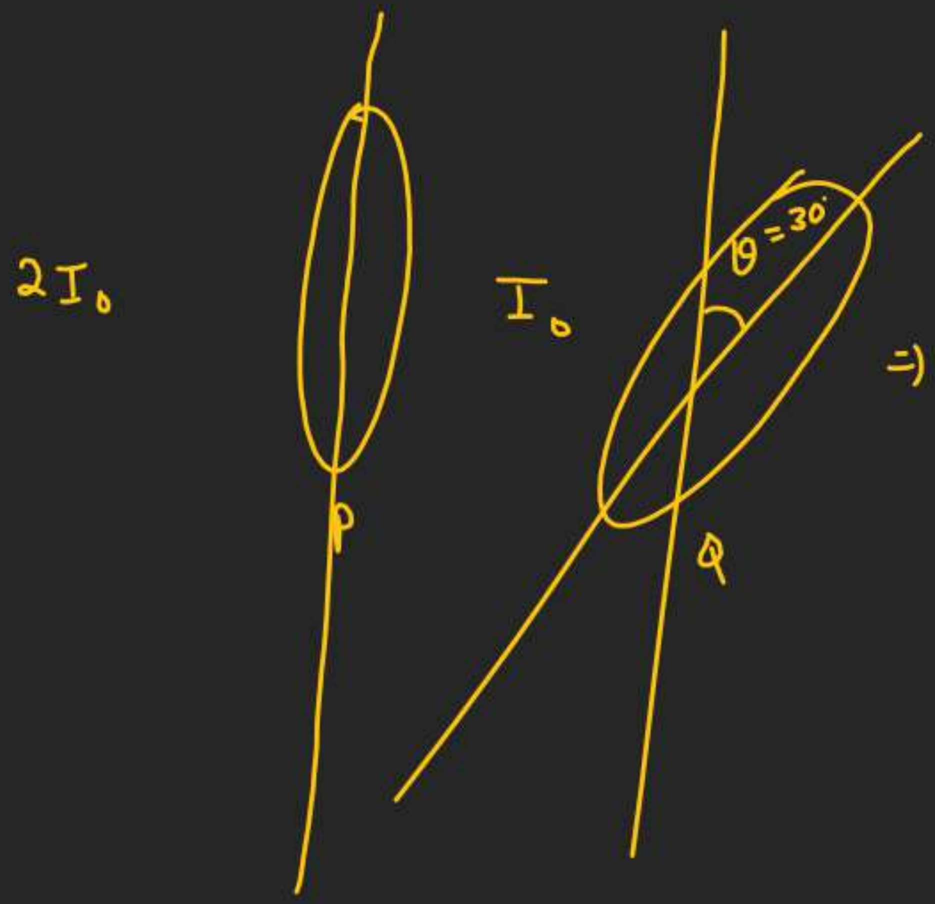
Q.1 An unpolarised light beam of intensity $2I_0$ is passed through a polaroid P and then through another polaroid Q which is oriented in such a way that its passing axis makes an angle of 30° relative to that of P. The intensity of the emergent light is **[July 29.2023 (II)]**

