$$\delta = \frac{\lambda}{2} + \left(\frac{\lambda}{4} + \frac{\lambda}{4}\right) + \left(\frac{\lambda}{4} + \frac{\lambda}{4}\right)$$
$$= \frac{\lambda}{2} + \frac{\lambda}{2} + \frac{\lambda}{2}$$
$$\delta = \frac{3\lambda}{2}$$
which results into dark fringe

Resolving power (RP)

The ability of an optical inst-rument to produce distinctly separate images of two objects located very close to each other is called its Resolving power.

The RP of two separated lines very close to each other is given by

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

λ = avg. wavelength of the 2 separated lines.

$d\lambda$ = separation of wavelengths of the separted lines

Expression for RP of a grating

The spectral RP of a grating is given by

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

where $d\lambda$ = wavelength interval b/w

A device consisting of a large number of parallel slits of equal width (a) separated from one another by equal opaque spaces is called diffraction grating.

distance b/w the centers of the adj slits → grating period.

the two spectral lines.

$\lambda \Rightarrow$ avg. wavelength of the spectral lines.

eq (1) can be written as

$$RP = \frac{\lambda}{d\theta} \frac{d\theta}{d\lambda} \rightarrow (2)$$

wher $d\theta \Rightarrow$ angular separation

diffraction grating eq^n is given by

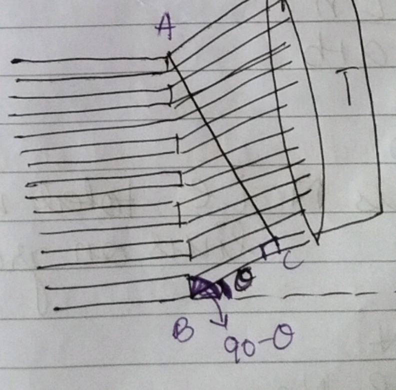
$$(a+b) \sin\theta = n\lambda \rightarrow (3)$$

diff. ~~this~~ (3) eq^n totally we get,

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

i.e. $$\frac{d\theta}{d\lambda} = \frac{n}{(a+b)\cos\theta} \rightarrow 3b$$

consider a telescope objective captur-ing the beam refracted ~~diffracted~~ ~~by~~ say ~~the~~ grating at an angle of 'θ' with dir^n of the incident beam as shown in following figure.



Here diameter (width) $AC = D$ of telescope objective

AB = length of the grating

$AB = L$

$x + 90 - \theta + 90 = 180 \quad \therefore \quad x = \theta$

from the right angled ~~tri~~ Δle ACB

$$\cos\theta = \frac{AC}{AB} = \frac{D}{L}$$

$$\therefore D = L\cos\theta \rightarrow (4)$$

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

$$d\theta = \frac{\lambda}{D} \rightarrow (5)$$

(4) in (5) we get

$$d\theta = \frac{\lambda}{L\cos\theta} \quad \text{or} \quad \frac{\lambda}{d\theta} = L\cos\theta \rightarrow (6)$$

putting eq^n 3b & eq (6) in eq (2)

$$RP = L\cos\theta \cdot \frac{n}{(a+b)\cos\theta}$$

$$= \frac{Ln}{a+b}$$

$$RP = \frac{Ln}{a+b}$$

But $\frac{L}{a+b}$ is N i.e. total no. of lines on grating

$\therefore$ ~~$RP = LN$~~

$\therefore RP = Nn$