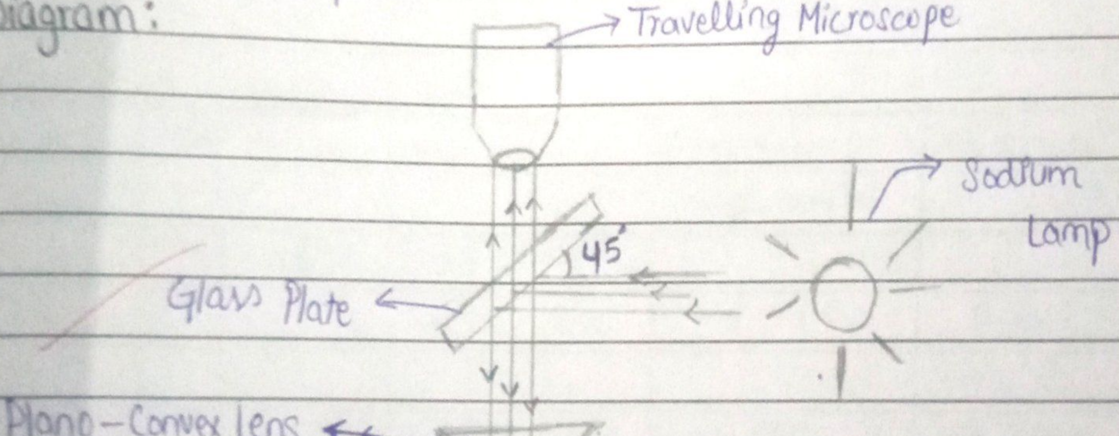
PRACTICAL - 3

Newton's ring : Determination of unknown wavelength (virtual)

Aim : To determine wavelength of monochromatic light by Newton's Ring experiment

Apparatus : A plano-convex lens of large radius of curvature, optical arrangement for Newton's rings, plane glass plate, sodium lamp and travelling microscope.

Diagram :



Formula : The wavelength λ of light is given by the formula

$$\lambda = \frac{D_{n+m}^2 - D_n^2}{4mR}$$

where, D_{n+m} = diameter of $(n+m)^{th}$ ring
D_n = diameter of n^{th} ring
m = an integer number (of the rings)
R = radius of curvature of the curved face of the plano-convex lens.

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Observations:

Travelling Microscope

- Smallest division on main scale = 0.05cm
- Number of division on vernier scale = 50

Least count = $\frac{\text{Smallest divisions on main scale}}{\text{Smallest divisions on vernier}}$ = $\frac{0.05 cm}{50}$

LC of = $\frac{0.05}{50}$ = 0.001 cm

Radius of curvature of the plano convex lens, R = 100 cm

m = 2

Observation table

No.	Order of Rings	Left side (x) cm			Right side (y) cm			Diameter of rings. |x-y| cm	$D_{n+m}^2 - D_n^2$ (cm)
		MSR	VSR	TR	MSR	VSR	TR		
1	12	2.25	15	2.265	2.65	41	3.06	-0.795	0.632
2	10	2.3	25	2.325	2.6	28	2.88	-0.555	0.3080
3	8	2.3	48	2.345	2.6	9	2.69	-0.342	0.427
4	6	2.35	21	2.371	2.6	34	2.94	-0.569	0.2010
5	4	2.35	42	2.392	2.55	14	2.69	-0.298	0.7620
6	2	2.34	26	2.426	2.45	30	2.85	-0.424	0.3120

Calculation :-

use the formula $\lambda = \dfrac{(D^2_{n+m} - D^2_n)}{4mR}$

$$\lambda = \frac{(1.44 - 1.0)}{4 \times 2 \times 100}$$

$$\lambda = \frac{0.44}{800}$$

$$\lambda = 0.000555$$

$$\lambda = 5.5 \times 10^{4} m$$

Result - The wavelength (λ) of the used monochr light is $5.5 \times 10^{-9} m$ = 550nm.

Procedure :

1. Start the virtual lab simulation
2. Choose air as the medium and "Sodium lamp" as the light source.
3. Adjust the radius of the plano-convex lens to 100cm
4. Use the focus controls to make the newton's ring image sharp and clear.
5. Switch the light source on to create the interference pattern of Newton Rings.
6. Look ~~at~~ at the concentric rings formed on the surface; Starting with the central dark ring.
7. Move the microscope to a position that allows you to clearly view the rings.
8. Adjust the microscope's zoom and focus to ensure clear and sharp images of the rings.
9. Measure the diameters of the rings using the virtual measuring tool.
10. Record the measurement and analyze the data for wavelength calculation.

- Theory.

Newton's Rings is an ~~optional~~ optical interference phenomenon that occurs when monochromatic light is reflected between two surfaces - typically a plano-convex lens and an optically flat glass plate. A thin air film with varying thickness is formed between the lens and the plate. When monochromatic light is incident on this setup it produces a pattern of concentric circular fringes known as Newton's Rings alternating between dark and bright bands.

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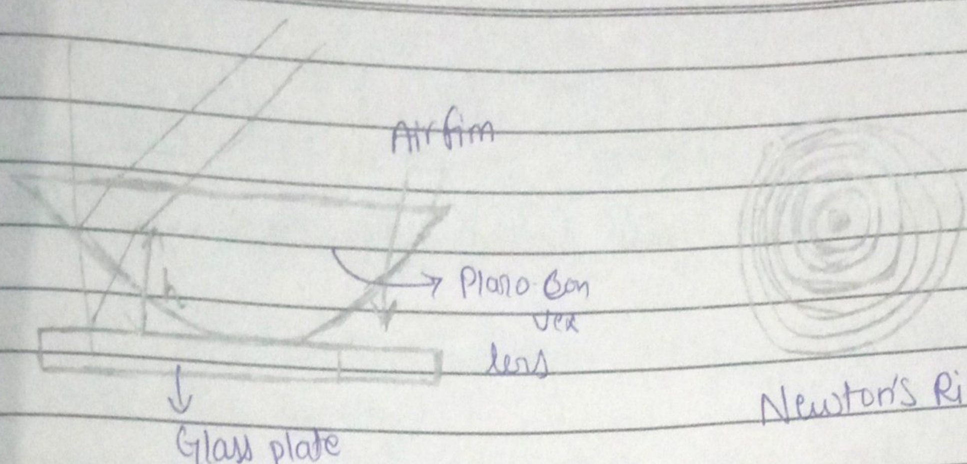

The diameter of the n^{th} dark ring (D_n) is related to the wavelength of the light by the formula.

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

where D_n is the diameter of the n^{th} dark ring
n is the ring number.
R is the radius of curvature of the plano-convex lens.
λ is wavelength of light

This formula comes from the interference condition where the path difference between the two reflected light rays causes destructive interference.

Due to imperfections in the surface of the lens the plate, the center may not be perfectly dark. To minimize the error, the diameters of two rings say the n^{th} and $(n+m)^{th}$ dark rings, can be measured and the wavelength can be calculated using

$$\lambda = \frac{D_{n+m}^2 - D_n^2}{4mR}$$

C
Bangade
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