Aim → To determine the specific resistence of the material of given wire using Carey Foster's bridge wire.

Apparatus.

(1) Carey Foster's bridge
(2) Decimal ohm box
(3) Leclanche cell
(4) Galvanometer
(5) Thick copper strip
(6) Plug key
(7) Given wire
(8) Screw guage
(9) Rehostat (10-20 Ω)
(10) Sand papers and connection wires.

Formula Used

The resistence per unit length of the bridge wire is given by the formula.

$$R - R' = \rho(l_2 - l_1) \qquad \rho = \frac{R}{l_2 - l_1} \quad [\text{when } R' = 0]$$

where l_1 & l_2 are the length of the balance point on the bridge wire before & after interchanging the resistence.

The specific resistence can be calculated as:

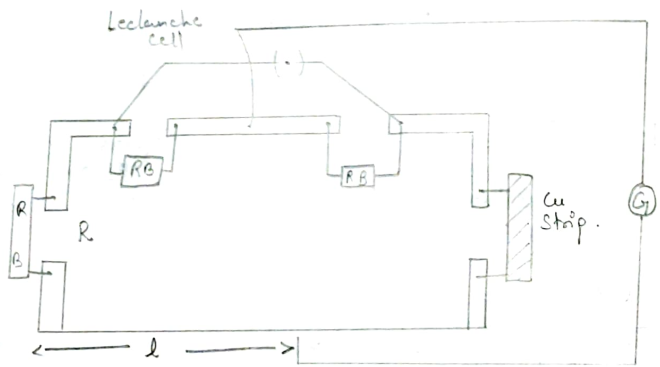
$$k_1 = \frac{R' \pi r^2}{l} \ \Omega\, cm.$$

where r is the radius & L is the length of given wire.

Specific resistence is the resistence offered by a conductor whose length is 1 cm & area of cross-section is 1 cm^2, the current flowing normally to the face.

Observation :-

S.No.	Resistence introduce from RB 'R' (ohm)	Position of balance point (cm)		$(l_2 - l_1)$	$\rho = \frac{R}{l_2 - l_1}$	Mean dimension
		l_1	l_2			
1.	0.1	14.5	17.3	0.8	0.035	$\rho = 0.141$
2	0.2	1.8	2.5	0.7	0.285	
3	0.3	41.8	44.3	2.5	0.12	0.14
4	0.4	4.1	45.1	4.1	0.09	
5	0.5	2.4	5.3	2.9	0.172	



Determination of Resistence of Wire

S. No.	Resistence introduce from RB 'R' (ohm)	Position of balance pt (cm) l_1'	l_2'	$(l_2' - l_1')$	Resistence of wire $R' = R - \rho(l_2' - l_1')$
1.	0.1	43.9	42.9	1	0.042
2.	0.2	43.4	43.7	0.3	0.0157
3.	0.3	42.8	43.2	0.4	0.243
4.	0.4	42.1	43.8	1.7	0.159
5.	0.5	42.2	44.9	2.7	0.117

Mean $= \frac{0.718}{5} = 0.144\ \Omega$

Length of the wire outside the terminal : l = 7 cm

Result

The specific resistence of a given wire $= 47 \times 10^{-6}$ ohm cm

$$k = \frac{R' \pi r^2}{l} = \frac{0.144 \times 3.17 \times (0.027)^2}{7}$$

$$= 4.7 \times 10^{-5}\ \Omega\,cm$$

Standard value $\Rightarrow 49 \times 10^{-6}\ \Omega\,cm$

% error $= \frac{\text{difference}}{\text{actual value}} \times 100\% = 4.08\ \%$

Teacher's Signature ______

VIVA - VOCE

1) What is specific resistence? What is its unit?

-> Specific resistence of a substance is defined as the resistance of a piece of the unit length & unit area of cross section.

$$k = R\frac{A}{l}$$

If $A = 1\,cm/s^2$ $l = 1\,cm$ $k_s = R$ ohm-cm.

2) Has specific resistence the same value for all materials?

-> No, it is different for different materials.

3) Has temperature any effect oil the specific resistance?

-> Yes, the specific resistence of pure metals decreases with temperature.

4) If a wire of certain length is stretched to twice to its original length, how will its specific change?

-> Specific resistence will remain the same as it depends on the material of the wire.

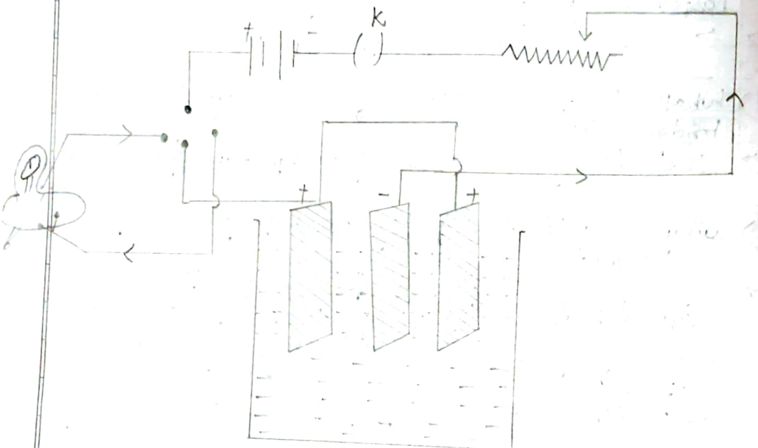
5) What is the effect of ↑sing the effective length of a Carey Foster's bridge wire?
→ By doing this, accuracy of the result will be increased.

6) Why the copper strip fitted on the Carey Foster's bridge is made thick?
→ So that it may offer a negligible resistance

7) What is the material of the Carey Foster's bridge wire?
→ The bridge wire is of constantum & maganin.

8) Why should the jockey be not pressed too hard?
→ If jockey is pressed too hard, the wire will become flat at that point & it's area of cross-section will no longer be uniform & hence the resistence of the wire will not be proportional to it's length.

9) What is the maximum & min. diff. in resistence that you can measure with Carey Foster's bridge wire?
→ Min. diff. measured by this bridge wire is resistence of one millimeter length of bridge wire.
Max. diff. is equal to resistence of total length of bridge wire.



Aim :- To determine the electro-chemical equivalent (ECE) of copper using a tangent Galvanometer.

Apparatus Required :-
1) Copper Voltmeter
2) Tangent galvanometer
3) Rheostat
4) One way key
5) Battery
6) Commutator
7) Stop watch
8) Ammeter
9) Sand paper & Connecting wires

Theory :- (i) Copper Voltmeter -> It consists of a glass vessel containing 16 to 22 % sol. of $CuSO_4$ with a few drops of sulphuric acid (H_2SO_4). The anode consists of a pair of a copper plates.

(ii) Faraday's law of electrolysis.

