MIT-WPU

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Pledge

I solemnly affirm that I am presenting this journal based on my own experimental work. I have neither copied the observations, calculations, graphs and results from others nor given it to others for copying.

Signature of the student

Experiment 1: Newton's Rings

Aim: To measure the radius of curvature of a planoconex lens using Newton's rings apparatus

Apparatus: (1) Newton's rings apparatus consisting of

a. Planoconvex lens
b. Optically flat glass plate
c. Beam splitter
d. T-type traveling microscope with scale with L.C. = 0.001 cm

(2) Monochromatic source of light of known wavelength (ex. Sodium)
(3) Reading lamp and reading lens

Significance of the experiment: *Newton's rings apparatus can be considered as an interferometer, since it generates a steady state and well defined interference pattern. One of the prime, applications of interferometers is precise measurements of dimensions. This experiment aims at a precise measurement of radius of curvature of a plano-convex lens using 'Newton's interferometer'. The other applications of this apparatus are, measuring the wavelength of monochromatic source of light, refractive index of the liquids and testing preciseness of glass plates and lenses.*

Theory: Newton's rings are the concentric and circular fringes obtained by using interference of circularly symmetric wedge shaped films. (Refer Fig. 1.1 a, b and c). Such film can be obtained by placing a planoconvex lens on a glass plate. The region between these two components forms a circularly symmetric wedge shaped film, as the locus of points having same path difference forms a circle. If this film is exposed to a plane wavefront of monochromatic light from the top, then the rays reflected from the top and bottom of the circularly symmetric wedge shaped film interfere and produce Newton's rings

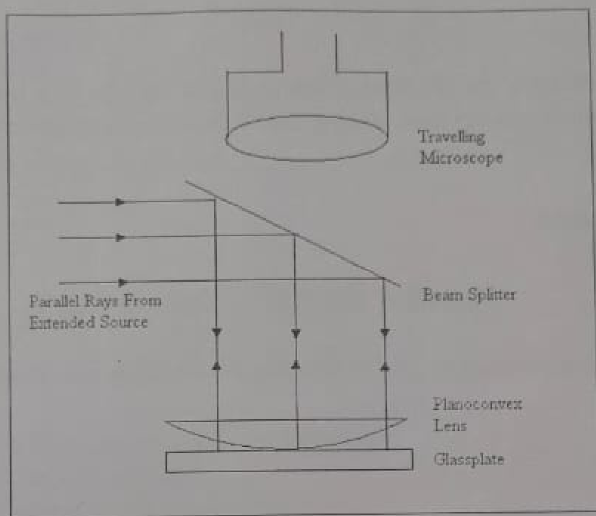

Fig 1.1 a: Experimental set up for observing Newton's rings

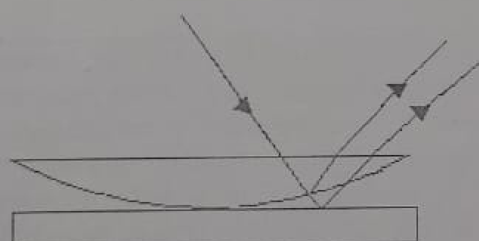

Fig 1.1b: The ray diagram for Newton's rings

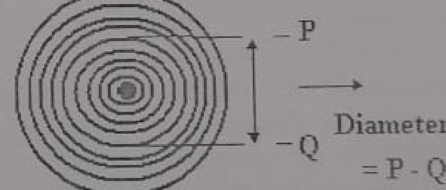

Fig 1.1c: Newton's Rings

By extending the theory of wedge shaped films to Newton's rings, it can be shown that

$$R = \frac{\mu(D_m^2 - D_n^2)}{4(m-n)\lambda} \qquad \ldots(1.1)$$

Where R = Radius of curvature of planoconvex lens
D_m = Diameter of m^{th} dark ring
D_n = Diameter of n^{th} dark ring
λ = Wavelength of monochromatic light
μ = Refractive index of the medium in betweenplanoconvex lens and glass plate

Thus if diameters of Newton's rings are measured then a few important physical quantities such as R, λ and μ of the liquid can be measured.

