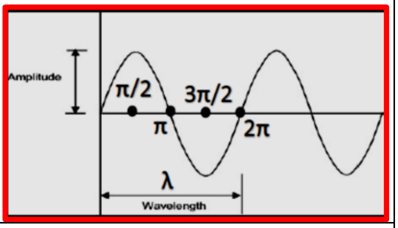
Effect on the interference fringes in a Young's double-slit experiment due to each of the following operations	
The screen is moved away from the plane of the slits	Since β = Dλ/d, as D increases, β also increases proportionately meaning the actual distance between (bright or dark) fringes increases in proportion to the distance of the screen from the plane of the slits. ➢ The angular separation (=λ/d) of the fringes remains constant.
Monochromatic source is replaced by another monochromatic source of shorter λ.	**Fringe width β = Dλ/d and the angular separation = λ/d** ∴ Fringe width β decreases and angular separation also decreases.
The separation between the two slits is increased	**Fringe width β = Dλ/d and the angular separation = λ/d (d is the separation between the two slits)** Fringe width β decreases and angular separation also decreases.
Source slit is moved closer to the double-slit plane	Let s be size of the source and S its distance from the plane of the two slits. For interference fringes to be seen, the condition s/S < λ/d should be satisfied; Otherwise, interference patterns produced by different parts of the source overlap and no fringes are seen. Thus, as S decreases, the interference pattern gets less & less sharp & when the source is brought too close for this condition to be valid, the fringes disappear. Till this happens, the fringe separation remains fixed.
Width of the source slit is increased	Let s be size of the source and S its distance from the plane of the two slits. For interference fringes to be seen, the condition s/S < λ/d should be satisfied; Otherwise, interference patterns produced by different parts of the source overlap and no fringes are seen. As the source slit width increases, fringe pattern gets less and less sharp. When the source slit is so wide that the condition s/S ≤ λ/d is not satisfied, the interference pattern disappears.
Monochromatic source is replaced by a white source.	➢ The interference patterns due to different component colours of white light overlap (incoherently). The central bright fringes for different colours are at the same position resulting in central fringe being white. ➢ For a point P for which S2P – S1P = λb/2, where λb (≈ 400 nm) represents the wavelength for the blue colour, the blue component will be absent and the fringe will appear red in colour. ➢ Slightly farther away where S2Q – S1Q = λb = λr/2, where λr (~ 8000 Å) represents the wavelength for the red colour, the red component will be absent and the fringe will be predominantly blue. ➢ Thus, the fringe closet on either side of the central white fringe is RED and the farthest will appear BLUE. After a few fringes, no clear fringe pattern is seen.
If the Young's experiment is done completely immersed in a liquid of refractive index μ	➢ If the Young's experiment is done completely immersed in a liquid of refractive index μ instead of being done in air and given that $\mu_{liquid} > \mu_{air}$, then the velocity of light travelling in the liquid decreases by a factor μ, that is $\left[v = \frac{c}{\mu}\right]$, and also the wavelength of the radiation is correspondingly reduced by the same factor $\left[\lambda = \frac{\lambda_0}{\mu}\right]$, where λ_0 is the wavelength of that light in vacuum. Therefore, $\left[\lambda_{liquid} = \frac{\lambda_{air\ or\ vacuum}}{\mu_{liquid}}\right] \Rightarrow$ $\lambda_{liquid} < \lambda_{air}$, the wavelength of light decreases. (*Frequency of the radiation* $\left[f = \frac{v}{\lambda}\right]$ *remains constant since* v *and* λ *are reduced by the same factor*) ➢ Since $\left[\beta = \frac{D\lambda}{d}\right]$, the fringe width β **decreases** if the apparatus of Young's double-slit experiment is immersed in a liquid whose refractive index is > that in air ** ➢ In optics, the refractive index **or** index of refraction of a material is a dimensionless number that describes how fast light travels through the material. It is defined as $\left[\mu = \frac{c}{v}\right]$, where c is the speed of light in vacuum and v is the phase velocity of light in the medium. ➢ For example, the refractive index of water is 1.333, meaning that light travels 1/1.333 times as fast in vacuum as in water. Increasing refractive index corresponds to decreasing speed of light in the material. ➢ *The refractive index can be seen as the* ***factor*** *by which the* *speed and the wavelength* *of the radiation are reduced with respect to their vacuum values: the speed of light in a medium is* $\left[v = \frac{c}{\mu}\right]$, *and similarly the wavelength in that medium is* $\left[\lambda = \frac{\lambda_0}{\mu}\right]$; *where* λ_0 *is the wavelength of that light in vacuum. This implies that vacuum has a refractive index of 1.* ➢ *We know that for a wave* $v = f\lambda$ *and hence* $f = \frac{v}{\lambda}$. *When light passes through a medium of μ >1, velocity decreases while travelling in the medium* $\left[v = \frac{c}{\mu}\right]$ *and also the wavelength decreases by the same factor* $\left[\lambda = \frac{\lambda_0}{\mu}\right]$ *and hence the frequency* $\boldsymbol{f = \frac{v}{\lambda}}$ *of the wave remains constant and is not affected by the refractive index. As a result, the perceived color of the refracted light to a human eye which depends on the frequency is not affected by the refraction or the refractive index of the medium.*
If one of the slits is closed	The interference pattern disappears. This shows that two coherent sources are required to produce interference pattern.

Relationship between Phase difference and Path difference	If Path difference between two points is λ, the phase difference is 2π. If Path difference between two points is Δx, then the phase difference is $\varphi = \left(\frac{2\pi}{\lambda}\right) \Delta x$, thus Phase difference = (2π/wavelength)* path difference Eg: if path difference is $\frac{\lambda}{2}$, then Phase difference φ= $\left(\frac{2\pi}{\lambda}\right)\left(\frac{\lambda}{2}\right) = \pi$ 
If two independent sources are used instead of coherent sources	Even the frequency (or wavelength) is same for the two independent sources, their phase difference vary rapidly and is never stable. When there is constant phase difference, the interference pattern will be seen and since phase between sources changes rapidly, the interference pattern (bright and dark fringes) shift so rapidly that our eyes cannot detect the interference pattern. In summary, two independent sources cannot produce interference as they are incoherent sources of light.
If amplitudes of two waves are not equal	If amplitudes of two waves are not equal, then the intensity at the position of destructive interference will not be zero. Hence, distinction between bright and dark bands becomes difficult.
Slit width	Slit width should be narrow. If it is not narrow, then it is equivalent to a large number of secondary sources that gives rise to multiple interference patterns which are overlapping producing general illumination instead of distinct interference fringe pattern.
What is fringe width	It is the distance between two successive bright or dark fringes on the screen.
Can sound waves interfere? X-rays?	Yes, both sound waves and X-rays (e-m waves) can interfere.

