SUBJECT – PHYSICS (LAB)

EXPERIMENT No. – 01

Title: Newton's Rings Experiment

Practical Significance:

The Newton's rings experiment helps in understanding the **interference of light** through the formation of circular fringe patterns. It is commonly used to determine the **radius of curvature of a plano-convex lens**, which is an important parameter in optical systems. The experiment also gives practical experience in using instruments such as a **travelling microscope** and taking precise measurements of small distances. Methods based on Newton's rings are widely applied in **optical testing, lens manufacturing, and surface analysis**.

Relevant program outcomes:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

3. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

4. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

5. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

6. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Relevant Course outcomes:

1. Students will be able to understand optical phenomena such as interference and diffraction in terms of the wave model.

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Practical learning outcomes:

Use travelling Microscope

1. To know the working principle and different parts of travelling microscope.
2. To know about the concept of Newton's ring.
3. To determine the radius of curvature of a Plano convex lens by Newton's ring.

Practical skills:

1. **Experimental Skills:** - The learner develops experimental skills in practical work if she/he is able to
    1. comprehend the theory and objectives of the experiment.
    2. conceive the procedure to perform the experiment.
    3. set-up the apparatus in proper order.
    4. check the suitability of the equipment, apparatus, tools regarding their working and functioning.
    5. know the limitations of measuring device and find its least count, error etc.
    6. handle the apparatus carefully and cautiously to avoid any damage to the instrument as well as any personal harm.
2. **Observational Skills: -** The learner develops observational skills in practical work if she/he is able to
    1. follow the correct sequence while making observations.
    2. take observations carefully in a systematic manner, keeping least count in mind.
    3. minimize some errors in measurement by repeating every observation independently a number of times.
3. **Drawing Skills: -** The learner develops drawing skills for if she/he is able to make schematic diagram of the apparatus.
4. **Reporting Skills**: - The learner develops reporting skills for presentation of observation data in practical work if she/he is able to
    1. record observations systematically and with appropriate units in a tabular form wherever desirable
    2. calculate error in the result
    3. state limitations of the apparatus/devices
    4. interpret the results, verify principles and draw conclusions and explore the scope of further investigation in the work performed.

Relevant affective domain related outcomes:

1. **Receiving: -**
   One of the earliest skills is the **receiving phenomena**, which in a nutshell means the person is able to listen and has a willingness to hear out others.

2. **Responding**
   Participating in discussions, asking questions, and presenting information to others are next-level skills that create a stronger foundation for interpersonal connection and expression.

Resources required:

S. No.	Name of equipment	Specifications	Quantity	Remark
1	Optical arrangement for Newton's Rings, travelling microscope		1	
2	Sodium lamp		1	
3	Short focus convex lens		1	
4	Plano Convex Lens		1	
5	Circular Plane glass plate		1	
6	Reading lens		1	

Theoretical Background:

Newton's rings are concentric circular interference patterns formed when a **plano-convex lens** is placed on a flat glass plate. Due to the curved surface of the lens, a thin air film is created between the lens and the plate, whose thickness gradually increases from the center outward.

When monochromatic light falls on this arrangement, light reflected from the upper and lower surfaces of the air film interferes with each other. This interference produces a series of alternating **bright and dark circular rings** known as Newton's rings. The center appears dark because the thickness of the air film is nearly zero at the point of contact.

For the dark rings formed in reflected light, the diameter of the n^{th} ring is related to the wavelength of light and the radius of curvature of the lens by

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

Here, R is the radius of curvature of the convex lens,

D_n is the diameter of the nth ring.

D_{n+p} is the diameter of $(n+p)^{th}$ ring,

P is a simple integer like 3, 4 or 5 and $\lambda = 5893 \times 10^{-8}$cm

By measuring the diameters of the rings and using the known wavelength of the light source, the **radius of curvature of the lens** can be determined

Experimental set-up:

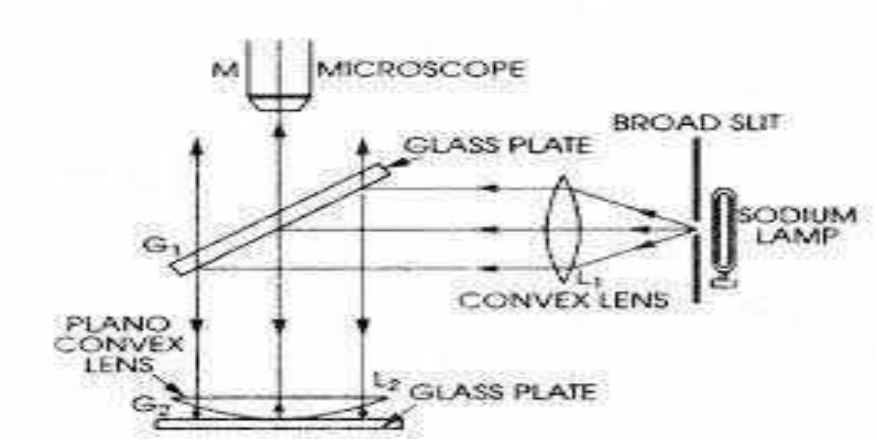

Fig: 1

Fig: -2

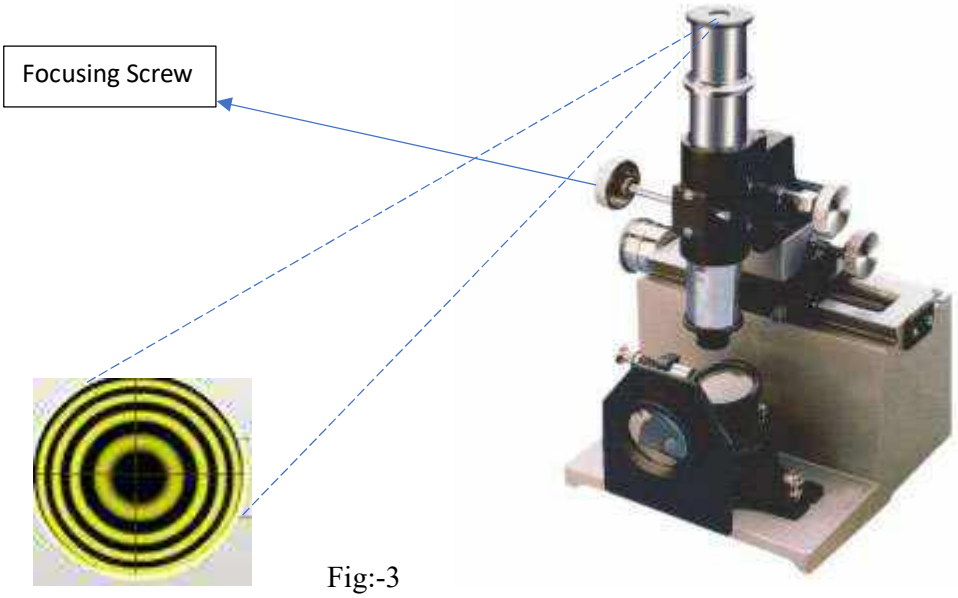

Fig:-3

Precautions:

i) Glass plates and lens should be cleaned thoroughly.

ii) The lens used should be of large radius of curvature.

iii) This is necessary for two reasons:

- **a.** the angle enclosing the air film becomes very small and
- **b.** the rings observed have then a large diameter and hence the error in the measurement of their diameters is minimized.

iv) The source of light used should be an extended one.

v) The light from sodium lamp should be rendered approximately parallel by means of a short focus lens.

vi) Its height should be so adjusted that the emergent pencil from it falls on the plate of glass almost horizontally.

vii) To avoid any error, the micrometer screw of the travelling microscope should be moved very slowly and be moved in one direction while taking observations.

viii) While measuring diameters, the microscope cross-wire should be adjusted in the middle of the ring.

Procedure:

1. Place the Newton's ring apparatus in front of sodium lamp as Shown in Figure 2.
2. Switch on the sodium lamp.
3. Wait till the colour of the sodium light turns yellow.
4. Put circular plane glass plate in container of Optical arrangement.
5. Now place the plano-convex lens in the above same container in such a way that its convex surface is in contact with the plane glass plate.
6. Adjust the plane glass plate (arranged above the container) so that it is inclined at 45 degrees from the vertical direction.
7. Now focus the microscope using the focusing screw until Newton's rings are clearly visible. (see fig 3)
8. Adjust the position of the microscope so that the point of Intersection of its cross wires coincides with the center of the ring system.
9. Then move the microscope to the left till the vertical cross wire becomes tangential to the 15^{th} dark ring.
10. Note down the reading on the horizontal scale of microscope.
11. Move the microscope towards right with the help of motion screw.
12. Note the reading when the cross wires lie tangentially on the 13^{th}, 9^{th}, 7^{th}.....and 1^{st} ring.
13. Now move the microscope to the right of the center of the rings.
14. Note the reading by coinciding the vertical cross wire on the 1^{st}, 3^{rd}, 5^{th}.... 15^{th} ring on the right side also.

