$A^2 \propto$ Intensity

19/08/2019

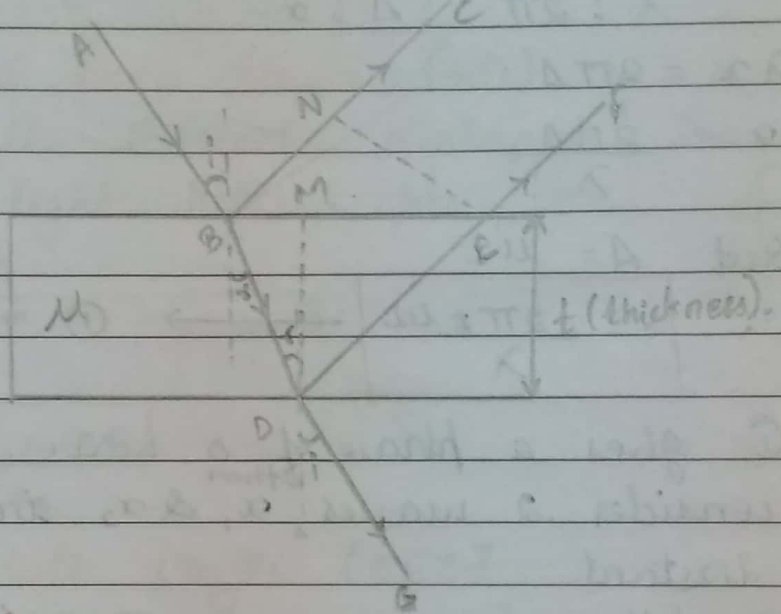
* Technique of obtaining coherent sources for interference

OR

Imp 4/5 M. Explain the two distinct methods of obtaining interference

method (a) A. Amplitude division technique.

Ex: Interference due to thin film.



Explanatn :

Consider a transperant thin film of thickness t. kept in air medium. Let refractive index of material of the film be 'μ'. A plane wave AB from a monochromatic source of light is incident on the film with an angle of incidence 'i'. Part of the wave gets reflected along BC & part of it gets refracted along BD which further gets reflected partially along DE. The wave DE gets refracted along EF.

Since the two waves BC & BDEF are derived from the same source, they must be coherent waves & can produce interference.

Path difference betⁿ the 2 waves BC & BDEF

i.e. $\delta = (BD + DF) - BN \longrightarrow ①$

From the Δ^{gle} BDM,

$\cos r = \frac{DM}{BD}$ i.e. $BD = \frac{DM}{\cos r} \longrightarrow ②$

IIIʸ from the right angled Δ^{gle} MDF.

$DE = \frac{DM}{\cos r} \longrightarrow ③$

adding ② & ③

$BD + DF = \frac{2DM}{\cos r}$.

But $DM = t$ (thickness of the film)

$\therefore BD + DF = \frac{2t}{\cos r} \longrightarrow ④$

From Δ^{gle} BNE, $\sin i = \frac{BN}{BE}$

$BN = BE \sin i$

$BN = (BM + ME)\sin i \longrightarrow ⑤$

From Δ^{gle} BMD, $\tan r = \frac{BM}{DM} = \frac{BM}{t}$.

i.e. $BM = t \tan r \longrightarrow ⑥$

From figure, $BM = ME$.

$\therefore$ from eqⁿ ⑥

$BM + ME = 2BM$.

i.e. $BE = 2t \tan r \longrightarrow ⑦$.

From eqⁿ ⑤ & ⑦,

$BN = 2t \tan r . \sin i \longrightarrow ⑧$

Sub eqⁿ ④ & ⑧ in eqⁿ ① Considering optical path we get, $\delta = \frac{2t\mu}{\cos r} - 2t \tan r \sin i$

$= \frac{2t\mu}{\cos r} - 2t \frac{\sin r}{\cos r} \sin i$

i.e $\delta = \frac{2t}{\cos r}\left[\mu - \sin r . \sin i\right] \longrightarrow (9)$

Applying Snell's law for the refract^n at the pt B

$$n_1 \sin i = \mu \sin r$$
$$1 \sin i = \mu \sin r$$
$$\text{i.e} \quad \sin i = \mu \sin r \longrightarrow (10)$$

substituting eq^n (10) in (9)
we get

$$\delta = \frac{2t}{\cos r}\left[\mu - \mu \sin^2 r\right]$$
$$= \frac{2\mu t}{\cos r}\left[1 - \sin^2 r\right]$$
$$\delta = \frac{2\mu t}{\cancel{\cos r}} \cos^{\cancel{2}} r$$
$$\delta = 2\mu t \cos r \longrightarrow (11)$$

Since a wave of light, when undergoes reflect^o while moving from rarer to denser medium, it undergoes an additional path length of $\frac{\lambda}{2}$

$\therefore$ eq^n (11) can be written as

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$$\boxed{\delta = 2\mu t \cos r - \frac{\lambda}{2}} \longrightarrow (12)$$

which gives the expression for total path difference in case of interference due to reflected light at a thin film.

case I: Condition for constructive interference.

Path difference,

$$\delta = n\lambda \quad \text{where } n = 0, 1, ---$$

from eq^n (12)

$$2\mu t \cos r - \frac{\lambda}{2} = n\lambda$$

i.e $2\mu t\cos r = n\lambda + \frac{\lambda}{2}$

$$2\mu t\cos r = \frac{2n\lambda + \lambda}{2}$$

Imp $\boxed{2\mu t\cos r = (2n+1)\frac{\lambda}{2}}$ → (13)

which is the condition for constructive interference.

Case II Conditⁿ for destructive interference

path difference,

$$\delta = (2n+1)\frac{\lambda}{2}$$

$$2\mu t\cos r - \frac{\lambda}{2} = (2n+1)\frac{\lambda}{2}$$

$$2\mu t\cos r = (2n+1)\frac{\lambda}{2} + \frac{\lambda}{2}$$

$$= (2n+1+1)\frac{\lambda}{2}$$

$$= (2n+2)\frac{\lambda}{2}$$

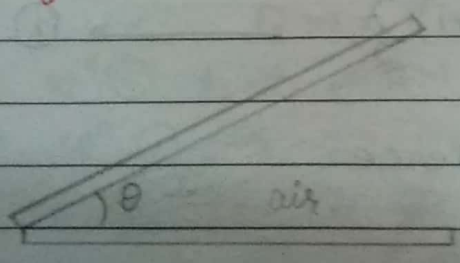
$$= \cancel{2}(n+1)\frac{\lambda}{\cancel{2}}$$

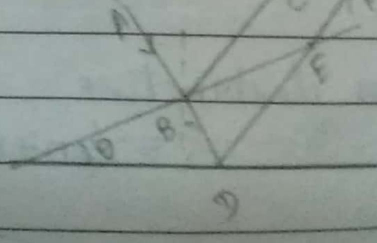
$$= (n+1)\frac{\lambda}{\cancel{2}}$$

Imp ⇒ $\boxed{2\mu t\cos r = n\lambda}$ → (14)

which is the condit^n for destructive interference.

