I BSC

SECOND SEMESTER PAPER-II

PHYSICS PRACTICALS

LAB MANUAL

(w.e.f 2020-2021 Batch)

Department of Physics

Sri Y.N.College (A)

Narsapur

* SPECTROMETER - DISPERSIVE POWER OF PRISM * Date 26/10/21.

Expt. No. 2 Page No. 4

Aim:- To determine the dispersive power of a prism by finding the refracting angle of the prism, its minimum deviation and the refractive index of the material of the prism.

Apparatus:- Spectrometer, mercury vapour lamp, reading lens spirit level, prism and hand lamp.

Formula:- The dispersive power of material of the prism for two colours is given by

$$\omega = \frac{\mu_1 - \mu_2}{\mu - 1}$$

where μ_1, μ_2 are refractive indices for two colours and

$$\mu = \frac{\mu_1 + \mu_2}{2}$$

$$\mu = \frac{\sin \frac{A+D}{2}}{\sin A/2}$$

where A = refractive angle of the prism and
D = angle of minimum deviation for light of the given colour.

Description:- A spectrometer is an optical instrument used to produce and study various types of spectra. The essential components of a spectrometer are i) collinator ii) prism table and iii) telescope. The instrument is supported on a heavy metal base which is provided with leveling screws L_1 and L_2. In the spectrometer the circular scale is fixed on the cylindrical block to which telescope is rigidly fixed and it can be rotated

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about the same vertical axis about which vernier table and the prism table rotate.

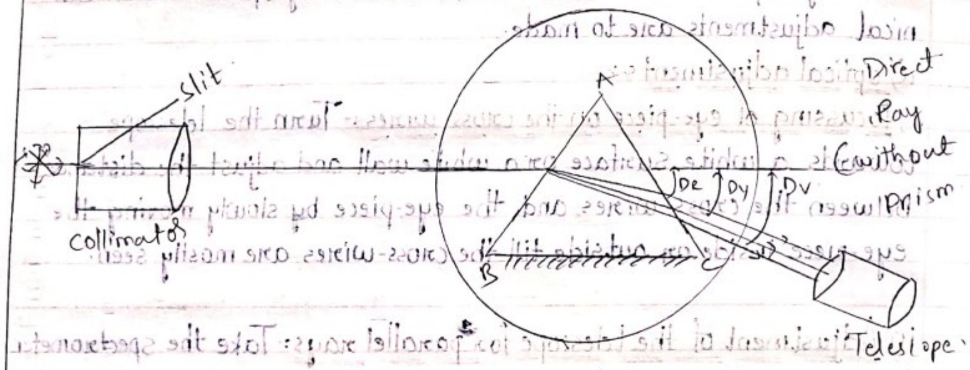
Adjustments of the spectrometer :- Before using the spectrometer for any experimental observation, the following optical and mechanical adjustments are to made.

a) optical adjustments :-

i) focussing of eye-piece on the cross-wires :- Turn the telescope towards a white surface or a white wall and adjust the distance between the cross-wires and the eye-piece by slowly moving the eye-piece inside or outside till the cross-wires are mostly seen.

ii) Adjustment of the telescope for parallel rays :- Take the spectrometer to an open place and place it on a stool. Turn the telescope towards a distant object (The top of distant telegraph pole or a tree) and adjust the distance between the objective and eye-piece by a rock and pinion screw until there is no parallex between the image of the object and the cross-wires whatever may be the point of view of the observer Now, the telescope is said to be adjusted to recieve the parallel rays.

iii) Adjustment of collimator :- widen the slit of the collimator and illuminate it with the source of light, then twin the telescope in line with the collinator and adjust the distance between the slit and the collimating lens by a rock and pinion screw until and well defined image of slit is observed through the telescope without the



parallax between the image of slit and the cross-wires. As the telescope is already adjusted to recieve parallel rays, then bean emerging out of the collimator is now said to have been adjusted to see a parallel beam. The slit should be vertical.

iv, **Slit adjustment:-**

Narrow down the slit to avoid abberations and to make the spectrum pure.

b) **Mechanical adjustments:-**

Levelling of prism table:-

By means of spirit level and levelling screws, the prism table can be adjusted perfectelly horizontal, place the spirit level on the prism table with its length parallel to the line joining any two of the leveling screws. Adjust the two screws so that the air bubble in the spirit level is at its centre. then, place the spirit level along the perpendicular to the line joining these two screws and adjust the third screw until the air bubble in the spirit level is at its centre again, Now, the prism table will be perfectly horizontal.

ii) **Determination of the angle of minimum deviation D:-**

Now turn the prism on the prism table such that the light from the collimator incident on one of the refracting surfaces, say AB. It emerges out of the second face Ac after refraction through the prism. A line spectrum with consists of number of lines can be seen through the telescope by turning it. Spectrometer can be covered with black cloth and extraneous light such that the spectrum is move clear while looking through the telescope rotate the prism table slowly In one direction following the spectal lines, we observe spectral lines

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To determine the angle of minimum deviation D

S.No	Colours	Telescope reading in mimum Deviation						Average of minimum deviation		$D=\frac{D_1+D_2}{2}$	$\mu=\frac{\sin\left(\frac{A+D}{2}\right)}{\sin(A/2)}$
		Left			Right						
		M.S.R acm	V.C (n)	Total reading	MSR acm	V.C (n)	Total reading	Left $D_1=V_1-V_1'$	Right $D_2=V_2-V_2'$		
	Violet	39°.30'	5'	39°.35'	219°30'	10'	219°40'	39°.35'	39°40'	39°37'	1.50
	Blue	39°	14'	39°.14'	219°	9'	219°.9'	39.14'	39°9'	39°23'	1.50
	Green	38°30'	10'	38°40'	218°30'	10'	218°40'	38°.40'	38°40'	38°40'	1.52
	Yellow	38°	4'	38°.4'	218	14'	218°14'	38°.4'	38°14'	38°9'	1.51
	Red	37°90'	6'	37°36'	217°.30'	10'	217°40'	37°36'	37°40	37°38'	1.48

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moving towards the direct reading position of the telescope. As we continue to rotate the prism table in the same direction, in one particular position, the spectral lines suddenly start refracting their path (or turn back). The particular position of the spectral line (λ). The corresponding angle of deviation is called angle of minimum deviation, when the spectrum is about refrace its path then clamp the prism table and adjust the position of the telescope with the slow motion screw until the vertical cross-wire coincides with say, the violet line of the spectrum. then, note the main scale reading and vernier coincidence on both the verniers V_1 and V_2. Find the total reading d_1 on each vernier. Now remove the prism from the prism table. release the telescope and turn it opposite to collimator, See the direct image of the slit through the telescope and adjust its position with slow motion screw until the vertical cross wire coincidences with the image of slit. Note the M.S.R and V.C on both the verniers Find the total reading d_2. The difference between the reading in the minimum deviation position d_1 and the reading in the direct image position d_2 on the vernier gives the angle of minimum deviation D_1 for that violet line. Similarly, the difference between the reading in the minimum deviation position and the reading in the direct imaage position on the vernier 2 gives the angle of minimum deviation D_2 for the same line of the spectrum. Then the mean angle of minimum deviation D is obtained from the relation.

$$D = \frac{D_1 + D_2}{2}$$

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Repeat the experiment for other spectral lines and in each case find the mean angle of minimum deviation for each line. the refractive index μ of the material of the prism for each wavelength (line) can be calculated using the relation. The dispersive power ω of the material of the prism for any two colours can be obtained using the relation. The results are to be tabulated.

precautions:-

1. The observation must be taken without parallax error.
2. The slit should be as narrow as possible.
3. The telescope and collimator should be properly arrange parallel rays.
4. The eye-piece should be adjusted so that cross-wire clearly visible.

