Experiment No. → 1

* Objective

To determine the refractive index of a material of the prism for the given wavelength of light ($\lambda = 5893 A$).

* Apparatus - [INDOSAW SK024 or SK001]

* Formula Used

Refractive index of prism material is given as

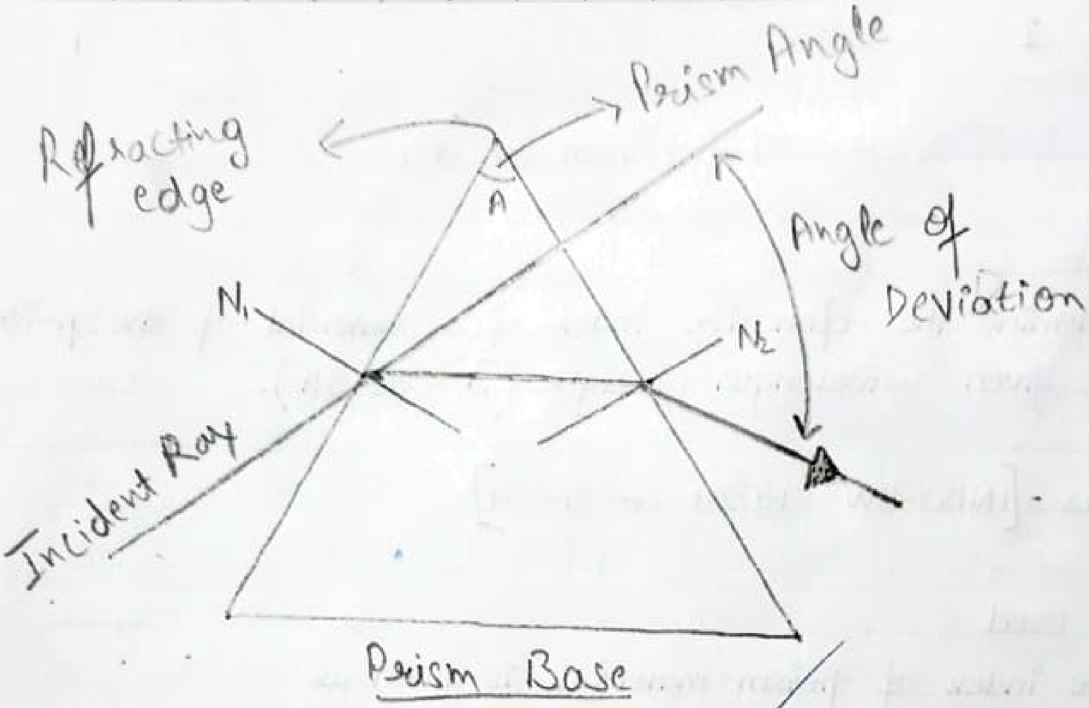
$$\mu = \frac{\sin(A+\delta_m)/2}{\sin A/2}$$

where, A is the angle of prism.
δ_m is the angle of minimum deviation.

* Introduction

An optical instrument used to measure the wavelengths of lights emitted by various light sources is called spectrometer. Spectrometer depends on a prism or a grating, to separate the light into its individual wavelengths. Once separated, measurement of different wavelengths can be done with a spectrometer.

The instrument consists of a collimator, a prism table and a telescope.



Prism Angle
Refracting edge
A
Angle of Deviation
N_1
N_2
Incident Ray
Prism Base

* Theory

Refraction through a prism

when a ray of monochromatic light passes through a prism, it is refracted twice, once as it enters and again as it leaves the prism. The angle A between the two surfaces where refraction takes place is called Prism Angel. The intersection of the two refracting planes is called the Refracting Edge of the Prism. The Prism Base is that side of the beam which is opposite to prism angle.

N_1 and N_2 are normals to the prism faces. The angle δ between the incident and emergent ray is defined as the angle of deviation. For a given prism the angle of deviation varies with the variation in angle of incidence. The particular angle of deviation depends on the prism angle, the index of refraction of the prism at that wavelength and the angle of incidence.

The angle δ_m is a minimum, if the angle of emergence is equal to the angle of incidence. This condition is found using a spectrometer. when the prism spectrometer is set at minimum deviation for a given wavelength, we have

$$\mu = \frac{\sin(A+\delta_m)/2}{\sin A/2}$$

where, A is the prism angle δ_m is the angle of deviation for a particular wavelength.