(iii) Acc. to first law mass (m) deposited

$$m \propto q \quad \text{or} \quad m \propto It$$

$$m = ZIT$$

where, Z is constant is called the electro-chemical equivalent of the substance.

For tangent galvanometer, $I = \frac{10 r H}{2\pi m} \tan\theta$

$$Z = \frac{2\pi n \cdot m}{10 \pi H \tan\theta \times t}$$

Teacher's Signature

Table for determination of θ

Time	Def. of pointer for direct current		[illegible]			
Minutes	Left point θ_1	Left pointer θ_2	Left poi θ_3	[illegible] θ_4	Mean	$\tan\theta$
0	45	45	45	45		
5	45	45	44	44	$\theta = 45^\circ$	$\tan\theta$
10	48	48	44	44		$\tan 45^\circ = 1$
15	48	48	43	43		
20	49	49	42	42		

Calculation :-

$$Z = \frac{2\pi n \times m}{10 a H \tan\theta \times t}$$

$$= \frac{2 \times 3.14 \times 50 \times 0.2}{10 \times 7.5 \times 0.339 \times 1 \times 2400}$$

$$= \frac{62.8}{61000}$$

$$= 0.00129 \text{ gm/C}$$

In case of Helmholtz galvanometer $I = \frac{5a\cancel{\delta}H}{32\pi n} \tan\theta$

Observations:-

Value of field (H) = 0.339 oersteds
Radius of coil (a) = 7.5 cm
No. of turns in each coil (n) = 50
Mass of copper plate before deposition of copper = 29.9 gm
Mass of copper plate after deposition of copper = 30.1 gm
Mass of copper deposited m = 30.1 - 29.9
= 0.2 gm.

Initial reading of stop watch = 0 sec.
Final reading of stop watch
Total time taken = 40×60 = 2400 sec.

Result :- The E.C.E of copper = 0.0129 gm/C
Standard value of E.C.E (Cu) = 0.00032 gm/C

Precautions:-

~~1) The magnetometer box should be carefully leveled so that the magnetic needle moves freely in a horizontal plane.~~

2) The coil should be set in magnetic meridian

3) All the magnetic materials & current carrying conductor should be at a considerable distance from the apparatus.

VIVA - VOCE

1) What is meant by electrochemical equivalent (E.C.E) of element?

→ From first law of electrolysis $m \propto It$

$m = ZIt$

Z is constant of proportionality & is called electro chemical equivalent (E.C.E)

2) What would you define E.C.E of an element or a substance.

→ E.C.E of an element or a substance will be defined as the mass of it which is liberated when one coulomb of electricity flows through the electrolyte.

3) What is the unit of E.C.E?

→ The unit of E.C.E is gm/Coulomb.

4) What is electrolysis?

→ It is a process of decomposing an electrolyte by the passage of current.

5) What are electrodes?

→ The metallic conductors through which the current leaves or enters the electrolyte are called electrodes.

Table for Calibration of voltmeter:-

Sr. No.	Voltmeter readings V_1 (Volts)	Balancing length of the potentiometer wire L_2. No. of complete wires	Length of sliding wire	Total L_2	$V_2 = E \times \frac{L_2}{L_1} = k \times L_2$	Error $V_2 - V_1$
1	0.1	0	72.5	72.5	$1.65 \times \frac{72.5}{1000}$ => 0.1196	0.0196
2	0.2	1	40	140	$1.65 \times \frac{140}{1000}$ = 0.231	0.031
3.	0.3	1	64	164	$1.65 \times \frac{164}{1000}$ = 0.2708	0.0294
4.	0.4	2	47	247	$1.65 \times \frac{247}{1000}$ = 0.4076	0.0076
5.	0.5	2	61	261	$1.65 \times \frac{261}{1000}$ => 0.4306	0.0694

Aim:- To calibrate a Voltmeter with a potentio-meter.

Apparatus Required:-
1) Potentiometer
2) Storage battery (two)
3) Rheostats (50Ω & 120Ω)
4) Standard cell.
5) Galvanometer
6) Voltmeter
7) One way key (two)
8) Two way key.
9) Connection wires & Sand paper.

Formula Used:-

The error in voltmeter reading is given by $V_2 - V_1 = (E L_2 / L_1) - V_1$ where,

V_1 = potential diff. b/w two points (voltmeter reading)

V_2 = potential diff. b/w the same two points (potentio-meter reading)

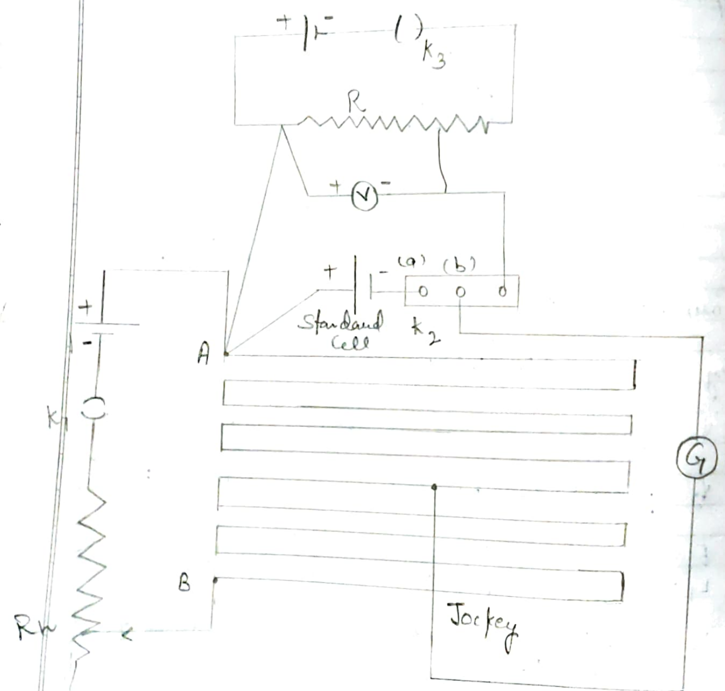
E = E.M.F of the standard cell.

L_1 = length of the potentiometer wire corresponding to E.M.F of standard cell.

L_2 = length of potentiometer wire corresponding to potential difference V_2.

Calculations :-

Potential gradient $K = \frac{E}{L_1} = 1.65 \times 10^{-3}$ volt/cm.



Theory :- The checking up the accuracy of voltmeter readings is known as calibration of voltmeter. This calibration is done by using potentiometer because it does not draw any current at null point.

Observation :- 1) length of the potentiometer wire corresponding to E.M.F of standard cell, l_1 cm = 1000 cm.

2) E.M.F of standard cell E = 1.65 Volts

3) Potential gradient = E/l_1 => 0.001

Result :- The graph of error $(V_2 - V_1)$ versus voltmeter reading V_1 is zig-zag in shape & this curve is called as calibration curve. This curve is point to point curve.