For visible light most transparent media have refractive indices between 1 and 2. A few examples are given in the table → These values are measured at the **yellow doublet D-line of sodium**, with a wavelength of **589 nanometers**, as is conventionally done.

Selected refractive indices at λ=589 nm. For references, see the extended List of refractive indices.

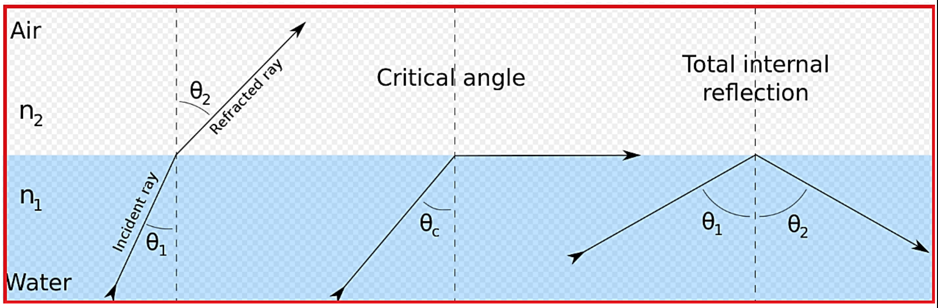
Material	*n*
Vacuum	1
Gases at 0 °C and 1 atm	
Air	1.000 293
Helium	1.000 036
Hydrogen	1.000 132
Carbon dioxide	1.000 45
Liquids at 20 °C	
Water	1.333
Ethanol	1.36
Olive oil	1.47
Solids	
Ice	1.31
Fused silica (quartz)	1.46[11]
PMMA (acrylic, plexiglas, lucite, perspex)	1.49
Window glass	1.52[12]
Polycarbonate (Lexan™)	1.58[13]
Flint glass (typical)	1.69
Sapphire	1.77[14]
Cubic zirconia	2.15
Diamond	2.42
Moissanite	2.65

Q: If velocity of light in air is 3 x 10^8 ms^{-1} and that in water is 2 x 10^8 ms^{-1}, then what should be the critical angle?

Ans: $\mu_{water} = \frac{c}{v} = \frac{3 \, x \, 10^8 \, ms^{-1}}{2 \, x \, 10^8 \, ms^{-1}} = \frac{3}{2}$

The concept of critical angle occurs when light travels from denser medium to rarer medium. Critical angle is that angle of incidence in which the angle of refraction = 90^0

- $\mu_{water} \, sin c = \mu_{air} \, sin 90^0$ (LHS is denser medium, RHS is rarer medium)
- $\therefore \frac{sinc}{sin90^0} = \frac{\mu_{air}}{\mu_{water}} = \frac{1}{3/2} = \frac{2}{3}$ (since $\sin 90^0 = 1$, $\mu_{air} = 1$), then
- $\sin c = \frac{2}{3} \Rightarrow c = sin^{-1}\left(\frac{2}{3}\right) = 41.8^0$



In Young's Double-slit experiment, if we use white light then what colour band will form closest to the central bright fringe? IIT answer = red. (NCERT book also gives as red) ; AIEEE answer = blue.

- White light consists of a continuous range of wavelengths from **400nm (Violet) to ≈ 800nm (Red)**. When **white** coherent light is used, it is equivalent to a number of pairs of monochromatic sources, each producing its system of fringes with different fringe width which is depending on λ ($\beta = \lambda D/d$)
- At the centre of the screen, the **path difference** and hence the **phase difference**, between the interfering waves is zero for all wavelengths. Therefore, all different coloured interfering waves produce a bright fringe at the centre. The superposition of the different colours makes the central fringe “white”. This is “zero-order fringe”.
- As we move away from the centre of the screen on either side, the path difference (λ) between two waves gradually increases from zero and as we move on, the first path difference in the Visible Light Spectrum encountered is 200nm, **which is $\lambda/2$ for violet** and as per superposition principle, we should get dark fringe (for violet).
  - **At the same instant of time**, since we use white light source, there is also red component that is at 800nm corresponding to a path difference of 2λ, which will lead us to constructive superposition for red. **So the FIRST fringe after the central bright fringe should be RED.**
  - **So, the first destructive interference (for violet) is the first constructive interference (for red) So, the inner edge of the first dark fringe, which is the first minimum for violet, receives sufficient intensity due to red ; hence it is reddish.**
  - Beyond this, we obtain the first minimum of blue, green, yellow and red in the last.
- The outer edge of the first dark fringe which is minimum for red, receives sufficient intensity due to violet and is therefore violet. The same applies to every other dark fringe. Hence we obtain a few coloured fringes on both sides of the central white fringe.
- As we move further away from the centre, the path difference becomes quite large. Then, a large number of wavelengths (colours) will produce maximum intensity at a given point, and an equally large number will produce minimum intensity at that point. Hence uniform white illumination will result at each point.