* OBSERVATIONS

- Table for angle of prism 'A' [L.C - 1/180]

S.No.	Vernier	Position of telescope for reflection from.		Difference $a \sim b = 2A^\circ$	Mean of Value $2A^\circ$	$A(^\circ)$
		$V_1(^\circ)$	$V_2(^\circ)$			
1.	Face I	143.055	323.194	121.333	121.430	60.715
	Face II	21.722	201.666	121.528		
2.	Face I	144.672	203.116	121.556	121.556	60.718
	Face II	23.116	203.116	121.556		
3.	Face I					
	Face II					

- Table for ~~of~~ angle of minimum deviation δ_m

S.No	Vernier	Telescop Reading		Difference $a'-b'=\delta_m$ $(^\circ)$	Mean value of δ_m $(^\circ)$
		Position of Min deviation (a)'	Direct image (b)'		
1.	V_1	128.338	79.00	49.38	49.00
	V_2	308.338	259.00	49.338	
2.	V_1	30.333	79.00	48.667	
	V_2	210.333	259.00	48.667	
3.	V_1				
	V_2				

* Calculations

Formula :-

$$\mu \Rightarrow \frac{\sin \frac{(A + \delta m)}{2}}{\sin \frac{A}{2}}$$

$$\mu \Rightarrow \frac{\sin \frac{(49 + 60.746)}{2}}{\sin \frac{(60.746)}{2}}$$

$$\boxed{\mu \Rightarrow 1.617}$$

* Result :

The refractive index of the prism for the given wavelength of light is (1.617).

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Precautions:

1) The telescope and the collimator must be set for parallel rays.
2) The prism table should be mechanically & optically leveled.
3) The experiment must be performed in a dark room.
4) The slit should be perfectly vertical and it should be made as narrow as possible.
5) The readings of both verniers should be read carefully. (one can use a magnifier and a lamp.)
6) The prism should be positioned with its refractive edge at the center of the prism table to find the angle of prism.
7) The minimum deviation positioned should be found as accurately as possible.
8) All movable parts such as the prism table and telescope move freely if the clamp are loosened.

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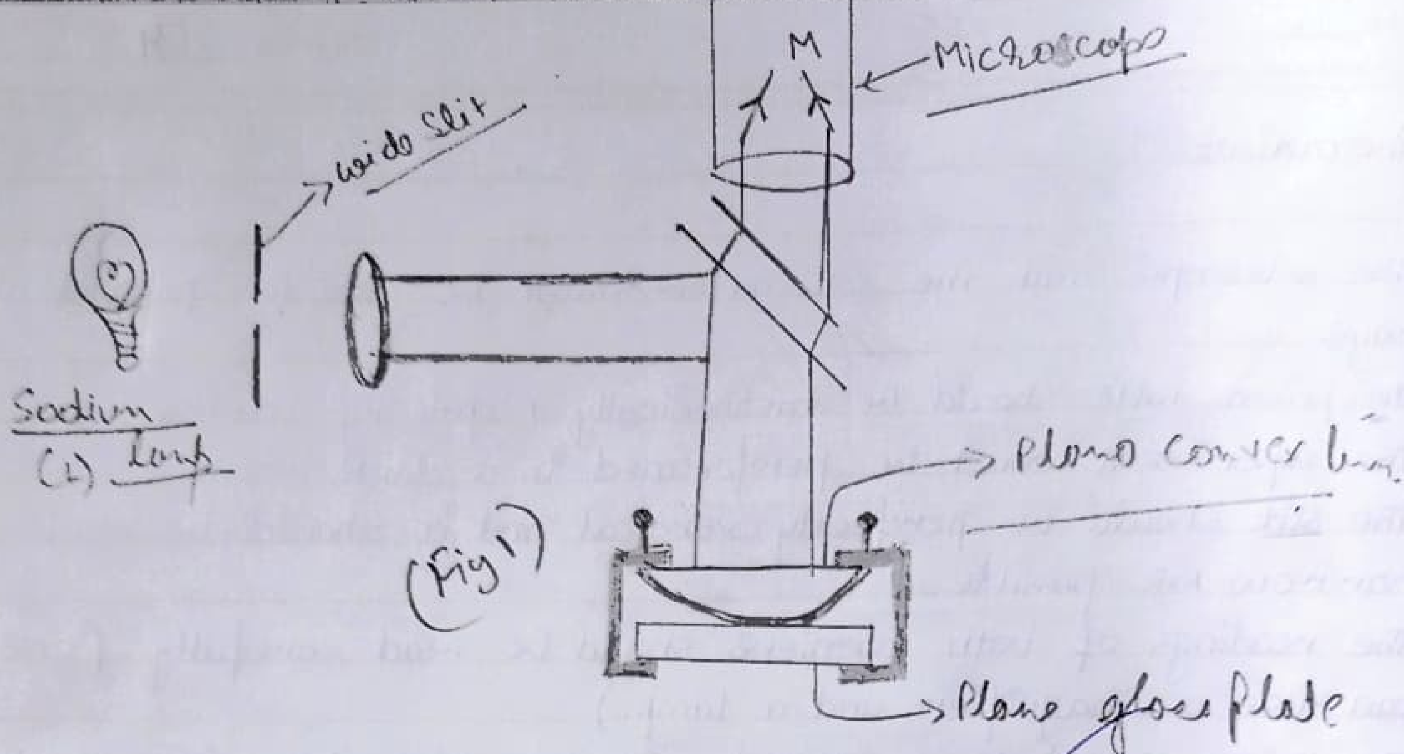
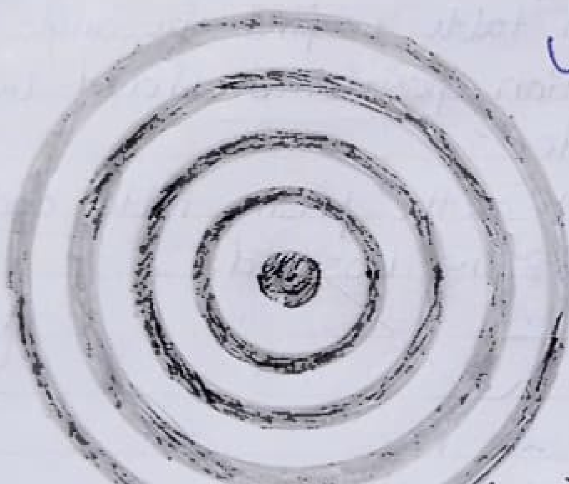
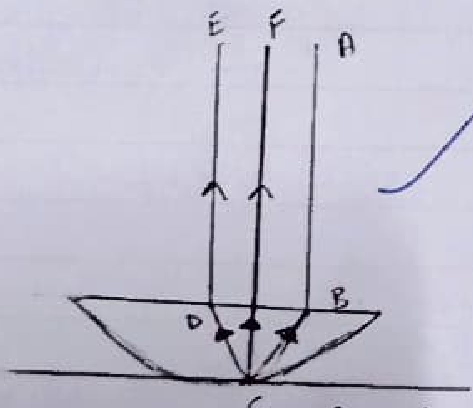