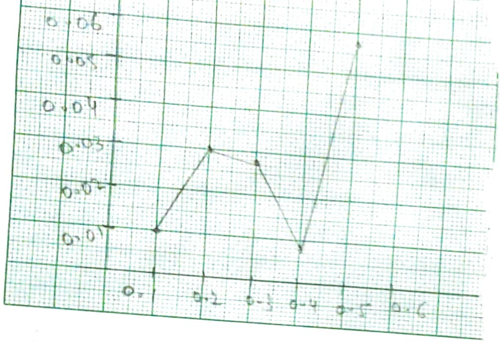
Precautions :-

1) The E.M.F of the battery should be greater than the E.M.F of the standard cell.

2) The (the) terminals should be connected at the point A.

3) Jockey should not be moved on the potentiometer wire

4) Voltmeter should be connected in parallel



Expt. No. ______

VIVA - VOCE

1. What is a Potentiometer?

→ A potentiometer consists of a long uniform wire of constantan or manganin fixed on a wooden board in which "a steady current" is allowed to flow by connecting it to a source of constant E.M.F.

2. Why is it called a Potentiometer?

→ It is called as potentiometer because it measures potential difference b/w any two points.

3. What is the principle of a Potentiometer?

→ It works on the for constant current fall of potential along a uniform wire is proportional to its length.

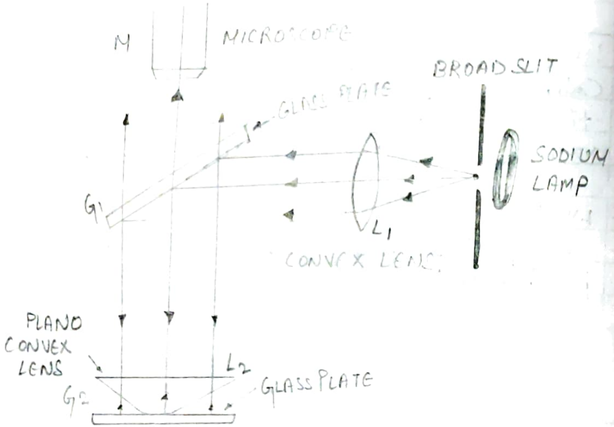
4. Why do we use constantan or manganin wire?

→ Both of these wires possesses high specific resistan & low temperature coefficient.

5. What do you mean by callibration of a voltmeter

→ Callibration of voltmeter means checking up the accuracy of its readings.

Teacher's Signature ______



Experimental arrangement for Newton's ring.

Objective :- Study of Interference of light.

Aim :- To determine the wavelength of monochromatic (sodium) light by Newton's rings.

Apparatus :-

1) Travelling microscope
2) 45° inclined glass plate
3) Optically plane glass plate
4) Plano convex lens.
5) Reading lens & lamp
6) Spherometer.

Formula Used :-

The wavelength λ of monochromatic light is given by

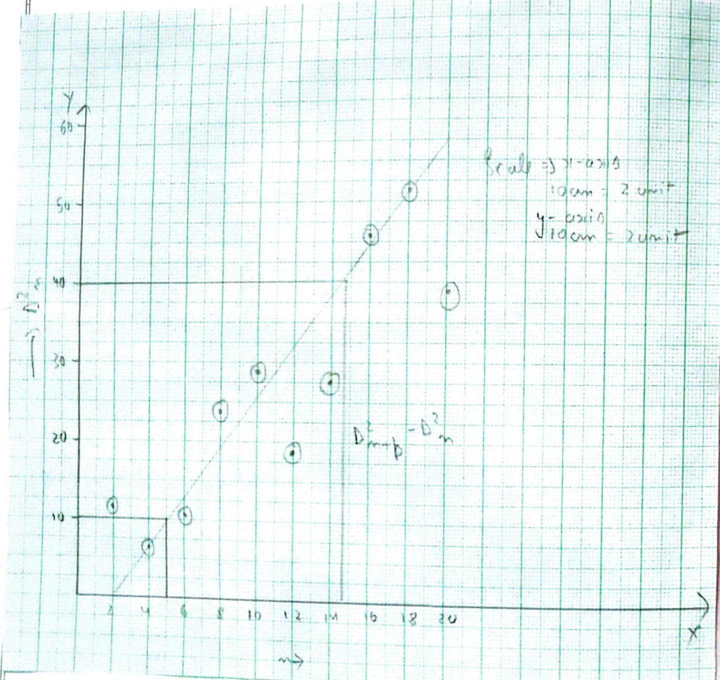
$$\lambda = \frac{D_{n+p}^2 - D_n^2}{4pR}$$

Where.

D_{n+p} = diameter of the $(n+p)$th bright ring.
D_n = diameter of nth bright ring
R = radius of curvature of convex surface of the plano convex lens & is given by

$R = \frac{a^2}{6h} + \frac{h}{2}$ where 'a' is the dis. b/w two legs & h height of convexity of lens.

Teacher's Signature



Theory :- When a plano-convex lens with its convex surface is placed on a plane glass-plate, an air film of gradually ↑sing thickness is formed b/w the two. If monochromatic light is allowed to fall normally & viewed as shown in fig., then alternate dark fringes & bright circular fringes are observed. These rings are known as Newton's rings.

Newton's rings are formed because of the interference b/w the waves reflected from top & bottom surfaces of air film formed b/w the plates.

We have for the diameter of the n^{th} dark fringe

$$D_n^2 = 4n\lambda R$$

Similarly diameter for $(n+p)^{th}$ dark fringe

$$D_{n+p}^2 = 4(n+p)\lambda R$$

$$D_{n+p}^2 - D_n^2 = 4pR\lambda$$

$$D_{n+p}^2 - D_n^2 / 4pR = \lambda$$

So, λ can be calculated using this formula.

Observations :- Least count of the vernier of travelling microscope $= 0.01$ mm.

Calculations

$R = 100\,cm \quad p = 6$

$$\lambda = \frac{D_{n+p}^2 - D_n^2}{4pR}$$

$$= \frac{15.24 \times 10^{-2}}{4 \times 6 \times 100}$$

$$= 6.35 \times 10^{-5}$$

$$= 6350 \times 10^{-8}\ cm$$

$$= 6350\ A^\circ$$

Table :- Diameter of the rings.

n	Microscope vernier reading Left hand side MS (mm)	VS (mm)	Total (a) (mm)	Right hand side MS (mm)	VS (mm)	Total (b) (mm)	D_n (a-b) mm	D_n^2 mm^2	$D_{n+p}^2 - D_n^2$ p=6 mm^2	Mean
20	33	0.25	33.25	26	0.96	26.96	6.29	39.56	12	
18	33	0.72	33.72	26.5	0.11	26.65	7.11	50.55	32.06	
16	33	0.52	33.52	26.5	0.24	26.74	6.78	45.96	17.34	
14	32.5	0.38	32.88	27	0.63	27.63	5.25	27.56	3.75	15.24
12	32	0.12	32.12	27	0.82	27.82	4.30	18.49	7.34	
10	32	0.90	32.90	27.5	0.05	27.55	5.35	28.62	22.02	
8	32	0.67	32.67	27.5	0.25	27.75	4.88	23.81	12.19	
6	31.5	0.39	31.89	28	0.55	28.55	3.34	11.51	27.83	
4	31	0.47	31.47	28	0.90	28.90	2.57	6.60	31.97	
2	31	0.69	31.69	28	0.28	28.28	3.41	11.62	27.79	

Radius of curvature of convex surface R(Given) = 100 cm.