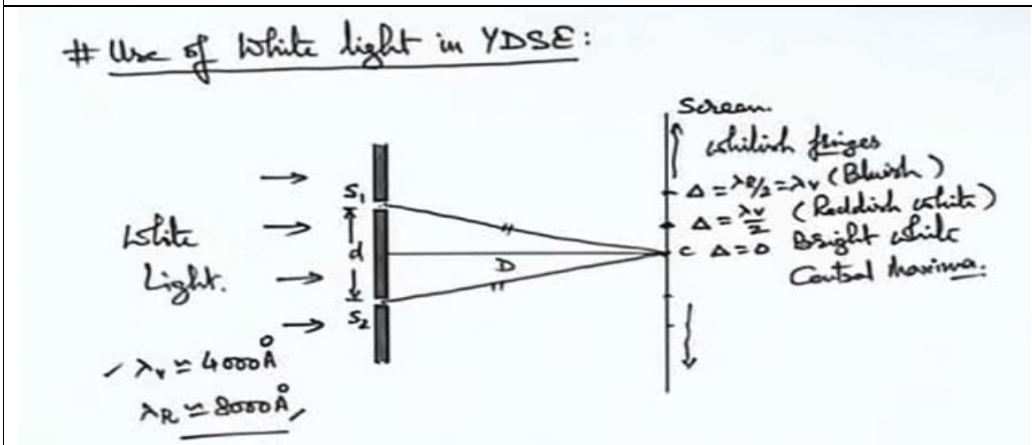
- When white source is used instead of monochromatic light, the interference patterns due to different component colours of white light overlap (incoherently).
- At the centre of the screen, the path difference and hence the phase difference, between the interfering waves is zero for all wavelengths. Therefore, all different coloured interfering waves produce a bright fringe at the centre. The superposition of the different colours makes the central fringe “white”. This is “zero-order fringe”.
- As we move on either side of the centre, the **path difference** gradually increases from zero. At a certain point, the path difference becomes equal to **half the wavelength** of the component having the smallest wavelength (**violet**). This is the position of the dark fringe (destructive interference due to path difference = half wavelength) of violet. (Beyond this, we obtain the first minimum of blue, green, yellow and of red in the last). So, the inner edge of the first dark fringe, which is the first minimum for violet, receives sufficient intensity due to red **; hence it is reddish.**
- In other words, for a point P for which $S2P - S1P = \lambda b/2 = 200$nm where λb (≈ 400nm represents the wavelength for the blue colour). So, the blue component will be absent due to **destructive interference** and the fringe will appear red in colour.
- Slightly farther away where $S2Q - S1Q = \lambda b = \lambda r/2 \approx 400$nm where λr (≈ 800nm represents the wavelength for the red colour) and so the red component will be absent and the fringe will be predominantly blue.

Thus, the fringe closet on either side of the central white fringe is RED and the farthest will appear BLUE. After a few fringes, no clear fringe pattern is seen.

Joe Frank Answered Jun 19

The interference pattern due to component colours of white light overlap (incoherently).

- The central bright fringes for different colours arrive at the same position. Therefore the central fringe is white.
- **For a point P for which $S_2P-S_1P= \lambda_b/2$, where λ_b (=400nm) is the wavelength of the BLUE colour, the blue component will be absent (due to destructive interference) and hence the fringe will appear RED.**
- **Slightly farther away where, $S_2Q-S_1Q= \lambda_r/2$, where λ_r (=800nm) is the wavelength of the red colour, the RED component will be absent (due to destructive interference) the fringe will be predominantly blue.**
- **Thus, fringe closest on either side of the central white fringe is red and the farthest will appear blue.**
- After a few after a few fringes, no clear fringe pattern is seen.



Following is only for info; but they are not the correct answers. **Correct answer is given in page --102 O--**

Dinesh Ramakrishnan, BS MS Physics, Indian Institute of Science Education and Research, Answered Dec 25, 2015

You can understand that the central fringe itself is white. Fringe width of individual colours is directly proportional to λ of the colour. Central fringe is the place on the screen where there is zero optical path difference (or phase difference) between any to waves simultaneously emanating from the two slits.

Moving away from the central fringe means there is a difference in distance travelled by such waves to reach the given point. When you move more closely to one of them means you increase the path difference. When you want more change in phase difference for lesser path difference, then wavelength must be smaller. 2π times the ratio of path difference to wavelength gives phase difference. **Yeah, the answer here necessarily is violet.**

White light consists of waves of innumerable wavelengths starting from violet to red colour. Therefore if monochromatic light in Young's interference experiment is replaced by white light, then the waves of each wavelength form their separate interference patterns. The resultant effect of all these patterns is obtained on the screen.

The path difference between waves starting from S1 and S2 at the location (M) of central fringe is zero, i.e., for point M of screen S1M − S2M=0 i.e., the waves of all colours reach at mid-point M in same phase. Therefore the central fringe (at M) is white. As fringe width ω = Dλ⁄ d or ω ∝ α and in visible region wavelength of violet colour is least and that of red colour is maximum, i.e., wavelength increases in order of colours denoted by VIBGYOR therefore on either side of it some coloured fringes are obtained in order of colour VIBGYOR. That is the violet (V) fringe appears first and the red (R) the last. After this the fringes of many colours overlap at each point of the screen and so the screen appears uniformly illuminated.

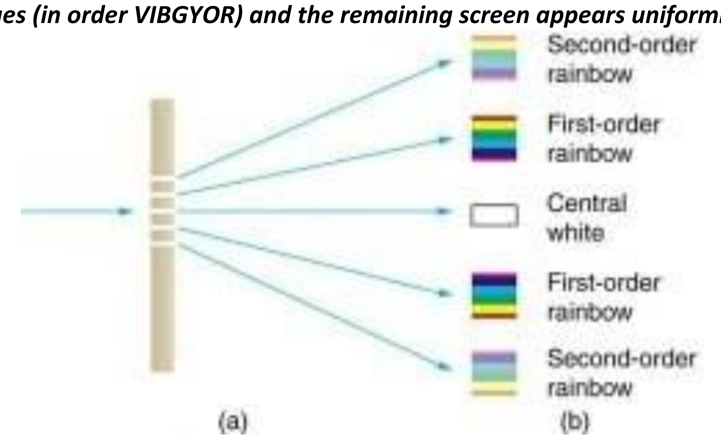
Thus if we use white light in place of monochromatic light the central fringe is white, containing on either side a few coloured fringes (in order VIBGYOR) and the remaining screen appears uniformly illuminated.

White light consists of waves of innumerable wavelengths starting from violet to red colour. Therefore if monochromatic light in Young's interference experiment is replaced by white light, then the waves of each wavelength form their separate interference patterns. The resultant effect of all these patterns is obtained on the screen.

The path difference between waves starting from S1 and S2 at the location (*M*) of central fringe is zero, *i.e.*, for point *M* of screen **S1m− S2m=0** i.e., the waves of all colours reach at mid-point *M* in same phase. Therefore the central fringe (at *M*) is **white**.