* Interference due to an air wedge. (triangular thin film filled with air)





- Air wedge is a thin film of varying thickness having a zero thickness at one end & progresivly increasing thickness towards the other end.
- When a light wave AB is incident on the wedge it gets partially reflected along BC from the glass to air boundary at the top of the air film.
- Part of the light is transmitted through the air film & gets reflected partly at D along DE at the air to glass boundary.
- The wave DE furthur gets refracted along EF
- The two waves BC & EF are coherent as they are derived from the same wave AB, by means of amplitude division technique.
- Therefore the two waves can get interfered constructivly or destructivly depending of the path difference betn them.
- W.K.T the optical path diff. betn the two waves BC & EF is given by.

$$\delta = 2\mu t \cos r - \frac{\lambda}{2}$$

★ For constructive interference

$$\delta = n\lambda \quad , \text{ where } n = 1, 2, 3 \ldots$$

i.e $$2\mu t \cos r - \frac{\lambda}{2} = n\lambda$$

i.e $$2\mu t \cos r = n\lambda + \frac{\lambda}{2}$$

$$2\mu t \cos r = (2n+1)\frac{\lambda}{2} \longrightarrow (1)$$

★ For destructive interference

$$\delta = (2n+1)\frac{\lambda}{2}$$

i.e $$2\mu t \cos r - \frac{\lambda}{2} = (2n+1)\frac{\lambda}{2}$$

i.e. $2\mu t \cos r = (n+1)\lambda$

or in general

$$2\mu t \cos r = n\lambda \longrightarrow (2)$$

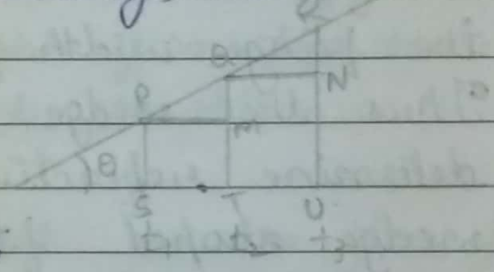
For normal incidence,

$$\cos r = 1 \quad (\because r = 0)$$

$\therefore$ eq^n (2) can be written as

$$2\mu t = n\lambda \longrightarrow (3)$$

The interference pattern consist of rectangular frings with equal distance apart through out the interfernce pattern.



Let P' be the posit^n of n^{th} dark fring at which thickness of the film is $t = t_1$

Eq^n (3) may be written as

$$2\mu t_1 = n\lambda \longrightarrow (4)$$

let the immidiate next dark fring i.e $(n+1)^{th}$ dark fringe lying at Q. where thickness of the film is $t = t_2$

Eq (3) may be written as

$$2\mu t_2 = (n+1)\lambda \longrightarrow (5)$$

subtracting (4) from (5)

$$2\mu(t_2 - t_1) = (n+1)\lambda - n\lambda$$

$$2\mu(t_2 - t_1) = \lambda \longrightarrow (6)$$

Consider Δ^{ale} MPQ,

We have $\tan\theta = \dfrac{QM}{PM}$

i.e. $QM = PM \tan\theta \longrightarrow (7)$

in eq^n (6) $t_2 - t_1 = QM$ from figure.

$\therefore$ eq^n (6) $\Longrightarrow$ $2\mu QM = \lambda$

i.e. ~~2t~~ $QM = \lambda / 2\mu \longrightarrow (8)$

from eq^n (7) & (8)

$\dfrac{\lambda}{2\mu}$ ~~t~~ $= PM \tan\theta$ or $PM = \dfrac{\lambda}{2\mu \tan\theta}$

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here $PM = \beta$, the fringe width

ie $\boxed{\beta = \frac{\lambda}{2\mu \tan\theta}} \longrightarrow (9)$

For small angle of wedge θ

$\tan\theta \simeq \theta$

$\therefore$ eqn (9) $\Longrightarrow \boxed{\beta = \frac{\lambda}{2\mu\theta}} \longrightarrow (10)$

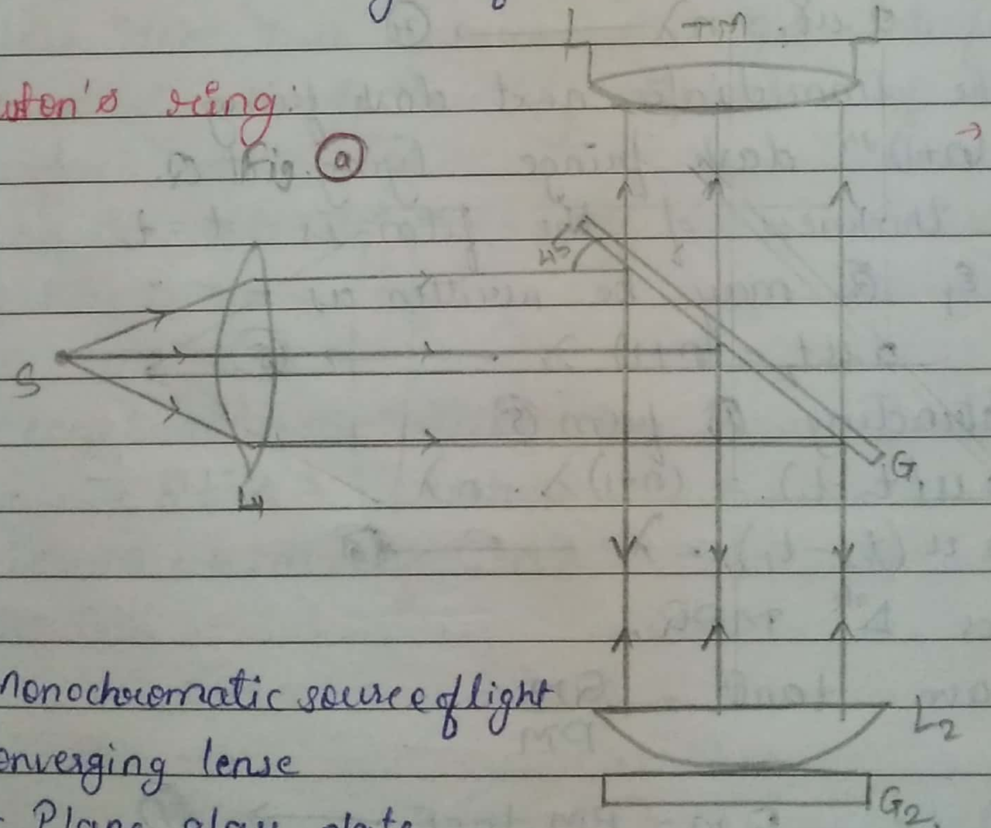
which gives the expression for fringe ~~wi~~ width. It indicates that as angle of the wedge increases the fringe width β decreases.

