• Que. what do you understand by resolving power?

• Explain Rayleigh's criterion for the limit of resolution. obtain an expression for the resolving power of a prism.

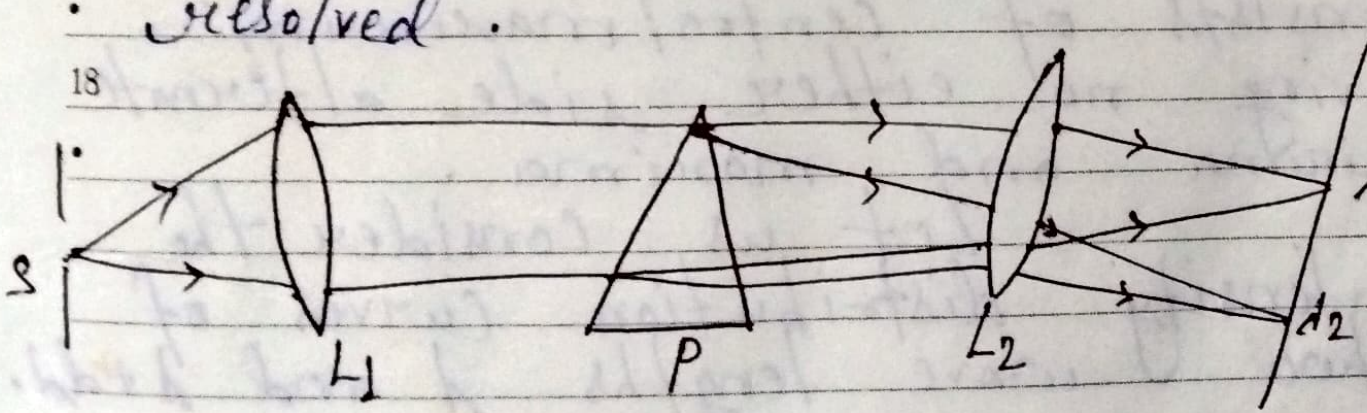
• Ans) Resolving power → The ability of an optical instrument to just resolve the images of two near by points sources. is called its resolving power.

Sunday

February 3 34th Day

Considering a simple prism spectroscope where S is narrow slit illuminated by a source which emits two closed wavelengths λ_1 and λ_2, a spectrum consisting of two lines corresponding to λ_1 and λ_2

is received in the focal plane of L.
In reality the focus of the prism
act as diffracting apertures.
So the two lines in the spectrum
are actually two fraunhoffer
pattern close together having
an intensity distribution. the two
patterns overlaps each other in
general but overlaping is only to
a little extent, the principle
maxima the two pattern are
indistinguished the line are said to
resolved. on the othehand if pattern
overlap to such extant that the
resultant intensity indicates no
drop in the middle then it is
imposible to Judge whether the
pattern corresponds to a single
line or two close line. In
such condition lines are not
resolved.



Therefore, the resolving power of such an optical instrument is defined spectral lines.

Rayleigh's criterion for resolution:→

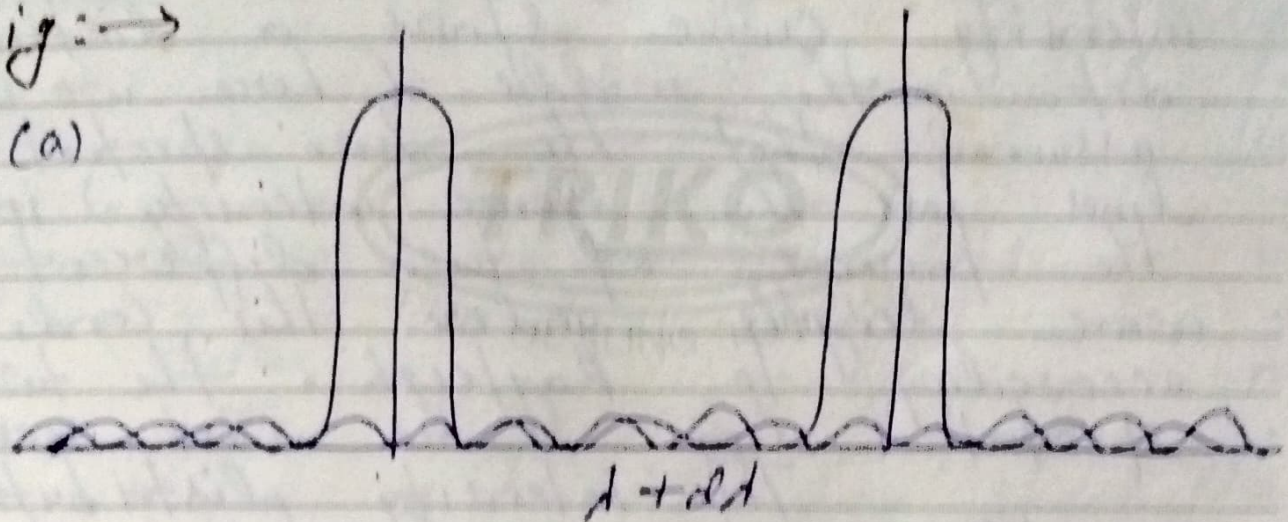
According to Lord Rayleigh's criterion the two points sources or two spectral lines of equal intensity are just resolved by an optical instrument when the central maximum of the diffraction pattern due to one fall on the first minimum of the diffraction pattern of the other.