Result:- The dispersive power of the material of the prism for different colours is calculated and results are given in table.

S.No.	colours	Dispersive power, ω
1.	Violet and Blue.	0.03
2.	Blue and Green	0.03
3.	Green and Yellow.	0.03
4.	Yellow and Red.	0.03
5.	Blue and Red	0.03.

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I Year PHYSICS PRACTICALS
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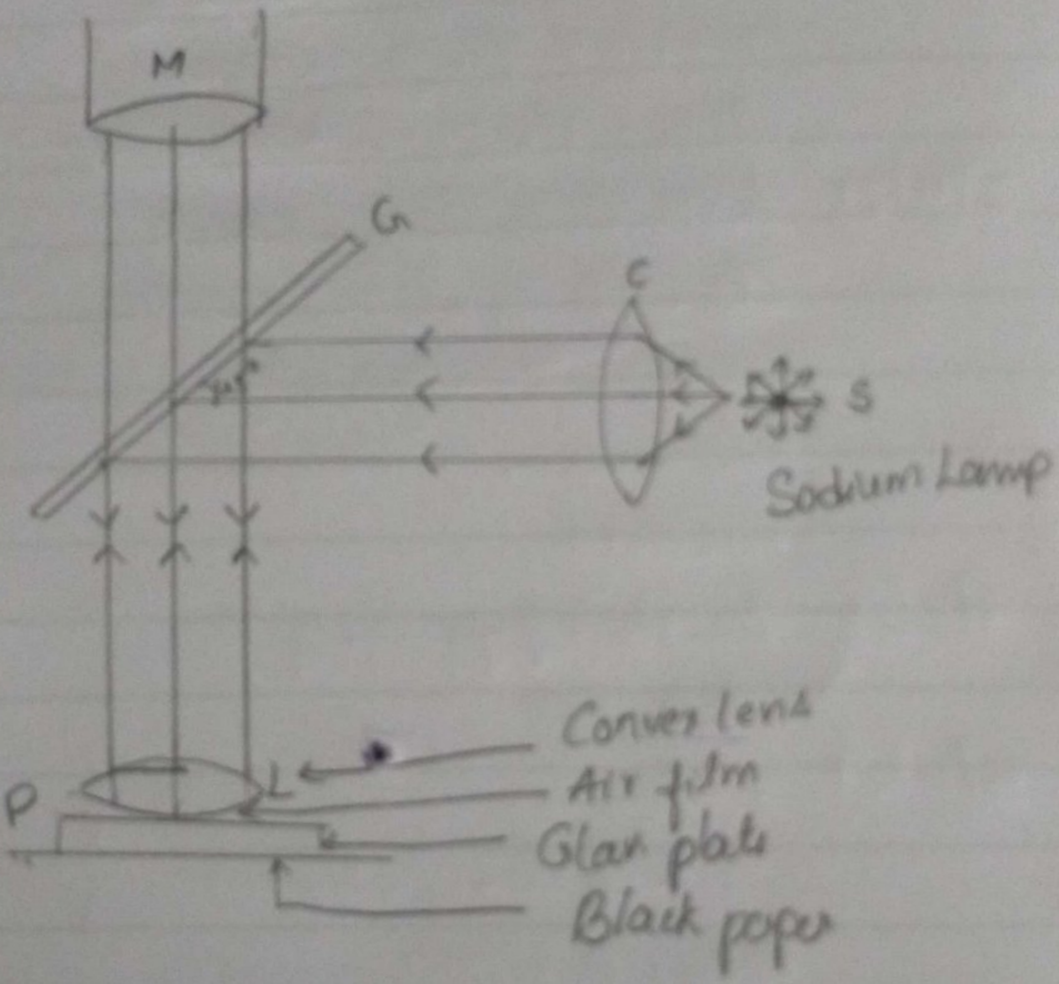
1. Determination of Radius of curvature of a given convex lens- Newton's Rings.
2. Dispersive Power of a Prism.
3. Determination of wave length of light using diffraction grating - Minimum deviation method.
4. Resolving Power of a Telescope.
5. Determination of Refractive Index of Liquid - Boye's method.
6. Aberrations - Determine the refractive Index of the material of a convex lens.

Diagram:


M
G
C
S
Sodium Lamp
Convex lens
Air film
Glass plate
Black paper
P
L

Aim: To determine the radius of curvature of a given lens by forming Newton's rings

Apparatus:

A convex lens of large focal length about 100 cm (or) a plano-convex lens of large radius of curvature, two plane glass plates, black cloth & paper, travelling microscope, a condensing lens, sodium vapour lamp, spherometer.

Formula:

$$R = \frac{D_m^2 - D_n^2}{4\lambda(m-n)} \text{ cm}$$

Where R = radius of curvature of the surface of the lens in contact with the glass plate

D_m = diameter of m^{th} dark ring (from graph)

D_n = diameter of nth dark ring (from graph)

m, n = number of the {monochromatic source of light (sodium light)}' chosen rings (from graph)

λ = wavelength of the monochromatic source of light (sodium light)

$\lambda = 5893\ A^\circ$

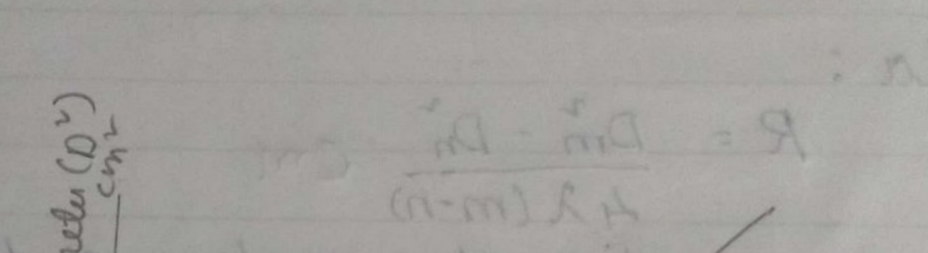
$= 5893 \times 10^{-8}$ cm

Description:

'S' is a monochromatic source of

Newton's rings

Graph:



light which is arranged at a suitable distance from a condensing lens c' (i.e. at its focus) such that a parallel beam of light rays will incident on the glass plate 'G' arranged at 45° to the horizontal. The glass plate 'G' in turn partially reflects the beam and this turns it by 90° and makes it incident normally on the experimental lens L, which encloses a thin film of air b/n its lower surface and the glass plate P. A part of the incident light is reflected by the surface of the lens "L" and a part is transmitted which is reflected from the surface of the plane glass plate. These two reflected rays, as these are derived from the same source interfere and give rise to an interference pattern in the form of circular rings. When these rings are viewed through a microscope M focussed on the air film, alternate dark and bright rings are called Newton's rings

Arrangement of the microscope:

The glass plate P and the convex lens 'L' should be cleaned well with a lens paper. The glass plate on a black paper and keep a white paper after.