Thus the wedge shaped film can be used to determine refractive index of the material of the wedge shaped film or it can be used to determine wavelength of the incident line.

* Newton's ring:

fig. (a)

→ experimental setup



S - Monochromatic source of light

L_1 - Converging lense

G_1 - Plane glass plate

L_2 - Plano convex lens.

G_2 - Plane glass plate

TM - Travelling microscope.

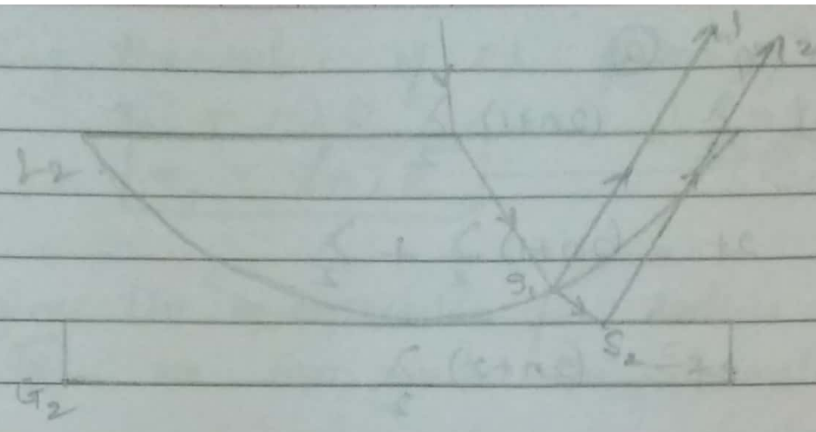


fig (b) : Origin of coherent waves

* The experiental setup is as shown in fig. a.
* A monochromatic beam of light from the source S is incident on a convex lense L_1 to obtain a ll'er beam of light.
* The beam is allowed to incident on the glass plate G_1 inclined at an angle of 45°.
* The beam after reflectn propogates vertically downwords & is incident on the air film produced betn: plano convex lense L_2 & a plane glass plate G_2
* The coherent waves are originated from top surface & bottom surface of the air film as shown in the fig (b)
* These coherent waves propogates in upword directn, pass through the glass plate G_1 & enters into TM.
* Depending upon the path diff betn the coherent waves, they interfere constructively or destructively & a concentric rings pattern is obtained. These rings are called Newton's rings

Path diff betn the coherent waves is given by

$$\delta = 2\mu t \cos r - \lambda/2 \longrightarrow (1)$$

For air film $\mu = 1$ &

for normal incidence $r = 0$

$$\therefore (1) \Rightarrow \quad \delta = 2t - \frac{\lambda}{2} \longrightarrow (2)$$

But for dark ring

$$\delta = (2n+1)\frac{\lambda}{2}$$

From eq^n (2)

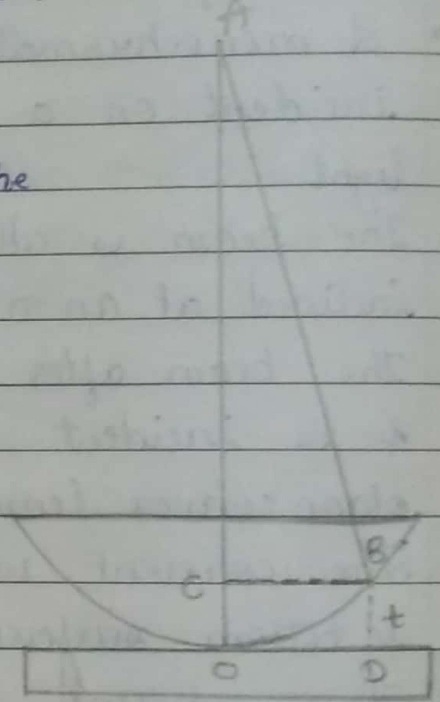
$$2t - \frac{\lambda}{2} = (2n+1)\frac{\lambda}{2}$$

$$2t = (2n+1)\frac{\lambda}{2} + \frac{\lambda}{2}$$

$$2t = (2n+2)\frac{\lambda}{2}$$

$$2t = (n+1)\lambda$$

In general $2t = n\lambda \longrightarrow$ (3)



* Consider an n^{th} dark ring located at the point 'D', at which thickness of the film is $DB = t$.
* From Δ^{gle} ACB, we can write
$AB^2 = AC^2 + BC^2$
i.e $AB^2 = (AO-OC)^2 + BC^2 \longrightarrow$ (4)
* If centre of curvature is located at pt 'A' then $AO = AB = R$ i.e. radius of curvature of the plano convex lens
* Hence eq^n (4) can be written as

$$R^2 = (R-t)^2 + BC^2$$

$$\cancel{R^2} = \cancel{R^2} + t^2 - 2Rt + BC^2$$

$$2Rt = t^2 + BC^2 \longrightarrow (5)$$

From the fig. it is clear that $OD = BC = r_n$ (i.e radius of n^{th} dark ring)

$\therefore$ (5) $\Rightarrow 2Rt = t^2 + r_n^2 \longrightarrow$ (6)

Since $2Rt >> t^2$.

as thickness of the film $t << R$ we can neglect the term t^2

$\therefore$ eq^n (6) $\Longrightarrow 2Rt = r_n^2$

i.e $r_n^2 = 2Rt \longrightarrow$ (7)

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substituting the value of 2t from eq^n (3).
we get $r_n^2 = n\lambda R$

i.e. $\boxed{r_n = \sqrt{n\lambda R}}$ $\longrightarrow$ (8)

which gives the ~~eq~~ expression for radius of n^{th} dark ring.
From eq^n (8), we can write the diameter of n^{th} ring as

$$\boxed{D_n = 2\sqrt{n\lambda R}} \longrightarrow (9)$$

Since $r_n \propto \sqrt{n}$, $\therefore D_n \propto \sqrt{n}$.

the diameter of the Newton's ring doesn't increase in the same proportion as the order of the ring. Therfore the rings gets closer as 'n' Increase
$\therefore$ The rings are not equally spaced

* Application of Newton's ring

(1) Determinat^n of wavelength of light.