(Fig 1)



(Fig 2)



(Fig 3)

Experiment No. →2

* AIM:-

To determine the wave length of Sodium light by newton's rings

* Apparatus Required:-

[INDOSAW SKOO8].

* Theory:-

light form a monochromatic source (sodium lamp) is allowed to fall on the convex lens through a slit which reduce it into a ~~money~~ nearly parallel beam.

A film is said to be thin when its thickness about the order of one wavelength of visible lieght.

Rings are fringes of equal thickness. They are observed when light is reflected from a plano - convex lens of a long focal length placed in contact with a plane glass plate. Then other film is foused between the plate and the near. The thickness of air film varies from the point of contact to some value t. when the system is Illuminated with monochromatic light. Consecutive Bright and dark frings are observed rings get closer as they order increases.

The wavelength of monochromatic length can be determined as

$$= \frac{D_{m+n}^2 - D_m^2}{4 \times n \times r}$$

* Observation Table -

S.No.	Ring No.	Left (a) cm	Right (b) cm	Diameter (a-b)	D^2 cm	$D_{n+p}^2 - D_n^2$ cm	Mean cm
1.	15	1.080	0.683	0.397	0.157	0.031	
2.	12	1.058	0.702	0.356	0.126	0.032	
3.	9	1.030	0.723	0.307	0.094	0.032	0.0225
4.	6	1.004	0.754	0.290	0.062	0.35	
5.	3	1.964	0.797	0.167	0.027	0.027	

Calculations :-
$$\lambda = \frac{D_{n+p}^2 - D_n^2}{4MR}$$
$$= \frac{0.325}{4 \times 3 \times 100}$$
$$= 2.708 \times 10^{-5} \text{ cm}$$
$$\therefore \lambda = 2708 \text{ Å}$$

where D_{m+n} is the diameter $m+n^{th}$ ring, D_m is the diameter of m^{th} ring. R is the radius of Curvature of lens.

* Procedure :-

After the experimental arrangement, the glass plate is inclined at an angle of 45° to the horizonate the glass plate reflects lights from the source vertically downwards and falls normally on the convex lens.

Newton's rings are seen using a long focus microscope. focused on the film. The microscope is made tangently to the first ring on the left side of the center the readings of the main scale and Vernier scale of the microscope are noted.

Then it is seen through the right side from the center and observation are taken. similarly readings from 3rd, 6th, 9th rings are taken from both left and right side.

The diameter of rings is found out by subtracting readings on the left and right side. The square of diameter and hence $Dn^2 + Dn^2 + m$ are found out. wavelength for rings is calculated and then mean wavelength is found out.

* Result :-

wavelength of the given light source is 2.708 Å.

* Precautions :-

Glass Plate and lens should be cleaned thoroughly.

The lens used should be of large radius of wavelength. The

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source of light used should be an extended one wire should be focused on a bright using tangentially radius of Curvature. should be measured accurately.

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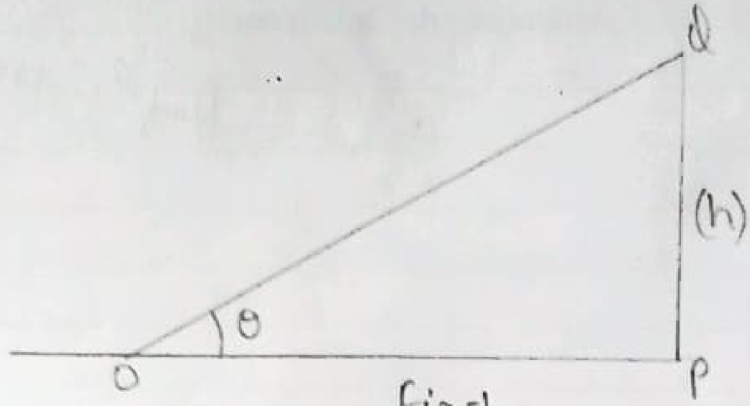