Result :-

The wavelength of sodium light was determined ~~&~~ is

VIVA - VOCE

1- What are Newton's ring?

-> When a plano-convex lens of large radius of curvature is placed with its convex surface in contact with a plane glass plate, an air film is formed b/w the lower surface of the lens & upper surface of the plate. If monochromatic light is allowed to fall normally, on this film, a system of alternate bright & dark concentric rings with their center dark is formed. These are called Newton's rings.

2- Why these rings are circular?

-> These rings are loci of constant thickness of the air ~~foilm~~ film & these loci are concentric circle hence fringe are circular.

3- Why do the rings get closer as the order of rings increases?

-> Because radius of dark ring $D_n \propto \sqrt{n}$ while for bright ring $D_n \propto \sqrt{(2n+1)}$ i.e. sq. root of odd natural no.

4- Why is the center of the ring dark?

→ Because effective path difference $P = 2t + \lambda/2$. At the point of contact $t = 0$ $\therefore P = \lambda/2$. This is the cond. for minimum intensity. Hence the centre of the ring is dark.

5- But sometimes it is observed that centre is bright why?

→ This is because dust particle comes b/w the two surfaces at the point of contact.

6- If sodium lamp is replaced by white light source then what will happen?

→ Few coloured fringes will be observed near the centre.

7- If a few drops of transparent liquid are introduced b/w the lens & plate, then what will happen?

→ The diameter of fringes is contracted.

8- On what factors, does the diameter of ring depend.

→ (1) Radius of curvature R, of convex lens.
(2) Refractive Index
(3) Wavelength of light used.

7/11

Expt. No. 5 Page No. 19 Date 26/09/19

Objective :- 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 & a reading lens.

Formula Used :- The wavelength of any spectral line can be obtained from the formula.

$$(e+d)\sin\theta = n\lambda$$

$$\lambda = \frac{(e+d)\sin\theta}{n}$$

where,

$(a+d)$ = grating element

θ = angle of diffraction

N = order of spectrum.

Observation :-

least count of spectrometer = 30 sec.

No. of lines per inch on the grating $N = 15000$

Grating element $(e+d) = 2.54/N$.

Teacher's Signature ____________

Observation table

Order of spectrum	Colour of light	Kind of Vernier	Spectrum on left			Spectrum of right			$2\theta = (a-b)$	Mean θ in degree
			MS	VS	Total	MS	VS	Total		
First	Violet	V_1	143	0	143	174.5	10	174.6	15.75	15.915
		V_2	323	24	323.44	355.0	30	355.6	16.08	
	Green	V_1	139.5	20	139.90	178	20	178.4	19.25	19.575
		V_2	319	20	319.90	358.5	60	358.7	19.9	

Calculations

Grating element $(e+d) = 2.54N$

$N = 15000$ (given)

$$\frac{(e+d)}{n} = \frac{2.54}{15000} \text{ cm} \Rightarrow \frac{2.54}{15000 \times 10^2} \text{ m}$$

$$\lambda = \frac{(e+d)\sin\theta}{n}$$

$\lambda = (e+d)\sin\theta$ where $n = 1$

$$\lambda_V = \frac{2.54}{15000 \times 10^2} \times \sin(15.915)$$
$$= 4.6433 \times 10^{-7}$$
$$= 4643.3 \, A^\circ$$

$$\lambda_V = \frac{2.54}{15000 \times 10^2} \sin(19.575)$$
$$= 5.6733 \times 10^{-7}$$
$$= 5.6733 \, A^\circ$$

Result :-

Violet light = 4643.3 A°

Green light = 5673.35 A°

VIVA - VOCE

1) Define Grating

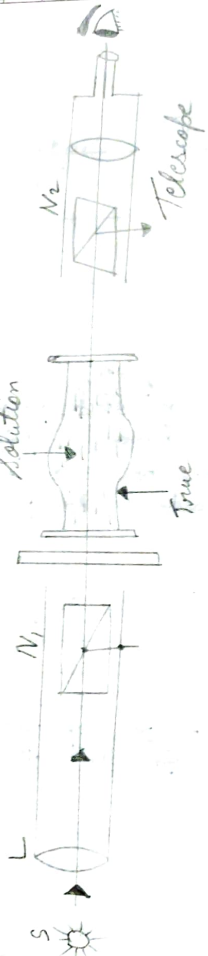
→ It is an arrangement in which there is a fine quality of glass in which parallel lines are ruled equidistant with diamond point by an automatic shifting machine. The ruled lines works as opaque & spacing works as transparent.

2) What is active medium?

→ It may be solid, liq. or gas which achieves population inversion.

3) What is the action of the optical resonator?

→ It is the combination of two reflecting mirror which is used to ↑se the intensity of laser light.



Objective :- To determine the specific rotation of cane-sugar sol. using half shade polarimeter.

Apparatus Required :-
1) Half - Shade polarimeter
2) Sodium lamp
3) 50 c.c flus
4) Two beakers
5) ~~Analytical balance~~
6) ~~Weight box.~~

Formula Used :- $S = \frac{\theta}{l \times c}$ degree $(dm)^{-1} (gm/cc)^{-1}$

where,
θ = rotation in degrees
l = length of the sol. in decimeters
c = conc. of sol. in gm/cm^3.

Theory :- The specific rotation 'S' of a substance at a given temp. & for a given wavelength of light is defined as the rotation (in degree) produced by one decimeter length of the substance in sol. when it's conc. is $1\, gm/cm^3$. Laurent's half - shade polarimeter.

It is an instrument used for measuring the

Table-1. Distilled water in the tube

S.No	First position of the analyser						Position of analyser 180° apart from the first setting						$\theta_1 = \frac{a+b+c+d}{4}$
	Clockwise rotation (a)			Anticlockwise rotation (b)			Clockwise rotation (c)			Anticlockwise rotation (d)			
	M.S	V.S	Total	M.S	V.S	Total	M.S	V.S	Total	M.S	V.S	Total	
1.	70.3	3	73.3	330.4	6	336.4	80.8	6	86.8	310.2	3	312.2	202.43
2.	90.1	6	96.1	310.6	6	316.6	90.7	6	96.7	300.6	6	306.6	204
3.	90.9	6	96.9	300.8	6	306.8	110.1	6	116.1	290.8	6	296.8	204.15

Table-2 Cane Sugar sol. in the tube

Conc	First position of the analyser						After 180°						$\theta_2 = \frac{e+f+g+h}{4}$
	Clock wise rotation (e)			Anticlockwise rotation (f)			Clockwise rotation (g)			Anti-clockwise rotation (h)			
	MS	VS	Total	MS	VS	Total	MS	VS	Total	M.S	V.S	Total	
1.	74	3	77	339	3	342	270	3	273	146	3	149	210.25
2.	88	3	91	330	3	333	289	3	292	132	3	135	212.75
3.	103	3	106	323	3	326	313	3	316	120	3	123	217.75

optical rotation of certain substances.