Consider an 'n^{th}' dark ring, its diameter is given by, $D_n = 2\sqrt{2n\lambda R}$

By squaring

$$D_n^2 = 4n\lambda R \longrightarrow (10)$$

Consider another $(n+m)^{th}$ ring, whose diameter is given by,

$$D_{(n+m)}^2 = 4(n+m)\lambda R \longrightarrow (11)$$

Subtracting eq^n (10) from (11) we get.

$$D_{(n+m)}^2 - D_n^2 = 4n\lambda R + 4m\lambda R - 4n\lambda R$$
$$= 4m\lambda R$$

i.e. $$\boxed{\lambda = \frac{D_{(n+m)}^2 - D_n^2}{4mR}} \longrightarrow (12)$$

Thus by knowing the radius of curvature of the plano convex lense & diameter of the 2 given rings we can evaluate wavelength of the incident line

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② Determinatⁿ of refractive index of a liquid:

The liquid whose refractive index is to be determine, is troduced ~~as~~ to fill the gap betⁿ plano convex lens & plane glass plate. Therefore interference pattern obtained will be due to liquid film.

Let 'μ' be the R.I. of the liquid, then the condition for dark ring can be written as,

$$2\mu t \cos r = n\lambda$$

For normal incident $r=0$ & $\cos r = 1$

$$\therefore 2\mu t = n\lambda.$$

$\therefore$ diameter of n^{th} ~~film~~ ring is given by.

$$D_{nL}^2 = \frac{4n\lambda R}{\mu} \longrightarrow (13)$$

Now,

Consider another $(n+m)^{th}$ ring for which diameter of the dark ring is given by,

$$D_{(n+m)L}^2 = \frac{4(n+m)\lambda R}{\mu} \longrightarrow (14)$$

Subtracting eqⁿ (13) from (14)

we get.

$$D_{(n+m)L}^2 - D_{nL}^2 = \frac{4m\lambda R}{\mu}.$$

i.e. $$\boxed{\mu = \frac{4m\lambda R}{(D_{(n+m)L}^2 - D_{nL}^2)}} \longrightarrow (15)$$

By knowing radius of curvature of plano convex lens & diameters of two rings we can calculate R.I. of the liquid.

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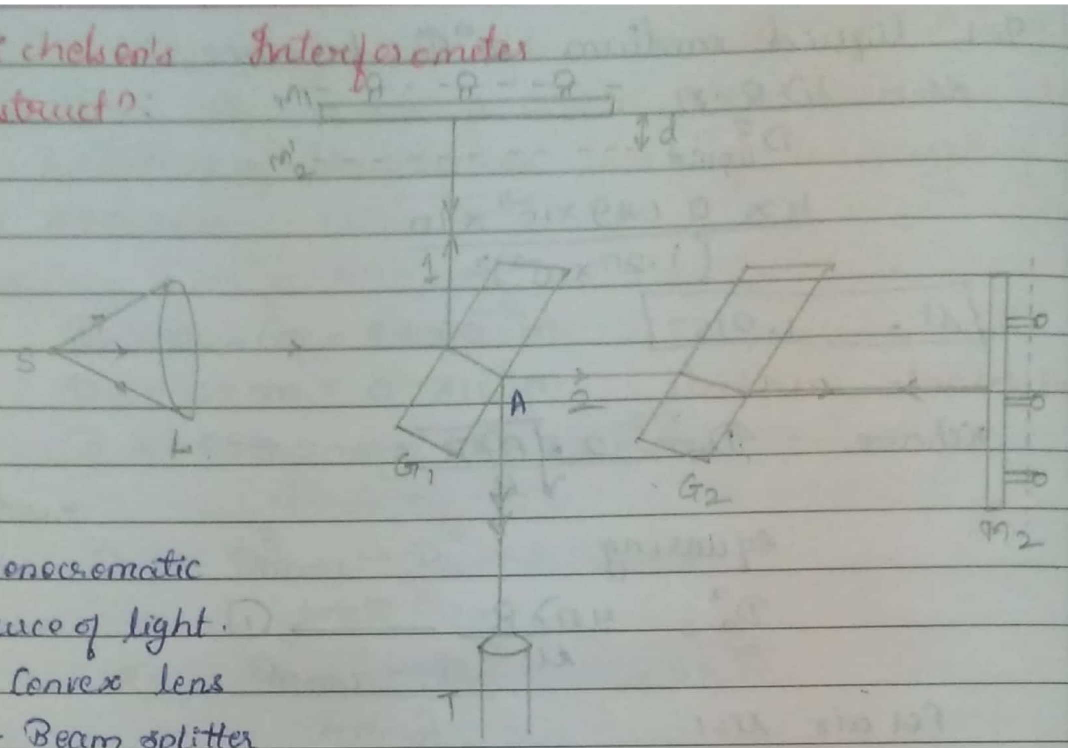
Michelson's Interferometer

• Construction:



S - Monochromatic source of light.
L - Convex lens
G_1 - Beam splitter
G_2 - Compensator
M_1 & M_2 → Plane mirror
T - Telescope
M_2' - Virtual image of mirror M_2
d - distance betn the mirror M_1 & virtual image M_2'

* It consists of a monochromatic source 'S', converging lense 'L', a beam splitter G_1, A compensating plate G_2 & two plane mirror M_1 & M_2. The beam splitter is partially silvered plane glass plate, which can transmite the light partially & reflects the rest.
• G_2 being a plane glass plate has the thickness same as that of G_1
* G_1 & G_2 are held $\parallel^{ler}$ to each other but inclined at an angle of $45°$ with respect to the mirror M_2
* The mirror M_1 & M_2 can be set $\perp^{ler}$ to each other with the help of the screw provided at their back. the interference pattern is observed in Telescope

