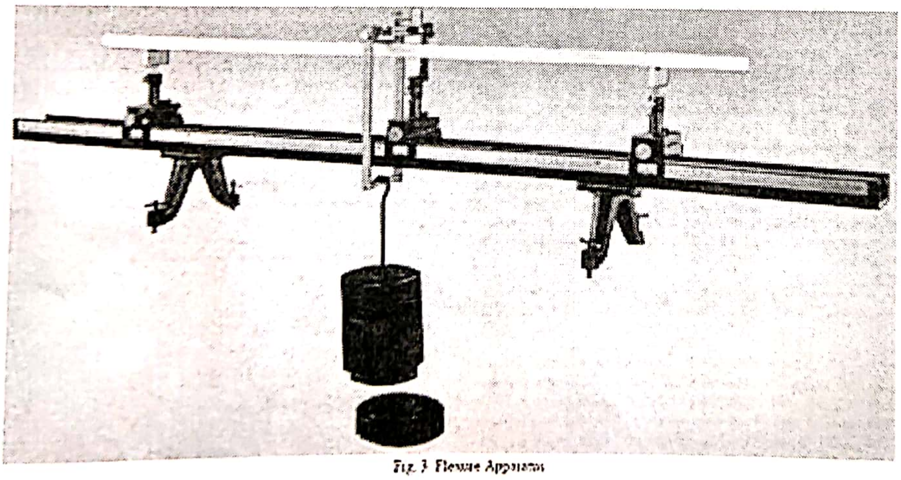


Fig. 3 Flexure Apparatus

APPARATUS REQUIRED:

1) A beam AB **2)** Two stands with two knife edges N_1 and N_2 **3)** Frame F **4)** Microscope **5)**weights (each 500 gm) **6)** Slide calipers.

OBSERVATION:

Determination of the vernier constant of travelling microscope:

Length of the beam between knife edges *l* =cm

V.C of the slide calipers = ……..cm.

Table -1

Data for determining the thickness 'd' of the beam:

Sl.No.	Main scale reading in CM	Vernier scale reading in cm	Thickness 'd' in cm	Mean 'd' in cm

Table -2

Data for determining the thickness 'b' of the beam:

Sl.No.	Main scale reading in CM	Vernier scale reading in cm	Breadth 'b' in cm	Mean 'b' in cm

Table -3

Measurement for the depression for loading and unloading for a length:

Length between the two knife edge: cm

Sl.No	Load in Gm	Travelling Microscope reading						Mean	Depression in cm
		Loading			Unloading				
		M.s.r	V.s.r	Total (a)	M.s.r	V.s.r	Total (b)		

CALCULATION :

RESULTS :

The Young's modulus Y of the material of the beam determined from the graph dynes/cm^2.

Discussion :-

EXPERIMENT NO: - 1

Determination of the modulus of rigidity of a wire by dynamical method:

Theory: If a solid cylinder be suspended by a long wire from a torsion head, forming a torsional pendulum and if the pendulum be set into torsional oscillations, the time period of such oscillations is given by $T = 2\pi\sqrt{I/C}$, or $C = 4\pi^2 I / T^2$, where I is the moment of inertia of the cylinder about the suspension wire as axis and C = shearing couple per unit twist.

Now, if the axis of the cylinder coincides with axis of rotation, then $I = (1/2) MR^2$ where M = mass of the cylinder, R = radius of the cylinder.

Again for the suspension wire $C = \pi\eta r^4/2l$, wher l = length, r = radius and $\eta = 8\pi . I\ l / r^4 T^2 = 4\pi\ l . MR^2 / r^4 T^2$

Experimental Data:

(A) Measurement of the radius of the wire

Screw pitch =

Number of circular scale divisions =

Least count =

Instrumental error =

No. of obs.	Liner scale reading	Circular scale reading	Total reading	Instrumental Error	Corrected diameter	Grand mean corrected diameter	Mean radius
1.							
2.							
3.							
4.							
5.							

(B) Measurement of the diameter of the cylinder by slide callipers:

1 smallest main scale division =
No. of vernier divisions =
Vernier Constant =

No of obs.	Main scale reading	Vernier scale reading	Total reading (D')	Instrumental Error (e)	Corrected diameter D = D' -e	Corrected Grand mean Diameter	Mean Radius
1. (a)							
(b)							
2. (a)							
(b)							
3. (a)							
(b)							

(C) Measurement of the time period of torsional oscillations:

No. of obs.	Time (t) in Secs. for 20 complete oscillations	Mean time period (T) in Secs.
1.		
2.		
3.		
4.		

(c) Calculation of n :

Length (l) between torsion heads =
Mass of the cylinder = 2.84kg /3.196

Radius of the wire (r)	Radius of the cylinder (R)	Mass of the cylinder (M)	Time period (T)	Length (l)	$N = 4\pi l MR^2 / r^4 T^2$ dynes/cm²

Discussion ;-

Expt. No. : 01

DETERMINATION OF THE RIGIDITY MODULUS OF THE MATERIAL OF A WIRE BY DYNAMICAL METHOD :

Apparatus : The apparatus, in its simplest form, consists of a solid cylinder of uniform cross-section suspended from the lower end B of a vertical fairly long and thin wire AB (whose rigidity is required) whose upper end A is kept firmly fixed (Fig. 2.14). This cylinder is capable of oscillating about the suspension wire as axis, which again coincides with the axis of the cylinder. Thus a torsion pendulum is formed with the suspended cylinder as its bob. A pointer P is attached to the bottom of the cylinder, which can move over a circular graduated scale S.

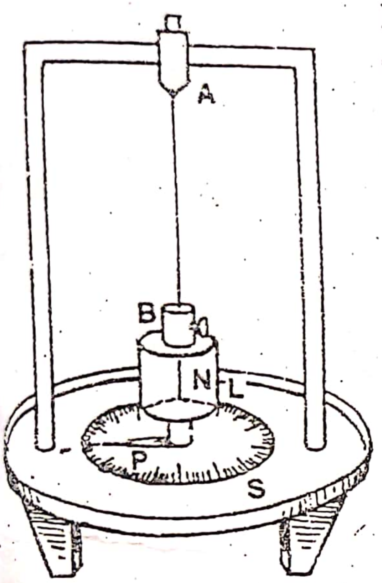


Fig 2.14

Theory : The period (T) with which the bob of a torsion pendulum oscillates, with its suspension wire as axis, is given by.

$$T = 2\pi\sqrt{\frac{I}{c}}; \text{ or } \quad c = \frac{4\pi^2 I}{T^2} \qquad \text{... (2.14}a\text{)}$$

Where, I is the moment of inertia of the suspended cylinder about its own axis and is given by $I = \frac{1}{2}$ (mass) (radius)^2 ...(2.14b)

Here c represent the resting couple exerted by the suspension wire of length for one radian twist at its free end and is given by,

$$c = n\pi r^4 / 2l \qquad \text{...(2.14}c\text{)}$$

where, n is the rigidity of the material of the wire, while l and r are respectively the length and radius of the suspension wire.

From (2-14a) and (2-14c) we get

$$\frac{n\pi r^4}{2l} = \frac{4\pi^2 I}{T^2} \text{ or, } \quad n = \frac{8\pi I l}{T^2 r^4} \qquad \text{...(2.14}d\text{)}$$

Calculating I from the relation (2.14b) and by measuring l, r, and T experimentally, we can find the rigidity n of the wire by employing the relation (2.14d).

If l, r are put in metres, I in kg-m^2 then n will be in N/m^2

Procedure :

(i) If the cylinder is detachable from the suspension wire, then it should be detached from the suspension wire and its mass (M) is to be found out either

Measurement of electron's charge to mass ratio

Aim: To measure e/m, where e is the charge of an electron and m is its mass.

