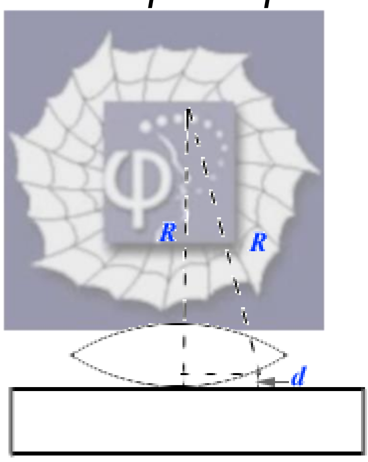
646.

Problem 45.45 (RHK)

A Newton's rings apparatus is used to determine the radius of curvature of a lens. The radii of the nth *and* (n+20)th *bright rings are measured and found to be* 0.162 cm *and* 0.368 cm, *respectively, in light of wavelength* 546 nm. *We have to calculate the radius of curvature of the lower surface of the lens.*



Solution:

We assume that fringes are formed by interference of rays reflected from the top and the bottom of the air gap between the lens and the glass plate.

Let the width of the air gap where the nth and the (n+20)th bright fringes are formed be d_n and d_{n+20},respectively.

Let the radii of the nth and (n+20)th bright fringe be r_n and r_{n+20}, respectively.

From geometry we note that

$$d_n = R - \left(R^2 - r_n^2\right)^{1/2}.$$

Assuming that R the radius of curvature of the lower surface of the lens is much bigger than r_n the radius of the nth bright fringe, that is

$$\frac{r_n}{R} = 1,$$

the approximate value of d_n will be given by

$$d_n = \frac{r_n^2}{2R} \ .$$

Similarly, we note that d_{n+20} will be approximately given by

$$d_{n+20} = \frac{r_{n+20}^2}{2R} \ .$$

Using monochromatic light of wavelength λ the condition for the mth bright fringe in the Newton's rings experimental set up is

$$2d_m = \left(m + 1/2\right)\lambda,\ m = 0,1,2,3..$$

Using the condition for bright fringe formation, we write the equation

$$\frac{r_{n+20}^2}{R} - \frac{r_n^2}{R} = 20\lambda,$$

or

$$R = \frac{\left(r_{n+20}^2 - r_n^2\right)}{20\lambda}.$$

We us the data of the problem

$r_n = 0.162$ cm, $r_{n+20} = 0.368$ cm, and $\lambda = 546$ nm,

and find that

$$R = \frac{\left(0.368^2 - 0.162^2\right)\times 10^{-4}}{20\times 546\times 10^{-9}}\ \text{m}$$

$$= 1.0\ \text{m}.$$