• Working

* A monochromatic beam of light is allowed to incident on the beam splitter G_1.
* It is partially reflected at the back surface of G_1 along AM_1 & partially tramitted along AM_2.
* The beam AM_1 gets reflected back along the same path & enters the telescope T.
* The beam AM_2 gets reflected back along the same path along M_2 to A & undergoes reflectⁿ once again by G_1 & enters the telescope 'T'.
* Since these two beams are produced from a single source through division of amplitude & hence are cohherent.
* It is clear that the beam 1 undergoing reflectⁿ at G_1 passes the glass plate G_1 two times.
* Therefore ~~two~~ compensate the path of the beam ~~two~~ the glass plate G_2 is used
* Now the optical path of the wave 1 is given by

$$P_1 = 2AM_1 + \frac{\lambda}{2} + \frac{\lambda}{2} \longrightarrow (1).$$

IIly optical path of the wave 2 is given by.

$$P_2 = 2AM_2 + \frac{\lambda}{2} + \frac{\lambda}{2} \longrightarrow (2).$$

subtracting eqⁿ (2) from (1)

we get the path diff betn the waves 1 & 2 as

$$\delta = P_1 - P_2$$

$$\delta = 2(AM_1 - AM_2) \longrightarrow (3).$$

Since M_2' the vertual image of mirror M_2 at the same distance as M_2 from the pt 'A'. Therefore

$$AM_2 = AM_2'$$

$$eq^n (3) \Rightarrow \delta = 2(AM_1 - AM_2') \longrightarrow (4)$$

From the fig. it is clear that

$$AM_1 - AM_2' = d \longrightarrow (a)$$

$\therefore \ \delta = 2d \longrightarrow (5)$

* The effect is same as the interference due to thin film of thickness 'd.'
* If we observe the system at an angle θ the path diff betn the 2 waves will be

$$\delta = 2d\cos\theta \longrightarrow (6)$$

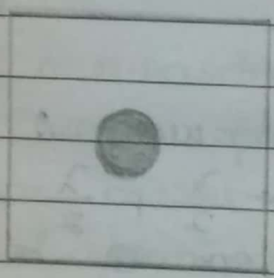
* Since the waves 2 undergoes reflectn from denser medium at G, it coverse an additional path of $\frac{\lambda}{2}$

$\therefore$ The total path diff betn the two waves (1) & (2).

$$\boxed{\delta = 2d\cos\theta + \frac{\lambda}{2}} \longrightarrow (7)$$

For the given values of d, λ & θ, the interference ~~case i)~~ fringes are obtained to be in circular shape

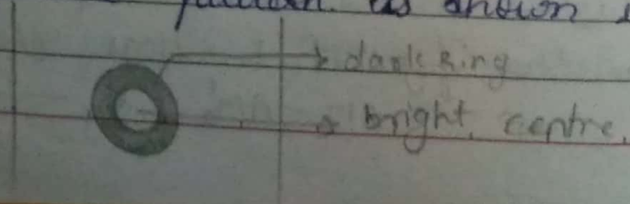
case(i) : If M_2' coinsides with M_1, then 'd' $= 0$. This leads to the additional path diff of zero. In otherwords total path diff $\delta = \frac{\lambda}{2}$. this leads to the destructive interference & therefore centre of the ~~filt.~~ field of view will be dark as shown below:



case(ii) : If one of the mirrors is moved through a distance of $\frac{\lambda}{4}$, the path changes by $\frac{\lambda}{2}$ & leads to the total path diff of,

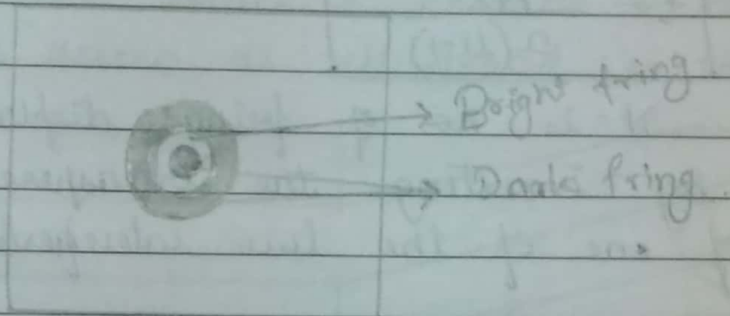
$$\delta = \frac{\lambda}{2} + \frac{\lambda}{2} = \lambda. \rightarrow \text{constructive}$$

This leads to the constructive interference at the centre of the interference pattern as shown in the fig



case(2) : By moving mirror through by another dist $\frac{\lambda}{4}$ dist, the total path diff is raised to be

$$\delta = \lambda + \frac{\lambda}{2} = \frac{3\lambda}{2}$$ which corresponds to destructive interference & again dark spot is obtained at the centre by displacing the bright fring outwards as shown in fig.



Thus as 'd' increase the new ring appear at the centre & the field becomes more crowded with thiner rings.

* Applicatn of Michelsons Interferometer

① To determine the wavelength of incident light.

The monochromatic source of light whose wavelength is to be determine is kept at the postion S.

* The wavelength of the light can be calculated by using the eqn

$$\lambda = \frac{2(d_2 - d_1)}{N}$$ where N is the no. of frings disappearing at the centre of the field of views, when one of the mirror is moved to change the dist appart from d_1 to d_2.

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(2) To determine the difference betn the wavelengths of two waves.