Working formula: Experimental setup consists of a glass bulb containing a filament, a cathode plate, a grid, a pair of deflection plates and an anode plate. The bulb is filled with helium at a very low pressure. Electrons emitted by the cathode collide with helium atoms which get excited and radiate visible light. Thus a beam of electrons leaves a visible track in the bulb. The bulb is placed between a pair of fixed Helmholtz coils which produce uniform magnetic field at the centre. The socket of the bulb can be rotated so that the electron beam is at right angles to the magnetic field.

Suppose the electron beam is deflected in a circular path of radius r under the application of the magnetic field $\boldsymbol{B}$ which is perpendicular to the electron beam. If v be the velocity of an electron in the beam, following relation will hold in equilibrium:

$$\frac{mv^2}{r} = eBv. \tag{1}$$

If the electron beam be produced in an accelerating potential V, then

$$\frac{1}{2}mv^2 = eV. \tag{2}$$

We eliminate v from eqn.(1) and (2) and obtain the required ratio as

$$\frac{e}{m} = \frac{2V}{B^2 r^2} \tag{3}$$

If N and a are number of turns and radius of each coil respectively, the magnetic field produced near the axis of the coils due to flow of I current in the loops is given by

$$B = \frac{N\mu_0 I}{(5/4)^{1.5} a} \tag{4}$$

Eliminating B from eqn.(3) and (4) we the required ratio

$$\frac{e}{m} = \frac{2V\,(5/4)^3 a^2}{(N\mu_0 I)^2 r^2}, \tag{5}$$

For a given current I (~ 1 amp) plot r^2 as a function of V (~ 0-250 Volts) and the curve will be a straight line. Take the ordinate and abscissa of an arbitrary point on the curve and substitute it in eqn.(5) to obtain the required ratio. The supplied data are given in the following:

$a = 14$ cm; N=160; $\mu_0 = 4\pi \times 10^{-7}$ Henry/m

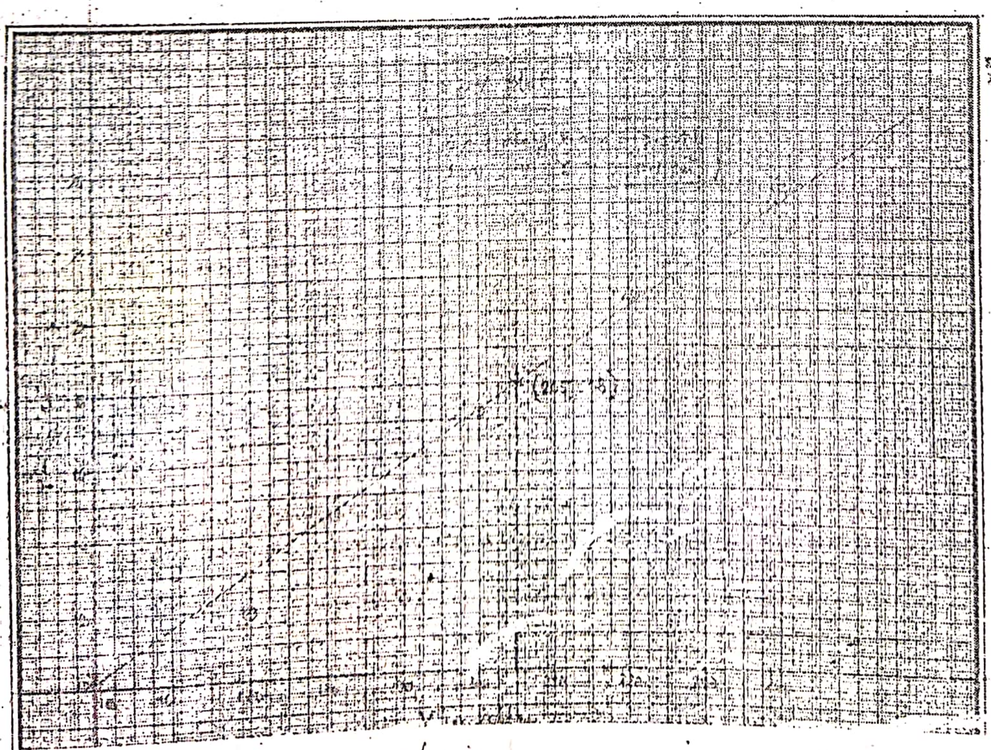
Measurements: Here the diameter of the electron beam is measured by a detachable scale mounted in front of the bulb. This scale has a slider with a hollow tube fitted with cross wires at its both ends to fix the line of sight while making the measurements of the diameter of the beam. The magnetizing current I and the accelerating voltage V are respectively measured by an ammeter and a voltmeter mounted on the front of the panel

A set of data for a typical measurement of e/m is given in the following:

Table: Data of beam diameter d (=2r) for different V and fixed I (=1 amp)

Number of observations	V in volts	d in cm	$r^2=d^2/4$ in cm^2
1.	150		
2.	170		
3.	200		
4.	220		
5.	240		

The r^2 versus V plot is shown b



Take an arbitrary point (205, 18) marked with cross on the straight line curve. Plug it in eqn.(5) to obtain the value as 2.16×10^{11} coulomb/kg.

The actual value quoted is 1.77×10^{11} coulomb/kg.

Note that the measurements can be done for different *I*.

Proportional error: The independent variables in eq.(5) are *V*, *I* and *r* and the rest can be taken as constant. Then the maximum value

$$\frac{\delta(\frac{e}{m})}{(e/m)} = \frac{\delta V}{V} + 2\frac{\delta r}{r} + 2\frac{\delta I}{I},$$

where δV , δI and δr are respectively the smallest divisions of voltmeter, ammeter and the detachable scale attached with the setup.

Discussions: One should discuss the experimental results from the perspective of her/his understanding of the working formula and the experimental setup given to her/him. Note that it should not contain the precautions that have taken while performing the experiment.

Discussion:

EXPERIMENT NO. : - 3

Determination of the refractive index of a liquid by using a plane mirror and a convex lens.

Theory : If a double convex lens C of focal length f_1, be placed over a few drops of liquid placed on a plane mirror, then a plano-concave liquid lens of focal length f_2 is formed between the lower surface of the convex lens and the plane mirror [figure 1]. If F be the focal length of the combination (which is behaving as a convex lens), then we have

$1/F = 1/f_1 + 1/f_2$ --(1)

Correcting for signs of F and f_1 which are both negative we get,

- $1/F = -1/f_1 + 1/f_2$

or, $1/f_2 = 1/f_1 - 1/F = (F - f_1) / F.f_1$ --(2)

Finding f_1 and F experimentally by coincidence method, and putting their numerical values liquid lens is given by,

$1/f_2 = (\mu - 1)(1/r - 1/r') = (\mu - 1).1/r$ [as $r' = \alpha$]

or, $\mu = 1 + r/f_2$

Finding r, the radius of curvature of the lower surface of the convex lens, by a spherometer and finding $1/f_2$ from the relation (2), we can calculate μ, the refractive index of the liquid.

Experimental data:

(A) Thickness (t) of the lens at the centre by slide callipers:-

Table I

Value of 1 small division of the main scale = 1 mm,

Total number of vernier division = 10

10 v.d. = 9 s.d. = 9mm. ∴ 1 v.d. = 9/10mm.

Vernier constant (v.c.) = (1 s.d. – 1 v.d.) = (1-9/10)mm = .01 cm. Instrumental error =

No. of Obs	Reading in cm of			Mean reading in cm	Corrected reading in cm
	Scale (s)	Vernier (v) = v.r × v.c	Total (s+v)		
1.					
2.					
3.					
4.					
5.					