Monochromatic light from source 'S' usually a sodium lamp after passing through a slit is rendered // by a convex lens L & falls on a polarising Nicol N_1. After passing through Nicol N_1 the light becomes plane-polarised. This light passes through a half-shade device Laurent's plate H & then through a tube containing the optically active sol. (cane sugar sol. in this case) & then falls on the analyzing Nicol N_2. The emergent light is viewed through a telescope T. The analyzing Nicol N_2 can be rotated about the light as axis, & its rotation can be measured on a circular degree scale by means of a vernier.

Observations :- least count of vernier of the analyser = 0.1°

Mass of sugar = 2 gm

Length of the tube = 20 cm or 2 decimeter.

Result :- The specific rotation of cane sugar sol. for sodium light is +68.5° $(dm)^{-1}$ $(gm/cc)^{-1}$

Standard value = +66.5° $(dm)^{-1}$ $(gm/cc)^{-1}$

Calculations

Mean Value of $\theta_1 = 203.52$

Mean Value of $\theta_2 = 213.58$

Angle of rotation = $\theta = \theta_1 - \theta_2 = 10.06$

$S_1 = \frac{\theta}{l \times C_1}$, $S_2 = \frac{\theta}{l \times C_2}$, $S_3 = \frac{\theta}{l \times C_3}$

Average value of $S = \frac{S_1 + S_2 + S_3}{3} = +68.5°$ degree per dm per unit conc

Precautions :-

1) There should be no air bubble in the sol^n contained in the polarimeter tube.

2) The caps of the tube should not be tightly screwed as to strain the glass which allows plane polarised light to pass through the sol^n

VIVA - VOCE

1) What is a polarimeter?

→ It is an instrument used for measuring the angle of rotation of the plane of polarisation by an optically active substance (cane sugar sol^n in this case).

2) What is mean by polarized light?

→ The light which has acquired the property of one-sideness is called polarised light.

3) What do you understand by plane polarised light?

→ When vibration takes place only in one direc^n // to the plane through the axis of a beam, light is said to be plane polarized.

4) Which crystal you are using in the experiment?
→ Nicol prism.

5) Name three method by which you can produce plane polarized light.
→ 1) Reflection 2) Refraction 3) Double refraction.

6) How many types of optically active substances are there?
→ There are two types of substances.
(1) Dextro - rotatory or right - handed
(2) Laevo - rotatory or left - handed.

7) Where is the half - shade plate fitted in the polarimeter?
→ This is fitted b/w the polarizer & the polarimeter tube containing the optically active solⁿ.

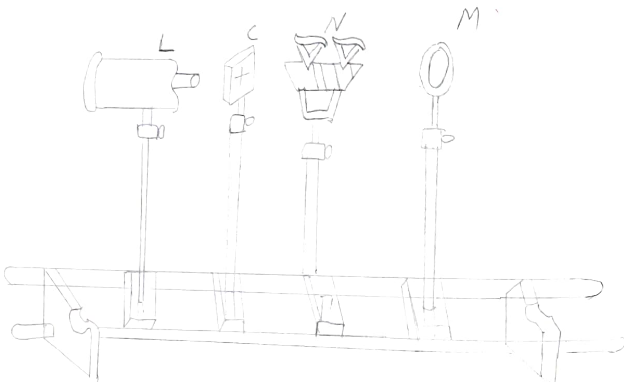
8) Which source of light is used for Laurent's half - shade polarimeter.
→ Sodium lamp.

9) Which source of light is used for Bi quartz polarimeter?

→ White light.

10) What is the standard value of specific rotation of cane sugar sol.?

→ Specific rotation of cane sugar sol. is $+66.5^\circ (dm)^{-1} (gm/cc)^{-1}$.



(a)

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Aim.

~~objective~~ :- To determine focal length of comb. of two lenses separated by distance & verify the formula for focal length of comb. of lens.

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{x}{f_1 f_2}$$

where

F = focal length of combination

f_1 = focal length of the first lens.

f_2 = " " " " second " .

and.

x = Dis. b/w the two lenses.

Apparatus Required :-

Nodal-slide assembly (consisting of an optical bench, plane mirror, cross-slit and lamp) & the two given lenses.

Principle :- The focal length of a lens system is the distance b/w its principal point & the corresponding focal points. The principal points concide with the corresponding nodal points when the medium are the same on both the sides of the system (here air). Thus the focal length of the system can be determined by locating a nodal point & corresponding

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Observations :-

Table 1:- Observation for the focal length of the lens.

S.No.	lens	Light incident on	Position of cross slit (a) cm	Pos. of lens (b) cm	focal length f (b-a) cm	Mean f cm.
1-	lens 1	One face	30	41	11	10.75
		Other face	30	40.5	10.5	f_1
2-	lens 2	One face	30	41.2	11.2	10.66
		Other face	30	40.1	10.1	f_2

Table 2:- Observation for the focal length of the comb. of two lenses.

S.No.	Dis. b/w lenses x cm.	Light incident on	Position of cross slit (a) cm	Position of the nodal slide (b) cm.	Exp. f length f (b-a) cm.	Mean	Calculated f length	Mean calculated (f)
1.	One face	3.8	30	37	7		6.608	
	Other face	3.3	30	37.5	7.5		6.410	
2.	One face	5	30	38.6	8.6		7.099	
	Other face	4.2	30	39	9		6.76.	

Calculations :-

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{x}{f_1 f_2}$$

$$F = \frac{f_1 f_2}{f_1 + f_2 - x}$$

(1) For $x = 3.8$ cm $\quad f = 7$ cm $\quad f_1 = 10.75$ cm

For $x = 5$ cm $\quad F = 8.6$ cm $\quad f_2 = 10.66$ cm.

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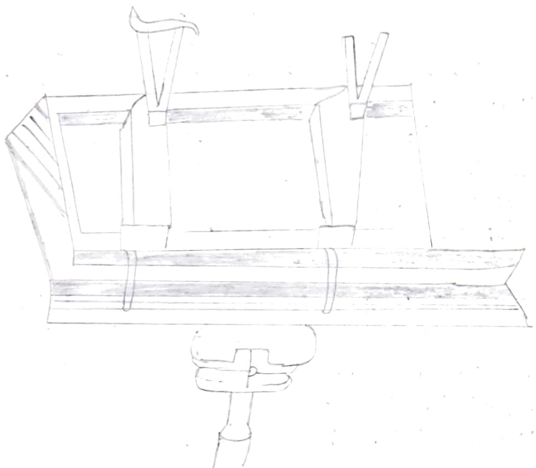
focal point.