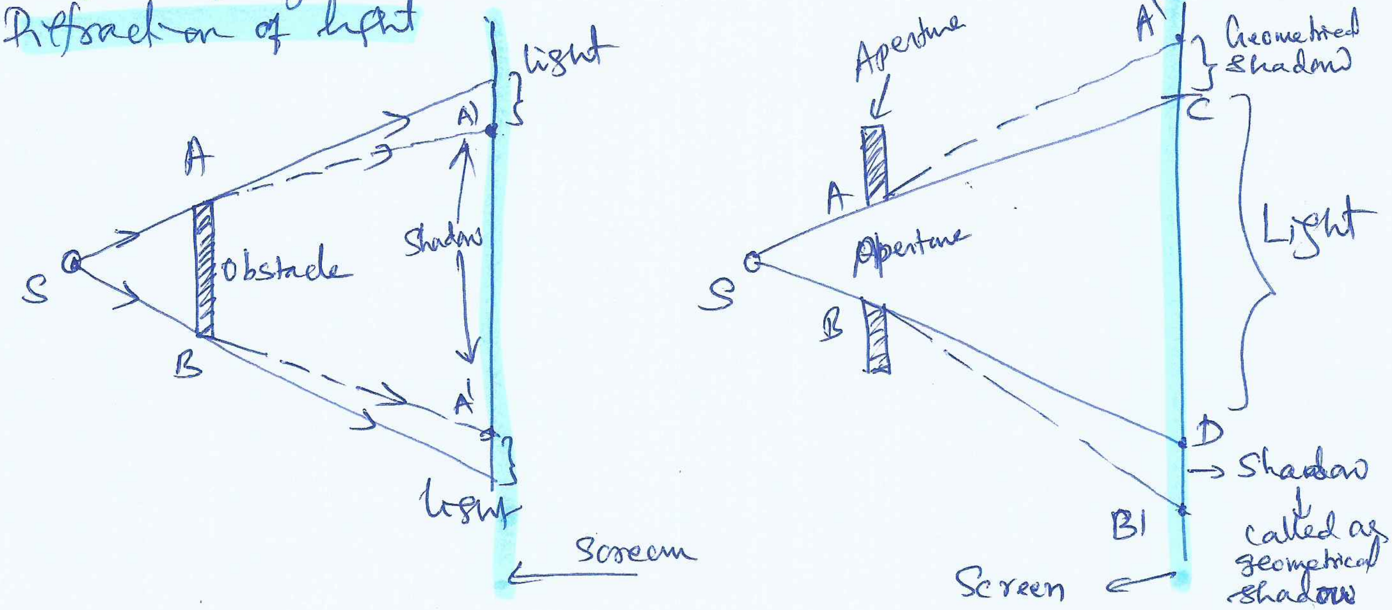
As fringe width, *i.e*., wavelength increases in order of colours denoted by VIBGYOR therefore on either side of it some coloured fringes are obtained in order of colour VIBGYOR. That is the violet (*V*) fringe appears first and the red (*R*) the last. After this the fringes of many colours overlap at each point of the screen and so the screen appears uniformly illuminated.

Thus if we use white light in place of monochromatic light the central fringe is white, containing on either side a few coloured fringes (in order VIBGYOR) and the remaining screen appears uniformly illuminated.



Diffraction of Light

The phenomenon of bending of light around the corners of an obstacle or an aperture into the region of geometrical shadow of obstacle is called Diffraction of light



- If we look clearly at the shadow cast by an opaque object, close to the region of geometrical shadow, there are alternate dark and bright regions just like interference. This phenomenon happens ~~due~~ due to diffraction.

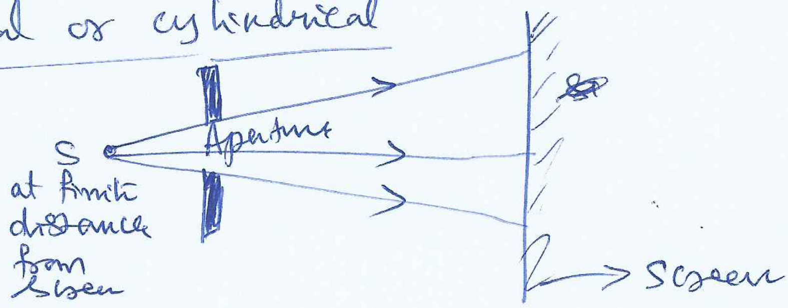
- Diffraction is a general characteristic exhibited by all types of waves → sound, light, water waves, e-m waves, matter waves etc...

→ • The diffraction is more pronounced when the dimension of the ~~ob~~ opaque object should be of the order of the wavelength of wave used. Since λ of light is much smaller than the dimensions of most obstacles that we encounter ~~in~~ everyday, we don't see ~~the~~ diffraction ~~easily~~ easily.