(B) Determination of the radius of curvature (r) of the surface of the lens which is in contact with the mirror:-

Table II

(a) Least count of the instrument:
The value of each division of the liner scale = ...mm
Total no. of circular divisions = ...(N)
Screw pitch = ...mm
Least Count (L.C) = Screw pitch / N = ...mm = ...cm

No. of obs	c.s reading when the screw touches the lens surface (R_1)	When the screw touches the plate			Total no. of c.s. divs. Rotated x = Nm + n	Value of those divisions in mm (h) = x×L.C	Mean h in cm	Radius of curvature $r = d^2/6h + h/2$
		Nos. of full rotation of the cir. Disc. (m)	Final c.s reading (R_2)	Addl. No. of c.s divs. Rotated (n)				
1. 2. 3.								R_1
1. 2. 3.								R_2

(A) Focal length determination :

Table III

No of obs.	Distance of the pin from the upper face of convex lens in cm (h)	Mean h_1 in cm	Focal length of convex lens in cm $f_1 = h_1 + t/2$	Distance of the pin from the upper face of compound lens in cm (h_2)	Mean h_2 in cm	Focal length of compound lens in cm $F = h_2 + t/2$	μ of the liquid
1. 2. 3.							

Discussion:

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Exp1. To determine the wavelength of sodium light

Exp.2. To find the radius of curvature of planoconvex lens using Newton's rings experiment, given λ =5893A^0

Exp.3 To find the thickness of a thin sheet of paper (Air Wedge Experiment)

A Plano-convex lens is placed with its convex surface on the optically plane glass plate so as to enclose a thin film of air of varying thickness between the lens and the plate. Light from an extended monochromatic source (i.e.sodium lamp) of light is converted into a parallel beam of light by using a convex lens L of short focal length and made to fall on an optically plane glass plate inclined at an angle of 45^0 to the vertical, where it gets reflected on to the Plano-convex lens L as shown in Fig.1 2
Interference takes place between the rays of light reflected from the upper and the lower surfaces of the wedge shaped air film enclosed between lens L and glass plate P and circular interference fringes (alternate dark & bright) called Newton's rings are produced as shown in Fig.2
The center will be dark because at the center, lens is in contact with the glass plate and thickness of air film at the center is zero. By Stoke's law, a phase change of (or path difference of Fig.2) takes place due to reflection at the lower surface of the air film (Fig. 3) as the ray of light passes from rarer to denser medium. As we proceed outwards from the center, the thickness of the air film gradually increases being the same all along the circle with the center at the point of contact. Thus the fringes produced are concentric circles and localized in the air film. The fringes can be viewed by means of a low power traveling microscope 'M' as shown in Fig.1

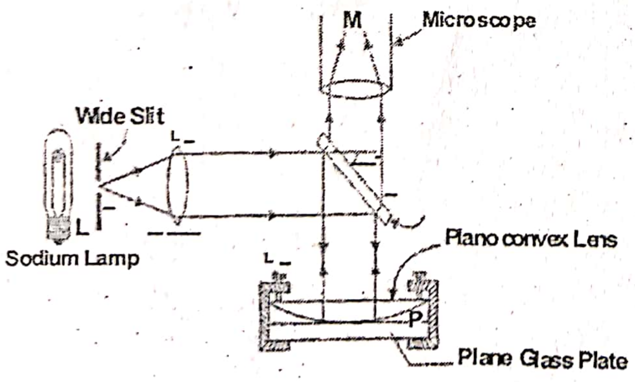

Fig. 1

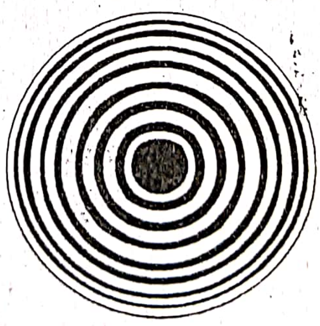

Fig. 2

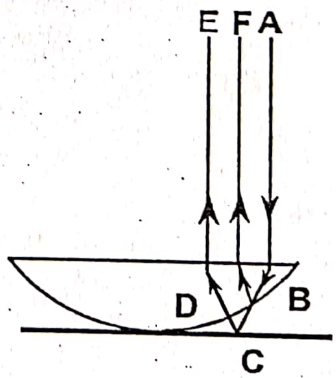

Fig. 3

The fringes are circular due to the fact that air film is symmetrical about the point of contact. The locus of all the points at same thickness is a circle i.e. all the points where the air film has a given thickness lie on a circle whose center is at 'O'.

Let 'R' be the radius of curvature of the surface of plano-convex lens in contact with the glass plate P,

D n= diameter of the n^{th} dark ring n

λ = Wavelength of monochromatic source of light used

2 then, $D_n^2 = 4nR\lambda$

It may be pointed out that surfaces of the lens and the plate may not be clean and the lens may not be perfect contact with the glass plate at the center. Then the center will not be dark. To eliminate the error due to this problem,

th th the diameter of any two dark rings say, n and m may be determined.

Therefore ,

$D_n^2 = 4nR\lambda$ ....(1)

$D_m^2 = 4nR\lambda$ ....(2)

from equations (1) and (2),we get

$\lambda = D_n^2 - D_m^2 / 4(n-m)R$..................(3)

since, this formula involves the difference of the squares of the diameters of two rings and is independent of the thickness of the air film at the point of contact 'O', the above error is minimized.

If the measurements are made on bright rings of the diameter of n bright ring is given by **$D_n^2 = 2(2n+1)R$**

Therefore Diameter of the ring depends upon the wavelength of light used.

If white light is used in place of monochromatic light, a few coloured rings are observed. Each color gives rise to its own system of rings. These colored rings soon superimpose and overlap thereby resulting in almost uniform illumination after a few rings.

If a plane mirror is placed in place of glass plate below the plano-convex lens, a uniform illumination is observed as whole of light gets reflected from the mirror.

PROCEDURE

1. Find the least count of microscope scale.
2. Clean the surface of glass plate, and the Plano-convex lens L .Put them in position as shown in Fig.1 in front of the sodium lamp.
3. Switch on the sodium lamp and see that only parallel beam of light coming from the convex lens falls on the glass plate.
4. Adjust the position of the microscope so that it lies vertically above the center of the lens .Focus the microscope so that alternate dark and bright rings are clearly visible.
5. Adjust the position of the microscope till the point of intersection of the cross-wires coincides with the center of the ring system and one of the vertical cross-wires is perpendicular to the horizontal scale.
6. Move the microscope to the left with the help of micrometer screw so that the vertical cross wire lies tangentially at one of the extreme ends of the 20th dark ring.

7. Note the reading of the micrometer scale of the microscope.
8. Slide the microscope backward with the help of micrometer screw and go on noting the readings when the cross wire lies tangentially at the extreme ends of horizontal diameter of 16 th,12th ,8 th and 4 th dark rings respectively.
9. Continue sliding the microscope to the right and note the readings when the vertical cross wires lies tangentially at the other extreme end of the diameter of 4 th,8 th ,16 th and 20 th dark rings respectively.
10. Now slide the microscope backwards and again note down the readings corresponding to the same rings on the right and then on the left to the center of the ring system.
11. Remove the Plano-convex lens and find the radius of curvature of its convex surface by using a sphero meter.

The radius of curvature may also be determined by plotting a graph between D_n^2 along Y-axis and then number of the ring(n) along X-axis as explained in part-2 of the experiment.

