DATE	PAGE NO.

EXPT. NO.

EXPERIMENT -2

OBJECTIVE :- To study the formation of Newton's ring in the air film in between a plano-convex lens and a glass plate using nearly monochromatic light from a sodium-source and hence to determine the radius of curvature of the plano-convex lens.

THEORY :- When a parallel beam of monochromatic light is incident normally on a combination of a plano-convex lens L and a glass-plate G as shown in Fig 1, a part of each incident ray is reflected from the lower surface of the lens, and a part after refraction through the air film between the lens and the plate, is reflected back from the plate surface. These two reflected rays are coherent, hence they will interfere and produce a system of alternate dark and bright rings with the point of contact between the lens and the plate as the centre. These rings are known as Newton's ring

For a normal incidence of monochromatic light, the path difference between the reflected rays is very nearly equal to $2\mu t$ where μ and t are the refractive index and thickness of the air-film respectively. The fact that the wave is reflected from air to glass surface introduces a phase of π.

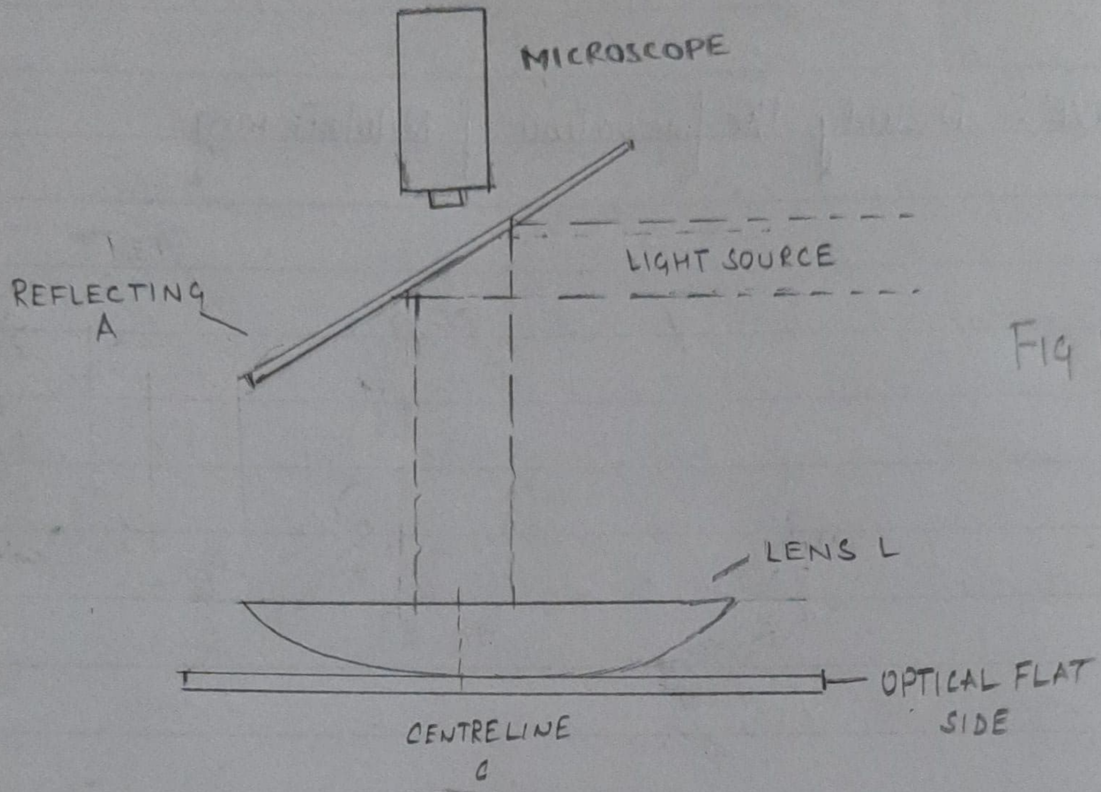

MICROSCOPE
LIGHT SOURCE
REFLECTING
A
LENS L
OPTICAL FLAT
SIDE
CENTRELINE
C

Fig 1

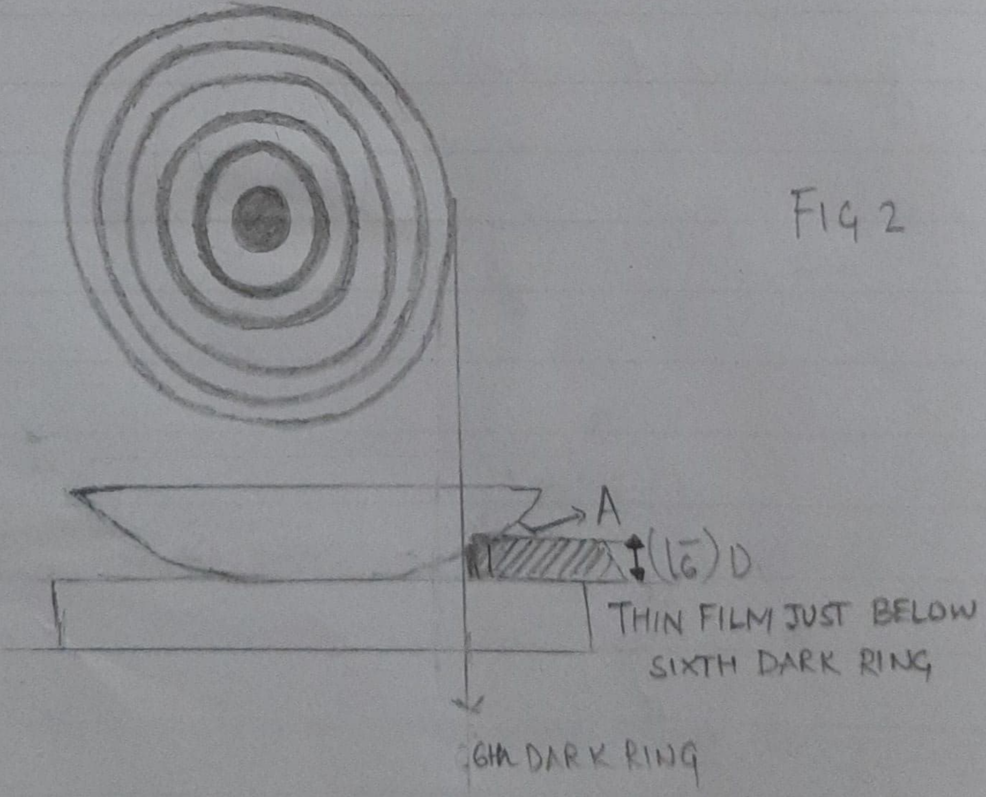

A
($1\bar{6}$) D