Fig-1

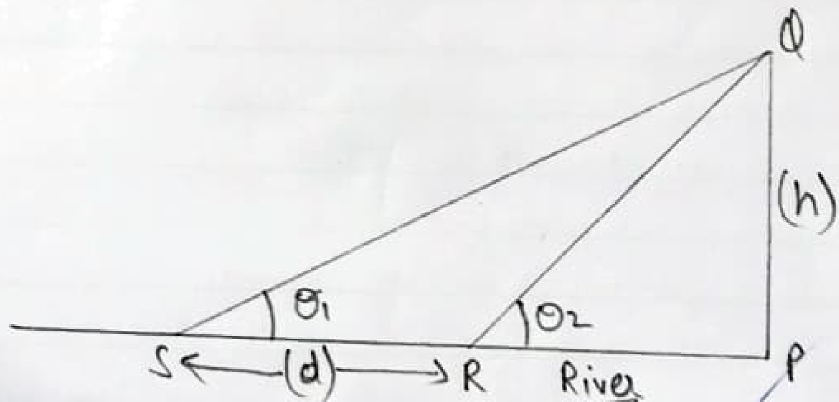


Fig-2

* **Observation (calculation)**

$A_1 = 9 + 8/60 + 3/300$

$A_2 = 37 + 23/60 + 3/300$

$B_1 = 9 + 14/60 + 5/300$

$B_2 = 28 + 35/60 + 5/300$

$\theta_1 = A_2 - A_1 \Rightarrow 37.386 - 9.136 = 28.25$

$\theta_2 = B_2 - B_1 \Rightarrow 28.585 - 4.235 = 19.35$

$\cot \theta_1 = RP/h = 1.861$

$\cot \theta_2 = SP/h = 2.847$

$\cot \theta_2 - \cot \theta_1 = d/h = \left(\frac{SR}{h}\right)$

$h = d / (\cot \theta_2 - \cot \theta_1)$

$\boxed{h = 1.52\ M}$

Experiment - 3

* Aim:-

To measure height of Pipe using sextant.

* Apparatus Required:-

→ sextant with tellescope
→ Regid clamp stand
→ measuring tape
→ Astronomical telescope

* Theory

height of accessible object
let
h: height of any accemble object.
using sextant, the angle made by object PQ = h at O is measure.