S.No	No. of dark fringes ring	Microscope readings						Diameter of the ring $D = d_1 \sim d_2$ (cm)	D^2 (cm²)
		Left edge of the ring			Right edge of the ring				
		M.S.R a (cm)	V.C (n)	Total reading $d_1 = a + (n \times LC)$ (cm)	M.S.R a (cm)	V.C (n)	Total reading $d_2 = a + (n \times LC)$ (cm)		
1.	20	3.95	3	3.953	3.25	12	3.262	0.691	0.477
2.	16	3.90	18	3.918	3.30	32	3.332	0.586	0.343
3.	12	3.85	23	3.873	3.35	5	3.355	0.518	0.268
4.	8	3.80	32	3.832	3.40	42	3.442	0.39	0.152
5.	4	3.75	10	3.76	3.45	18	3.468	0.292	0.085

Procedure:

Viewing through the microscope the rings thus formed, move the microscope's vertia vertical piller horizontally on the box such that the point of intersection of the crosswire coincides with the central dark spot. By counting the central spot as zero, move the microscope to the left side using the slow motion screw counting the dark rings. When the vertical cross-wire is tangential to the 20th ring note the main scale reading and the vernier coincidence. Now, move the microscope towards the centre of the ring system and make the vertical cross-wire coincide with 18th, 16th, 14th, 12th, 10th, 8th, 6th, 4th and 2nd ring and note down the readings of M.S.R and V.C as above. then, move the microscope towards the right side of the central spot and note the readings for 2nd, 4th, 6th, 8th.... etc.

The difference b/n the readings of any parti-cular ring on left side (d_1) and right side (d_2) gives the diameter of the particular ring. The square of the diameter for each ring can be found

Graph:

Draw a graph with no. of dark rings on the x-axis and the square of the diameter of the rings on Y axis. A straight line passing through the origin will be obtained. From the graph, the value of D_m^2 and D_n^2 corresponding to mth and nth rings are to be noted. By substituting the above values in formula, the radius of curvature of the given lens can be found.

Observations:

To determine the diameter D of darkings: Travelling microscope:
Value of 1 main scale divison S = 0.1 mm
No of divisions on the vernierscale N = 0.01
∴ least count (L.C) = S/N = mm = 0.001 cm

Precautions:
1. Light should be incident normally on the lens
2. The central spot should be dark
3. the lens and the glass plate should be thoroughly Cleaned with benzene

Result:
Radius of curvature of the given convex lens
R = 95.4522 cm

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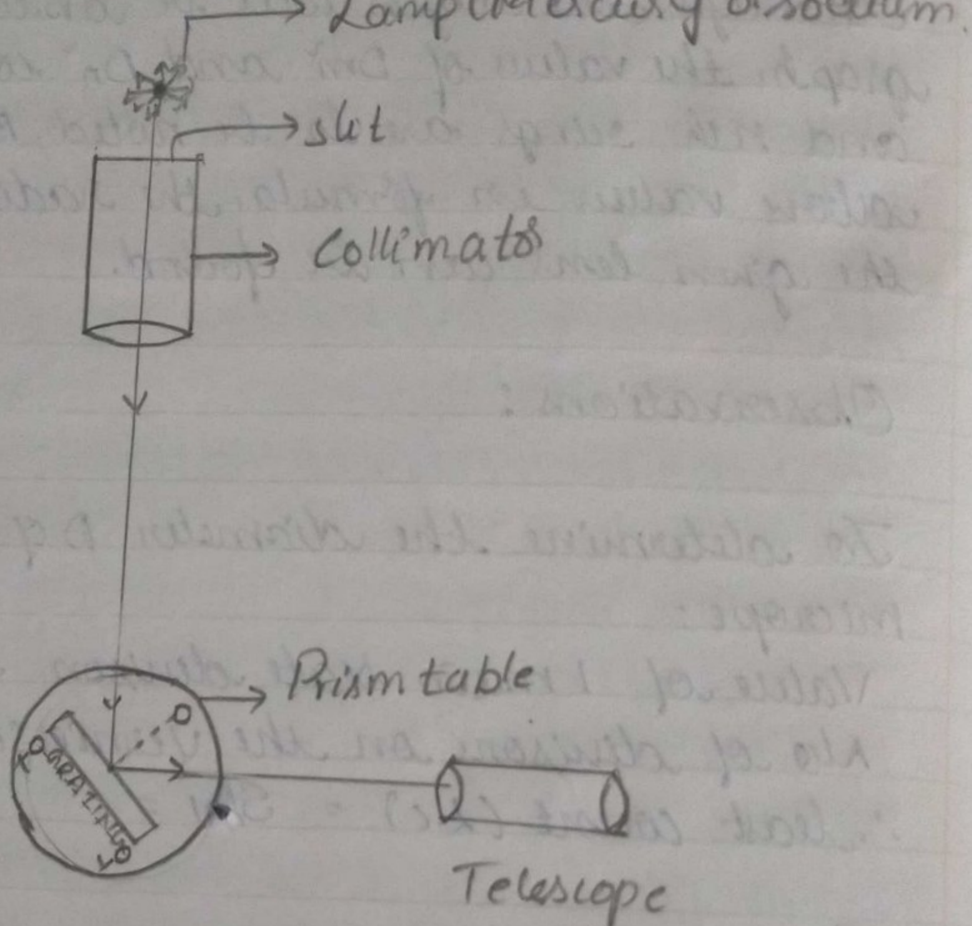
Lamp (mercury & sodium)
slit
Collimator
Prism table
Telescope

Aim: To determine the wavelength of a given source of light using a plane diffraction grating in the minimum deviation position

Apparatus: Plane diffraction grating, spectrometer, spirit level, reading lens, mercury vapour lamp (& sodium deviation pos lamp) and hand lamp.