Procedure:

1. Produce Newton's rings by the procedure given below.

    a. Make every component dust free.
    b. Level the whole apparatus using spirit level
    c. Keep the wooden boxes containing a beam splitter and glass plate below the T type microscope. Keep planoconvex lens on the glass plate exactly below the microscope such that its curved part touches the glass plate
    d. Render a parallel wavefront of sodium by placing the source at the focal length of a lens. Expose planoconvex lens-glass plate system parallel wavefront of light. Now Newton's rings can be seen through the microscope.
    e. Adjust the eyepiece of the microscope so that sharp Newton's rings are produced
    f. If the central ring is not dark then gently tap the apparatus to make the centre dark. The central ring should be dark throughout the experiment.

2. The central dark ring is the zeroth one. Measure the diameters of first five dark rings by using the procedure given below

    a. Move the microscope, so that crosswire is adjusted on upper part of the first dark ring. Measure this position, say P on the scale of the microscope, in the following manner

$$P = MSR + VSR \times LC \quad cm$$

Where **MSR** is the reading on main scale which coincides with the zero of the vernier scale. If no reading coincides, then the reading on the main sale previous to with the zero of the vernier

VSR is the sequence number of division on the vernier scale which exactly coincides with the division on the main scale.

LC is the least count of the scale of the microscope

    b. Move the microscope down to adjust the crosswire on the lower part of first dark ring. Measure the corresponding position on the scale, say, Q by using the procedure given above
    c. The diameter of the ring is $P - Q$ cm
    d. Repeat the above procedure for measuring the diameters of 2^{nd}, 3^{rd}, 4^{th} and 5^{th} dark rings

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3. Plot the graph of D_n^2 *Vs n*. Calculate the slope of this graph. The slope gives the precise value of $\left(\frac{D_m^2-D_n^2}{m-n}\right)$
4. Calculate the radius of curvature of planoconvex lens by using formula (1.1). Take μ =1, as in this experiment, Newton's rings are produced in air. The source used is sodium, therefore take $\lambda = 5890\ \ A^o = 5890\times 10^{-8}cm$
5. Compare this R_e with the standard radius of curvature (R_s) given. Calculate the percentage deviation, which needs to be as less as possible.

Observations:

Table 1.1: Calculation of the least count of the scale on microscope

Smallest Division on the main scale	1 cm
Number of Divisions on vernier scale	1000
L.C. of traveling microscope	0.001 cm

Calculations:

Slope of the graph of D_n^2 *Vs n* = 0.0109 cm^2,

Wavelength of sodium source used in the experiment= 5890 A° = 5890×10^{-8} cm

Radius of curvature of planoconvex lens = 50 cm

$$R_e = \frac{\mu(D_m^2 - D_n^2)}{4(m-n)\lambda} = \frac{1 \times slope}{4 \times \lambda} = \frac{1 \times 0.0109}{4 \times 5890 \times 10^{-8}} = 46.26\ cm$$

Standard radius of curvature R_s, cm	Radius of curvature using Newton's rings R_e, cm	$\% \, deviation = \left\lvert \frac{R_s - R_e}{R_s} \right\rvert \times 100\ \%$
50 cm	46.26	7.47 %

FAIR WORK

Table (1.2) Diameters of Newton's rings

Seq. no. of Dark ring (*n*)	Upper position (*P*), *cm*	Lower position (*Q*), *cm*	Diameter $D_n = P - Q$ *cm*	Square of diameter D_n^2, cm^2
1	5.016	4.904	0.112	0.0125
2	4.973	4.818	0.155	0.0240
3	4.941	4.754	0.187	0.0349
4	4.914	4.701	0.213	0.0453
5	4.887	4.858	0.029	0.0084

Calculations:

Slope of the graph of D_n^2 *Vs n*= 0.0109 cm^2.