(A) $\frac{I_0}{4}$

(B) $\frac{I_0}{2}$

(C) $\frac{3I_0}{4}$ ✓

(D) $\frac{3I_0}{2}$

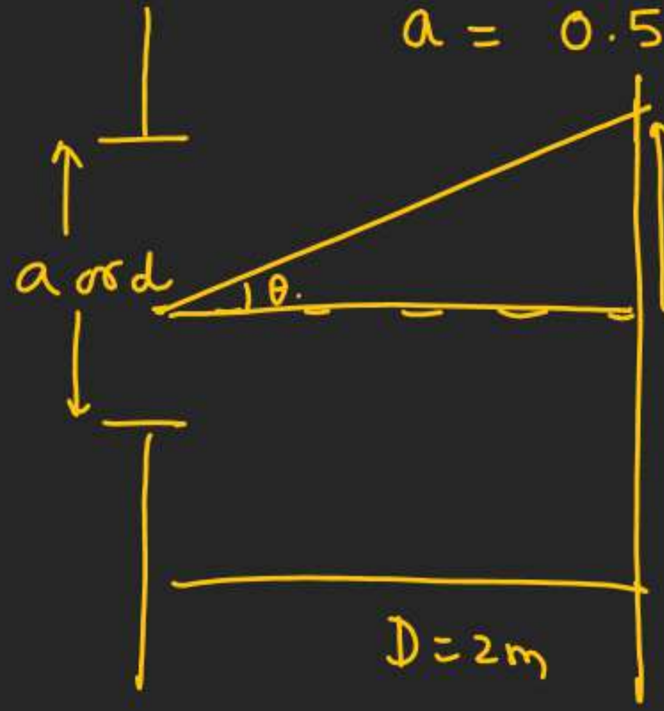


$\Rightarrow I = I_0 \cos^2 30^\circ$

$I = I_0 \frac{3}{4} = \frac{3I_0}{4}$ ✓

Q.2 Sodium light of wavelengths $650\ \mathrm{nm}$ and $655\ \mathrm{nm}$ is used to study diffraction at a single slit of aperture $0.5\ \mathrm{mm}$. The distance between the slit and the screen is 2.0 m. The separation between the positions of the first maxima of diffraction pattern obtained in the two cases is $\underline{\ 3\ } \times 10^{-5}\ \mathrm{m}$.

$a = 0.5\,mm = 0.5\times10^{-3}$



$\Delta x = a\sin\theta = (2n+1)\frac{\lambda}{2}$

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

$\frac{a}{D}y_1 = \frac{3\lambda_1}{2}$ — ①

$\frac{a}{D}y_2 = \left(\frac{3\lambda_2}{2}\right)$ — ②

② − ①

$\frac{a}{D}(y_2-y_1) = \frac{3}{2}(\lambda_2-\lambda_1)$

$\underline{y_2-y_1} = \frac{3a}{2D}(\lambda_2-\lambda_1)$

$= \frac{3}{2}\times\frac{0.5\times10^{-3}}{2}(5\times10^{-9})$

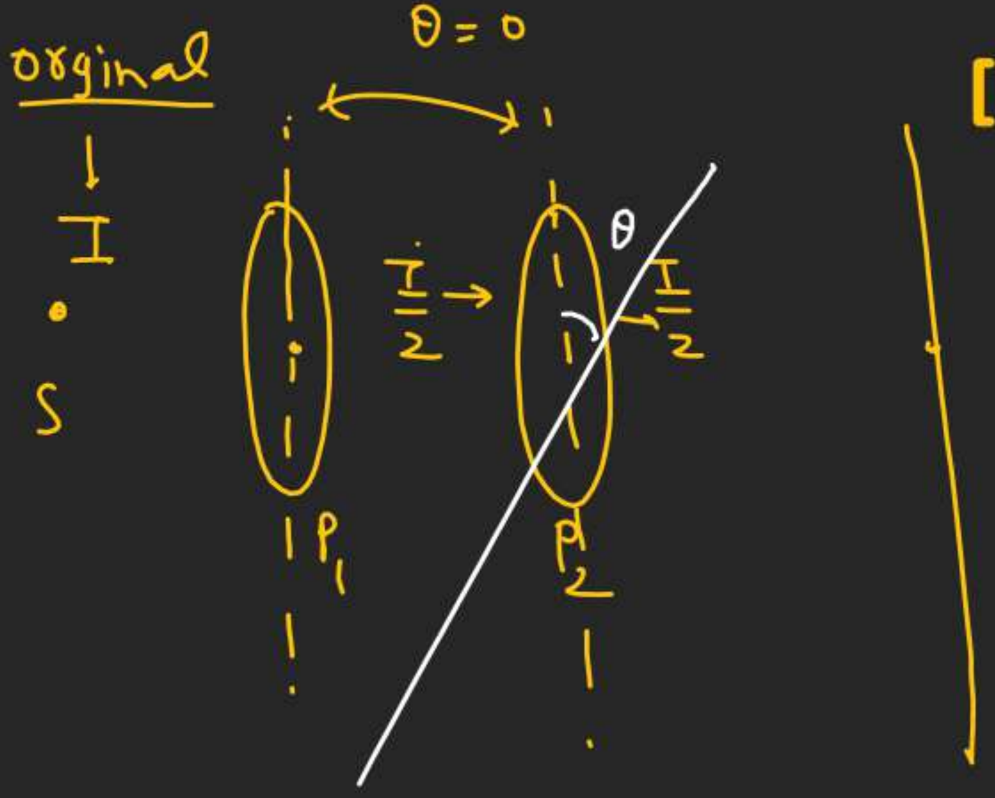
Q.3 A source of light is placed in front of a screen. Intensity of light on the screen is I. Two Polaroids P_1 and P_2 are so placed in between the source of light and screen such that the intensity of light on screen is $I/2$. P_2 should be rotated by an angle of <u>30°</u> (degrees) so that the intensity of light on the screen becomes $\frac{3I}{8}$.