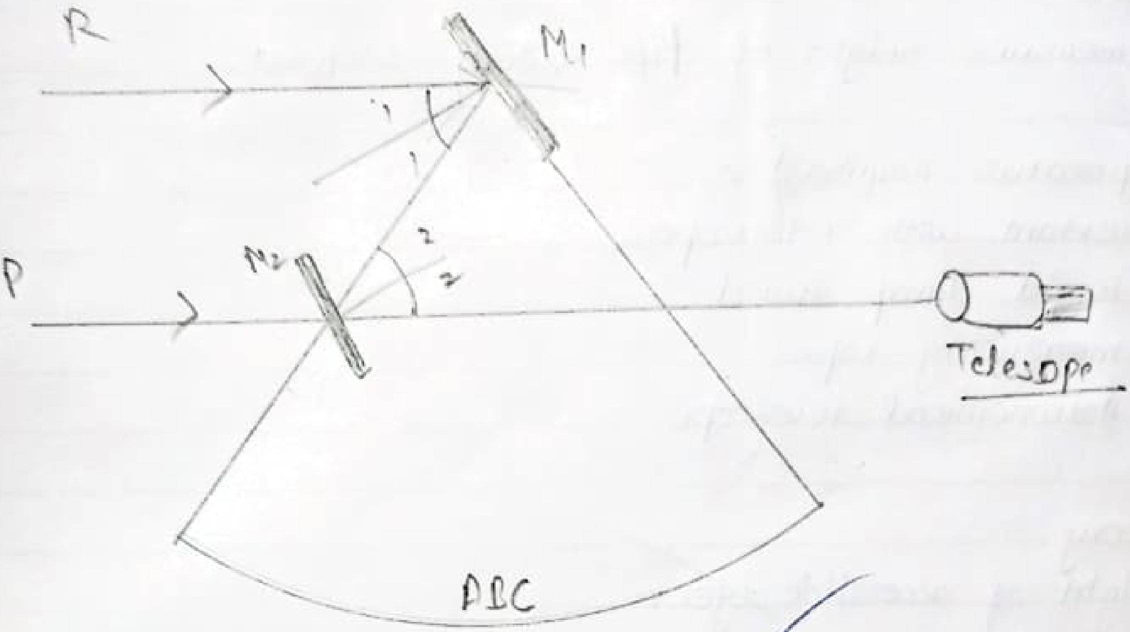
$$\cot \theta_1 = \frac{RP}{h}$$

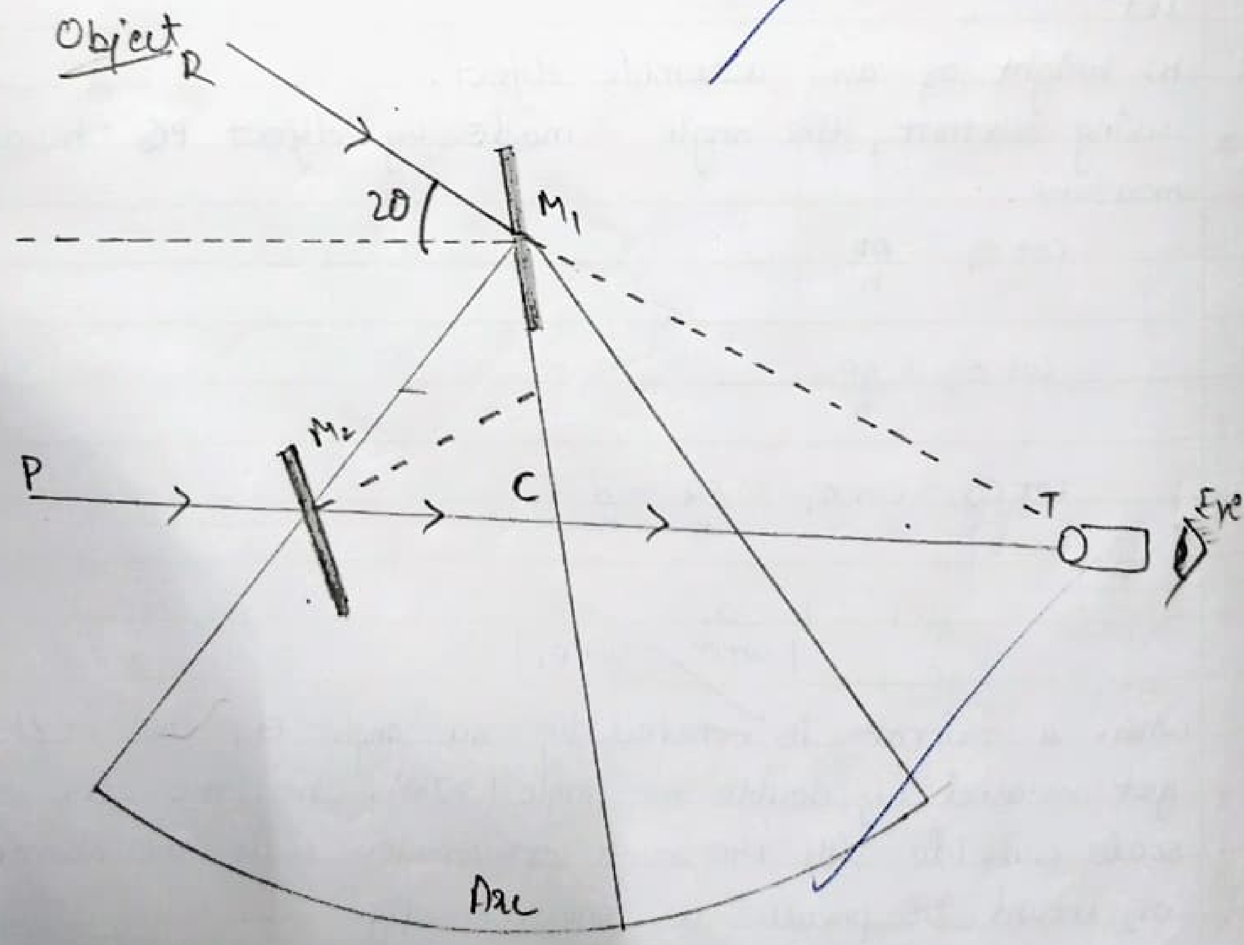
$$\cot \theta_2 = \frac{SP}{h}$$

$$\cot \theta_2 - \cot \theta_1 = \frac{SR}{h} = \frac{d}{h}$$

$$h = \frac{d}{|\cot \theta_2 - \cot \theta_1|}$$

when a mirror is rotated by an angle θ, the reflectced ray get rooted by double the angle (=2θ). when the zero of main scale coincide with the zero of vernier scale the mirror m_1 and m_2 should be parallel as shown in fig.


R
M_1
P
M_2
Telescope
ABC


Object
R
2θ
M_1
M_2
P
C
T
Eye
Arc

To find the angle Between into object. along M_1R and M_2P the aim containing M_1 is rotated such that the ray Pm_2T coming directly from P and ray RM_1M_2T coming from R concide with each other.

* **Calculation:-**

* **Result:-**

the height of roof using sextant is 1.52 M

=

* **Precautions**

1. The axis of telescope should be parallel to the plane of the graduated arc.
2. The plane of index mirror as well as horizontal mirror should be perpendicular to the plane of graduated circular scale.
3. The reading should be taken when the direct image and the reflected image concide and have the same intensity.
4. The initial reading should be taken saparately for each distance.
5. The axis of rotation of the index mirror must concide with centre of the graduated arc.

