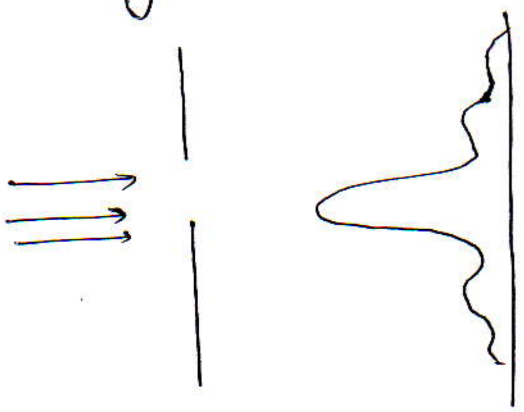
<u>Diffraction</u> - It is <u>bending</u> (or <u>spreading</u>) of light around a corner (hole) if the <u>dimension of</u> the hole is of the <u>order of wavelength</u> of light.

Generally we always observe the diffraction of sound around a building but not of light waves. It is because the wavelength of sound is comparable to the dimension of the object (wall etc) but diffraction of light is possible only when the dimension of the diffracting object is close to the wavelength of light.

<u>Single slit Diffraction:</u>



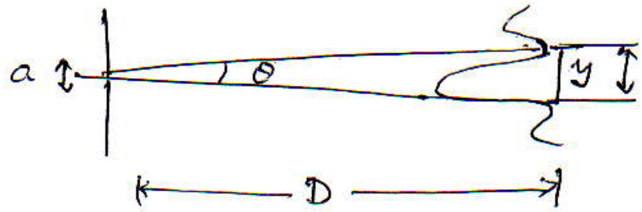
<u>Points to NOTE</u>: In the single slit diffraction exp. both interference & diffraction is taking place but historically it is termed as diffraction.

The only way it differs from Youngs double slit Interference is, there the hole was so narrow such that only single ray of light can pass but here the slit has a finite width such that many rays can pass through. The expression for the minima is done by dividing the slit into many ... such that the first ray undergoes destructive interference with the last ray and the condition of minima becoms.

$$\boxed{a \sin\theta = m\lambda} \quad \text{(Condition for minima)}$$

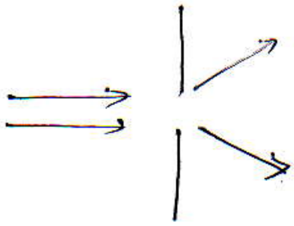
a = Slit width

θ = angle That is formed between the slit & minima



$$\sin\theta \approx \tan\theta = \frac{y}{D}.$$

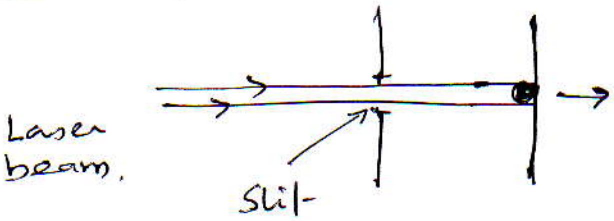
- Another point to note is That the diffraction occurs perpendicular to the length of the slit



~~bcid~~ The slit is into The page. The light is diffracted $\perp$ to the slit.

These are the few important points about Diffraction.

* If There is no diffraction how will the pattern look like.



→ one bright Spot

But because of diffraction and interference you see a fringe pattern, the intensity distribution is as shown above ⇒

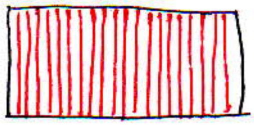
* What is the main Diff bet-
Fraunhofer Diffraction – |||
Fresnel Diffraction –)))).

Grating.

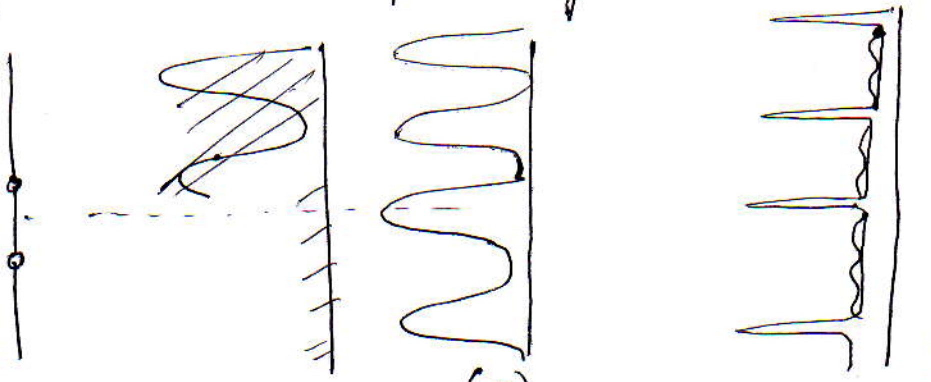
A grating (as you have seen) is a glass plate where large number of closely spaced lines are etched such that they act as a slit (or the space between the slit act as a slit)

So there are two important point.

- A large number of very closely spaced lines.
- Slit width is very narrow.