Types of Diffraction phenomenon

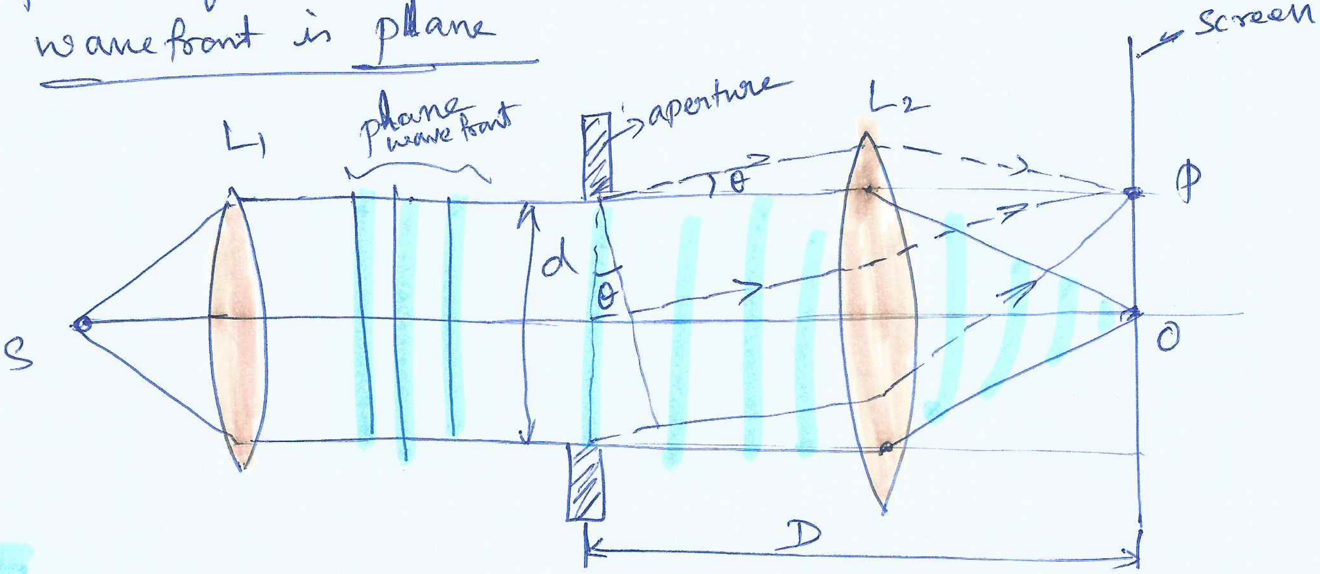
• Fresnel's Diffraction

→ Here the source of light and the screen on which diffraction pattern is observed are at finite distances from the obstacle (or aperture). In this case, no lenses are used and the incident wavefront is either spherical or cylindrical



• Fraunhofer's Diffraction

Here, the source of light and the screen are effectively at infinite distances from the obstacle (or aperture). This is achieved by placing the source and the screen in the focal planes of two convex lens. In this case, the incident wavefront is plane



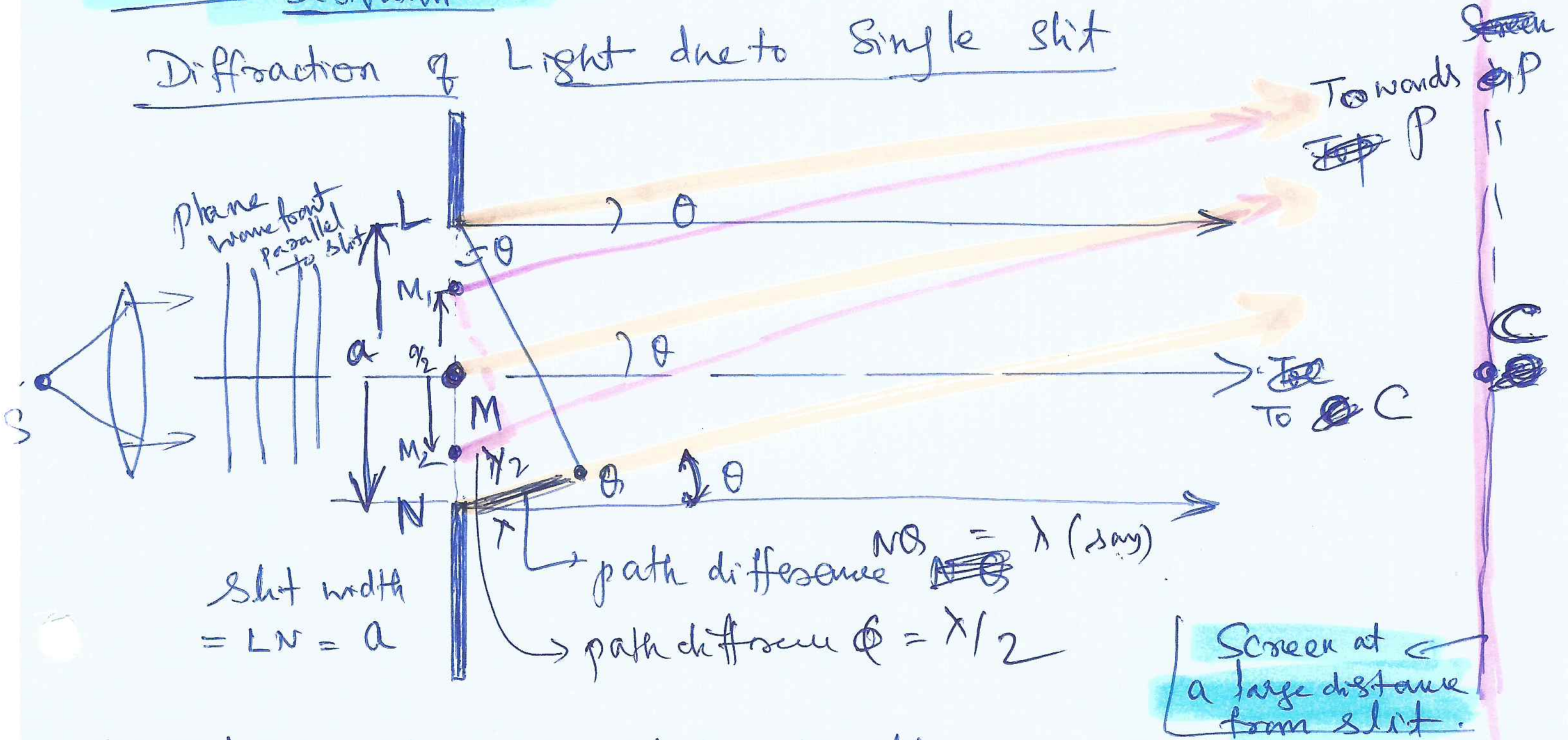
IMP

→ In Fresnel's Case, since the screen on which fringes are formed is at a large distance ~~for~~ from single slit, then the paths from the slit can be treated as parallel. This situation also occurs when we place convex lens after the slit and place the screen at the focus. Note that lens does not introduce any extra path differences in a parallel beam. This arrangement is often used to get more intensity than placing screen far away.

As in NCERT book

IMP Derivation

Diffraction of Light due to Single slit



- plane wavefront is incident on the slit
- The basic idea is to divide slit into much smaller parts and treat different points betw slits as a source of secondary ~~wavefront~~ sources emitting wavefronts.