Formula: $\lambda = \frac{2\sin(D/2)}{N/n}$

Where, λ = wavelength of light of particular colour of radiation
D = Angle of minimum deviation
N = number of lines per cm on the grating
(15000/2.54) = 5906
n = Order of the spectrum.

Description:

(A) plane transmission grating:

An arrangement consisting of a parallel sided glass plate with a large no. of parallel slits of equal width and seperated from one another by opaque spaces is called diffraction grating when a wave front is incident on a grating surface light is transmitted through the slits and obstructed by the opaque portions. such a grating is called a transmission grating 15,000 lines per

inch are normally drawn on the student grating
(a) To set the grating plane vertical and its rulings parallel to the slit:

Make the preliminary adjustments of the spectrometer as given in exp no. 2. illuminate the slit with the given source of light whose wavelength is to be determined place the grating on the prism table vertically so that its plane is parallel to the line joining two of the travelling levelling screws as shown in the fig 7.1. Turn the telescope as well as the prism table until the partially reflected image of the slit from the grating is clearly visible through the telescope. then, adjust the screws x and y so that the image of the slit is centrally situated in the field of view. Now, in the prism table such that the grating is approximately at 45° to the incident beam on the other side. Release the telescope and catch the partially reflected image on that side and adjust the third screw such that the image is at the centre in the field of view. (This is optical levelling). Now, rotate the prism table until the ruled surface of the grating is normal to the axis of the spectrometer and the ratings on the grating are parallel to the slit.

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Procedure: Viewing through the telescope observe the direct image of slit. Reduce the width of the slit so that a sharp & distinct image of the slit is clearly seen. fix the telescope opposite to the collimator and adjust its position with slow motion screw until the vertical cross-wire coincides & (point of intersection of the cross-wires is on the slit) with the image of the slit. Note the main scale reading and vernier coincidence on both the verniers (V_1 and V_2). find the total reading d_1 on each vernier. Now, turn the telescope to one side, say left and observe the diffracted image of the first order. If mercury vapour lamp is used, then the spectrum with violet 1, violet 2, blue, blue-green, green, yellow-1, yellow 2 and red lines appear. If sodium light is used, then D_1 and D_2 lines appear.

Then, release the prism table and rotate it slowly to the left following the spectrum. we Observe the spectral lines moving towards right as we continue to rotate the prism table in the same direction in one particular position, the spectrum. spectral lines suddenly retrace their path. when, the spectrum is about to retrace its path, then clamp the prism table and adjust the position of the telescope with slow motion screw until the vertical cross-wire coincides with, say Blue

Observations:

Value of one main scale (1 M.S.D), S = 0.1

Total number of division on the vernier, N = 0.01

∴ Least count of the vernier of the spectrometer,

$$L.C = S/N = 0.001$$

line of the spectrum of first order. Then, note the M.S.R and V.C on both the verniers(V_1 and V_2). Find the total reading d_2 on each vernier. The difference between the reading in the direct image position d_1 and the reading d_2 in the minimum deviation D_1 for Blue-line in the first order spectrum. Similarly, the difference between the reading in the direct image position and minimum deviation position on the vernier-2 gives the angle of minimum deviation D_2 for the same line of the spectrum. Then, the mean angle of minimum deviation D is Obtained from the relation

$$D = \frac{D_1+D_2}{2}.$$

Repeat the experiment for other spectral lines, and in each case find the value of D. Repeat the procedure case find the value of D. repeat the procedure for the second order spectrum also. Similarly, find the angles of minimum deviation for the first and second order spectrum for the same lines in the right side also. Tabulate the observations in the table 7.1.

Precautions:

1. The mechanical and optical adjustments of the spectrometer should be made initially.
2. the plane of the grating should be adjusted

TO determine the angle of minimum Deviation D first order spectrum.

Colours of spectrum	Telescope reading in minimum deviation position						Angle of minimum deviation		Mean angle of minimum deviation	Mean of	wave length
	Left			Right			Left	Right			
	M.S.R	V.C	Total reading $v_1 = a + (n \times LC)$	M.S.R	V.C	Total reading $v_2 = a + (n \times LC)$	$v_1' = 0$ $D_1 = v_1 - v_1'$	$v_1' = 180°$ $D_2 = v_2 - v_2'$	$D = \frac{D_1 + D_2}{2}$	$D/2$	$\lambda = \frac{2\sin(D/2)}{N/n}$ Å
Violet	14°30'	6	14°36'	195°	16	195°16'	14°36'	15°16'	14°26'	7°13'	4254×10^{-8}
Blue	15°	18	15°18'	195°	17	195°17'	15°18'	15°17'	15°17'	7°36'	4478×10^{-8}
Blue 2 (Bluish green)	16°30' 14°30'	10	16°40'	197°	4	197°4'	16°40'	17°4'	16°22'	8°11'	4820×10^{-8}
green	19°30'	10	19°40'	199°	6	199°6'	19°40'	19°6'	19°23'	9°46'	5744×10^{-8}
Yellow 1	20°	15	20°15'	199°30'	7	199°37'	20°15'	19°37'	19°26'	9°51'	5793×10^{-8}
Yellow 2	20°	15	20°15'	199°30'	7	199°37'	20°15'	19°37'	19°26'	9°51'	5793×10^{-8}
Orange	20°30'	20	20°50'	201°	8	201°8'	20°50'	21°8'	20°29'	10°15'	6345×10^{-8}
Red	21°	21	21°17'	202°	11	202°11'	21°17'	22°11'	21°14'	10°31'	6180×10^{-8}

normal to the incident light
3. The ruled surface of the grating should face the telescope
4. The slit should be as narrow as possible and parallel to the ruled lines of the grating
5. the ruled surface of the grating should never be touched

Result: The wavelength of light for different colour in the minimum deviation is calculated.

Violet = 4254×10^{-8}
Blue = ~~4820×10^{-8}~~ 4478×10^{-8} cm
Bluish green = ~~4478×10^{-8}~~ 4820×10^{-8} cm
green = 5744×10^{-8} cm
Yellow1 = 5793×10^{-8} cm
Yellow2 = 5793×10^{-8} cm
Orange = 6345×10^{-8} cm
red = 6180×10^{-8} cm