Grating→ 

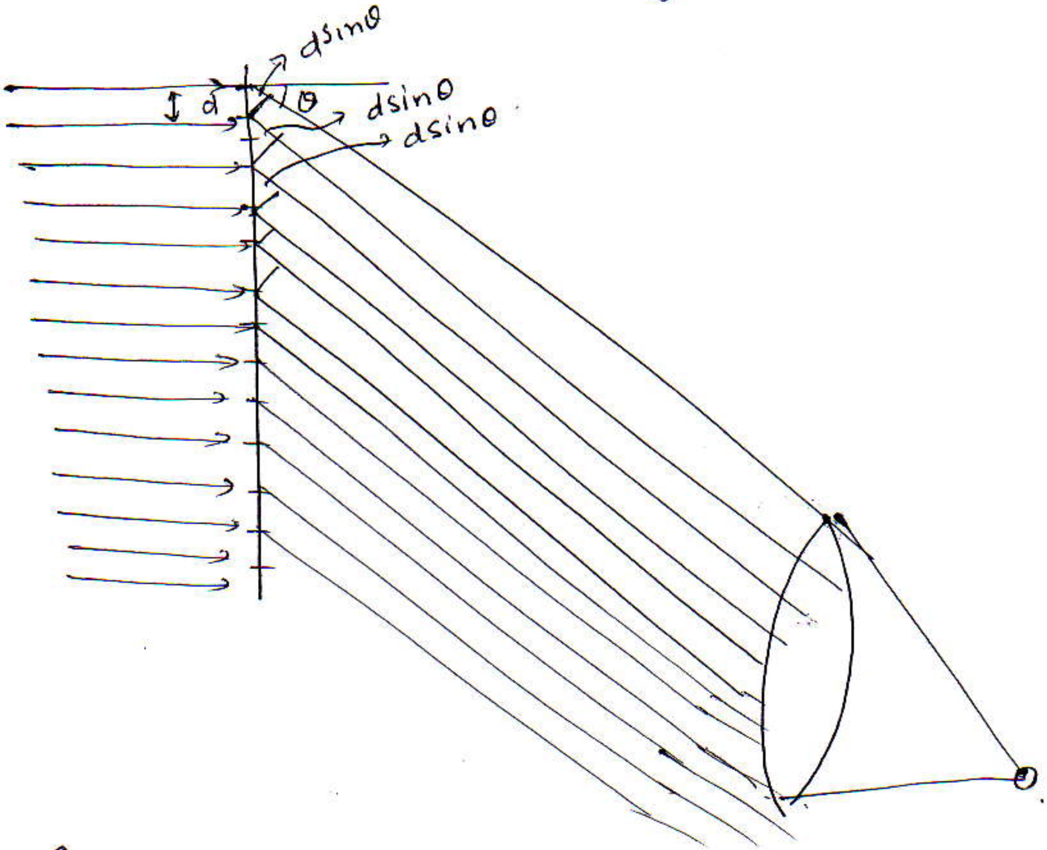
Now this reminds us of Youngs Double Slit Exp. where slits ~~are~~ (or holes) are very narrow. Let us draw the intensity distribution of Youngs Double Slit exp. (a)



(a) (b)

Basically one gets dark and bright bands of equal intensity. Now if the slits are increased from 2 to 20 then what will happen? The main thing that will happen is these patterns will get narrower (b). That means the resolving power has increased (How?)

If a particular beam of light consist of more than one wavelength and they are very close to each other then the maxima of one will overlap with the maxima of other. So one cannot resolve them. If I want to resolve them I would like to have 2 separate peaks. Which happens in the second case. This is the use of a grating. Let us see how it works by very simplistic treatment.



Suppose we take one particular angle & draw the parallel rays which are diffracted by those slit. The path diff between 2 parallel rays is $d\sin\theta$.

Now when $\boxed{d\sin\theta = m\lambda}$ then it is maxima.

When $m = 1$ that is first order. If we increase the angle after sometime $d\sin\theta = 2\lambda$ then again maxima will occur

So suppose if I take the first order

$$d \sin\theta = \lambda .$$

then if I know d and Calculate θ from the experiment. λ of the light can be calculated.

So gratings are used to measure the wavelength of light. (V Imp)

Suppose I want to measure two wavelength which are very close to each other λ_1 and λ_2. Can I resolve them using a grating which has certain number of lins say 300 lins/mm.

Resolving power of a Grating is

$$R = \frac{\lambda}{\Delta\lambda} = m.N.$$

λ = average of two wavelength $= (\lambda_1+\lambda_2)/2$

$\Delta\lambda$ = Wavelength difference $= \lambda_1 - \lambda_2$

N = Total No of Slit

m = order.

Gratings Can be of many typs

- Transmission Grating (the one in our lab)
- Reflection Grating.

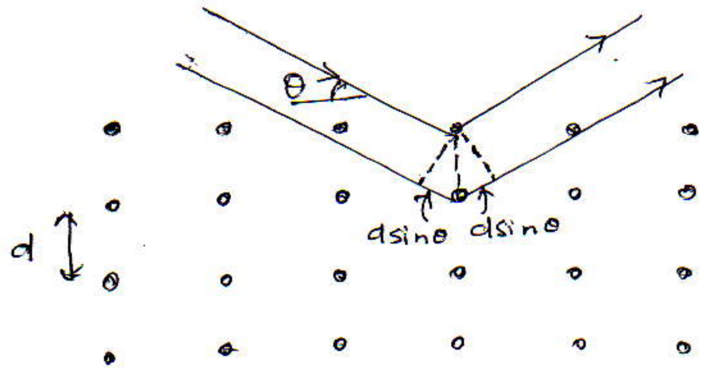
Crystal Grating.

What is a Crystal Grating.?

The grating equation is

$$d \sin\theta = m\lambda.$$

Now in Case of X rays when λ is very small $\sin\theta$ is also very small and it is difficult to measure. So it is necessary to decrease d. But after a certain limit it is not possible to decrease d. So at that time a crystal is used as a grating. ~~and~~ These atoms can be visualized as being arranged in planes with characteristic interplanar spacing d which diffract light



The Total path difference between two rays ~~reflected from~~ Diffracted by two atoms (or lattice points) ~~are~~ is $2d\sin\theta$.

When $\boxed{2d \sin\theta = n\lambda}$ maxima. (Constructive Interference)

This is known as Bragg's Law.