THIN FILM JUST BELOW
SIXTH DARK RING
6th DARK RING

Fig 2

For the bright fringe

$$2\mu t = \left(n+\frac{1}{2}\right)\lambda \quad n=1,2,3 \ldots\ldots (1)$$

For the dark fringe.

$$2\mu t = n\lambda \quad n=1,2,3 \ldots\ldots (2)$$

For n-th ring

$$\frac{D_n^2}{4} + (R-t)^2 = R^2$$

where D_n = the diameter of the n-th ring and R = the radius of curvature of the lower surface of the plano-convex lens. On neglecting t^2. equation (3) reduces to-

$$D_n^2 = 8tR$$

From equation (1) and (4), we get,

$$D_n^2 = 4\left(n+\frac{1}{2}\right)\frac{\lambda R}{\mu} \quad \text{For nth bright ring}$$

$$D_n^2 = 4\left(n+m+\frac{1}{2}\right)\frac{\lambda R}{\mu} \quad \text{For } (n+m)^{th} \text{ bright ring}$$

DATE | PAGE NO. | EXPT. NO.

Similarly from equations (2) and (4), we obtain

$$D_n^2 = \frac{4n\lambda R}{\mu}, \text{ For } n\text{th dark ring}$$

$$D_{n+m}^2 = 4\left(n+m+\frac{1}{2}\right)\frac{\lambda R}{\mu}, \text{ For } (n+m)\text{th dark ring}$$

Thus for bright as well as dark rings, we obtain

$$R = \frac{\mu\left(D_{n+m}^2 - D_n^2\right)}{4m\lambda}$$

Since $\mu = 1$ for air film, above equation gives

$$R = \frac{\left(D_{n+m}^2 - D_n^2\right)}{4m\lambda}$$

APPARATUS :

- A nearly monochromatic source of light (source of sodium light).
- A plano - convex lens.
- An optically flat glass plate.
- A convex lens
- A travelling microscope.