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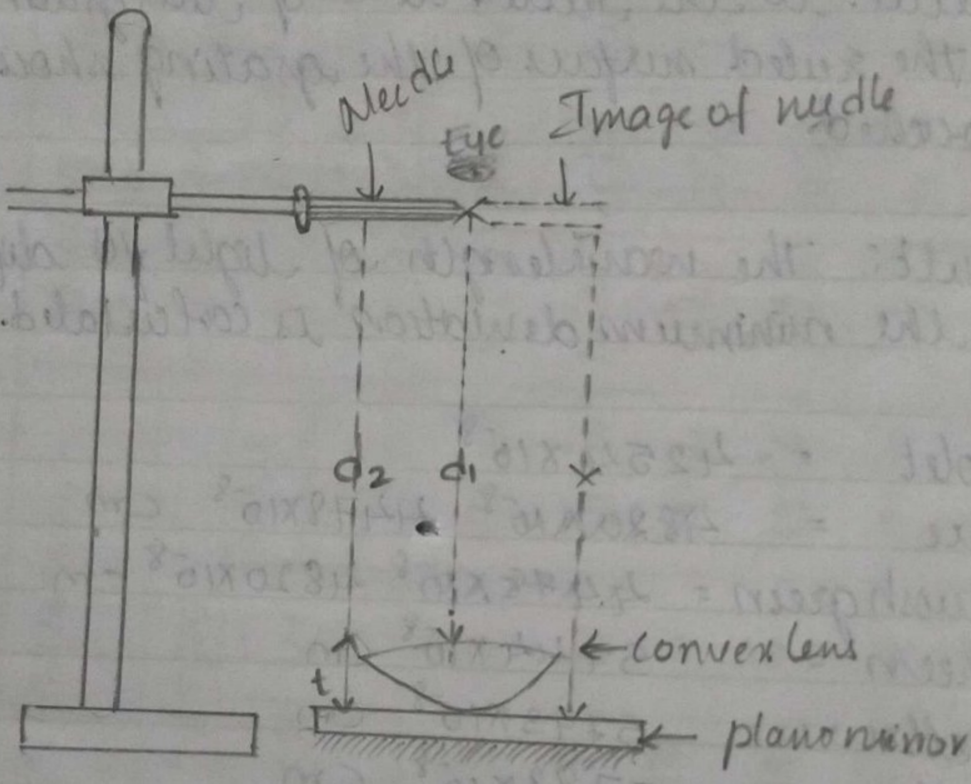
Needle
Eye
Image of needle
d2
d1
convex lens
t
plano mirror

Aim: To determine the refractive index of the material of a convex lens and a liquid.

Apparatus:

A convex lens (of about 15 & 20 cm focal length), needle, mercury, a retort stand, liquid, shallow dish, a plane mirror and meter scale.

Formula:

$$f_2 = \frac{F f_1}{F - f_1} \text{ cm}$$

$$r = \frac{\mu f_1}{f_1 - \mu} \text{ cm}$$

$$\mu_w = 1 + \frac{r}{f_2}$$

$$\mu_g = 1 + \frac{r}{2f_1}$$

where f_1 = focal length of the convex lens (cm)

F = combined focal length

μ_w = refractive index of water

μ_g = refractive index of water

r = radius of curvature of two surface of convex lens (using Hg cm)

f_2 = focal length of the plane convex liquid lens (cm)

Procedure:

Determination of focal length f and thickness

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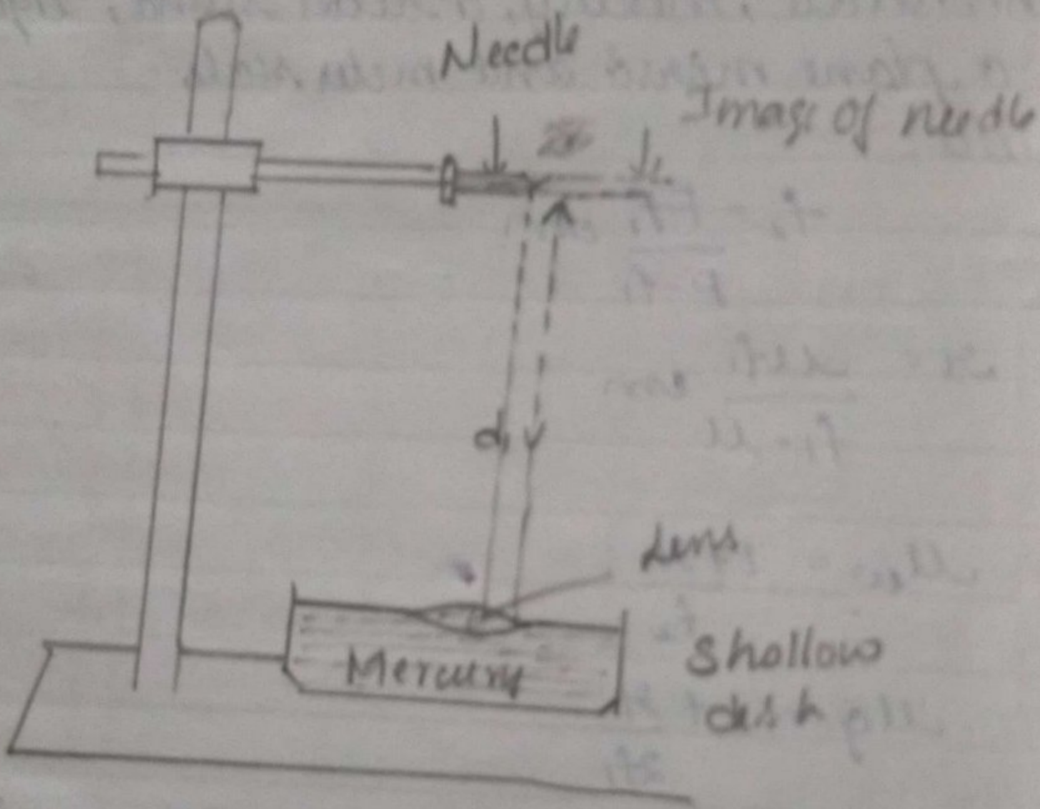
Needle
Image of needle
d
Lens
Mercury
Shallow dish

t of the convex lens: plane mirror method

Take a convex lens and clean it with a lens paper place the plane mirror on a horizontal table (or on the horizontal base of a retort stand) with its reflecting surface facing upwards, place the given convex lens where focal length is to be determined on the plane mirror as shown in fig 5.1. Take a needle N and fix it horizontally with the help of a rubber cork (The cork is clamped to a retort stand) so that the tip of the needle is held vertically above the centre of the lens. First move the tip of the needle nearer to the lens and adjust its height so that the tip of the needle passes through the axis of the lens. Virtual image will be formed at this position ($u<f$), then the keep eye above the tip of the needle and gradually move it vertically upwards until a real and inverted image appears close the left eye, open the right eye and looking vertically downwards from above the tip of the needle, adjust the height of the needle until the needle inverted image of the tip of the needle coincides stand. The convex lens is allowed to float on the surface of the mercury fix the needle horizontally through a rubber cork (the cork is clamped to a retort stand) so that the tip needle is held vertically above the centre of the lens i.e over the principal axis of the

Observations:

Table 5.1 to determine the focal length f and thickness of the convex lens

S No	Distance of tip of the needle from (f) upper surface of the lens d_1 cm	upper surface of the plane mirror d_2 cm	Focal length $f_1 = \frac{d_1+d_2}{2}$ cm	Thickness $t = d_2 - d_1$ cm
1.	9.5	10.3	$\frac{9.5+10.3}{2} = \frac{19.8}{2} = 9.9$	0.8

∴ Average focal length of convex lens f = 9.9 cm

Average thickness of convex lens t = 0.8 cm lens adjust the height of the needle until the tip of the inverted image of the needle exactly coincides with the tip of the (needle) object needle without parallax between them. Measure the distance d_1 between the tip of the needle and the upper surface of the lens. Then, add half the thickness of the lens to the distance. Let it be u_1. Then the radius of curvature of the first surface of the lens in contact with mercury can be obtained using the formula,

$$r_1 = \frac{u_1 f}{f - u_1}$$

where f = focal length of the lens.