The second nodal point can be located by using the fact that in case of // beam of light incident on a convergent lens system, thus forming an image on a screen in its second focal plane, the image does not shift literally when the system is rotated about a vertical axis passing through its second nodal point.

Result :- Focal length of the first lens = 10.75 cm

Focal length of the second lens = 10.66 cm

Lens formula verified since calculated value of focal length is comparable to the measured value (comb. lenses).



(b)

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VIVA - VOCE

1) What is a lens?

→ It is a transparent refracting medium bounded by two spherical mirrors.

2) What is refraction of light?

→ When light travels from one medium to another medium without changing its frequency called refraction of light.

3) What are convex & concave lens?

→ Convex lens is thick at centre & thin at the periphery while Concave lens are thin at centre & thick at the periphery.

4) What are the focal point?

→ The rays // to principal axis converges at a point are refraction, that pt. is known as focal point.

5) How [illegible]

→ These are a pairs of conjugate points which have unit positive angular magnification.

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→ It is the distance b/w optical centre & focus points.

→ Convex lens converges the light while concave lens diverges the light.

Objective :- Study of motion of charged particle in crossed electric & magnetic field.

Aim :- To study the Hall effect & determine hall coeff. carrier's density & mobility of a given semi-conductor sample using Hall-effect set-up.

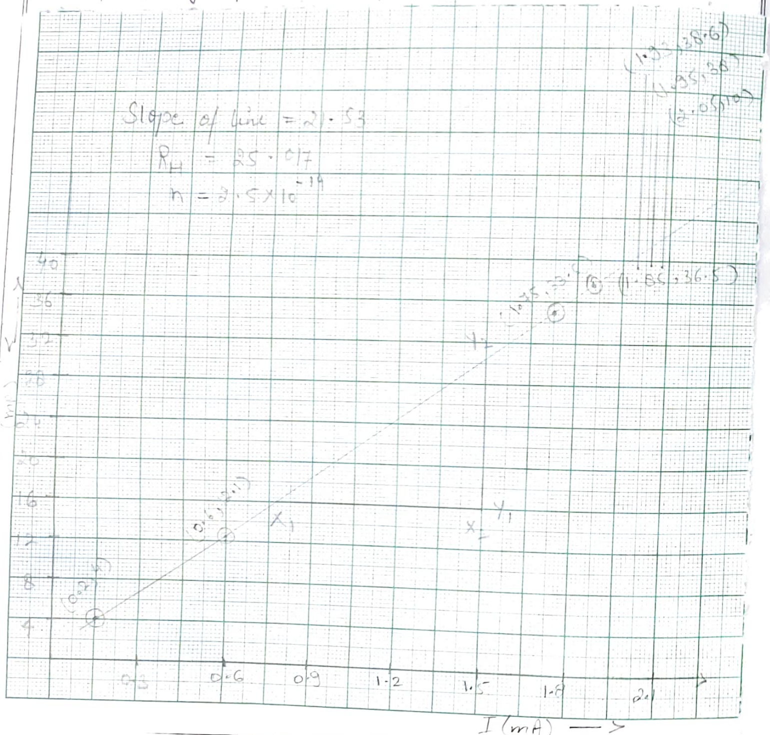
Apparatus Required :-
Hall effect set up Electronics, const. current power supply, hall probe (Ge crystal, Digital gauss meter etc).

Importance of Hall Effect :-

1) The sign of current carrying charge is determined.
2) The mobility is measured directly.
3) Charge carrier density can be determined the electronic from hall coeff. R_H.
4) It can be used to determine the electronic str. i.e. whether the specimen is metal, semi-conductor or inductor.
5) If we know the hall coeff. of a given metal then by the knowledge of hall voltage developed we can calculate the magnetic field.

Observation :-

Magnetic field (B) = 4300 Gauss
Distance b/w magnetic pole = 1.5 cm
Thickness of sample (t) = 0.5 mm
Resistivity of sample (ρ) = 6 ohm cm



Formula Used :-

Hall coeff. $R_H = V_H \, t/BI$ cm³/coulomb.

Carrier charge density $R_H = 1/ne$. $n = 1/R_H$ cm³

Mobility $\sigma = ne\mu$ then $\mu = \sigma/ne$ so

$\mu = R_H \sigma$

$\boxed{\mu = R_H/\rho}$ cm²/V sec

Observation table :-

S.No.	Current I(mA)	Hall voltage V(mV)	VH/I
1	0.20	4.0	20
2	1.85	36.5	19.72
3	1.95	38.0	19.48
4	2.05	40.0	19.51
5	0.60	12.1	20.166
6	1.93	38.6	20
7	1.75	33.5	19.14

Avg VH/I = 19.71

$t/B = \frac{0.5 \text{ mm}}{4300 \text{ Gauss}}$

$= \frac{0.5}{4300 \times 10^4}$

$= 1.162$

$R_H = 19.71 \times 1.162$

$= 22.90$

$n = I/R_H e$

$= 2.72 \times 10^{-19}$

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Result :-

Hall coeff. $R_H = 22.90\ cm^3/coul.$

Carrier charge density $n = 2.72 \times 10^{-19}/cm^3$

Mobility $\mu = 3.816\ cm^2/V\ sec.$

VIVA - VOCE

1) Define Hall Effect?

→ When a current carrying specimen is placed in a transverse magnetic field then a voltage is developed which is ⊥ to both direcⁿ of current & magnetic field. This phenomenon is called Hall effect.

2) What causes Hall Effect?

→ Whenever a charge moves in a mutually ⊥ electric & magnetic field, it experiences Lorentz force due to which it deflects from its path & Hall voltage is developed.

3) What is Lorentz force?

→ If a charge 'q' moves in a magnetic & electric field 'B' & 'E' resp. with velocity 'v' then force on it is given by:-

$$F = qE + BqV\sin\theta$$

4) What is Hall coeff.?
→ It is the electric field developed per unit current density per unit magnetic field.

5) What are the uses of Hall Effect?
→ To determine the sign of charge carrier & charge carrier concentration.

6) Define charge carrier concentration?
→ No. of charge carrier per unit volume.

7) Why Hall voltage differ for different type of charge carrier?
→ Because direcn of Lorentz force is different for different type of charge carrier.

8) What is unit hall coeff.?
→ Ohm-meter / Tesla.

9) What is the unit of charge carrier concentration?
→ Per Cubic centimeter.

10) Which type of magnet is used in the experiment temporary or permanent?
→ Temporary.

