B.Sc Physics (Hons) Part II

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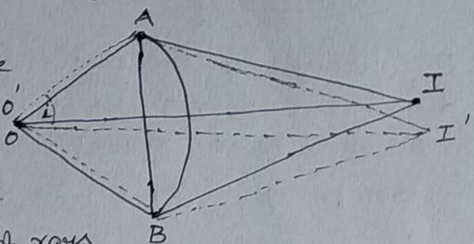
Q:- Explain and Deduce an expression for the resolving power of a Microscope.

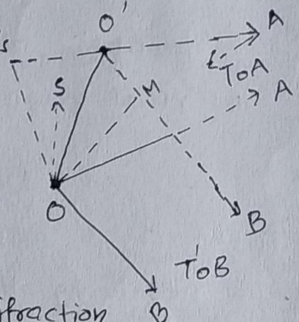
Ans:- Resolving Power of the microscope :→

It represents the ability of microscope to form distinctly seperate images of two objects lying very close togather. This is measured by the smallest distance between two point objects whose images are just resolved by the objective of the microscope. The smaller the value of distance, the higher is said to be the R.P.



Let us suppose two point object O and O' whose image are just resolved by the objective AB of the microscope. Let 'i' be the semivertex angle of the cone of rays received by the objective.

From O, the boundary of the objective works as a ciricular aperture so the images of the two point objects formed by the objective are actually Fraunhoffer diffraction patterns. Every patterns has a central bright disc sourrounded by a series of alternate dark and bright ~~fringes~~ rings. The ~~entires~~ centres of the disc ~~lake~~ A lies at I and I', the geometrical images of O and O' respectively.



Now according to Rayleigh's criterion O and O' will be just resolved when the centre I of the disc due to O falls on the first dark ring due to object O' and vice-versa.

It means that for just resolution the wave from O', after diffraction by the objective must from the first dark ring which passes through I.

Airy has indicates that it will happen when path difference between the extreme rays

O'BI − O'AI is expressed as

$$O'BI - O'AI = 1.22\lambda$$

As the paths AI and BI are same then above condition has form

$$O'B - O'A = 1.22\lambda$$

If 'S' be the distance between O and O' and are very close togather we may take O'A to be parallel to OA and O'B parallel to OB, we get

$$\cancel{O'B} = O'B - OB = O'M = S \sin i$$

$$\& \; OA - \cancel{OA} \; O'A = O'N = S \sin i$$

Thus if α is the angle subtended by distant point object x and the objective and β is the angle subtended by the feinal images at the eye. The magnifying power of the telescope is given by

$$M = \frac{\beta}{\alpha} = \frac{D}{d} \quad \text{------} \quad (1)$$

D = diameter of the objective extrance pupil

d = its diameter of exist pupil

Now when d = de (diameter is of the pupel of the eye)

∴ Magnifying power is said to be normal

$$M = \frac{D}{de} \quad \text{------} \quad (2)$$

Now the limit of resolution of the telescope is

$$\theta = \frac{1.22\lambda}{D} \quad \text{------} \quad (3)$$

and that of eye is

$$\theta' = \frac{1.22\lambda}{de} \quad \text{------} \quad (4)$$

from (4) & (3). we get

$$\frac{\theta'}{\theta} = \frac{D}{de} \quad \text{------} \quad (5)$$

So from (2) and (5)

$$\text{Normal magnifying power} = \frac{\text{limit of resolution of the unaided eye}}{\text{limit of resolution of the telescope}}$$

. Hence the product of the normal magnifying power and resolving power of the telescope is equal to the resolving power of the unaided eye.

This is required relation.