Now, reverse the lens so that the second surface of the lens is in contact with mercury and repeat the experiment as above. If d_1 is the distance between the tip of the needle and with the tip of the object needle without parallax, measure the distance d_1 between the tip of the N and the upper surface of the lens with a meter scale. Then, remove the lens and measure the distance d_2 between the tip of the needle, and upper surface of plane mirror. The mean of the two readings gives the focal length f of the lens the difference between the two readings give the thickness t of the lens. Repeat the experiment twice and record the observation in table 6.1 Find

To determine the combined focal length F of the given convex lens and the liquid concave lens

S.No	Distance of tip of the needle from upper surface of the lens d_1 cm	upper surface of the plane mirror d_2 = cm	combined focal length $F = \frac{d_1+d_2}{2}$ cm
1.	15	15.7	~~15+15.75~~ $\frac{15+15.7}{2}$ = 15.35

Average focal length F = 15.35 cm

$\frac{1}{F} = \frac{1}{f} + \frac{1}{f_1}$ f_1 = cm

$\therefore f_1 = \frac{fF}{f-F}$ F_2 = cm

$\mu_{\omega} = 1 + \frac{r_1}{f_2}$

the average focal length and thickness of the lens

(When the tip of the object needle without is exactly at the focus of the lens, the rays from the convex lens after passing through the lens become become parallel. These parallel rays they are incidently normally after reflection from the plane mirror retrace their path and converge to the focus of the lens. Thus the distance between the centre of the lens and the needle gives the focal length of the convex lens)

2. Determination of radii of curvature (r_1 and r_2) of the two surfaces of the convex lens using mercury Boys method.

Take a clean and dry mercury in a shallow dish and place it on a stool of (retort) base of the retort the upper surface of the lens, then the radii of curvature of the second surface can be obtained using the formula,

$$r_2 = \frac{u_2 f}{f - u_2}$$

3. Determination of the combined focal length F of the convex lens and the liquid concave lens: Liquid convex lens method.

pour a few drops of the given liquid (like water) on the plane mirror. Over the liquid

To determine the combined focal length of F of the given convex lens measuring mercury

S.NO.	Distance between the tip of the needle and upper surface of the lens d cm	Distance between the needle and centre of the lens $u = d + \frac{t}{2}$ cm	Radius of curvature $r = \frac{uf}{f-u}$ cm
1.	5	5.4	11.8

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$

place the convex lens with its surface, of radius of curvature r_1, is in contact with the liquid. Then, the liquid between the convex lens and the plane mirror is squeezed and takes the form of a plano-concave liquid lens. Fix a needle N horizontally with the help of a rubber cork which is clamped to a retort stand, so that the tip of the needle is held vertically above the centre of the lens.

$$\text{ie, } F = \frac{d_1 + d_2}{2}$$

4. determination of the focal length f_1 of the plane concave liquid lens.

For a lens combination, we have,

$$\frac{1}{F} = \frac{1}{f} + \frac{1}{f_1}$$

$$\frac{1}{f_1} = \frac{1}{F} - \frac{1}{f} = \frac{f-F}{fF}$$

$$\therefore f_1 = \frac{fF}{f-F}$$

Where f = focal length of the convex lens.

F = combined focal length

Since, the liquid lens is plano-concave, the value of f_1 is negative

5. Determine of the refraction index μ_w of the given liquid (water)

The refractive index of the given liquid (water) can be calculated from the formula, Calculation :

i. $\mu = \left[d + \frac{t}{2}\right]$

$\mu = \left[5 + \frac{0.8}{2}\right]$

$= [5 + 0.4]$

$\mu = 5.4 cm$

iii, $F_2 = \frac{FF_1}{F - F_1}$

$= \frac{15.35(9.9)}{15.35 - 9.9}$

$= 27.8$

ii $r = \frac{\mu f}{f_1 - \mu}$

$= \frac{(5.4)(9.9)}{9.9 - 5.4}$

$= 11.8$

iv, $\mu_w = 1 + \frac{r}{f_2}$

$= 1 + \frac{11.8}{27.8}$

$= 1.42$

ii. $\mu_g = 1 + \frac{r}{2f_1}$

$= 1 + \frac{11.8}{2(9.9)}$

$= 1.59$

$$\frac{1}{f_2} = (\mu_w - 1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$

Where, μ_w = refractive index of water

For a liquid concave lens $r_2 = \infty$ ∴ $1/r_2 = 0$

$$\therefore \mu_w = 1 + \frac{r_1}{f_1}$$

Precautions:

1. The convex lens and the plane mirror should be cleaned before performing the experiment.
2. The needle use should be properly illuminated so that the image appear bright
3. Mercury should be pure with a clean reflecting surface.
4. Parallax should be removed carefully

Result:

Refractive index of the convex lens μ_g = 1.59

Refractive index of the liquid (water) μ_w = 1.42

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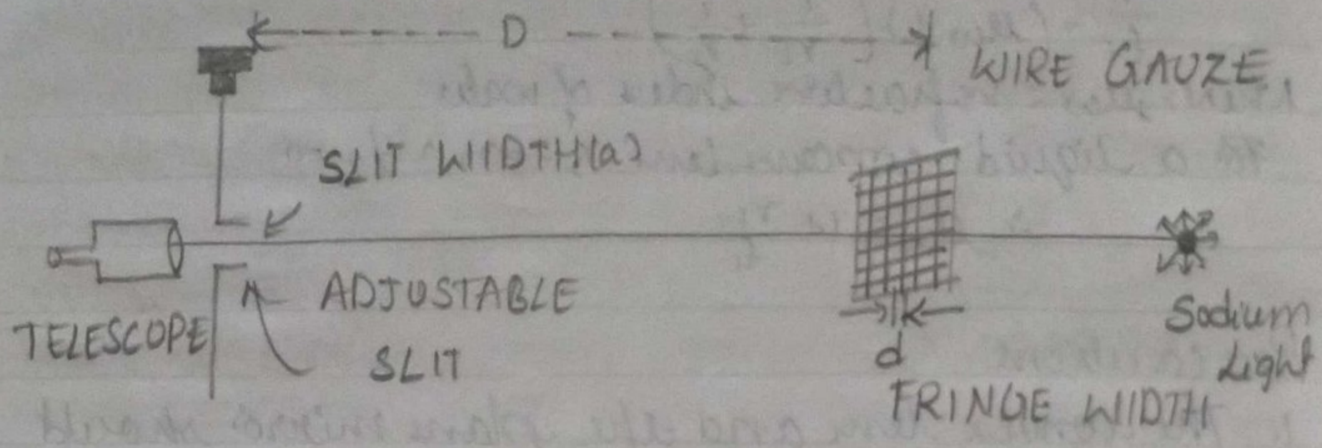

Observation:

TO determine the width a of the micrometer screwguage.