* **Sources of Error:-**

1. Instrumental Error.
2. The plane of index and plane of mirror might not be perpendicular to graduated arc.
3. Errors during recording.
4. Error while adjusting the appratus

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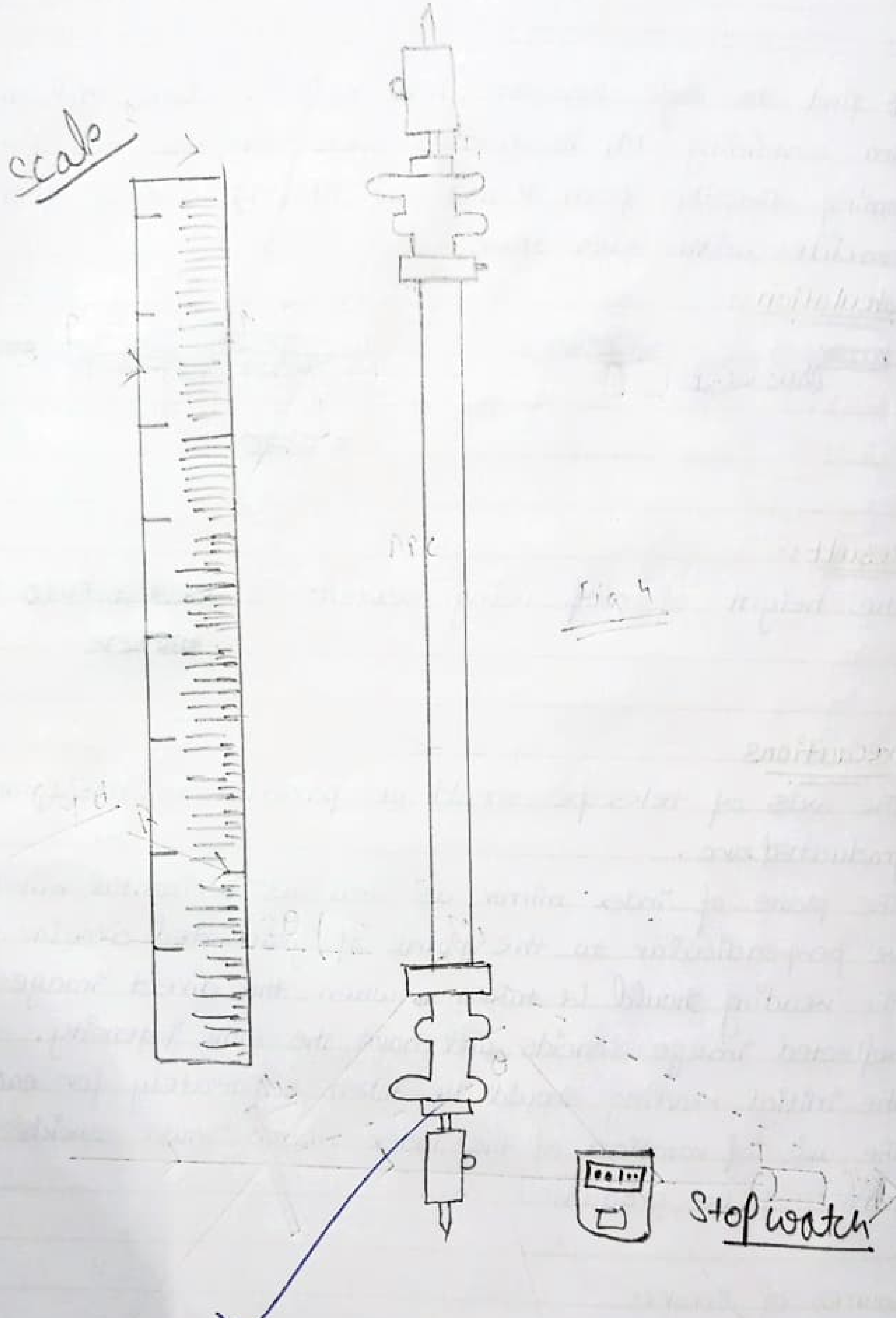
scale
Stop watch

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Experiment - 4

* Aim:- Determine the value of 'g'..

* Apparatus :-

Compound pendulum, Knife edge, Meter Scale, Stopwatch.

* Theory:-

Let L_1 and L_2 be the distances from the centre of gravity of the pendulums from K_1 and K_2 corresponding to the time periods T_1 and T_2. Then,

$$T_1 = 2\pi\sqrt{\frac{L_1^2 + K^2}{L_1 g}} \qquad (1)$$

$$T_2 = 2\pi\sqrt{\frac{L_2^2 + K^2}{L_2 g}} \qquad (2)$$

The results are similar to that obtained for a simple pendulum $\{ T = 2\pi\sqrt{\frac{l}{g}} \}$. In fact a simple pendulum of length $l = \frac{K^2}{L} + L$ would have the same time period T. Such a pendulum is called as equivalent simple pendulum.

where K = radius of gyration

Subtract 1 from 2

$$\frac{1}{2}\left[\frac{T_1^2 + T_2^2}{L_1 + L_2} - \frac{T_1^2 - T_2^2}{L_1 - L_2}\right] \qquad (3)$$

$$g = \frac{8\pi^2}{\frac{T_1^2 + T_2^2}{L_1 + L_2} - \frac{T_1^2 - T_2^2}{L_1 - L_2}} \qquad (4)$$

Teacher's Signature

S.No	Distance of knife edge	T	$T_1 = \frac{t}{30}$	T_2	$T_2 = \frac{t_2}{30}$
1	86.4	55.35	1.845	55.53	1.851
2	82.4	55.11	1.837	55.86	1.862
3	80.4	54.4	1.813	54.52	1.817

where L_1 and L_2 can be made to have large difference by suitably adjusting the masses M and m.
with a little efforts T_1 and T_2 can be made near by equal.
So the term $\left[\frac{T_1^2 - T_2^2}{L_1 - L_2}\right]$ can be neglected.