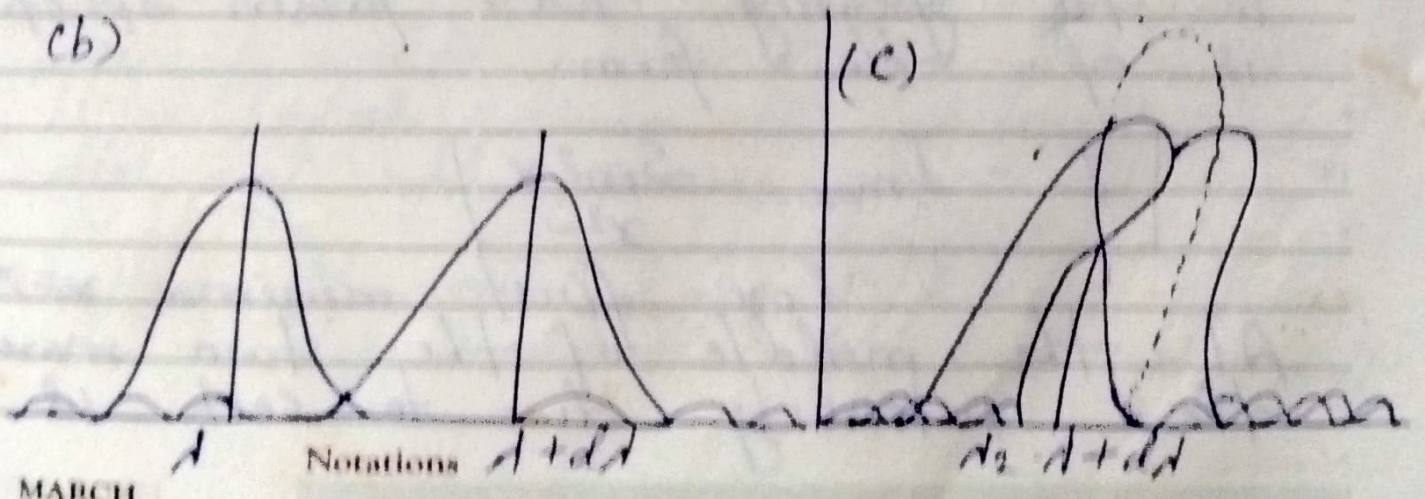
To illustrate the above criterion, consider the spectrum formed by a prism or grating. In the spectrum each lines consists of central maximum having no either side alternate minima and maxima.

Let us consider the intensity distribution curves of two wave lengths λ and $\lambda + d\lambda$.

The separation between the central maximum will depend upon the value of $d\lambda$. If $d\lambda$ is sufficiently large, the central minima due to the two wave lengths are quite seperate and the two spectral lines appear will resolved.

Fig :→





Notations

However d will have a limiting value for which the angular separation between their maxima is such that the central maxima of one coincides with the first minimum of one coincides with the first minimum of the other and vice versa.

In this case the resultant intensity curve shows a distinct dip in the middle (here we have assumed that the two spectral lines have the same intensity.) indicating the presence of two different wave lengths. under this condition, according to Rayleigh, the two spectral lines are just resolved.

The intensity distribution in the grating or prism spectra is of the form.

$$I = I_{max.} \frac{\sin^2 x}{x^2}$$

For first minima $x = \pi$.

At the middle of the two maxima, the intensity due to each is

given by, putting.

$$x = \frac{\pi}{2}$$

Hence, the total intensity at the middle at the maxima is given by,

$$I_{middle} = 2I_{max.} \frac{\sin^2 \frac{\pi}{2}}{\left(\frac{\pi}{2}\right)^2} = \frac{8}{\pi^2} I_{max.}$$

$$\therefore \frac{I_{middle}}{I_{max.}} = \frac{8}{\pi^2} = 0.81 \text{ (approx)}.$$

Thus, Rayleigh's Criterion may be stated as the two spectral lines are just resolved if the intensity at the dip in the middle is $8/\pi^2$ times the intensity at either of the maxima.

If however $d\lambda$ is smaller than the two diffraction pattern will overlap and the resultant intensity

Curve shows as if there is only one maximum. Hence, in this case the two spectral lines are not resolved.