Newton's Rings:-

When a Plano-convex lens is placed on a plane glass plate, an air film is enclosed between the convex ~~lens~~ surface of the lens and the upper surface of the plate. When monochromatic light is allowed to fall normally on this film, a system of alternately bright and dark concentric rings are formed in the air film. These rings are called Newton's rings.

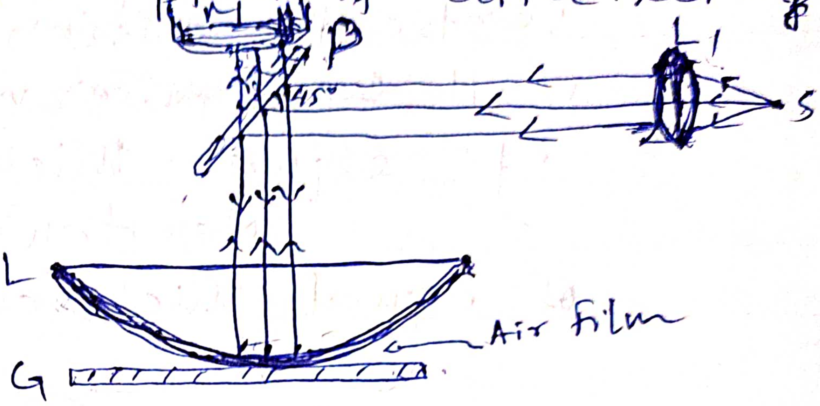

fig 1

Theory:-

Suppose AB is a plane glass plate. DFC is a plane convex lens of large radius of curvature R. The air film between the lens and the glass plate is of variable thickness.

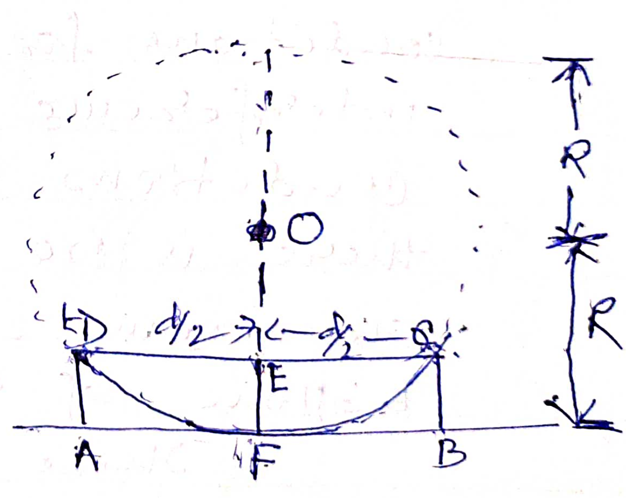

fig 2

Let $DA = EF = CB = t$

and $DC = d$.

from Geometry of the figure 2

Date :

$$(2R - EF)\,EF = DE \times EC$$

or $(2R - t)\,t = \frac{d}{2} \times \frac{d}{2}$

or $2Rt - t^2 = \frac{d^2}{4}$

$\because t^2 << 2Rt$, Then Neglecting t^2

$\therefore 2Rt = \frac{d^2}{4}$

or $t = \frac{d^2}{8R}$ ⟵ (I)

For bright ring,

$2\mu t \cos r = (2n+1)\,\lambda/2$ ⟵ (II)

$n = 0, 1, 2 \ldots$ etc.

Here for air film $\mu = 1$.

and for near normal incidence $r = 0^\circ$.

Hence $2t \cos 0^\circ = (2n+1)\,\lambda/2$

$2t \times 1 = (2n+1)\,\lambda/2$

or $2t = (2n+1)\,\lambda/2$

$\therefore t = (2n+1)\,\frac{\lambda}{4}$ ⟵ (III)

$\therefore \frac{d_n^2}{8R} = (2n+1)\,\lambda/4$

or $d_n^2 = 2(2n+1)\,\lambda R$

$\therefore d_n \propto \sqrt{2n+1}$ ⟵ (IV)

Thus, the diameter of bright ~~frin~~ rings are proportional to the square root of the odd natural numbers.

For dark rings,

$2\mu t \cos r = n\lambda$ ⟵ (V)

where $n = 0, 1, 2 \ldots$ etc

Teacher's Signature

$\mu = 1, \; r = 0^\circ$

from (V) $\quad 2t = n\lambda$

or $\quad t = n\frac{\lambda}{2}$

also from (1) $\quad t = \frac{d^2}{8R}$

$$\therefore \frac{d_n^2}{8R} = \frac{n\lambda}{2}$$

$$\text{or } d_n^2 = 4Rn\lambda$$

$$\therefore d_n \propto \sqrt{n}$$

Thus, the diameters of dark rings are proportional to the square root of natural numbers

__Determination of the wavelength of sodium light:—__

Let d_n = diameter of n^{th} bright ring

d_{n+m} = diameter of $(m+n)^{th}$ bright ring

Thus $\quad \frac{d_n^2}{4R} = (2n+1)\lambda/2$

and $\quad \frac{d^2_{n+m}}{4R} = \left\{2(n+m) + 1\right\}\lambda/2$

$$\therefore \frac{d^2_{n+m} - d_n^2}{4R} = 2m\lambda/2 = m\lambda.$$

$$\therefore \boxed{\lambda = \frac{d^2_{n+m} - d_n^2}{4Rm}} \quad \text{— (XI)}$$

This formula holds good for dark rings also.