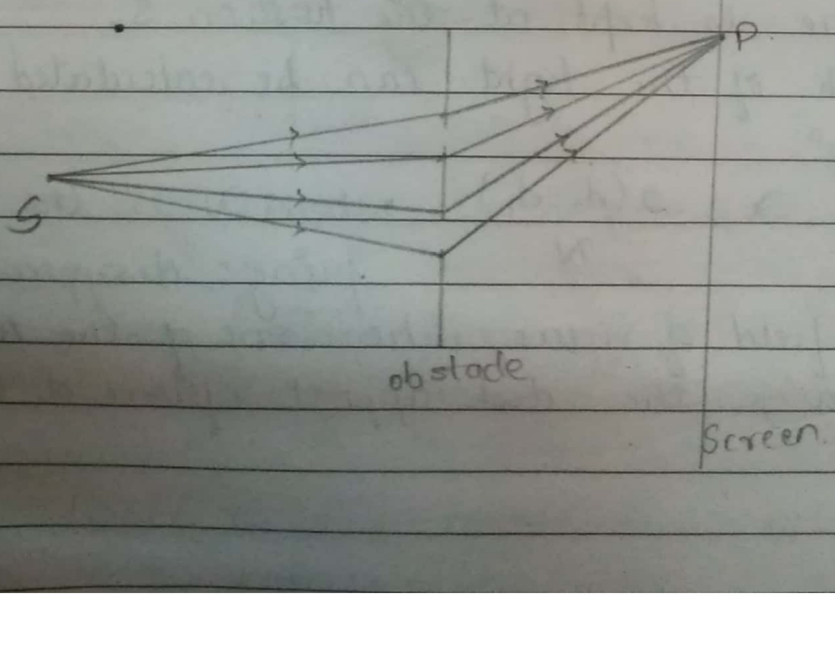
It can be calculated by using the relation
$\Delta\lambda = \frac{\lambda^2}{2d}$ where λ is mean wavelength

(3) Measurement of thickness of a thin transperent sheet
It can be calculated by using the relⁿ.

$$\boxed{t = \frac{N\lambda}{2(\mu-1)}}$$

where - N - is no of frings displaced in the field of view by inserting the transperent sheet in the path of one of the two intereffering beams.

* Diffractⁿ : There are two types of diffractⁿ.
1) Fresnel diffractⁿ: In this types of diffractⁿ source of light & the screen are effectivly at finite distances from the obstacle.
* Spherical wavefronts or Cylinderical wavefronts are employed to obtain the diffractⁿ pattern in this case. The fig A shown below elustrates the Fresnel diffractⁿ.



② Fraunhoffer diffractⁿ

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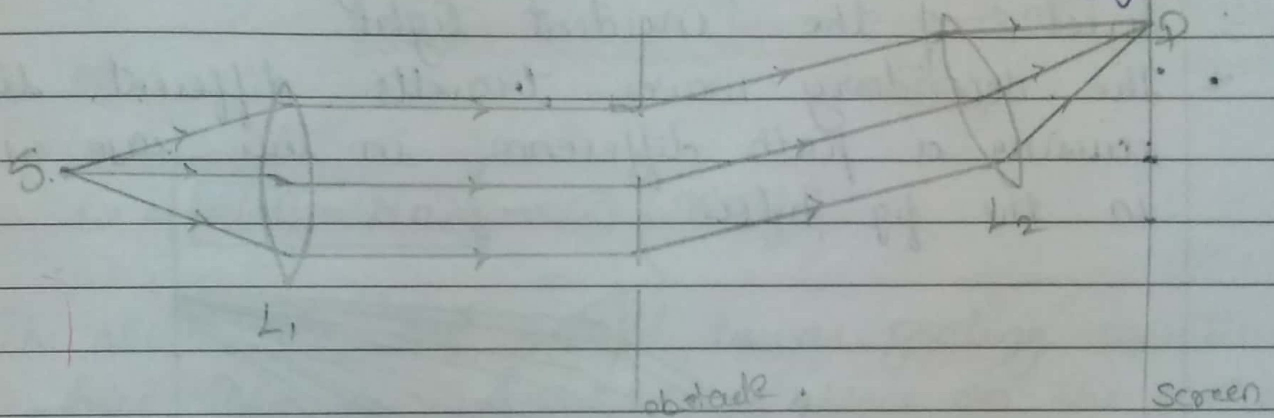
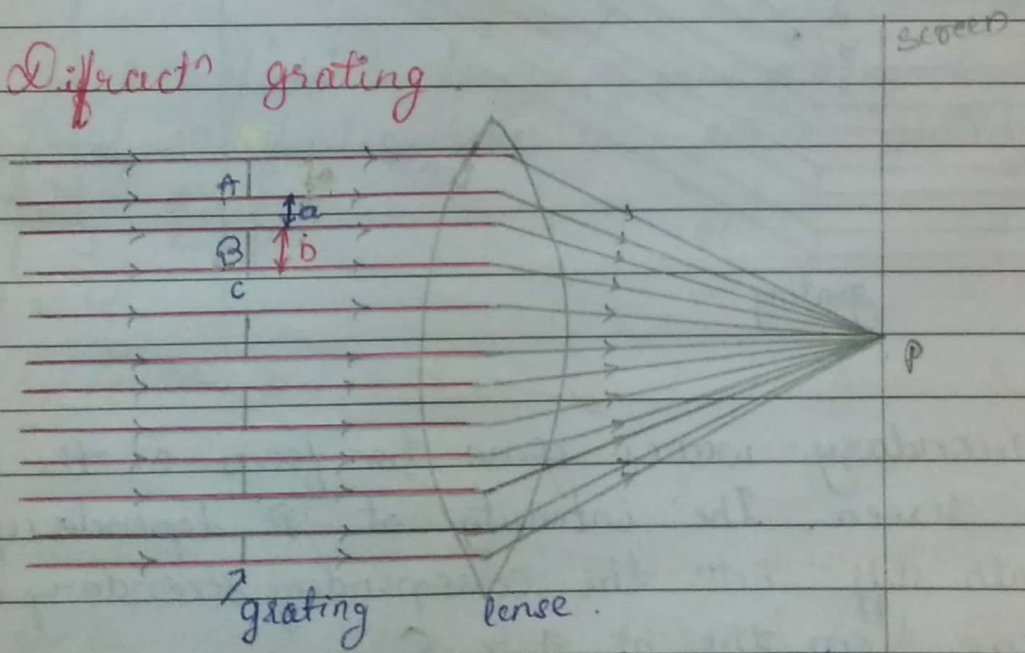
In this type of diffractⁿ source of light & the screen are effectively kept at infinite distances from the obstacle.

* Plane wavefronts are employed to obtain the diffractⁿ pattern in this case.
* Two convex lenses are used to meet the above condition, one betⁿ source & obstacle & the other betⁿ obstacle & the screen as illustrated in the fig. below.