- **Case(i)** : Central Maxima $(\theta = 0)$
  Since $LC = NC$ at central point C on screen, path lengths are same and we get central bright intensity.
- Case(ii) : At point P on screen (angle $= \theta$)

path difference $= NP - LP = NQ$

$\sin\theta = \frac{NQ}{a}$ Since θ is small, $\theta \simeq \frac{NQ}{a}$

$$\boxed{\text{path difference } (NQ) \simeq a\theta} \rightarrow (1)$$

Similarly, if $M_1M_2 = y$, then $M_2P - M_1P = y\theta$

Thus summing up equal, coherent contributions for large number of sources, we get some pattern.

→ Consider path difference $a\theta = \lambda$ (phase diff $= 2\pi$) $\boxed{\theta \simeq \frac{\lambda}{a}} \rightarrow (2)$

→ Divide slit into two equal ~~halves~~ equal halves LM and MN, each of size $= a/2$.

→ For every point M_1 in "LM", there is a point M_2 in "MN" such that $\boxed{M_1M_2 = a/2}$. The path difference between M_1 & M_2 at $P = M_2P - M_1P = \theta\frac{a}{2}$

$= \frac{\lambda}{a}\frac{a}{2} = \lambda/2$

— P.T.O —

105 a ~~106~~ Contd from 105

Since path diff = ~~λ/a~~ λ/2

⟹ ∴ Contributions from M_1 & M_2 are 180° out of phase and cancel in the direction of $\theta = \lambda/a$. Therefore, the contributions from LM and MN cancel each other so that intensity falls to zero.

$$\therefore \boxed{\theta = \frac{n\lambda}{a}}$$ where $n = \pm1, \pm2, \pm3 \ldots$

$n \neq 0$ [Except n=0]

(3)

∴ Secondary minima is when path difference = $\boxed{a\theta = n\lambda}$ where $n = \pm1, \pm2, \pm3 \ldots$, $n \neq 0$

Case (iii): Condition for Secondary Maxima.

Consider path difference $a\theta = \frac{3\lambda}{2}$ or $\boxed{\theta = \frac{3}{2}\frac{\lambda}{a}}$

(phase diff = 3π)

→ Divide slit in 3 equal parts
If we take the first 2/3 of the slit, path difference $\left(\frac{2}{3}a\right)\theta = \cancel{\frac{2a}{3}} \cdot \cancel{\frac{3\lambda}{2a}} = \lambda$

→ Again first two-thirds of the slit can be divided in to two equal halves which have a $\lambda/2$ path difference. As explained in case(ii), they cancel each other.

→ only the remaining $1/3$ of the slit contributes to the intensity at a point betn two minima. Clearly, this will be much weaker compared to central maxima (where the entire slit contributes in phase).

→ In General, Secondary maxima is when path diff = $\boxed{a\theta = \left(n+\frac{1}{2}\right)\lambda}$ where $n = \pm1, \pm2, \pm3 \ldots$, $n \neq 0$

Secondary maxima becomes weaker with $n = 2, 3, 4 \ldots$

Conclusion:

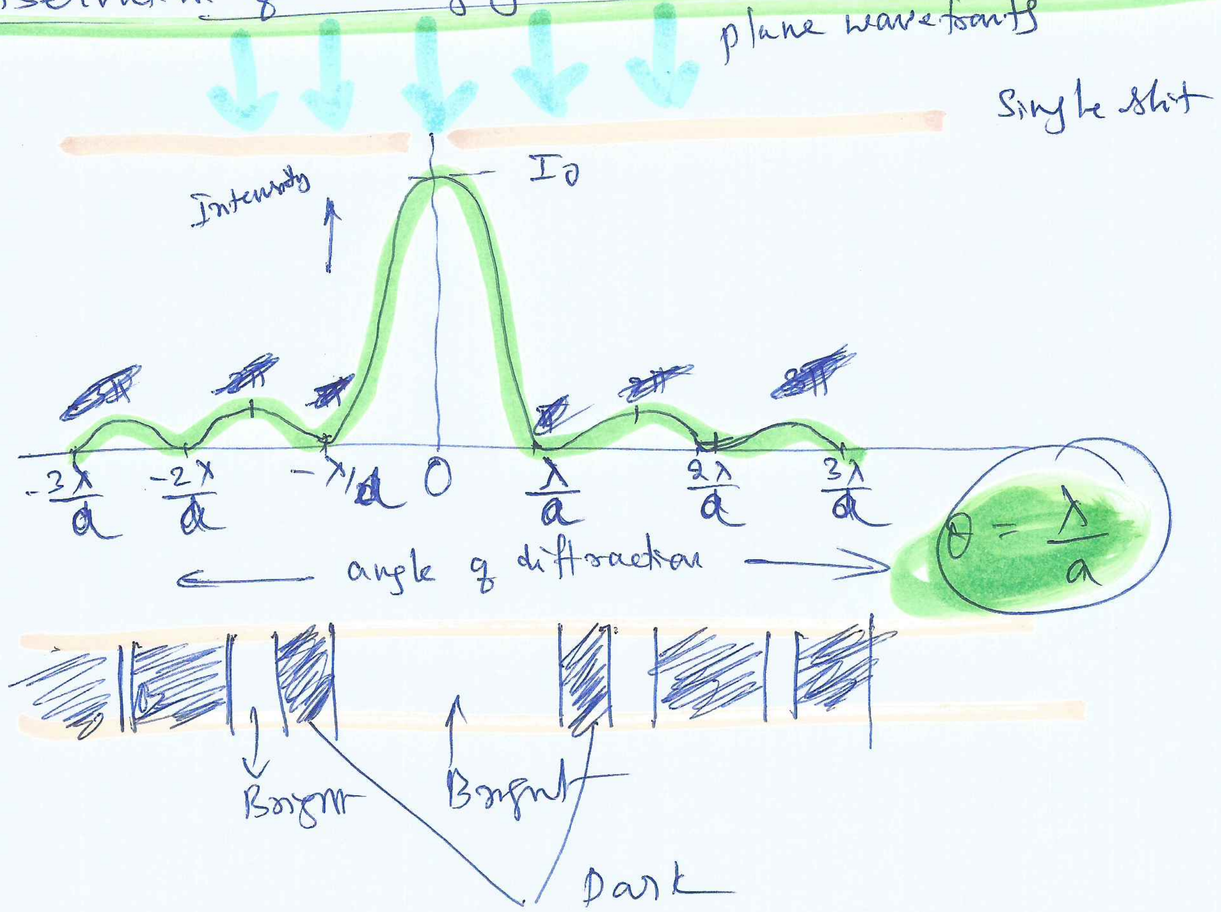
If path difference = 0 ⟶ Central maximum intensity
If — do — $= n\lambda$ ⟶ Secondary Minima ($n \neq 0$)
If — do — $= \left(n+\frac{1}{2}\right)\lambda$ ⟶ Secondary Maxima ($n \neq 0$)

The above is exactly opposite to interference formula using two slits. $n = 0$ corresponds to Central Maxima.

