Experiment: 3

NEWTON'S RINGS

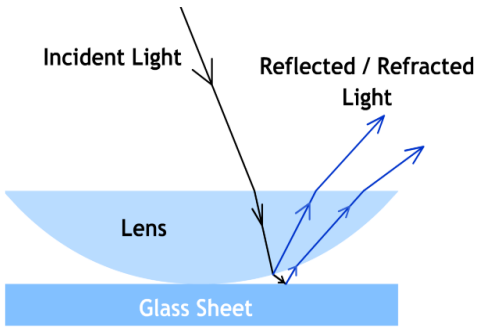
AIM: To determine the radius of curvature of the given plano-convex lens by forming Newton's Rings.

APPARATUS: Plano-convex lens, traveling microscope, adjustable reflector, glass plate, sodium vapour lamp, reading lens

INTRODUCTION: When a Plano-convex lens with its convex surface is placed on a plane glass sheet, an air film of gradually increasing thickness outward is formed between the lens and the sheet. The thickness of the film at the point of contact is zero. If monochromatic light is allowed to fall normally on the lens, and the film is viewed in reflected light, alternate bright and dark concentric rings are seen around the point of contact. These rings are called NEWTON'S RINGS.

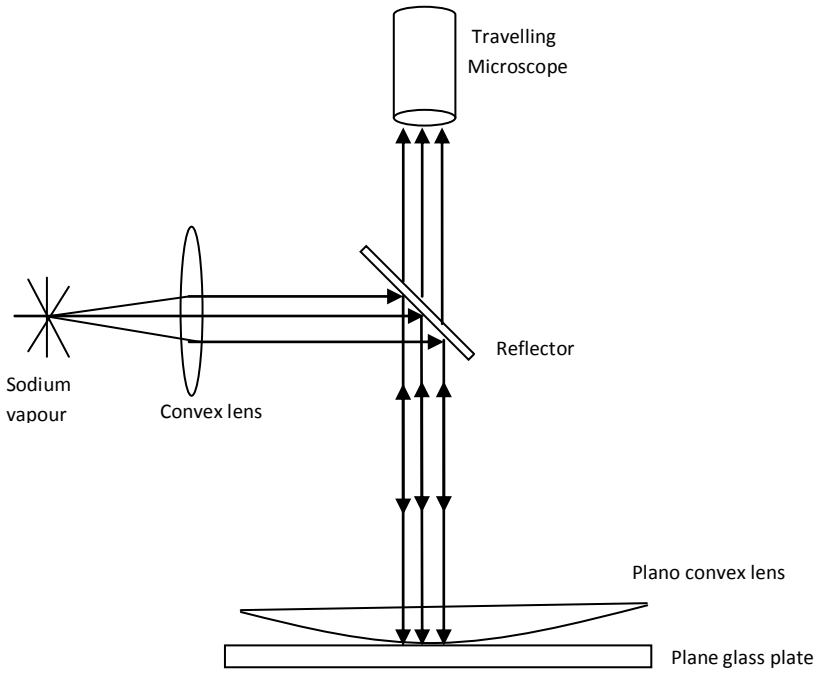
The phenomenon of the formation of the Newton's rings can be explained on the basis of wave theory of light

- An air film of varying thickness is formed between the lens and the glass sheet.
- When a light ray is incident on the upper surface of the lens, it is reflected as well as refracted.
- When the refracted ray strikes the glass sheet, it undergoes a phase change of 180^{O} on reflection.
- Interference occurs between the two waves; which is constructive if path difference between them is **(m+1/2)**λ and destructive if path difference between them is **m**λ producing alternate bright and dark rings.

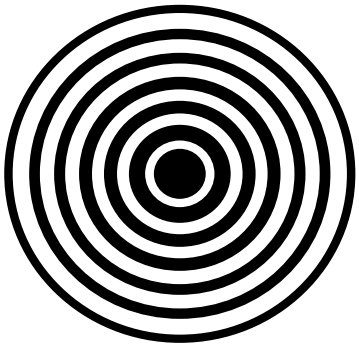


Experimental Arrangement for Newton's Rings

RAY DIAGRAM:



Newton's Rings Set up



Newton's Rings

FORMULA:

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

Where, R is the radius of curvature of the lens in m
λ is the wavelength of the source in m
D_m & D_n are the diameters of the m^{th} & n^{th} rings respectively in m
m,n are the order of the rings

PROCEDURE:

1. Clean the convex lens, glass plate and the inclined glass plate of the stand with a soft cloth. Place this combined system below the objective of the traveling microscope (TM).
2. Look through the TM and adjust the inclination of the reflector till the field of view is bright.
3. The TM is focused to obtain Newton's Rings with dark spot (0^{th} dark) at the centre.
4. Move the carriage of the microscope towards left by turning the head scale such that the vertical cross wire is tangential to the 12^{th} dark ring. Note the reading.
5. Position the cross wire tangentially to the 10^{th}, 8^{th}, 6th, 4th, and 2^{nd} dark ring and record the readings respectively.
6. Similarly record the position of the 2^{nd}, 4^{th}, 6^{th}, 8^{th} ,10^{th} and 12^{th} rings on the right hand side of the central dark spot.
7. The radius of curvature is determined using the relation $R = \frac{D_m^2 - D_n^2}{4(m-n)\lambda}$

OBSERVATION:

1. Wavelength of the given source of light (λ) = 5893 Å
2. Least count of TM= $\frac{Pitch}{Total\ number\ of\ head\ scale\ divisions} = \frac{1mm}{100} = 0.01mm$

Ring No	Reading of T M						Ring Diameter (R_1~ R_2)	D_m^2 $(mm)^2$	Ring No	Reading of T M						Ring Diameter (R_3~ R_4)	D_n^2	D_m^2-D_n^2
	Left hand side			Right hand side						Left hand side			Right hand side					
m	PSR (mm)	HSD (div)	TR R_1 (mm)	PSR (mm)	HSD (div)	TR R_2 (mm)	D_m (mm)		n	PSR (mm)	HSD (div)	TR R_3 (mm)	PSR (mm)	HSD (div)	TR R_4 (mm)	D_n (mm)	$(mm)^2$	$(mm)^2$
12									6									
10									4									
8									2									

Mean (D_m^2-D_n^2) = _____mm^2 = _____m^2

RESULT: The radius of curvature of the given plano-convex lens is found to be……. m

PROPORTIONAL ERROR CALCULATION:

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

$$\frac{\delta R}{R} = \frac{4 \times Least\ count\ of\ TM}{Typical\ measured\ value\ of\ (D_m - D_n)}$$

The radius of curvature of the given plano-convex lens = (R±δR)

= ……..

References:

Refer the following manuscript/book

1) *Optics*, Ajoy Ghatak, Tata Mcgraw Hill, 1991, 3rd Edn, (Page 13.16 - 13.31)
2) *An advanced course in Practical Physics*, Chattopadhyay, Central Publn, 2002, 6th Edn, (Page 227 – 233)
3) *Practical Physics*, R K Shukla, New Age International, 2006,1st Edn, (Page 239 – 241)
4) Refer the following links

   https://www.youtube.com/watch?v=dsociG2sXGM

   https://www.youtube.com/watch?v=PU-SeNfIRcs

   https://www.youtube.com/watch?v=CAe3lkYNKt8