Observations: -

Table for $D_{(n+p)}$ and D_n

Vernier Least Count = ……..

S. No.	Ring no. (n)	Microscope Reading (cm)						D_n = L - R (cm)	D_n^2 (cm^2)	(D_{n+p}^2 - D_n^2) (cm^2)
		Left side of centre of Rings (L)			Right side of centre of Rings (R)					
		m.s.	v.s.	Total	m.s.	v.s.	Total			

Calculations:

Given value of $\lambda = 5893 \times 10^{-8}$cm

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

Results:

The radius of curvature of the plano convex lens is found to be R =…….. cm.

Interpretation of results:

% error =

Conclusion and recommendations: (It is sample only you have to write your own)

Conclusion

In this experiment, the radius of curvature of a plano-convex lens was determined using the Newton's rings method. By measuring the diameters of the interference rings and applying the required formula, the radius of curvature was calculated. The result obtained is reasonably close to the expected value, confirming the validity of the method.

Recommendations

1. The glass plate and lens should be clean and free from dust to obtain clear interference rings.
2. The microscope should be focused carefully for accurate measurement of ring diameters.
3. Readings should be taken on both sides of the rings to minimize observational errors.
4. Multiple readings should be recorded and averaged to improve the accuracy of the result.

Practical related questions:

1. Why is sodium light used in Newton rings?
2. Why fringes are circular in Newton's ring experiment?
3. What is the role of the glass plate in Newton's Ring experiment?

4. Why is the Central dark in Newton rings?
5. What are the two applications of Newton's rings?
6. What is the principle of Newton's ring method?
7. What apparatus was used in the Newton's ring experiment?
8. What is the aim of the Newton's ring experiment?
9. What do you understand by the interference of light?
10. What will happen if the glass plate is silvered on the front surface?
11. Why do the rings get closer and finer as we move away from the center?
12. What will happen when a little water is introduced in between the plano-convex lens and the plate?
13. How does the diameter of rings change on the introduction of liquid?
14. Can you find out the refractive index of a liquid by this experiment?

References/ suggestions for further readings:

Assessment Process: Rubrics

S.N.	Criteria ⇩ / Scale ⇨ Poor		Satisfactory	Good	Excellent
1	**Understanding of Experiment**	Shows little understanding of the aim and theory of the experiment.	Basic understanding of the aim but explanation is incomplete.	Good understanding of the aim and theory with minor gaps.	Demonstrates clear and thorough understanding of the aim and underlying theory.
2	**Experimental Procedure & Handling of Apparatus**	Unable to follow procedure properly; improper handling of apparatus.	Follows procedure with guidance; handling of apparatus needs improvement.	Performs experiment correctly with minimal guidance.	Performs experiment independently with proper handling of apparatus.
3	**Observation & Data Recording**	Observations are incomplete or incorrect; data not properly recorded.	Records basic observations but with some errors or missing details.	Observations recorded correctly with minor mistakes.	Observations are complete, accurate, and systematically recorded.
4	**Graph / Calculations / Analysis**	Graphs or calculations missing or incorrect.	Graphs or calculations attempted but contain noticeable errors.	Graphs and calculations mostly correct with minor errors.	Graphs, calculations, and analysis are accurate and clearly presented.
5	**Neat and Clean Reporting of Practical Record**	Record is untidy with overwriting and missing diagrams or sections.	Record is somewhat neat but contains formatting or labeling issues.	Record is neat with properly drawn diagrams and organized content.	Record is very neat, well organized, and professionally presented.

6	**Viva / Conceptual Questions**	Unable to answer basic questions related to the experiment.	Answers some questions but lacks clarity in concepts.	Answers most questions correctly with reasonable explanation.	Answers confidently with clear conceptual understanding.
7	**Precautions**	Not known	Known but not understand	Known and understand	Known, understand and also know the importance
8	**Safety measures**	Doesn't follow	Follow but reason is not known	Follow and reason is known	Follow known and understand
9	**Team work ability**	Doesn't participate and perform the experiment	Perform but not interact with group	Perform and participate	Perform, participate, lead actively