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- Objective :-

Study the stefan's law for radiation

- Aim :-

To verify Stefan's law by electrical method.

- Apparatus :-

1- D.C. Voltmeter (0-10 V)
2- D.C. Ammeter (0-1 A)
3- Small electric bulb (6V, 6W) [Having tungsten filament]
4- Rheostat (100 Ω)
5- Battery eliminator (6 V)

- Formula Used and Theory :-

Stefan's law states that the total radiant energy emitted per second from the unit surface area of a perfectly black body is proportional to the fourth power of its absolute temperature.

Or $E = \sigma T^4$

where σ is called Stefan's constant.

In case of black body radiation, Stefan's law is

$$E = \sigma (T_0^4 - T^4)$$

where E is the net amount of radiation emitted per second per unit area by a

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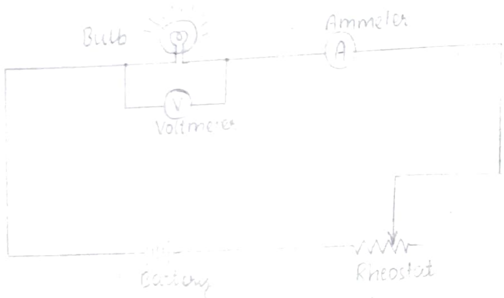

body at temperature T and surrounded by another body at Temperature T_0
for other bodies (other than black)

$$P = A(T^a - T_0^a)$$

where p is the power emitted by a body at temperature T surrounded by another at temp T_0, $a \approx 4$ and A is constt depending on the material and area of such a body.

$$P = AT^a\left[1 - \frac{T_0^a}{T^a}\right]$$

when $T >> T_0$, $\left(\frac{T_0}{T}\right)^a$ can be neglected

$$P = AT^a$$

Taking log both sides

$$\log_{10} P = a\log_{10} T + \log_{10} A$$

The graph b/w $\log_{10} P$ versus $\log_{10} T$ will be a straight line. Its slope will give the value of 'a'

Therefore to verify Stefan's law P and T should be measured.

• Observation:

Table 1. Determination of R_g: Filament temperature = 300 K

S.No	Current Increasing			Current decreasing		
	Voltage V	Current I	$R_g = \frac{V}{I}$	Voltage V	Current I	$R_g = \frac{V}{I}$
1.	0.6	0.14	4.28	5	0.4	12.5

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2.	0.8	0.16	5	3.6	0.32	~~12.2~~ 11.2
3.	1	0.18	5.55	2.4	0.28	~~8.5~~ 8.5
4.	1.2	0.18	6.66	1.2	0.18	~~8.5~~ 6.6
5.	1.4	0.2	7	1	0.18	~~6.6~~ 5.5
6.	1.6	0.22	7.2	0.8	0.16	~~5.5~~ 5
7.	1.8	0.24	7.5	0.6	0.14	~~5~~ 4.2
8.	2	0.24	8.3	0.4	0.12	~~4~~ 3.3
			Mean$_1$ = 6.44			Mean$_2$ = 7.1

Mean value of $R_g = \frac{6.44 + 7.1}{2}$

$= \frac{13.54}{2} = 6.77$ ohm

Table 2. Determination of Power P: for different temperature T

S.No.	Pot. diffe.	Current	$R_t = \frac{V}{I}$	R_t/R_o	Temp	$\log_{10} T$	$P = VI$	$\log_{10} P$
1.	0.8	0.16	5	2.9	200	2.3	0.128	-0.8
2.	1.2	0.18	6.6	3.9	500	2.698	0.216	-0.66
3.	1.6	0.22	8	4.7	600	2.778	0.352	-0.45
4.	4	0.38	10.5	6.21	800	2.9	1.52	0.18
~~5~~								

$R_0 = \frac{6.77}{4} = 1.69$

- Result :- The graph of $\log_{10} P$ versus $\log_{10} T$ is a straight line.
Hence $P = AT^a$ law is verified.
Because slope comes out to be 4. Hence $a = 4$

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- **Precautions:**

1- Use the bulb having tungsten filament
2- Increase the current in steps.
3- Note down the voltage reading after every change in current.
4- Choose the rheostat of appropriate range.
5-

- **Viva-Voce:**

Q.1 What is Stefan's law?
Ans Acc to this law the total energy emitted per second from the unit surface area of perfectly black body is proportional to the fourth power of its absolute Temp.

Q.2 What is Stefan's constant?
Ans As $E = \sigma T^4$. Here the proportionality constant σ is known as Stefan's constant.

Q.3 What is its value?
Ans Its value is $5.670 \times 10^{-8}\ W/m^2K^4$

Q.4 What is a black body?
Ans A body that absorbs all the radiations incident upon it, irrespective of frequency.

Q.5 What is function of Rheostat in this

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Q.5 What is function of Rheostat in this experiment?

Ans Rheostat is used to increase and decrease the value of current flowing in the circuit.

Q.6 What is the temperature at the stage when the tungsten filament first starts glowing?

Ans. Filament temperature is 800K

Q.7 What is Rg?

Ans Rg is the filament resistance at glow [at 800K]

• Objective :- Study of Tangent Law for magnetic field.

• Aim :- To determine the variation of magnetic field along the axis of a circular coil carrying current & to estimate the radius of coil.

• Apparatus Used :-

1. Stewart & Gee type tangent galvanometer
2. Ammeter
3. Battery Eliminator
4. Rheostat
5. Spirit level
6. Reversing key or a cummutator
7. A plug key
8. Sand paper & connecting wires.

• Theory :-

If a current of 'I' units be flowing through 'l' length of wire bent into an arc of 'r' radius, the magnetic field intensity (F) at the centre of arc is given by

$$F = \frac{\mu_0}{4\pi} \cdot \frac{Il}{r^2}$$

where $\mu_0 = 4\pi \times 10^{-7}$ W/A-m and is known

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as the permeability of free space.
If the wire forms one complete circle $l = 2\pi r$

$$F = \frac{\mu_0}{4\pi} \cdot \frac{I \cdot 2\pi r}{r^2} = \frac{\mu_0 I}{2r}$$

For a circular coil carrying 'n' turns

$$F = \frac{\mu_0 n I}{2r} = \frac{2\pi n I}{r \times 10^7}$$

Hence $F \propto n$
$\propto I$

In order to study the effect of 'n' and 'I' on the magnetic field intensity F, the coil is placed in the magnetic meridian the magnetic field due to the current 'I' flowing in the coil is perpendicular to H (Horizontal component of earth's magnetic field) and the magnetic needle is acted upon by two uniform magnetic field F and H which are at right angles to each other.
The field F along the axis of a coil is given by

$$F = \frac{2\pi n r^2 I}{10^7 (x^2 + r^2)^{3/2}}$$

Where x is the distance of the point from the centre of the coil.
When $x = 0$ i.e., at centre

$$F = \frac{2\pi r^2 I}{10^7 r^3} = \frac{2\pi n I}{10^7 \times r}$$

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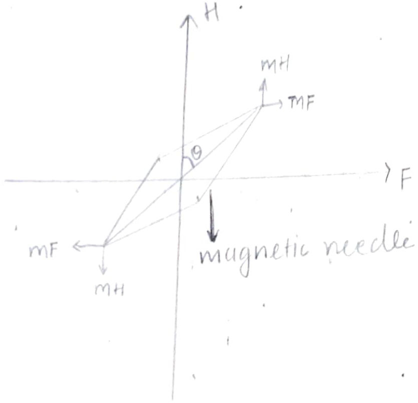

Fig. 7.1 Tangent Law

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Let the magnetic needle make angle q with H in the equilibrium position.