So formula which can used for calculating acc. due to gravity

$$g = \frac{8\pi^2}{\frac{(T_1^2 + T_2^2)}{L_1 + L_2}} \quad \text{——— (5)}$$

* Precautions and sources of error :-

1. The knife edges should be sharp.
2. Amplitude of oscillations should be small.
3. The time period about K_1 and K_2 should be nearly equal as far as possible.
4. $(L_1 + L_2)$ must be measured accurately.
5. Avoid wind, fan etc at the place of experiment.

* Result :-

The value of acceleration due to gravity 'g' is 9.71 m/s².

Calculation

Deepak 30/11/23

Experiment No. → 5

* **Aim :-**

To determine the wavelength of the HeNe laser light source using Michelsons inferrometer.

* **Apparatus Used :-**

Michelsons Inferrometer, screen, Hilium Neon laser.

* **Formula :-** wavelength of monochromatic is calculated by the relation $\lambda = 2d/mn$

d = distance Moved by the screw for the shift of m number of finger.

m = no. of fingers

* **Theory :-**

The rays falling on mirrors M_1 and M_2 are derived from the same wave (source) originally incident center point on beam splitters BS. The wave reflected from M and entering the vicuring screen cross the compersating place C device.

change in Phase : A phase change depend accurs on reflection at M_1 and M_2. The enact phase change at the Beam spilitter will depend on the dptical path difference between the two rays is due to the different path ~~difference~~ trauled in air before the two rays is due to the differ paths trauled in air before making the weving screen.

$\Delta = 2m\lambda/2 = m\lambda$ for maxima.

$\Delta = (2m+1)\lambda/2$ for minima

[illegible]

Calculations:

[illegible]

= 474 (approx.)

* Observation :-

Initial Reading (L_1) cm	(No) of frings (m)	final Reading (L_2) cm	(d) Distance L_2-L_1 cm	$\lambda = 2d/m$
0.45722	20	0.45840	0.00118	0.000118
0.45840	20	0.45911	0.0081	0.000081
0.45911	20	0.46000	0.0099	0.000099
0.4600	20	0.46129	0.00129	0.000129
0.46129	20	0.46190	0.00061	0.000061
0.46190	20	0.46250	0.00060	0.000060
0.46250	20	0.46309	0.00059	0.000059

* Result :-

The wavelength of monochromatic light source is 674 nm.

* Percentage Error :-

Standard value = 632 nm

Calculated = 674 nm

$$\% \text{ error} = \frac{632 - 674}{632} \times 100 = 6.6\%$$

* Precautions :-

(1) The mirror & beam splitter surface are precision coated. Dirt or scratcher will distract the fringe. Pattern, so handle all optical surface with care.

(2) clean the surface occasionally with lens tissue.

(3) Place the whole setup in dust free zone.

(4) Laws should be operated carefully.