LEAST COUNT = Pitch / 100 = 0.001 cm

OBSERVATIONS: Pitch of the micrometer scale= 0.1 cm

Ring No.	Microscope reading		Diameter	Microscope reading		Diameter	Mean diameter
	Left(a) cm	Right(b) cm	=(a-b) or =(b-a)	Right(c) cm	Left(d) cm	=(c-d) or =(d-c)	
20							
16							
12							
8							
4							

*Microscope reading = main scale reading + circular scale division **x** Least count

Radius of curvature of surface of plano-convex lens in contact with the glass plate

Pitch of spherometer = distance moved on mm scale/no. of rotations =o.1cm

Least count= pitch/no. of divisions on circular scale = 0.001 cm

Distance between the tips of two legs of spherometer:

1. L_1 = cm **2. L_2 =** cm **3. L_3 =** cm

Mean L = (L_1 + L_2 +L_3) / 3 = cm

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S. No.	Spherometer Reading on		h = (a-b) If a > b or = (100 + a-b) if a < b
	Convex Surface (a) cm	Plane Surface (b) cm	
1			
2			
3			
4			

Mean h =

Calculations & results :

1. Radius of curvature of convex surface :

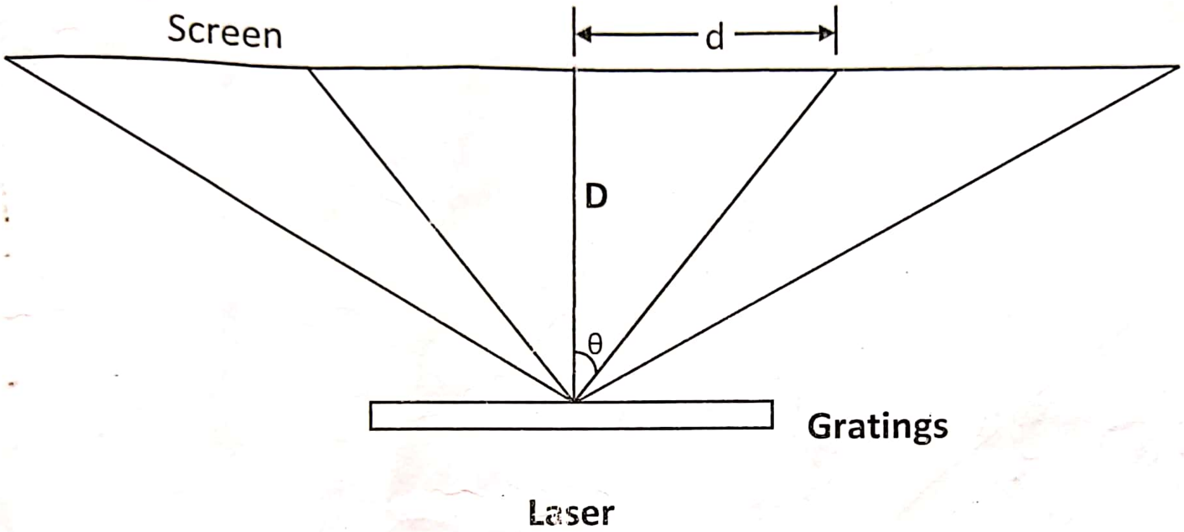
$$R = L^2/6h + 0.5h$$

$$= 75.761 \text{ cm}$$

Name of the experiment: ~~LASER DIFFRACTION~~

Objective: DETERMINATION OF WAVELENGTH OF A MONOCHORAMATIC LASER LIGHT BY DIFFRACTION METHOD.

Principle: Let a parallel beam of light of wavelength λ coming from laser source fall normally on a plane transmission grating. Diffraction maxima of different orders would be formed on the other side of the grating at different angles with the incident beam. The angle of diffraction (θ) for any particular order can be measured from the image of diffraction primary maximum on the screen.



If'd' is the distance of 'n' th order primary maximum from the central maximum and 'D' is the distance of the screen from the grating, then the angle of diffraction for the 'n'th order is

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

Knowing 'θ', the wavelength of the monochromatic light can be determined from the given formula (1)

$$\lambda = \sin\theta/nN$$

Where N is the number of line per unit length of the grating.

TOOLS/ APPARATUS REQUIRD:

1. Laser
2. 2. Screen
3. 3. Plane Transmission Gratings
4. 4.Scale

Procedure:-

1. Switch on the laser source.
2. Place the transmission grating on the grating stand keeping it perpendicular to the source.
3. Diffraction spot are seen on the screen
4. The distance (d) of different diffraction maxima are measured from the central spot by meter scale.
5. Note the distance 'D' of the screen from the grating.
6. From table -I calculate the angle of diffraction.
7. Using table –II calculate the wave length of laser beam.

EXPERIMENTAL DATA:

Table –I

Distance of the screen from the grating (D) = cm

Order no.	Distance from the central spot (cm)			Angle of diffraction $\theta=\tan^{-1}(d/D)$
	Left d_l	Right d_r	Mean $d=(d_l+d_r)/2$	

Table –II

Determination of wavelength of laser light

N = 10^5 lines/metre 10^5

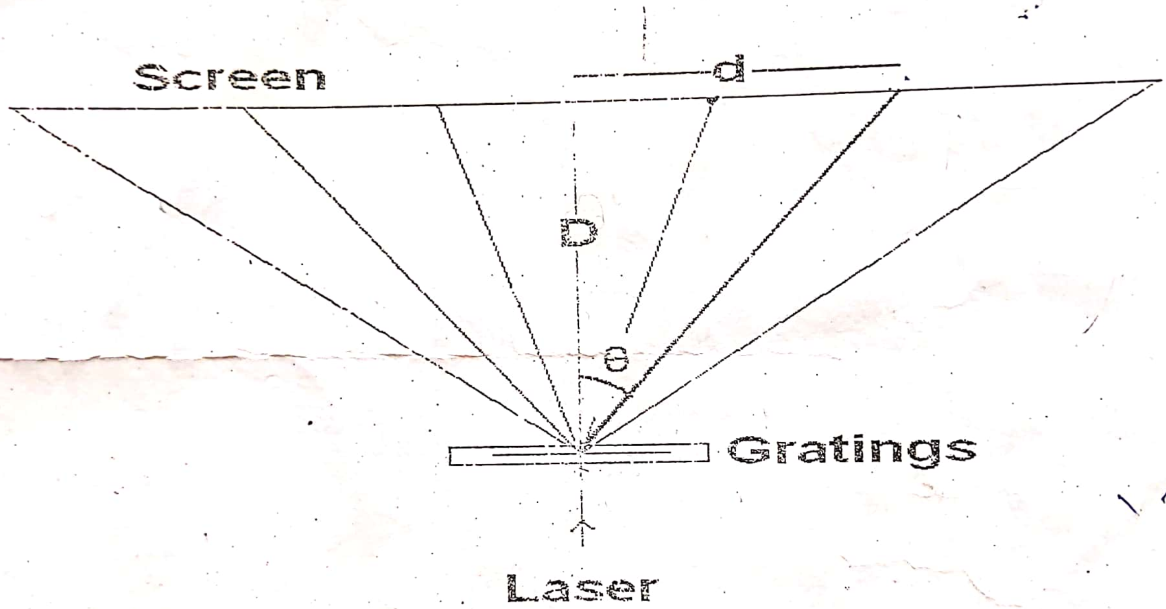
Order no- n	Angle of diffraction	Wavelength of laser $\lambda=\sin\theta/nN$ in metres	Mean λ in metres	Mean λ in A°

WORK INSTRUCTION

1.0 **NAME OF EXPERIMENT:** ~~LASER DIFFRACTION~~ (5)

2.0 **OBJECTIVE:** DETERMINATION OF WAVELENGTH OF A MONOCHROMATIC LASER LIGHTBY ~~LASER~~ DIFFRACTION METHOD

3.0 **PRINCIPLE:** Let a parallel beam of light of wavelength λ coming from laser source fall normally on a plane transmission grating. Diffraction maxima of different orders would be formed on the other side of the grating at different angles with the incident beam. The angle of diffraction (θ) for any particular order can be measured from the image of diffraction primary maximum on the screen.