Number of divisions on the head scale =

pitch of the screw = $\frac{\text{Distance moved on the pitch scale for n rotations}}{\text{Number of rotations made by the head scale (n)}}$

= mm

Least count, L.C = $\frac{\text{Pitch of the screw}}{\text{Number of head scale divisions}}$

= mm

2

Aim: To determine the resolving power of a telescope

Apparatus:

A telescope, wire-guaze with fine uniform mesh sodium vapour lamp, travelling microscope, measuring tape of a long thread, a rectangular slit of adjustable width attached to a micrometer screw and a reading lens

Formula:

The resolving power of a telescope is given by

1. Theoretical, $R.P = \frac{a}{1.22\lambda}$ cm

2. Experimental, $R.P = \frac{D}{d}$ cm

where, λ = wave length of sodium light (5893×10^{-8} cm)

a = width of the rectangular slit, when the two point objects are just resolved

d = average distance between any two adjacent wires of the mesh.

D = distance between the wire-guaze and the objective of the telescope

Description:

The experimental arrangement is shown in fig. is a monochromatic source of light (sodium lamp). A wire ~~gauge~~ gauze with uniform mesh fixed to a retort stand is placed before the source of light. A telescope provided with a adjustable

To determine the width a of the microsphere microscope.
Number of divisions on the head scale:

S.No	Distance between the telescope (D)	Telescope Reading						fringe width A-B=a	$\frac{a}{1.22\lambda}$	$\frac{D}{d}$
		Left side			Right side					
		M.S.R	V.C	a+n×LC (B)	M.S.R	V.C	a+n×LC (A)			
1.	200	5.5	2.5	5.5025	5.6	3.3	5.6033	0.1008	1,40205	1,257.86
2	300	7.20	32	7.232	7.35	22	7.372	0.14	1,947.29	1,886.79

To determine the distance d between two adjacent wires of the mesh: Travelling microscope

Value of one division on the main scale, S= m = cm

Total number of divisions on the vernier, N =

∴ Least count of the vernier L.C = S/N = mm = cm slit attached to the micrometer screw is placed at a distance of about 3 to 4 meter from the wire guaze

Procedure:

1. To determine the width of the slit:

Mount the wire-guaze vertically on a retort stand at a suitable height and place it infront of the sodium light. Arrange the telescope at a distance D (say 100cm) from the wire guaze. adjust the position of the eye-piece by moving it in & out until the cross wires are clearly visible. Now illuminate the wire-gauze with sodium light. Focus the telescope on the wire-gauze so that the vertical and horizontal wires of the mesh are distinctly seen in the plane of the cross-wires. Find the least count of the micrometer screw, Mount the adjustable slit fixed to the micrometer screw, on the Objective of fixed to the micrometer screw, on the Objective of of the telescope. Adjust the position of the micrometer screw so, that the slit is Vertical and parallel to the vertical wires of mesh Now, open the slit and Observe the vertical and horizontal wires of the mesh, then, gradually reduce the width of the slit by turning the micrometer

2. To determine the distance d between the two adjacent wire of the mesh

Signature :

S.No	No. of the Vertical wire	Horizontal scale reading on the microscope when the vertical cross-wire is tangential to the left edge of the vertical wire				Width of 5 interspaces cm
		M.S.R	V.C	Total reading a+n×L.C	Difference	
1.	0	1	39	1.039	0.786	0.159
2.	5	1.80	25	1.825	0.791	
3.	10	2.60	16	2.616	0.804	
4.	15	3.40	20	3.42	0.799	
5.	20	4.20	19	4.219	0.795	

Average width of 5 interspaces, $x = 0.795$ cm

Average distance between two adjacent wires $d = x/5 =$ cm 0.159

Remove the wire-gauze and place it on the base of the travelling microscope. Find the least count of the travelling microscope. Adjust the position of the eye-piece by moving it in or out until the cross wires are clearly visible. Then, focus the microscope on the mesh and observe the magnified vertical and horizontal wires of the mesh viewing through the eye-piece, move the microscope horizontally to one side (say left side) of the mesh such that the point of intersection of the cross-wires is tangential to the intersection of the cross-wires is tangential to the centre of the vertical wire, say first wire (near the extreme left of the mesh). Then, after tightening the free motion screw, with the help of a tangential screw, adjust the microscope such that the vertical cross-wire is tangential to the left edge (or right edge) of the vertical wire of the mesh. Note the M.S.R and V.C let the total reading be R_0 for convenience, treat the first wire as 0th wire. Now, by counting the member of vertical wires, move the microscope so that the vertical cross-wire is tangential to the left edge of the 5th wire. Again, Note the M.S.R and V.C. Let the total reading be R_1. Repeat the experiment and note the observations (in table) for the 10th, 15th, 20th, 20th, 25th, 30th vertical wire. Tabulate the observations in table 13.2

Signature :

the difference between (R_0) the two Reading R_0 and R_1 gives the distance between 5 interspace of the mesh. Find the average bel width of 5 interspaces. From this, find the width of one interspace which is equal to the average distance d between two adjacent wires of the mesh. The theoritical and experimental value of the R.P of the telescope can be calculated using the formula.

Precautions:

1. The plane of the adjustable slit should be parallel to the vertical wire of the mesh.
2. The adjustable slit and wire-gauze should be kept at the same height in the vertical position.