Acc to the tangent law:-

$F = H \tan\theta$

Since 'H' is constt at the place of experiment

$$\tan\theta = \frac{2\pi n r^2 I}{H(x^2+r^2)^{3/2}} \times 10^{-7}$$

Description of Apparatus -

Stewart and Gee tangent galvanometer consists of an insulated circular coil. The ends of these sets of coil are connected to the binding screws, fixed at the base-board of the instrument. One terminal is common to all the coils. A compass box is placed inside the coil such that it can slide on the bench in such a way that the centre of the needle always lies on the axis of the coil. The distance of the needle from the centre of the coil can be read on the graduated scale fixed on the arms of the compass box.

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• Observations :-

S.No.	Distance of needle from the centre, x cm	Current one way		Current reversed		Mean	$\tan\theta$
		θ_1	θ_2	θ_3	θ_4		
~~1-~~	~~θ~~						
1-	0	68	70	65	65	67	2.35
2-	5	60	62	58	57	59.5	1.69
3-	10	40	42	40	35	39.25	0.82
4-	15	20	23	18	20	20.25	0.37
5-	20	10	14	14	10	12	0.21
6-	25	5	10	8	4	6.75	0.12
7-	30	4	8	5	1	4.5	0.08

Table 2: for other side

S.No	Distance of needle from the centre, x cm	Current one way		Current Reversed		Mean	$\tan\theta$
1-	0	68	70	65	65	67	2.35
2-	5	64	65	60	59	62	1.88
3-	10	45	48	42	40	43.7	0.95
4-	15	24	28	24	21	24.25	0.45
5-	20	12	15	14	10	12.75	0.23
6-	25	5	8	10	6	7.25	0.12
7-	30	1	4	8	5	4.5	0.08

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Result :- The graph shows the variation of magnetic field along the axis of a circular coil carrying current. The distance b/w the points of inflexion A, B gives the diameter of the coil, and hence the radius of the coil =

Precautions:-

1. Clean the ends of the connecting wires with sand paper. The connection should be clear & tight.
2. Always use a key in the battery and remove the plug of the key while making connections as well as after each reading is taken.
3. The coil should be adjusted properly in the magnetic meridian.
4. The apparatus must be at considerable distance from current carrying conductors & magnetic material.
5. The +ve marked terminal of the ammeter should always be connected to the +ve pole of the battery.
6. While reading the deflection, avoid error due to parallex.
7. Reading of both ends of the pointer

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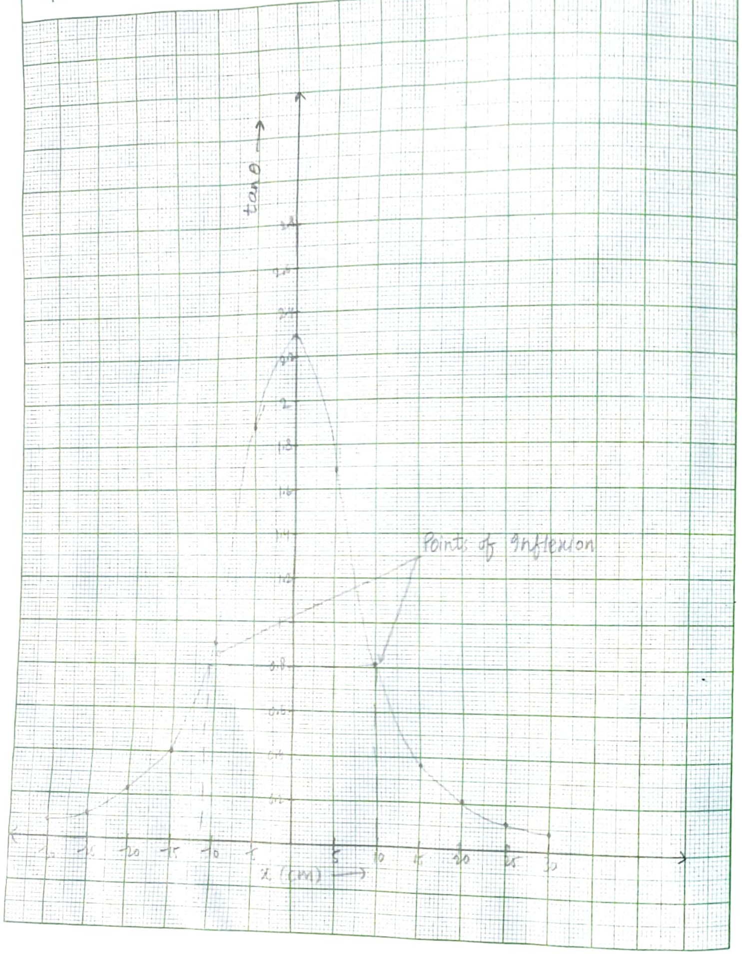

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should be taken.

Viva-Voce :-

1. What is the magnitude of the field at the centre of the coil?

→ $H = \frac{\mu_0 n r^2 i}{2(x^2+y^2)^{3/2}}$ $x = 0$

$H = \frac{\mu_0 n r^2 i}{2r^3} = \frac{\mu_0 n i}{2r} = \frac{2\pi \times 10^{-7} n i}{r}$

$H = \frac{2\pi n i}{10^{7} r}$

where r is the radius of the coil & 'n' is the no. of turns in it.

2. If any current carrying conductor is placed close to the coil then will it effect measurment?

→ Yes

3. Define (a) Magnetic meridian (b) Equatorial line

→ Magnetic meridian is a vertical plane passing through the magnetic axis of a freely suspended magnet at a place.

Equatorial line is a straight line perpendicular to the magnetic axis through its middle point.

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4. What is meant by point of inflexion?

→ Point of inflexion is the point where the slope of the curve changes suddenly.

5. How does the field vary along the axis of the coil?

→ The variation of the field along the axis of the coil is shown in (fig 4.4). The points at which curve changes its direction of curvature are called point of inflexion. The distance b/w them is equal to the diameter of the coil.

6. Is the field uniform at the centre?

→ It is uniform only over a very small region at the centre.