If "d" is the distance of 'n'th order primary maximum from the central maximum and 'D' is the distance of the screen from the grating, then the angle of diffraction for 'n'th order is

$$\theta = tan^{-1}\frac{d}{D} \quad ....(i)$$

Knowing 'θ', the wavelength of the monochromatic light can be determined from the given formula (i).

$$\lambda = \frac{\sin\theta}{nN}$$

Where N is the number of lines per unit length of the grating.

$\frac{1}{N}$ = 2.5 × ... slit separation between

EXPERIMENT NO: - 2

VERIFICATION OF STOKE'S LAW AND HENCE TO DETERMINE THE COEFFICIENT OF VISCOSITY OF A VERY VISCOUS LIQUID.

Theory :

If a small sphere of radius **r** and density ρ attains a terminal velocity v in an infinite ocean of liquid of density δ then according to Stoke's law the viscous drag $\mathbf{F = 6\pi\eta rv}$, would be equal to the apparent weight of the sphere.

$$6\pi\eta rv = (4/3)\,\pi r^3\,(\rho - \delta)g$$

$$\eta = (2/9)r^2\,(\rho - \delta)g/v \qquad \text{(Coefficient of Viscosity of the fluid)} \quad \text{----------------(1)}$$

Since the experiment is performed in a liquid of total depth **H** and taken in a cylinder of inner radius **R**, the experimentally determined velocity **v'** of the ball will not be equal to the velocity **v** in the infinite ocean of liquid. There will be a wall (radius) effect and end (finite depth) effect of the liquid employed.

$V = v' K$, where $K = (1+2.4\,r/R)\,(1+3.3r/H)$

So, equation (1) may be written as,

$$\eta = (2/9)r^2\,(\rho - \delta)g/(v'K) \quad \text{--------------------------------------(2)}$$

Thus equation (2) may be employed to find the coefficient of viscosity of the given liquid. Again if Stoke's law be true then the ratio (r^2/v) should remain constant at a given temperature.1 If a graph be drawn with r^2 along X-axis and v along Y-axis then the graph should be a straight line. Thus if by experiment we can show that (r^2 vs. v) graph is a straight line the Stoke's law will be verified.

EXPERIMENTAL DATA :

(A) Measurement of the diameter (2r) of the balls by screw gauge:

Screw pitch = ...

Number of divisions of the circular scale =

Least count = ...

Instrumental error =

Size number of sphere	Sphere number	Diameter of the sphere in various directions				Mean diameter(cm)	Grand mean of corrected diameters(cm)	Mean radius of a givensizes(r) (cm)
		a	B	C	d			
1	1 2 3							
2	1 2 3							
3	1 2 3							

(B) Measurement of the internal diameter of the cylinder by slide calipers:

1 smallest main scale division = ...

No. of vernier divisions = ...

Vernier Constant = ...

Diameter in cm at different places								Mean diameter in cm. (D')	Corrected diameter in cm. **D = D'- e**	Corrected radius in cm. **R = D/2**
1		2		3		4				
a	B	a	b	A	B	a	b			

(C)Determination of terminal velocity (v) of the spheres:

Radius of the jar in cm ®	Total height of the liquid in the jar in cm (H)	Length of the middle portion of the liquid column in cm (h)	Size no. of ball	Redius of the ball in cm (r)	R^2in cm^2	Time of fall (sec.)	Mean time (sec)	Velocity of ball V' = h/t Cm/sec.	Corr. Factor K =(1+2.4r/R)(1+3..3r/H)	Corrected celocity V = v'K

CALCULATIONS : $\eta = (2/9)r^2 (\rho - \delta)g/(v'K)$ **gm cm^{-1} Sec^{-1} (poise) (from graph)**

Scanned with CamScanner

EXPERIMENT NO. : - 4

Determination of the refractive index of a transparent substance by using a travelling vernier microscope:

Theory : The normal ray PO and an oblique ray Pl preceeding from an object P, placed in the denser medium of refractive index μ_1 are incident on the surface of a rarer medium of refractive index μ_2. The emergent rays OO1 and LL1 when produced backwards meet at Q which is the virtual image of P. Hence the object distance is u = OP while the image distance is v = OQ (figure). For refraction at L, Φ_1 and Φ_2 are the angles of incidence and refraction and hence,

$\mu_1 \sin \Phi_1 = \mu_2 \sin \Phi_2$ are very small and hence, we may write,

$\mu_1 \tan \Phi_1 = \mu_2 \tan \Phi_2$

$\mu_1 OL/OP = \mu_2 OL/OQ$

or, $\mu_1/u = \mu_2/v$

If the rarer medium is air, ($\mu_2 = 1$) and the denser medium has the refractive index, μ then,

$\mu_1/u = 1/v$; or, $\mu_1 = u/v$

μ_1 = real depth/ apparent depth

The formula is employed to find the refractive index μ of a transparent slab.

Experimental Data:

(B) Vernier constant of vertical scale:

Smallest division of vertical scale = s = ...cm

No of vernier division = n = ...

Vernier constant (v.c.) = s/n = ...cm.

(C) Reading for the scratch when the beaker is empty :-

Table-I

vertical Scale (s)	Reading in cm of the ink mark Vernier V = (v.r) x (v.c)	 Total reading R_1 = (s+v)	Mean R_1 in cm

(d) Reading for image and liquid surface :

Table II

Liquid depth	Reading for image in cm				Reading for surface in cm				$u = R_3 - R_1$ in cm	$V = R_3 - R_2$ in cm	$\mu = u/v$	Mean μ
	Scale (s)	Vernier V = (v.r x v.c)	Total R_2 = (s+v)	Mean R_2	Scale (s)	Vernier V = (v.r x v.c)	Total R_3= (s+v)	Mean R_3				
Small												
Medium												
Big												

Calculations:

1) $\mu =$

2) $\mu =$

3) $\mu =$

Discussions:

INTRODUCTION

Current carrying conductors produce magnetic field around them. Study of their correlation, distribution of its strength in space around the conductor, effect of two current carrying conductors placed closely are of primary interest. The present set up aims towards this when the conductors are in the form of two coaxial circular coils.

EXPERIMENTS

1. To study the variation of magnetic field with distance along the axis of a circular current carrying coil and to calculate diameter of the coil.
2. To study the principle of superposition of magnetic field, and in particular to study the axial variation of the magnetic field due to both the coils when the distance between them is (i) less than the radius of the coils (ii) equal to it (iii) more than it.

BRIEF THEORY

We know, the intensity of magnetic field at a point 'P', lying on the axis of a circular coil 'AB' of radius 'a' having 'n' turns at a distance 'x' from the centre 'O' of the coil in S.I. units, is given by

$$B = \frac{\mu_0}{4\pi} \cdot \frac{2\pi n I a^2}{\left(a^2 + x^2\right)^{3/2}} \text{ Tesla}$$

I is the current flowing through the coil

μ_0 is the permeability of the free space, which is equal to $4\pi \times 10^{-7}$ H/m

The units of B are Tesla or Wb/m^2

The direction of the magnetic intensity at P is along OP produced if the current flows through the coil in the anti-clock-wise direction as seen from P. If the direction of the current is clockwise the field at P is along PO.

