EXERCISE 81B	DETERMINATION OF RADIUS OF CURVATURE OF THE LENS AND THE WAVELENGTH OF LIGHT USING THE NEWTON'S RINGS

Measurement procedure

1. List of equipment
- Microscope with compound table and mounted lens
- Sodium-vapour lamp with power supply

2. Goals
- Investigation of Newton's rings – light interference in optical wedge
- Determination of radius of curvature of the lens

3. Measurement setup

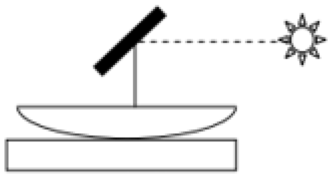


Fig. 1. The setup of a flat glass plate, plano-convex lens and a light source.

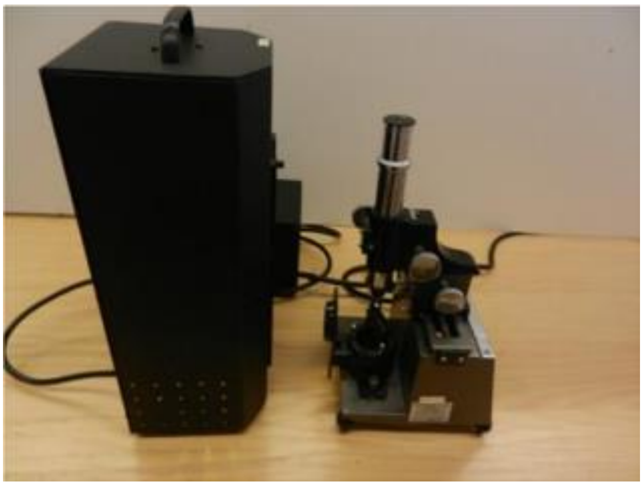
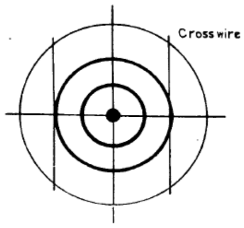


Fig. 2. Complete measurement setup.

4. Measurements plan

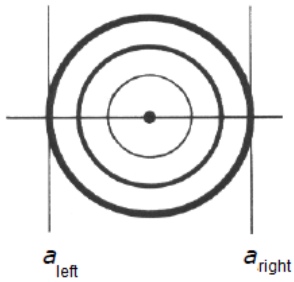
a) Turn on the sodium lamp and wait for it to heat up (approx. 15 min.). Align the beamsplitter plate in a 45° angle in the light path to illuminate the field observed in the microscope ocular.
b) Using the micrometre screws of the compound table align the microscope tube in the optical axis of the setup. The setup consist of the investigated lens, beamsplitter plate, ocular and objective of the microscope.

c) Adjust the height of the microscope tube to obtain a sharp image of Newton's rings. The brightness of the image can be corrected by adjusting the beamsplitter angle.
d) Adjust the centre of the crosswires at the centre of the rings pattern (see schematic figure below).



e) Move the microscope to the left of the chosen dark ring (select the rings of higher order – for example beginning from the 6th ring) and adjust the crosswire tangentially in the middle of it. Note down the reading of the micrometre screw $\boldsymbol{a_{left}}$ (see figure below).
Repeat 6 times.

f) Move the microscope to the right of the same dark ring and adjust the crosswire tangentially in the middle of it. Note down the reading of micrometre screw $\boldsymbol{a_{right}}$ (see figure below).
Repeat 6 times.



g) Repeat the measurements described in e) and f) for 8-10 chosen Newton's rings of higher orders. At the teacher's discretion you can decrease the number of repetitions for additional rings.

5. Analysis of results

a) Determine the radius r of each ring using the following formula:

$$r = 0.5 \cdot \left| a_{right} - a_{left} \right|$$

b) Calculate the mean value of the radius of the selected Newton's ring $\bar{r}$ using the formula:

$$\bar{r} = \frac{r_1 + r_2 + \ldots + r_6}{6}$$

c) Calculate the radius of curvature of the test lens using the following the expression:

$$R = \frac{\bar{r}^2}{k\lambda}$$

where λ=589±1 nm is the wavelength of the sodium lamp light and *k* is the number of ring. Do the same calculations for all the chosen Newton's rings.

d) Calculate the mean value of the radius of curvature of the lens $\bar{R}$ using the formula:

$$\bar{R} = \frac{R_1 + ... + R_3}{3}.$$

e) Calculate the uncertainties of all the determined quantities.

f) Plot the graph of the squares of the determined ring's radii r^2 vs the product of sodium light wavelength λ=589±1 and the number of the ring *k*. According to the formula:

$$\bar{r}^2 = R(k\lambda)$$

it should form a linear function, with the slope equal to the radius *R* of the investigated lens. Using the linear regression technique calculate the value of *R* and its uncertainty.

g) Compare the obtained values of *R* and its uncertainties between the two methods used.

6. Proposed result table (for teacher approval)

Lp.	***λ*** $\times 10^{-9}$ [m]	***u(λ)*** $\times 10^{-9}$ [m]	***k***	$\bar{r}$ $\times 10^{-3}$ [m]	***u(r)*** $\times 10^{-3}$ [m]	***R*** [m]	$u_c(R)$ [m]	$\bar{R}$ [m]	***u(R)*** [m]
1									
2									
...									