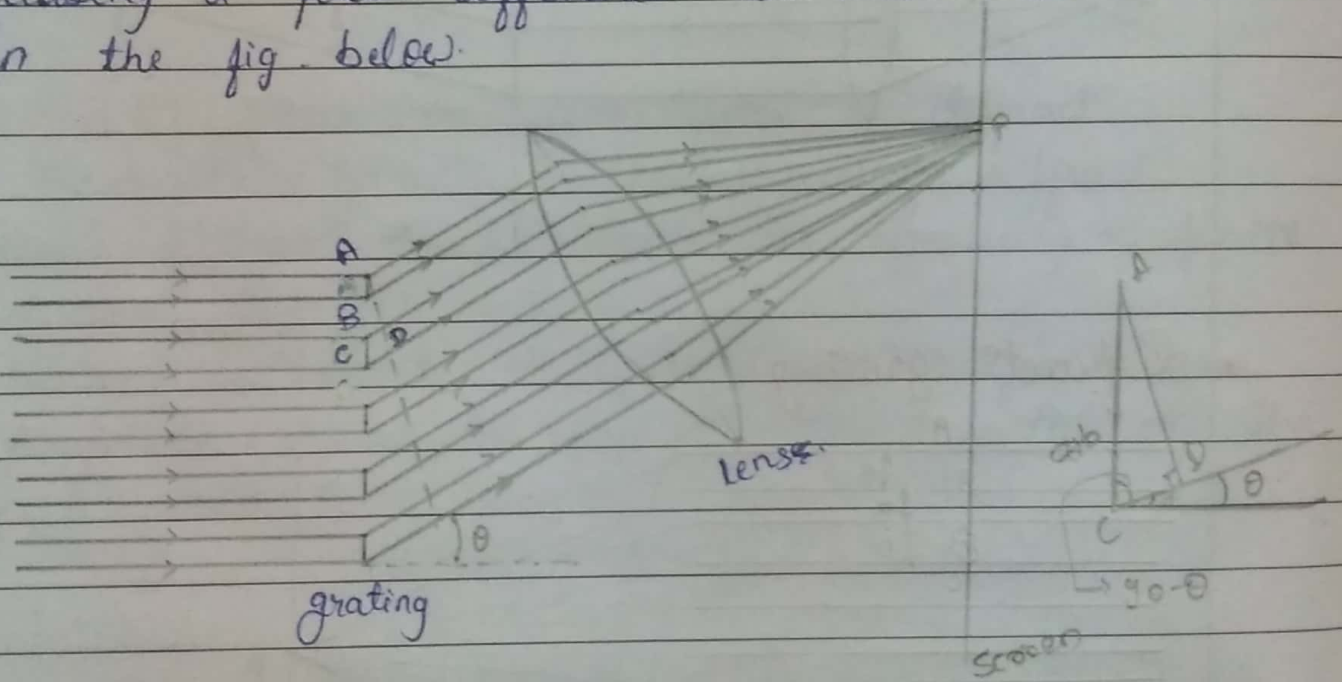


* Diffractⁿ grating



* Consider a ~~grate~~ transmission grating in which a width of a transparent sheet. AB = a & width of an opacity B.
* The distance a+b=d is called grating constant or grating element. It is also called grating period.

* When a parallel beam of monochromatic light is incident normaly on the grating surface, the secondary waves travelling in the same directⁿ come to focus at the pt 'P' on the screen. The pt P corresponds to the positⁿ of central maximum.
* Now consider the secondary waves travelling in a directⁿ inclined at an angle θ with the directⁿ of the incident light.
* The secondary waves travells different distanes causing a path difference in this case as shown in the fig below.



* The secondary waves come to focus at the pt 'P' on the screen. The intensity at 'P' depends upon the path diff betⁿ the corresponding secondary waves originating from the pt A & C.
* It is clear than path diff betⁿ the corresponding waves $\delta = CD \longrightarrow$ (1)

From Δ^{le} ACD

$\sin\theta = \frac{CD}{AC}$ But $AC = a+b = d$.

i.e $a+b = d$ (the grating const.

& $CD = \delta$ (path diff)

$\therefore \sin\theta = \frac{\delta}{(a+b)}$

i.e $\boxed{\delta = (a+b)\sin\theta} \longrightarrow$ ②.

The pt 'P' corresponds to the max. intensity of
constructive Interference
the path diff $\delta = n\lambda \longrightarrow$ ③

$\therefore$ from eq^n ② & ③

$$a+b = n\lambda.$$

in general $(a+b)\sin\theta_n = n\lambda \longrightarrow$ ④.

which can also be written as

$\boxed{d \sin\theta_n = n\lambda} \longrightarrow$ ⑤ d-grating const.

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Or

$\sin\theta_n = \frac{1}{d} n\lambda.$

i.e. $\boxed{\sin\theta_n = N n\lambda} \rightarrow$ ⑥ $\left(N = \frac{1}{d}\right)$

The above eq^n's are refered to as grating equations.

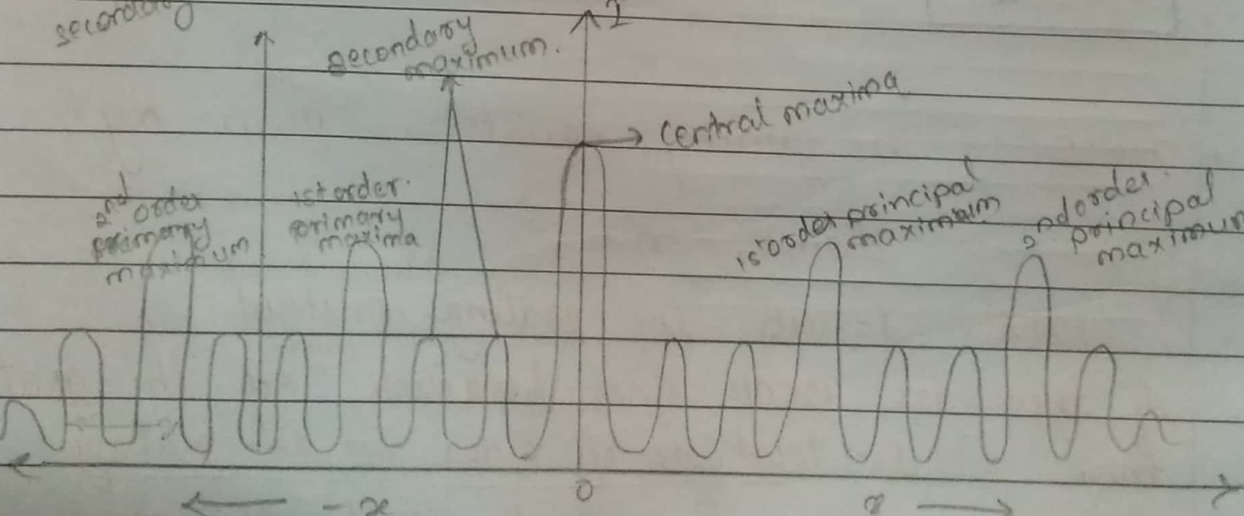
$\because$ here $N = \frac{1}{d}$ referes to no of lines on the grating per unit length.