The value of the magnetic intensity is maximum at the centre O of the coil and is given by

$$B = \frac{\mu_0}{4\pi} \frac{2\pi n I}{a} = \frac{\mu_0 n I}{2a} \text{ Tesla}$$

or

$$\frac{4\pi \times 10^{-7} \, nI \times 10^4}{2a} \text{ gauss} \qquad (1)$$

If we move away from O towards the right or left, the intensity of the magnetic field decreases. A graph showing the relation between the intensity of the magnetic field B and the distance x is given in Fig. 2. The curve is first concave towards O but the curvature becomes less and less, quickly changes sign at P and Q and afterwards becomes convex towards O.

Observations

Experiment -1

1. Position of coil 1 = 30mm
2. Position of coil 2 = 142mm
3. Distance between the coil = 112mm
4. Length of sensor rod = 265mm
5. Current in the coils = 500mA

Sl. No.	Sensor stand position (mm)	Sensor position (mm)(Sensor Stand Position -265mm)	Magnetic Field (Gauss)		
			Coil-1	Coil-2	Both Coils

Experiment -2

1. Position of coil 1 = 30mm
2. Position of coil 2 = 30mm+Distance between coils
3. Radius of the coil = 112mm
4. Fixed Length of sensor rod = 265mm
5. Current in the coils = 500mA

Sl. No.	Sensor stand position (mm)	Sensor position (mm)(Sensor Stand Position -265mm)	Magnetic Field (Gauss)		
			Coil-1	Coil-2	Both Coils

Fig 4: Variation of the magnetic field for individual coils and both the

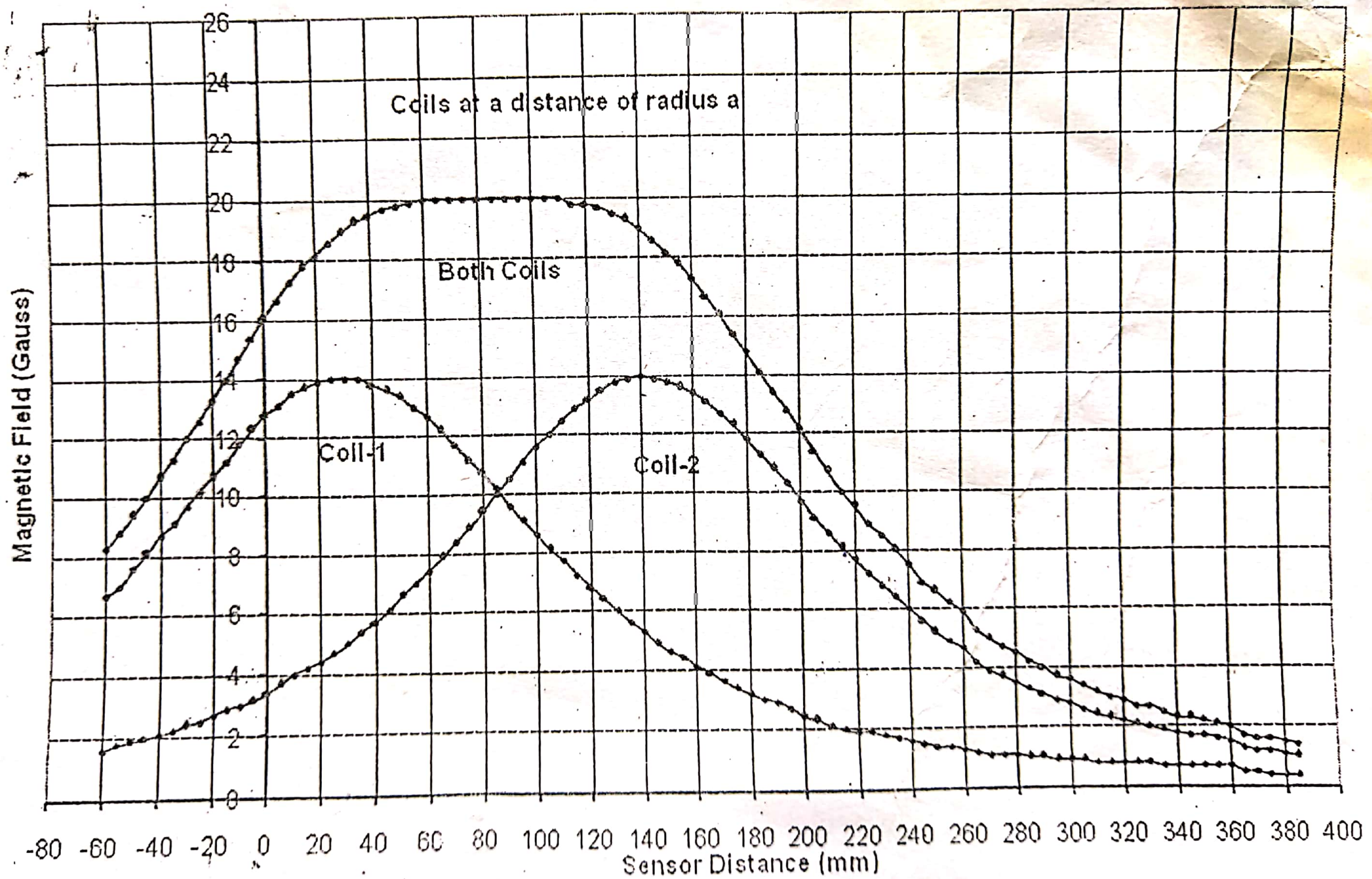
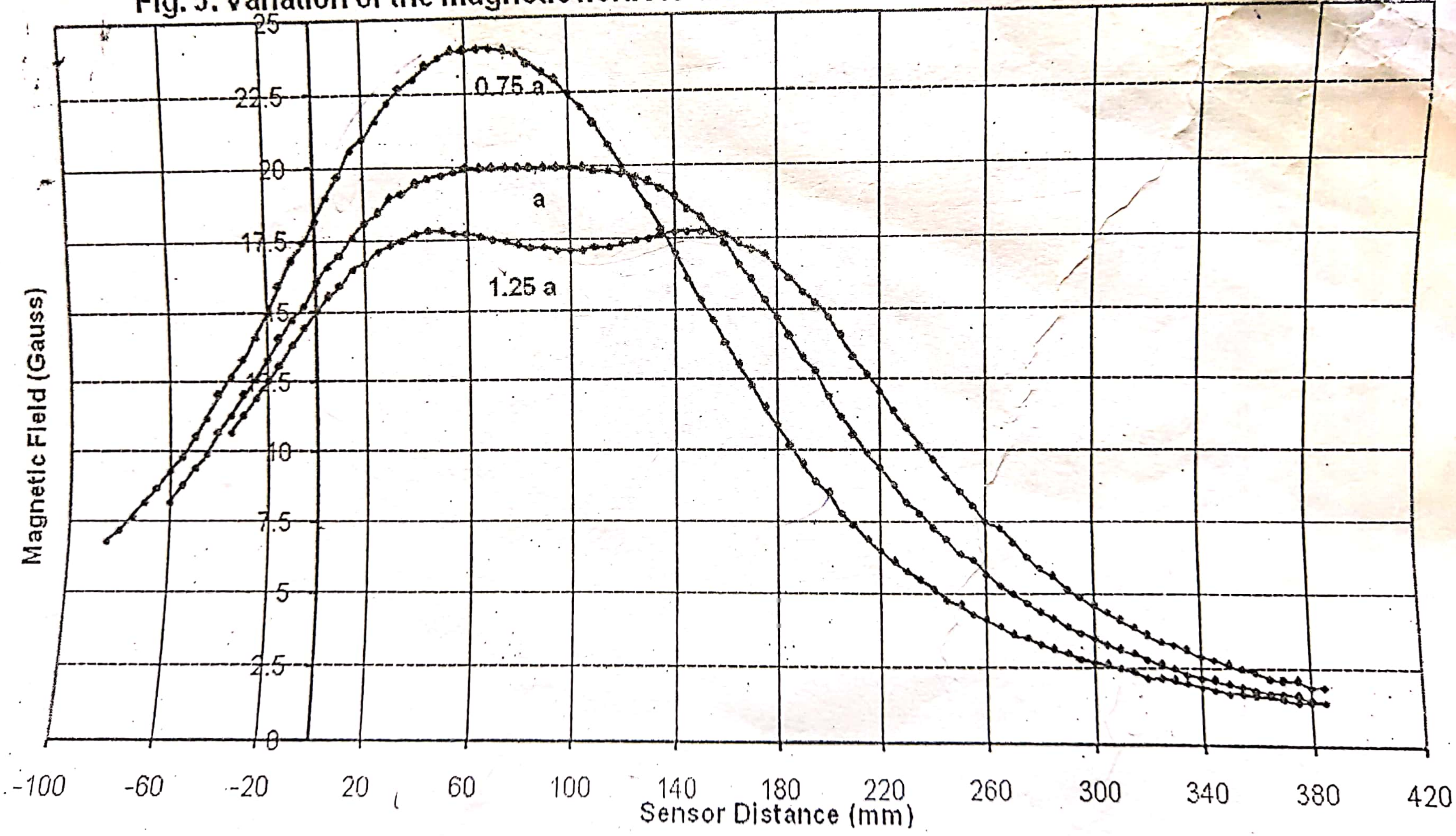