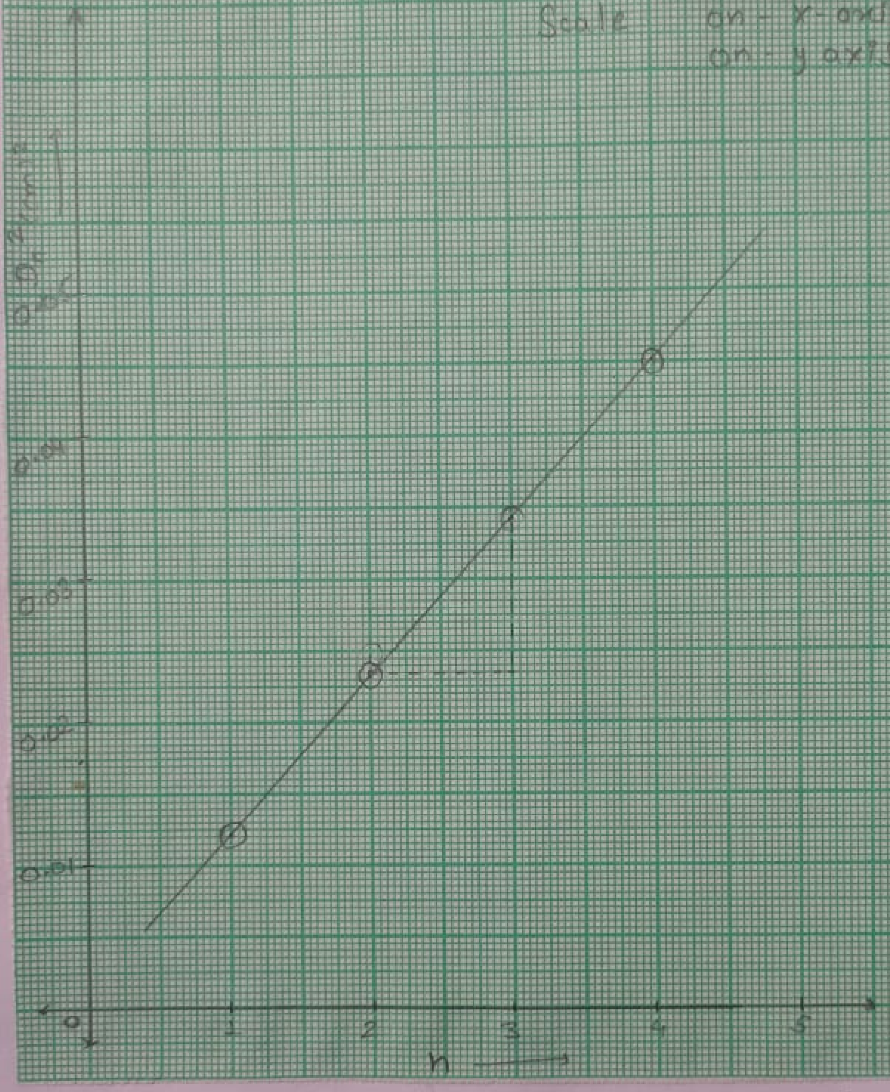
Wavelength of sodium source used in the experiment= 5890 A°

Radius of curvature of planoconvex lens

$$R_e = \frac{\mu(D_m^2 - D_n^2)}{4(m-n)\lambda} = \frac{1 \times slope}{4 \times \lambda} = \frac{1 \times 0.0109}{4 \times 5890 \times 10^{-8}} = 46.26\ cm$$

Standard radius of curvature R_s, cm	Radius of curvature using Newton's rings R_e, cm	$\% \, deviation = \left\lvert \frac{R_s - R_e}{R_s} \right\rvert \times 100\ \%$
50	46.26	7.47 %

Scale on - x-axis → 2cm = 0.01 cm2
on - y axis → 2cm = 1 u



$$slope = \frac{y_2 - y_1}{x_2 - x_1}$$

$$= \frac{D_m^2 - D_n^2}{m - n}$$

$$= \frac{0.349 - 0.240}{3 - 2}$$

$$= 0.0109\ cm^2$$

My Understanding of the Experiment

(Not exceeding 5 to 6 lines)

By this experiment we get to know the intereference produced due to wedge shaped film of convex lens. Also this experiment can be used to determine the wavelength of monochromatic light if radius of curvature of the convex surface is provided.