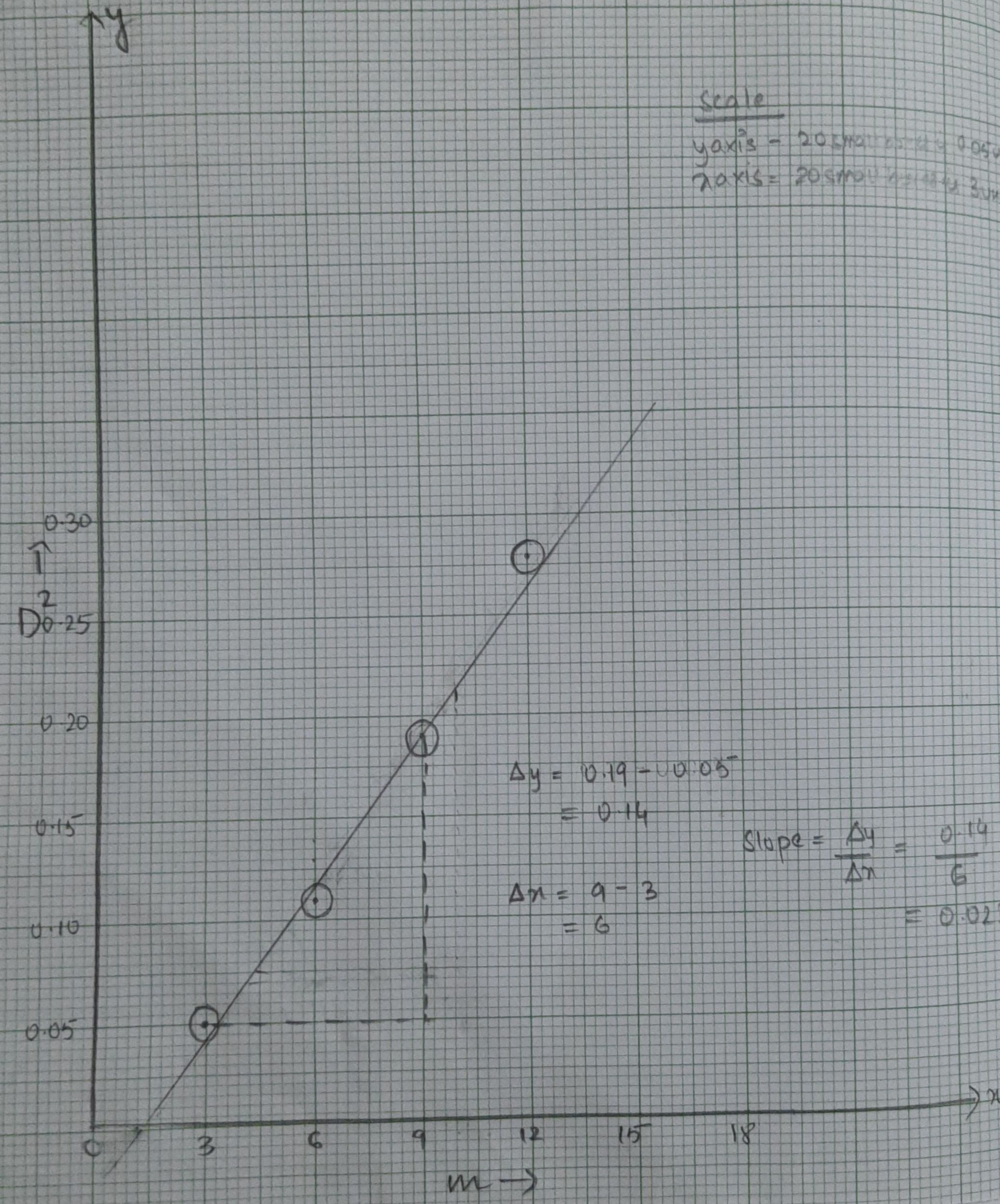
DATE	PAGE NO.	EXPT. NO.

OBSERVATION :-

Least count (L.C) of the circular scale = 0.001 cm or (0.01 mm)

TABLE I : Determination of the diameter (D) of the rings

RING NO	OBS STARTED FROM	READING OF THE MICROSCOPE: LEFT END OF THE RING (R_1) M.S.R (in cm)	C.S.R (in cm)	T = M.S.R + (C.S.R × L.C) (in cm)	RIGHT END OF THE RING (R_2) M.S.R (in cm)	C.S.R (in cm)	T = M.S.R + (C.S.R × L.C) (in cm)	DIAMETER (D) = ($R_2 - R_1$) (cm)	MEAN (D) (cm)
3	LEFT	9.85	33	9.88	10.10	18	10.11	0.23	0.24
	RIGHT	9.85	28	9.87	10.10	26	10.12	0.25	
6	LEFT	9.80	2	9.80	10.15	29	10.17	0.30	0.34
	RIGHT	9.80	7	9.80	10.15	34	10.18	0.38	
9	LEFT	9.75	13	9.76	10.20	23	10.22	0.42	0.44
	RIGHT	9.75	17	9.76	10.20	27	10.22	0.46	
12	LEFT	9.70	26	9.72	10.25	13	10.26	0.54	0.53
	RIGHT	9.70	30	9.73	10.25	9	10.25	0.52	



<u>Scale</u>

y axis = 20 small squares = 0.05 units

x axis = 20 small squares = 3 units

$\Delta y = 0.19 - 0.05$
$= 0.14$

$\Delta x = 9 - 3$
$= 6$

$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{0.14}{6}$
$= 0.023$

DATE	PAGE NO.	EXPT. NO.

TABLE 2 : Determination of radius of curvature (R)

RING NO.	MEAN DIAMETER (D) (cm)	D^2 (cm^2)
3	0.24	0.05
6	0.34	0.11
9	0.44	0.19
12	0.53	0.28

CALCULATION :-

Slope of the graph $= \frac{\Delta y}{\Delta x} = \frac{0.14}{6} = 0.023$

$\lambda = 5,893 \times 10^{-7}$ mm $= 58,9.3 \times 10^{-7}$ cm

$R = \frac{Slope}{4\lambda} = \frac{0.023}{4 \times (589.3 \times 10^{-7})} = 100$ cm $= 1000$ mm. (Ans)

CONCLUSION :- The radius of curvature (R) is 100 cm Ans.

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