Fig. 5: Variation of the magnetic field for distance between the coils equal to 0.75a, a



EXPERIMENT 1

Determination of Planck's Constant

Theory:

It was observed as early as 1905 that most metals under influence of radiation, emit electrons. This phenomenon was termed as photoelectric emission. The detailed study of it has shown.

1. That the emission process depends strongly on frequency of radiation.
2. For each metal there exists a critical frequency such that light of lower frequency is unable to liberate electrons, while light of higher frequency always does.
3. The emission of electron occurs within a very short time interval after arrival of the radiation and member of electrons is strictly proportional to the intensity of this radiation.

The experimental facts given above are among the strongest evidence that the electromagnetic field is quantified and the field consists of quanta of energy E= hν where ν is the frequency of the radiation and h is the Planck's constant. These quanta are called photons.

Further it is assumed that electrons are bound inside the metal surface with an energy eϕ, where ϕ is called work function. It then follows that if the frequency of the light is such that

$$h\nu > e\phi$$

it will be possible to eject photoelectron, while if hν<eϕ, it would be impossible. In the former case, the excess energy of quantum appears as kinetic energy of the electron, so that

$$h\nu = \frac{1}{2}mv^2 + e\phi \qquad (1)$$

which is the famous photoelectrons equation formulated by Einstein in 1905.

The energy of emitted photoelectrons can be measured by simple retarding potential techniques as is done in this experiment. Retarding potential at which the photo current stop, we call it stopping potential V_s and is used to measure kinetic energy of electrons E_c, we have,

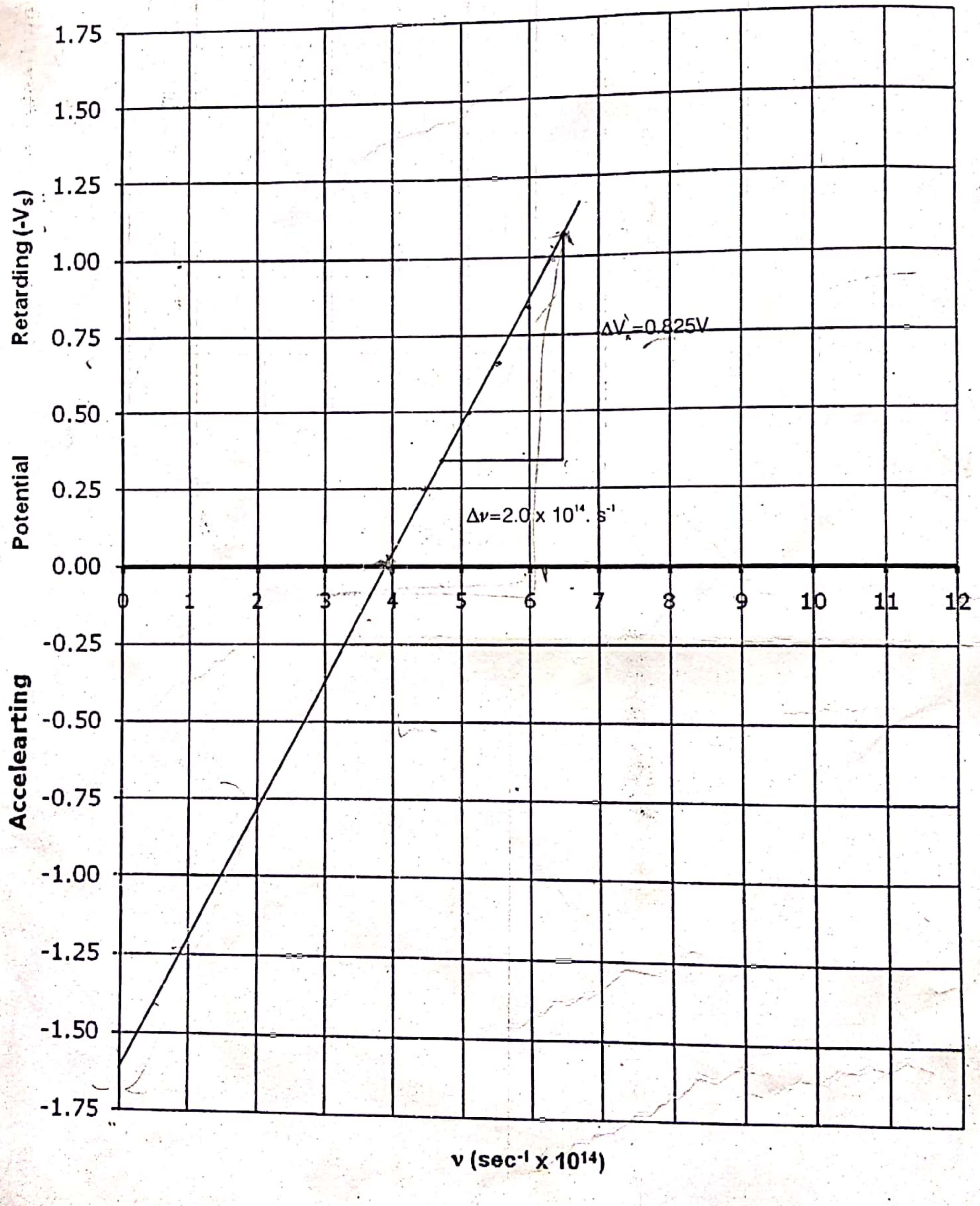
$$E_e = \frac{1}{2}mv^2 = eV_s \quad \text{or} \quad V_s = \frac{h}{e}\nu - \phi$$

So when we plot a graph V_s as a function of ν, the slope of the straight line yields $\frac{h}{e}$ and the intercept of extrapolated point ν=0 can give work function ϕ.

PROCEDURE

1. Insert the red color filter (635 nm), set light intensity switch (12) at strong light, voltage direction switch (14) at '-', display mode switch (10) at current display.
2. Adjust to de-accelerating voltage to 0 V and set current range selector (4) at X 0.001. Increase the de-accelerating to decrease the photo current to zero. Take down the de-accelerating voltage (V_s) corresponding to zero current of 635 nm wavelength. Get the Vs of other wave lengths, in the same way.