Feynman's notes on Interference and Diffraction.

" No One has ever been able to define the difference between interference and diffraction satisfactorily. It is just a question of usage, and there is no specific, important physical difference between them. The best we can do is, roughly speaking, when there are only a few sources, say two interfering sources, then the result is usually called Interference. But if there is a large number of them, it seems that the word diffraction is more often used".

In Interference & diffraction, light energy is redistributed. If it reduces in one region, producing a dark fringe, it increases in another region, producing a bright fringe. There is no gain or loss of energy, which is consistent with the principle of conservation of energy.



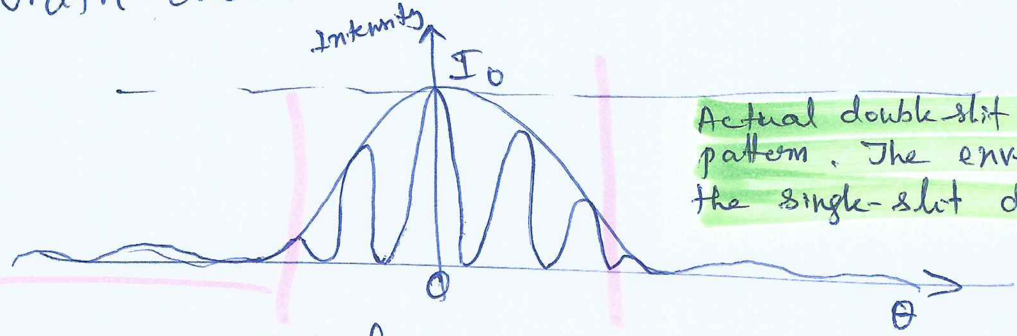
— 105 C —

IMP.

In ~~a~~ Young's double-slit interference experiment, the pattern on the screen is actually a superposition of

1. Single-slit diffraction from each slit and
2. Interference pattern due to double-slit.

(1) results in broader diffraction peak within which there appears several fringes of smaller width due to double-slit interference.



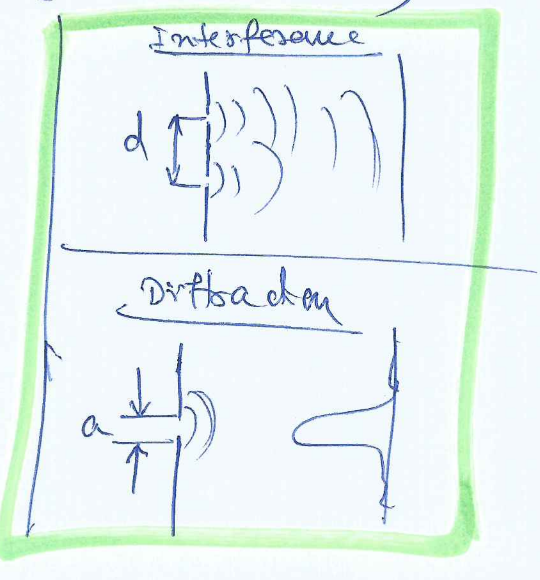
Actual double-slit interference pattern. The envelope shows the single-slit diffraction.

→ Number of Interference Fringes within broad diffraction peak depends on ratio d/a

where d = dist. bet^n two slits (as in interference)

a = width of the slit (as in diffraction).

→ When $a \to$ becoming very small, diffraction pattern will become very flat and we will observe only the two-slit interference pattern.



