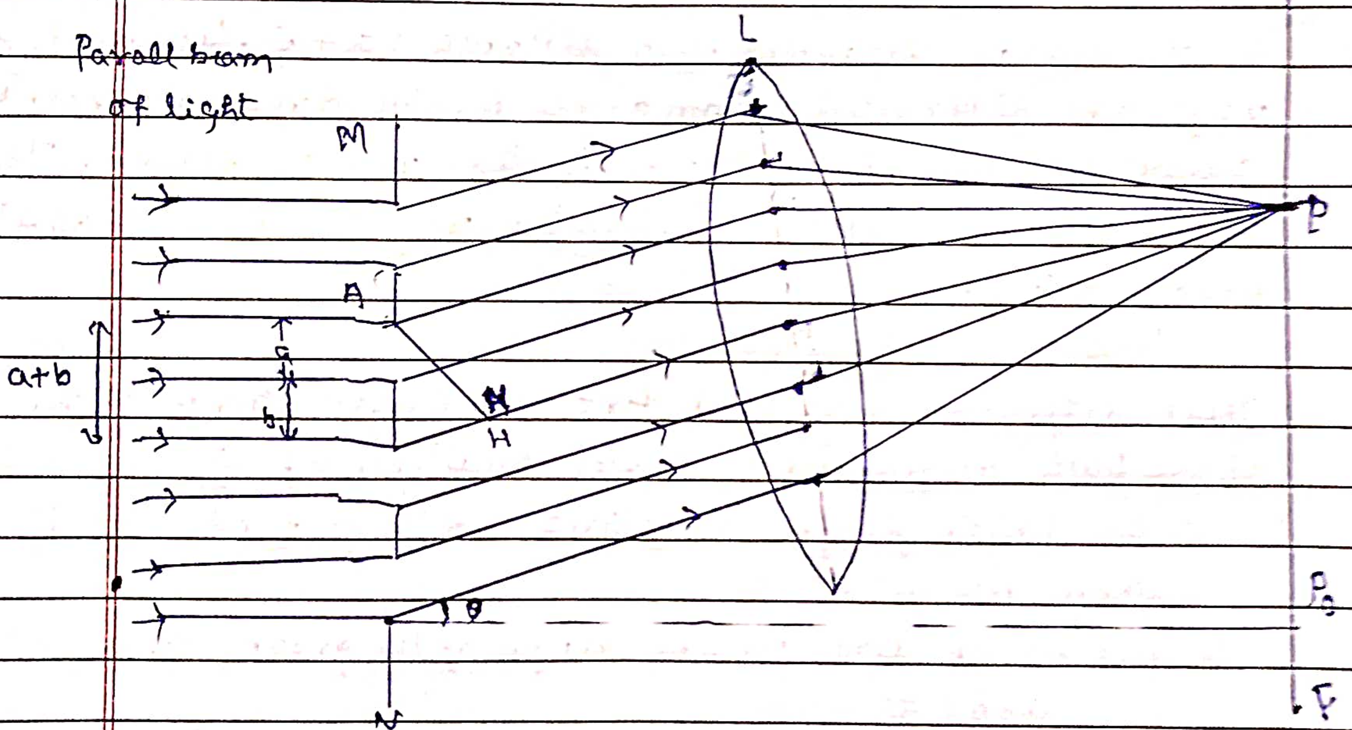
* **Plane diffraction grating :-** The phenomenon of Fraunhofer diffraction at several slits is of great importance and is used in the construction of plane diffraction grating. It is an optically plane glass plate on which a no. of equidistant parallel lines are drawn with a dimond point. The rulings are opaque to light while space between two rulings acts as a slit. Thus a no. of slits of equal width, separated by opaque portions are arranged at equal distances.



The fig shows a plane diffraction grating MN. Width of every slit is a while width of each slit acting as opaque is b. Then distance a+b = distance between two successive slits, is called the grating constant. Two consecutive points on the grating separated by this distance a+b are called corresponding points.

let a parallel beam of monochromatic light of wavelength λ fall normally on the grating. At grating these rays are deffracted which are brought to focus at a screen EF with the help of convex lens L.

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Most of the light falling on grating will proceed straight on and when focussed by L will give a point of max^m intensity called the central maximum P_0. But as the width of each slit is extremely small and can be compared to the wavelength of light, some of the light will spread out and be diffracted on leaving each slit. We can look upon each slit as giving rise to a single wavelet. With a no. of such slits we have to find the total contribution made by each slit.

The fig. shows two corresponding points A and B of the grating separated by a distance $(a+b)$. Let the light rays are diffracted at an angle θ. We draw a perpendicular AH from A on the diffracted ray as shown. The path difference between diffracted ray at A & B will be equal to BH.

$\therefore BH = (a+b)\sin\theta$.

These diffracted rays will form a bright fringe if the above path difference is even multiple of $\frac{\lambda}{2}$.

$\therefore$ For bright fringe, $(a+b)\sin\theta = 2n \cdot \frac{\lambda}{2} = n\lambda$ — (i)

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

If m = No. of lines per unit length of the grating then

$a+b = \frac{1}{m}$

From Eqn (i)

$\frac{1}{m}\sin\theta = n\lambda$

$\therefore \sin\theta = m \cdot n\lambda$ — (ii)

For $n=0$, we get central max^m at Point P_0. For $n = 1, 2, 3, \ldots$ We get first, second, third, ... orders maxima respectively.

Discussions:—

1) If $(a+b) < \lambda$ then $\sin\theta > 1$ which is not possible. Hence first order max^m will be obtained if

$(a+b) < 2\lambda$ but the second will be not obtained. Thus we get maxima of different orders, if the path difference increases by steps of $\lambda, 2\lambda, 3\lambda, \ldots$

2) If the distance between lines in large then the principal and secondary maxima are clearly visible.

3) When the distance between the lines is small, bright and narrow pricipal maxima are formed.

4) If width of the slit is less than λ then no light may be pass through and the grating will be opaque.

5) If the incident light contains two wavelengths λ_1 and λ_2 and if $\lambda_2 > \lambda_1$, light of each wavelength will give rise to its own maxima. The maximum corresponding to λ_2 for any order will be farther away from the central maximum than for λ_1.