PLANCK'S CONSTANT MEASUREING APPARATUS



$\theta = \frac{4.2}{2.7}$

BSERVATIONS

S.No	Filters	ν (sec^{-1} x 10^{14})	Stopping Voltage (V)
1	Red (635 nm)		
2	Yellow I (585 nm)		
3	Yellow II (540 nm)		
4	Green (500 nm)		
5	Blue (460 nm)		

ALCULATIONS

Planck's Constant: $h = e\dfrac{\Delta V_s}{\Delta \nu}$

Where e is the charge of electron

y putting the value of ΔV_s & $\Delta \nu$ from graph

$$h = 1.602 \times 10^{-19} \times \frac{0.825}{2.00 \times 10^{14}}$$

$$= 1.602 \times 10^{-19} \times 0.413 \times 10^{-14}$$

$$= 6.61 \times 10^{-34} \text{ Joules sec.}$$

om Graph 1 intercept at ν = 0 the value of

$\phi = 1.625$ V

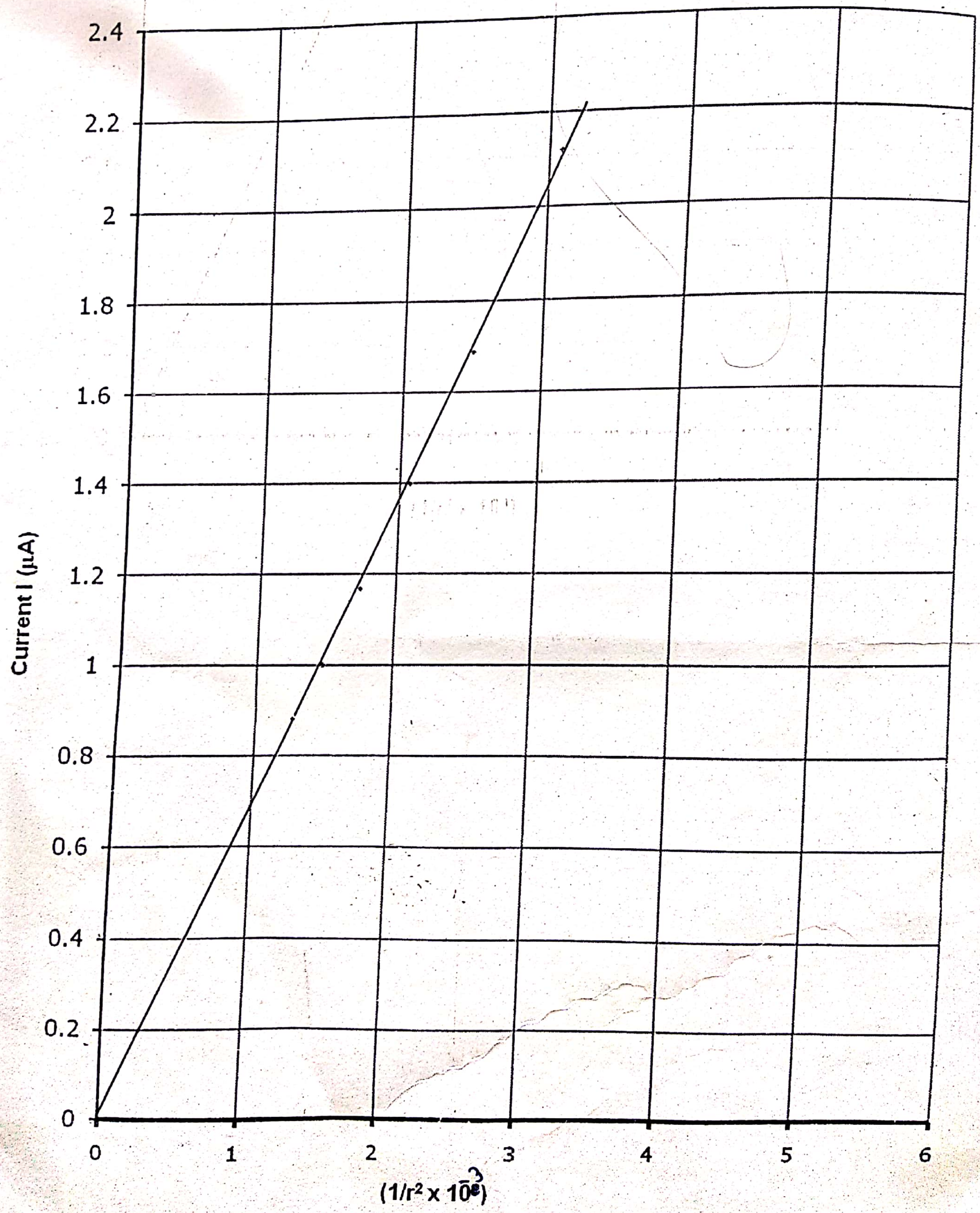
Compared with accepted value of h = 6.62 x 10^{-34} Joules. sec. the results are well ithin accepted error range.

RECAUTIONS

1. This instrument should be operated in a dry, cool indoor space.
2. Phototube particularly should not be exposed to direct light, particularly at the time of installation of phototube; the room should be only dimly lit.
3. The instrument should be kept in dust proof and moisture proof environment, if there is dust on the phototube, color filter, lens etc. clean it by using absorbent cotton with a few drops of alcohol.
4. The color filter should be stored in dry and dust proof environment.
5. After finishing the experiment remember to switch off power and cover the drawtube (4) with the lens cover (15) provided. Phototube is light sensitive device and its sensitivity decreases with exposure to light, due to ageing.

VERIFICATION OF INVERSE SQUARE LAW

Graph : $1/r^2$ vs I



EXPERIMENT 2

To verify inverse square law of radiation using a photoelectric cell

Theory:

If L is the luminous intensity of an electric lamp and E is the luminescence (intensity of illumination) at point 'r' from it, then according to inverse square law.

$$E = \frac{L}{r^2}$$

If this light is allowed to face on the cathode of a photo-electric cell, then the photo-electric current (I) would be proportional to E.

$$E = \frac{L}{r^2} = K.I$$

Hence a graph between $\frac{1}{r^2}$ and I is a straight line, which verify the inverse square law of radiation.

PROCEDURE

(1) The connection would be same as before except a positive voltage would be applied to the anode with respect to cathode.

(2) Place a filter in front of the photoelectric cell.

(3) Keeping the voltage constant and position of photocell fixed, increase the distance of lamp from photo-cell in small steps. In each case note the position of the lamp r on the optical bench and the current I.

(4) The experiment may be repeated with other filters.

OBSERVATIONS & CALCULATIONS:

Filter red λ 6400 nm

Anode Voltage: 0.25 V

Reading of Photo-electric cell on the optical bench = 0 cm

S. No.	Distance between lamp and photo-cell (r)	$\frac{1}{r^2} \times 10^3\ cm^{-2}$	I μA
1.	18 cm	3.09	2.12
2.	20 cm	2.50	1.69
3.	22 cm	2.07	1.40
4.	24 cm	1.74	1.17
5.	26 cm	1.48	1.00
6.	28 cm	1.28	0.88
7.	30 cm	1.11	0.78

Graph between $\frac{1}{r^2}$ taken along the X-axis and I along the Y-axis is a straight line proving the inverse square law of radiation.

PRECAUTIONS

1. This instrument should be operated in a dry, cool indoor space.
2. Phototube particularly should not be exposed to direct light, particularly at the time of installation of phototube; the room should be only dimly lit.
3. The instrument should be kept in dust proof and moisture proof environment, if there is dust on the phototube, color filter, lens etc. clean it by using absorbent cotton with a few drops of alcohol.
4. The color filter should be stored in dry and dust proof environment.
5. After finishing the experiment remember to switch off power and cover the drawtube (4) with the lens cover (15) provided. Phototube is light sensitive device and its sensitivity decreases with exposure to light, due to ageing.