Result:

The theoritical and Experiment values of the Rp of the telescope are calculated and compared they are found to be equal

S.No	D	Theoritical a/1.22λ	Experiment D/d	Difference
1.	200	1,402.05	1,257.86	144.19
2.	300	1,947.29	1,886.79	60.5

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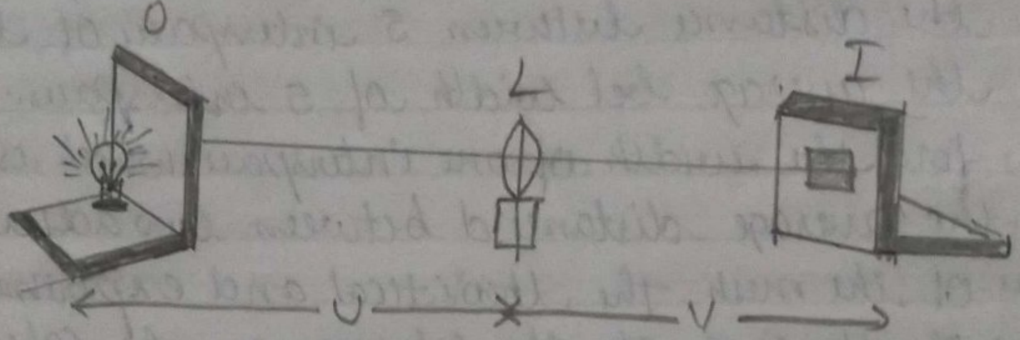
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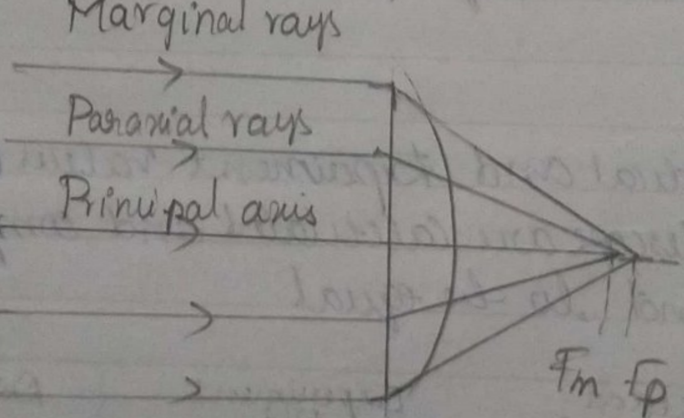
Marginal rays
Paraxial rays
Principal axis
Fm Fp

Aim: To ~~g~~ determine the longitudinal spherical aberration and longitudinal chromatic aberration of a convex lens

Apparatus:

A convex lens; sodium vapour lamp, optical bench, a screen, scale.

Formula:

1. longitudinal spherical aberration $= f_p - f_m$
2. longitudinal Chromatic aberration $= f_R - f_B$.
3. the paraxial focal length f_p of the lens can be Calculated

$$f_p = \frac{uv}{u+v} \text{ cm}$$

4. The marginal focal length f_m of the lens can be calculated $f_m = \frac{uv}{u+v}$ cm

5. The focal length f_R of the lens can be calculated

$$f_R = \frac{uv}{u+v} \text{ cm}$$

6. The focal length f_B of the lens can be Calculated

$$f_B = \frac{uv}{u+v} \text{ cm}$$

Description:

The experimental arrangement is shown in figure. The optical bench consists of a long

Signature :

Observations:

TO determine the paraxial focal length fp of the convex lens:

S.No	Object distance u (cm)	Image distance v (cm)	$f_p = \frac{uv}{u+v}$ (cm)
1	36	42.1	19.40
2	38	40.2	19.53 19.53
3.	40	38.7	19.66
4.	42	37.2	19.72
5.	44	34.7	19.40

Avg (fp) = 19.54 cm

TO determine the marginal focal length fm of the convex lens:

S.No.	Object distance u (cm)	Image distance (cm)	$f_m = \frac{uv}{u+v}$ (cm)
1.	34	42	18.78
2	36	38.9	18.69
3.	38	38.4	19.09
4	40	36.7	19.13
5.	42	34.3	18.8

Avg (fm) = 18.91 cm

heavy metal bar MN (cast iron) of double rod type nearly 2 meters long. one arm of the bench is graduated in millimeters. Four levelling screws are provided at the base of the bench by means of which the optical bench can be made horizontal. The various components used like the slit Object, convex lens and the screen.

Theory: Parallel rays after passing through a lens converge at different points on the fo paro principal axis. The rays which are close to the principle axis are called paraxial rays and the rays which are away from the principal axis are called marginal rays. The lens can be divided into circular zones. So, different zones have different focal lengths. The marginal rays after refraction come to focus on the principal axis at Fm. The differ distance b/n Fm and the optical centre is called the marginal focal length fm. The paraxial rays meet the principal axis at Fp and the distance b/n Fp and the optic centre is called the paraxial focal length fp. The paraxial rays form the image at a point distance than the marginal rays. Therefore, the image is not sharp at any point on the axis. The defect is called spherical aberration. The difference b/n fp and fm gives the longitudinal spherical aberration.

Signature :

To determine the focal length f_R of the convex lens for red colour:

S.No.	Object distance (u) cm	Image distance v (cm)	$f_R = \frac{uv}{u+v}$ (cm)
	34	41.5	18.68
	36	40.5	19.05
	38	39	19.24
	40	37.5	19.35
	42	35.8	19.32

Avg (f_R) = 19.12 cm

To determine the focal length f_B of the convex lens for Blue colour.

S.No.	Object distance (u) cm	Image distance (v) cm	$f_B = \frac{uv}{u+v}$ cm
	34	40	18.37
	36	38.8	18.67
	38	36.5	18.61
	40	34.8	18.60
	42	32.9	18.44

Avg (f_B) = 18.53 cm

the difference b/n fp and fm gives the longitudinal spherical aberration.

Procedure:

1. To determine the longitudinal spherical aberration:

Level the optical bench so that it is perfectly horizontal by means of the convex lens of focal length about 20 cm; mount it on one of the uprights and place it at distance of 40 cm from the object. The screen is to be placed on the fourth upright beyond the convex lens in order to observe the image of the Object.

Take a thin round card board and make a small circular hole at its centre. Fix this card board on one side of the lens which given. Due to this, only paraxial rays are allowed to pass through the lens whereas the marginal rays are cut off. Adjust the distance of the screen until a clear and bright image of the object is formed on the screen. then the distance u of the object from the lens and the distance v of the image from the lens the paraxial focal length fp of the lens can be calculated using the formula

$$f_p = \frac{uv}{u+v}$$

Signature :

The distance u of the object from the lens and the distance v of the image from the lens. The marginal focal length fm of the lens can be calculated using the formula.

$$f_m = \frac{uv}{u+v} \text{ cm}$$

Repeat the experiment 3 or 4 times by placing the object at various distance. Find the average paraxial focal length and average marginal focal length. Take observations in table.

2. To determine the longitudinal chromatic aberration

In order to find out the longitudinal chromatic aberration. The red filter allows light of single wavelength which falls in the red region. Place the convex lens at a distance "u" from the slit. Adjust position of the eye-piece until the red image of the slit is clearly visible. Note the distance

$$f_B = \frac{uv}{u+v} \text{ cm}$$

$$f_R = \frac{uv}{u+v} \text{ cm}$$

Take observations in the table. The longitudinal chromatic aberration can be calculated. Using above formula

Precautions:

1. The Optical bench should be made perfectly horizon-
-tal
2. the slit should be vertical and narrow
3. All the components should be mounted at the same height

Result:

1. longitudinal spherical aberration = 0.63 cm
2. longitudinal chromatic aberration = 0.59 cm

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