EXPERIMENT: 4

Object: To find the wavelength of Sodium light by Newton's ring.

Apparatus used: A Plano convex lens of large radius of curvature, optical arrangement for Newton's rings, plane glass plate, sodium vapour lamp and traveling microscope.

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

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

Where, D_{n+p} = diameter of $(n+p)^{th}$ ring

D_n = diameter of n^{th} ring,

p = an integer number,

R = radius of curvature of the curved face of the plano- convex lens.

Procedure: If a point source is used only then we require a convex lens otherwise while using an extended source, convex lens L_1 is not required. Before starting the experiment the glass plates G_1 and G_2 and the plano-convex lens L_2 should be thoroughly cleaned. The centre of lens L_2 is well illuminated by adjusting the inclination of glass plate G_1 at 45° as shown in figure 1 (Left).

- Focus the eyepiece on the cross-wire and move the microscope in the vertical plane by means of rack and pin on arrangements till the rings are quite distinct. Adjustments are to be done till satisfactory fringe system of perfect circular shape with a dark spot at the centre is obtained. The microscope is focused to get clear dark and bright fringes in the field of view as shown in figure 1 (right). Clamp the microscope in the vertical side.
- First, the microscope is adjusted so that the centre of the cross wires coincides with the central dark spot of the fringe system. The microscope is then moved slowly either towards left or right of the centre. While the microscope is moved, the number of dark rings is counted say, up to 14. At the 14^{th} dark ring the microscope is stopped and its motion is reversed. It is brought back to the position of 12^{th} ring. The vertical cross wire is adjusted such that it will be tangential to the 12^{th} dark ring. In this position the reading of the microscope is noted. The microscope is then moved to the 10^{th} dark ring such that the vertical cross wire is again tangential to the ring. The reading of the microscope is noted. The above process is continued till 2^{th} dark ring is reached. After taking the reading for the 2^{th} ring the microscope is moved in the same direction on to the opposite side of the centre. The microscope is moved till the 2^{th} dark ring on the opposite side is reached. The reading is taken as before for the 2^{th} dark ring. The measurements are continued on the opposite side till 12^{th} dark ring is reached. The observations are noted in table.

The radius of the curvature can be determined by the using a spherometer. In this case,

$$R = \left(\frac{l^2}{h}\right) + \left(\frac{h}{2}\right)$$

Where l is the distance between the two legs of the spherometer as shown in figure 2 (right) and h is the difference of the readings of the spectrometer when it is placed on the lens as well as when placed on the plane surface.

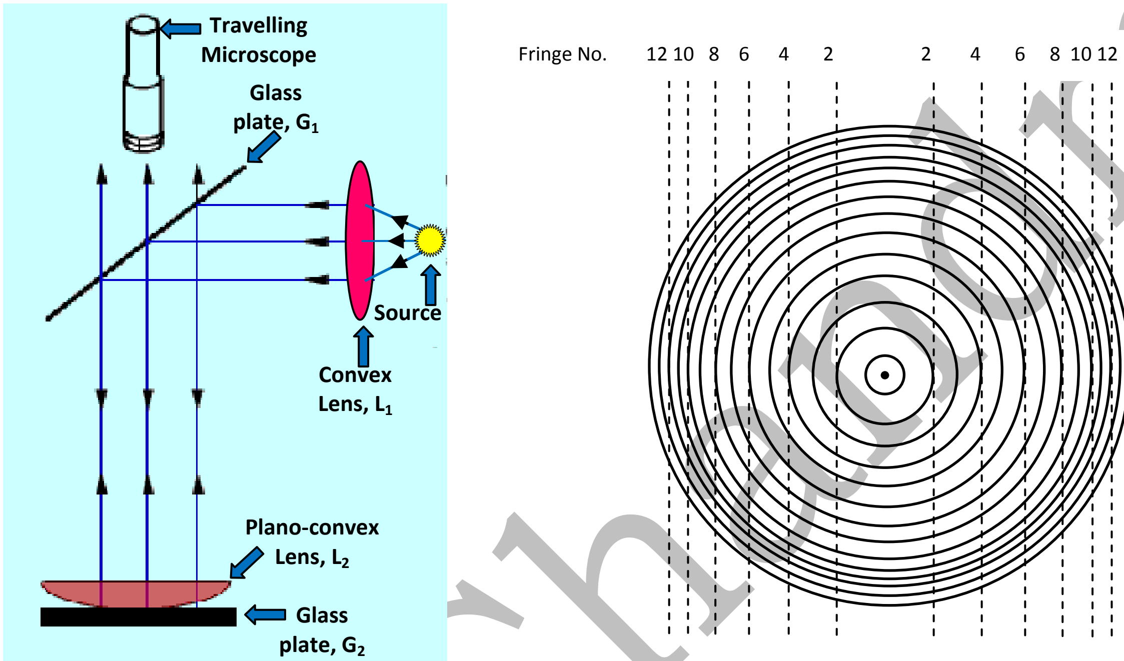


Figure: Left: Experimental arrangement to obtain Newton's ring. **Right:** Newton's ring observed.