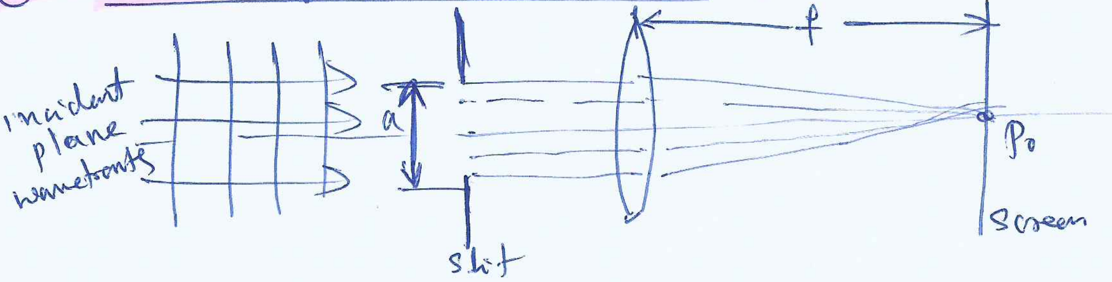
Using convex lens

~~108~~ $\boxed{105\,d}$

Info only : Not in NCERT book

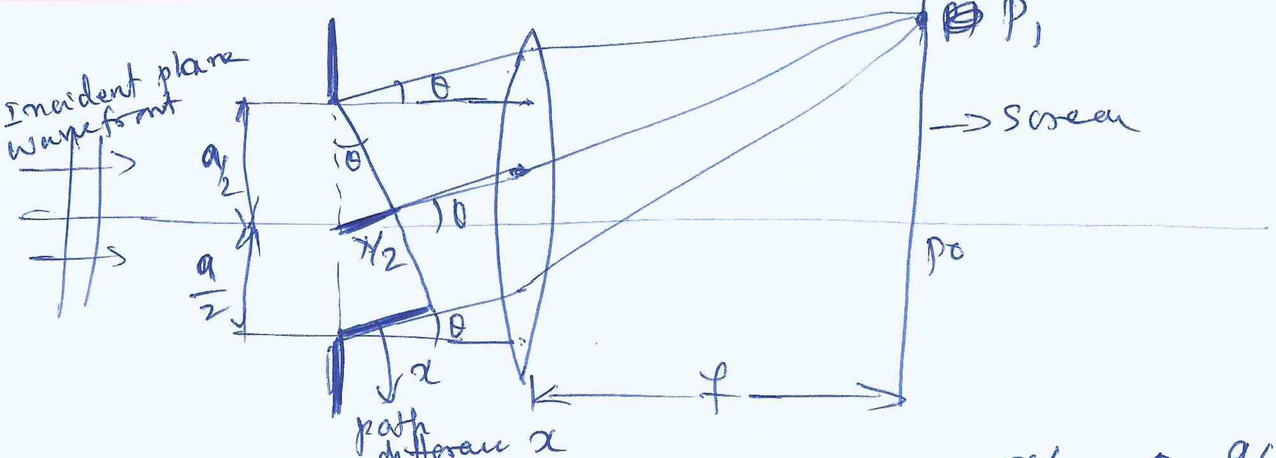
Diffraction of light at a single slit

(a) Condition of central maxima of the diffraction pattern



Since path diff = 0, we get central max. intensity

(b) Condition ~~f~~ at the first Minimum of the diffraction pattern



$\sin\theta = \dfrac{x/2}{a/2}$ $\quad \theta \simeq \dfrac{x/2}{a/2}$ $\quad \therefore$ ~~$x = a\theta$~~ $x/2 = \theta \cdot a/2$

~~path difference = $a\theta$~~

If path diff $= \lambda/2$ ($\Rightarrow$ phase diff. $= \pi$ for destructive interference)

$\lambda/2 = \theta \frac{a}{2} \Rightarrow a\theta = \lambda \longrightarrow$ we get secondary Minima.

$\boxed{a\theta = n\lambda}$ where $n = \pm 1, \pm 2, \pm 3 \ldots$
$n \neq 0$

(c) Condition for Secondary Maxima :-

If path difference $= \boxed{a\theta = \frac{3\lambda}{2}}$ (phase diff $= 3\pi$ for constructive interference)

path difference $a\theta = \left(n + \frac{1}{2}\right)\lambda$ where $n = \pm 1, \pm 2, \pm 3 \ldots$
$n \neq 0$

Conclusion :

If path diff $= 0 \longrightarrow$ Central Maxima.

If —do— $= n\lambda \longrightarrow$ Sec. Minima ($n \neq 0$)

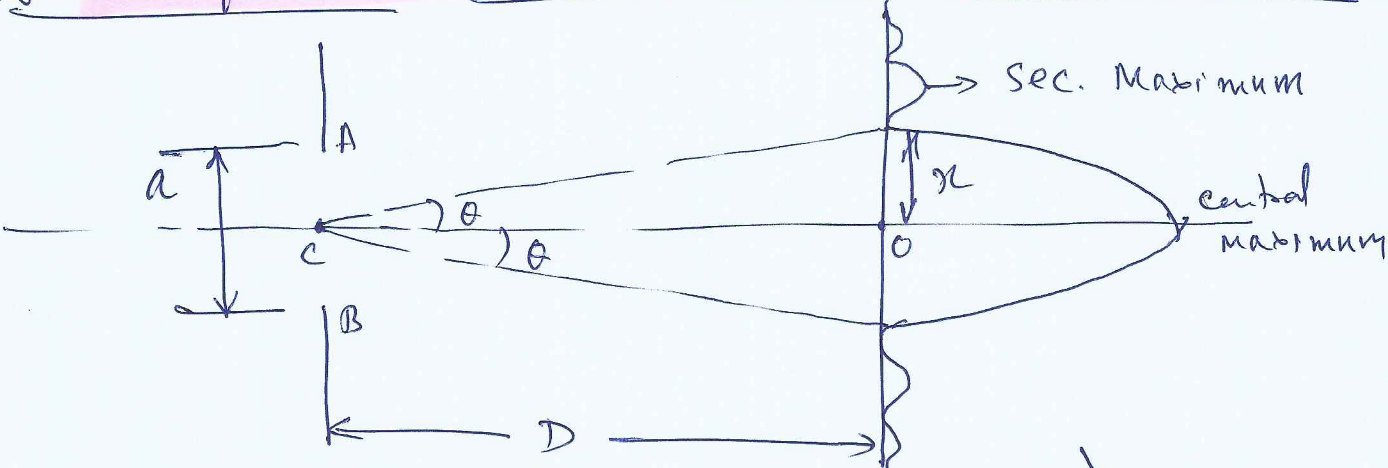
If —do— $= \left(n + \frac{1}{2}\right)\lambda \rightarrow$ Sec. Maxima ($n \neq 0$)

Above is opposite to Interference pattern condition.

IMP

— 105 e —

Width of Central Maximum of Diffraction pattern



We know that angle of diffraction $\theta = \frac{\lambda}{a}$

Central Maximum angular width $2\theta = \frac{2\lambda}{a}$

$\therefore x = D\theta = \frac{D \times \lambda}{a}$

Linear width of Central Maxima $= 2x = \beta_0$

$$\boxed{\beta_0 = \frac{2\lambda D}{a}} \longrightarrow (1)$$

$\tan\theta \simeq \theta = \frac{x}{D}$

$\therefore x = D\theta$

Width of Secondary maximum

Angular width of n^{th} secondary maximum = angular separation betn the directions of n^{th} and $(n+1)^{th}$ minima.

$\therefore$ Angular width of n^{th} sec. maximum

$$\phi = \theta_{n+1} - \theta_n$$

$\theta_n = \frac{n\lambda}{a}$ is the direction of n^{th} minimum

$\theta_{n+1} = \frac{(n+1)\lambda}{a}$ is the direction of $(n+1)^{th}$ minimum.

$$\theta_n = \frac{n\lambda}{a}$$

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

$$\phi = (n+1)\frac{\lambda}{a} - \frac{n\lambda}{a} = \frac{\lambda}{a}$$

$$\boxed{\phi = \frac{\lambda}{a}}$$

$\therefore$ Linear width of secondary maximum

$$\beta = \phi D$$

$$\boxed{\beta = \frac{\lambda D}{a}} \longrightarrow (2)$$

$$\beta_0 = 2\beta$$

Comparing (1) and (2), width of Central maximum is twice the width of secondary maximum.

PTO