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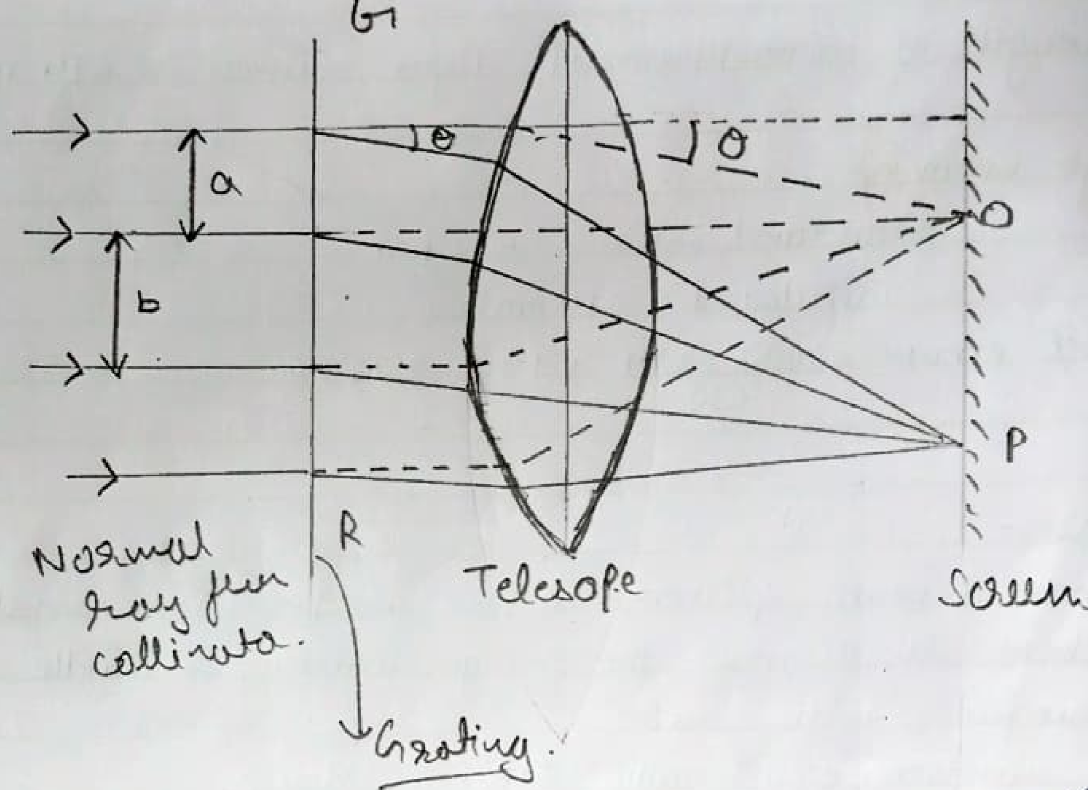
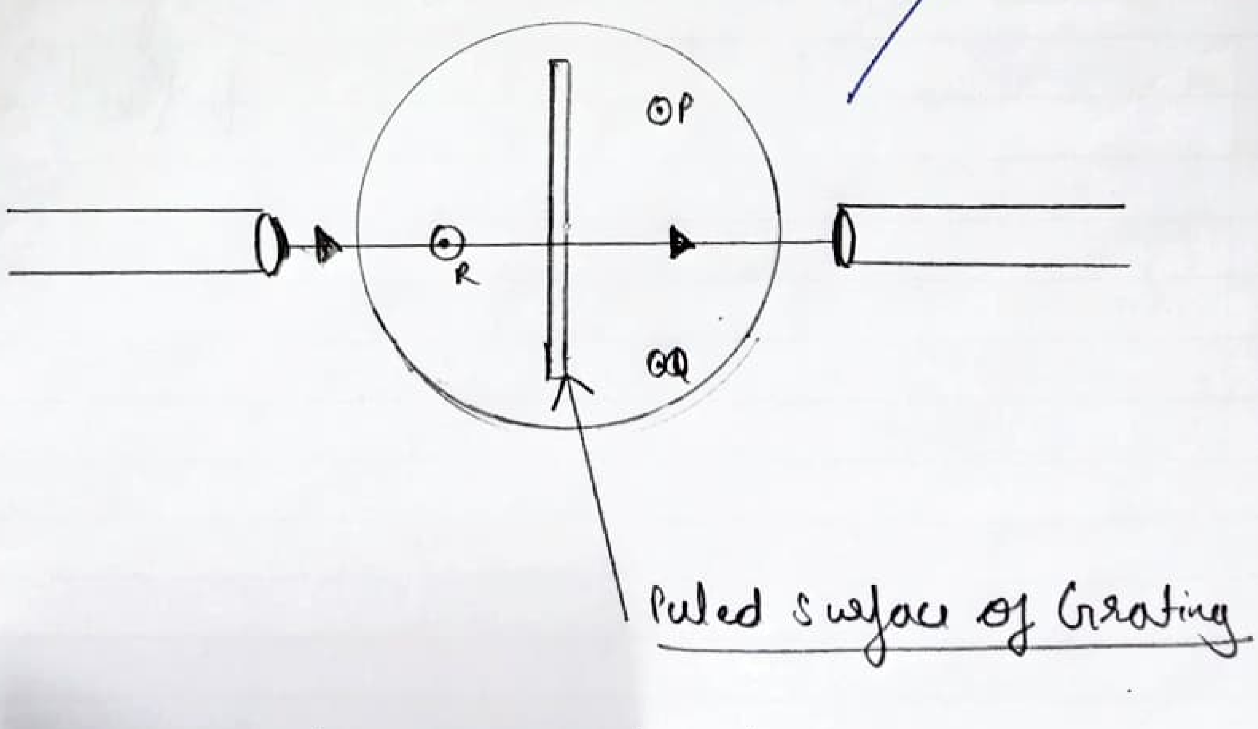


G
a
b
θ
θ
O
P
R
Normal ray from collimator.
Telescope
Screen
Grating.



P
R
Q
Ruled surface of Grating

Experiment No. - 6

* **Aim :-**

To find the wavelength of different colours of light using diffraction grating.

* **Material Required :-**

Spectrometer, grating element

* **Formula Used :-**

$(a+b) \sin\theta = n\lambda$

where,

$a+b = \frac{2.54}{15000}$ is width of each grating in grating element. The grating element has 15000 lines per inch.

λ is wavelength of light.

n is order of spectrum.

θ is angle of deviation.

* **Theory :-**

i) In figure O represents the central maxima due to un-diffracted rays. As the width of the slit is comparable with the wavelength of light, the diffracted beam produced by grating is focused by lens in its focal plane, to produce secondary maxima on both sides of central maxima O.

ii) The direction of n^{th} principle maxima is given by

$$(a+b) \sin\theta = n\lambda$$

where,

$n = \pm 1, \pm 2, \pm 3, \ldots$