The intensity distribution of the diffraction pattern by a grating 'n' no of slits is given by

$$\boxed{I = I_0\left(\frac{\sin^2\alpha}{\alpha^2}\right)\cdot\frac{\sin^2 N\gamma}{\sin^2\gamma}}$$

where $\gamma = \frac{\pi d \sin\theta}{\lambda}$.

- the expression for the intensity consists of 2 terms
  $I_0\left(\frac{\sin^2\alpha}{\alpha^2}\right) \longrightarrow$ which represents the intensity distribution due to a single slit diffraction.
- And the 2nd term,
  $\left(\frac{\sin^2 N\gamma}{\sin^2\gamma}\right) \rightarrow$ represents the intensity distribution due to the diffraction by 'N' no of equally spaced slits.
- The resultant intensity distribution is as shown in the following figure.



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* Resolving Power

An ability of an optical instrument to produce distinctly seperate images of two objects located very close to each other is called its resolving power

- It is given by the reciprocal of the smallest angle subtended at the objective by two pt objects which can just be distinguish seperate

V.V. Imp

Expression for resolving power of a grating

The spectral resolving power of a grating is given by

$$RP = \frac{\lambda}{d\lambda} \longrightarrow ①$$

where λ is average wavelengths of two spectral lines

- $d\lambda$ is the difference betn the wavelengths or spectral ~~wavelengths~~ interval

eqn ① can be modified as follows

$$RP = \frac{\lambda}{d\theta} \cdot \frac{d\theta}{d\lambda} \longrightarrow ②$$

the grating eqn is given by

$d \sin\theta_n = n\lambda \quad d = a+b$

$$(a+b)\sin\theta = n\lambda \longrightarrow ③$$

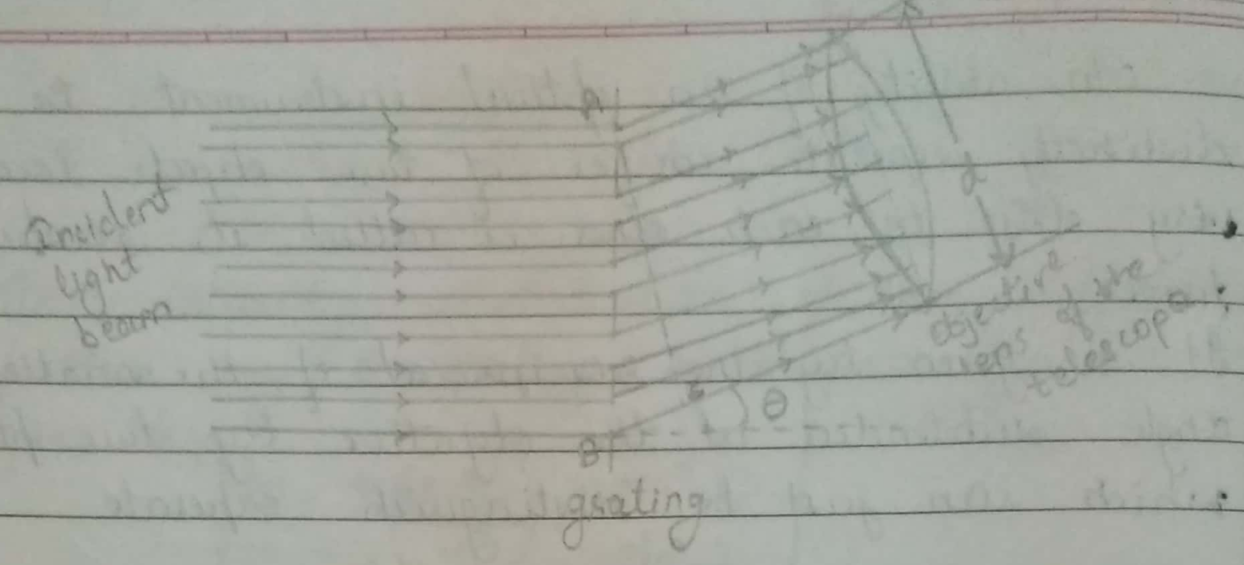
diff eqn ③ ~~wrt~~ totally

$$(a+b)\cos\theta \cdot d\theta = n \cdot d\lambda$$

i.e $$\frac{d\theta}{d\lambda} = \frac{n}{(a+b)\cos\theta} \longrightarrow ④$$

Consider a telescope objective capturing the beam refracted by a grating at an angle of θ' with the directn of the incident beam as shown in fig below.

Scanned with CamScanner



The angular limit of resolution of a telescope objective is given by.

Imp formula $$\boxed{d\theta = \frac{\lambda}{d}} \longrightarrow (5)$$

where $d \rightarrow$ diameter of the objective lense.
From the geometry of the figure, its clear from the $\triangle^{gle}$ ACB that

$$\cos\theta = \frac{AC}{AB} = \frac{d}{AB}$$

$$d = AB\cos\theta$$

Let 'L' be the length of the grating.
i.e. $AB = L$.

$$\therefore \quad d = L\cos\theta \longrightarrow (6).$$

eq^n (5) may be written as.

$$d\theta = \frac{\lambda}{L\cos\theta} \longrightarrow (7)(a)$$

$$\underline{or} \quad \frac{\lambda}{d\theta} = L\cos\theta \quad (7b)$$

substituting eq (4) & (7b) in eq^n (2)
we get

$$R.P = \cancel{L\cos\theta}\cdot\frac{n}{(a+b)\cancel{\cos\theta}}$$

$$\boxed{R.P = \frac{Ln}{(a+b)}} \longrightarrow (8a)$$

Since $\frac{L}{(a+b)} = N$, the total no of lines on the grating

eq^n (8a) may be written as

$$RP = nN \longrightarrow (8b)$$

which gives the expression for resolving power of the grating.