OBSERVATION: Value of one division of the main scale=…….. cm.

No of division on the vernier scale=……….

Least count of the travelling microscope = ………. cm.

(A) Table for determination of $(D_{n+p}^2 - D_n^2)$:

Sr. No.	No. of the ring	LHS reading in cm			RHS reading in cm			Diameter D=(L~R)	D^2 in cm²	$D_{n+p}^2 - D_n^2$ in cm²
		MSR	VSR	TR(L)	MSR	VSR	TR(R)			
1	12								a =	$a - d$ =
2	10								b =	
3	8								c =	$b - e$ =
4	6								d =	
5	4								e =	$c - f$ =
6	2								f =	
									For p = 6, Mean $D_{n+p}^2 - D_n^2$	

(B) Table for determination of R using spherometer:

Distance between the two legs of spherometer l = ……… cm.

Sr. No.	Spherometer reading on plane surface			Spherometer reading on lens surface			h =(b-a) in cm
	MSR	VSR	TR(a)	MSR	VSR	TR(b)	
1							
2							
3							
						Mean, h in cm	

MSR = Main Scale Reading, VSR = Vernier Scale Reading, TR = MSR+VSR = Total Reading.

Calculations:

Using h and l obtained in Table (B), the radius of curvature of the plano-convex lens R is given by:

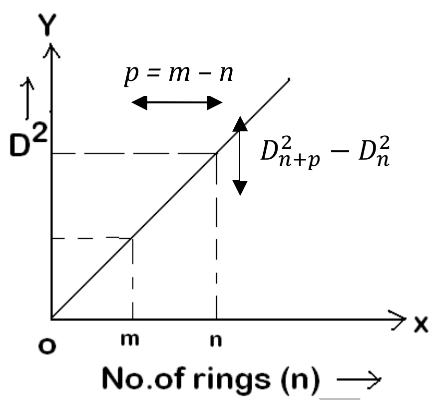
$$R = \left(\frac{l^2}{h}\right) + \left(\frac{h}{2}\right)$$

Using $(D_{n+p}^2 - D_n^2)$ obtained in Table (A) for p = 6, the wavelength of sodium light is given by:

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

The value of $(D_{n+p}^2 - D_n^2)$ can also be obtained using a graph as shown in figure 2 (left). The graph is plotted between the square of diameter of the ring along Y-axis and corresponding number of ring along X-axis. A straight line is obtained. Slope of the graph is calculated. The slope of the straight line gives the value of $[(D_{n+p}^2 - D_n^2)/p]$. Then the radius of curvature R is calculated from the formula using the values given above. The wavelength of sodium light is, thus

$$\lambda = \frac{Slope\ of\ straight\ line}{4R} = \_\_\_\_\text{Å}$$



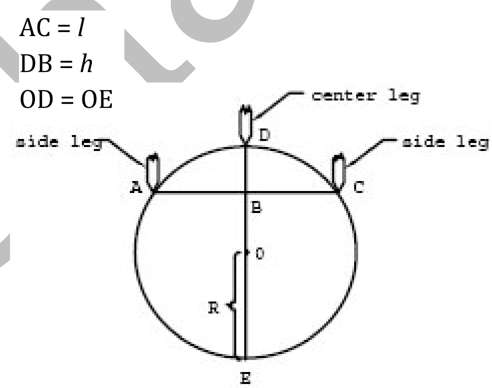


Figure: Left: The graph between the square of diameter of the ring and number of rings.
Right: Spherometer on the lens convex surface ADC of the plano-convex lens.

RESULT: The mean wavelength λ of sodium light = ……….Å
Standard mean wavelength λ = ……….Å
Percentage Error = ……..%

SOURCES OF ERROR and PRECAUTION:

(1) Glass plates and lens should be cleaned thoroughly.
(2) The plano-convex lens should be of large radius of curvature.
(3) The sources of light used should be an extended one.
(4) The range of the microscope should be properly adjusted before measuring the diameters.
(5) Crosswire should be focused on a dark ring tangentially.
(6) The centre of the ring system should be a dark spot.
(7) The microscope is always moved in the same direction to avoid back lash error.
(8) Radius of curvature should be measured accurately.