[NA, Aug 26.2021 (I)]

$$\frac{3I}{8} = \frac{I}{2}\cos^2\theta$$

$$\cos\theta = \sqrt{\frac{3}{4}} = \frac{\sqrt{3}}{2}$$

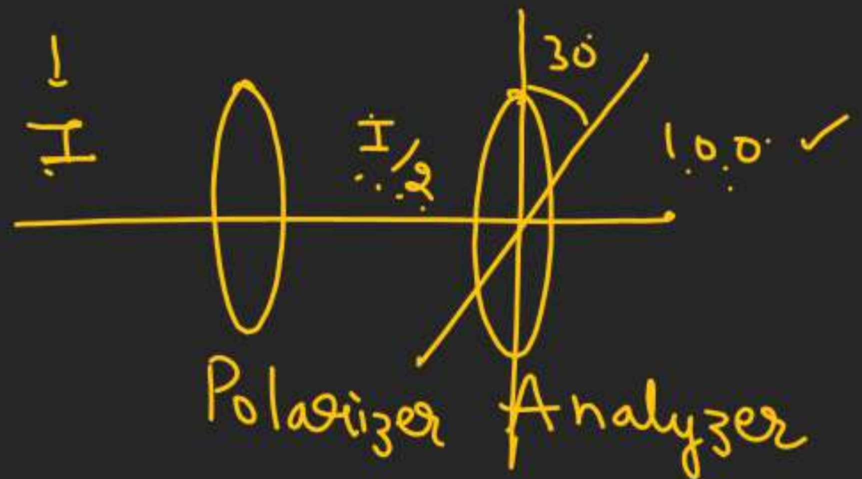
$$\theta = 30^\circ$$



Q.4 An unpolarized light beam is incident on the polarizer of a polarization experiment and the intensity of light beam emerging from the analyzer is measured as 100 Lumens. Now, if the analyzer is rotated around the horizontal axis (direction of light) by 30° in clockwise direction, the intensity of emerging light will be 75 Lumens. **[Feb.24.2021 (I)]**

$\theta = 0^\circ$

$\left(\frac{I}{2} = 100\right)$



When rotated by θ

$$I = \frac{I}{2} \cdot \cos^2 30^\circ$$

$$= 100 \times \frac{3}{4}$$

$$= 75^\circ$$

Q.5 A polarizer - analyser set is adjusted such that the intensity of light coming out of the analyser is just 10% of the original intensity. Assuming that the polarizer analyser set does not absorb any light, the angle by which the analyser need to be rotated further to reduce the output intensity to be zero, is:

(A) 71.6°

(B) 18.4°

(C) 90°

(D) 45°

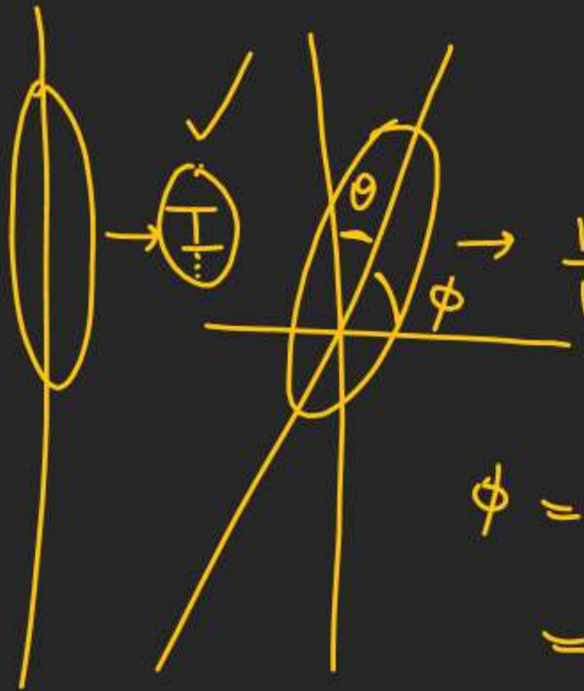
$$\frac{I}{10} = I\cos^2\theta$$

$$\cos^2\theta = \frac{1}{10}$$

$$\cos\theta = \frac{1}{\sqrt{10}}$$

$$\theta = \cos^{-1}\left(\frac{1}{\sqrt{10}}\right)$$

$$= 71.6^\circ$$



$$\rightarrow \frac{10}{100} I = \frac{I}{10}$$

$$\phi = \frac{\pi}{2} - \theta$$

$$= 90 - 71.6^\circ$$

$$=$$

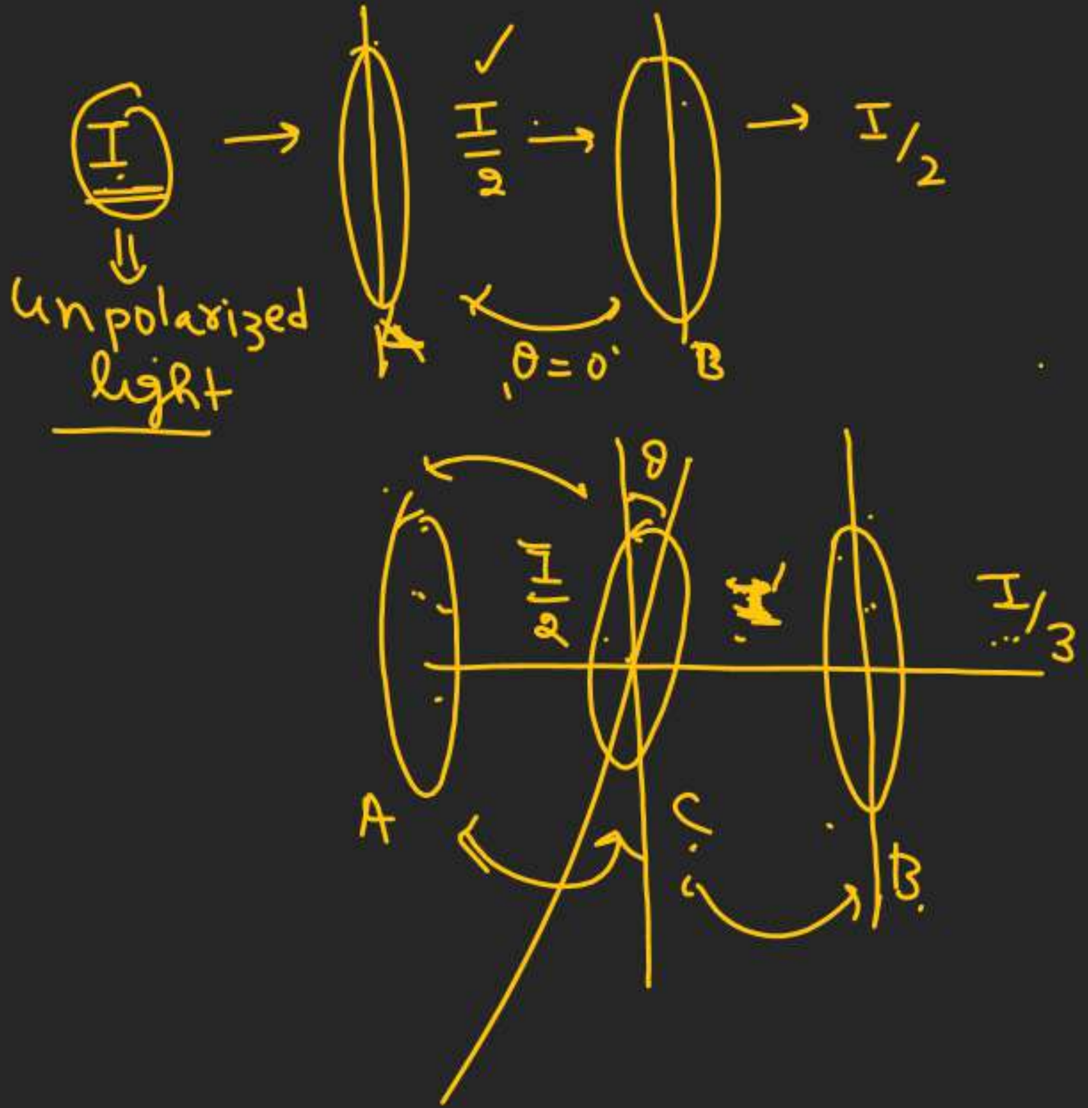
Q.6 Unpolarized light of intensity I is incident on a system of two polarizers, A followed by B. The intensity of emergent light is $I/2$. If a third polarizer C is placed between A and B, the intensity of emergent light is reduced to $I/3$. The angle between the polarizers A and C is θ. Then **[April.16.2018]**

(A) $\cos\theta = \left(\frac{2}{3}\right)^{1/4}$

(B) $\cos\theta = \left(\frac{1}{3}\right)^{1/4}$

(C) $\cos\theta = \left(\frac{1}{3}\right)^{1/2}$

(D) $\cos\theta = \left(\frac{2}{3}\right)^{1/2}$



$I' = \frac{I}{2}(\cos^2\theta)$

$\frac{I}{3} = I'\cos^2\theta$

$\frac{I}{3} = \frac{I}{2}\cos^4\theta.$

$\frac{2}{3} = \cos^4\theta.$

$\cos\theta = \left(\frac{2}{3}\right)^{1/4}$

Q.7 Unpolarized light of intensity I passes through an ideal polarizer A. Another indentical polarizer B is placed behind A. The intensity of light beyond B is found to be $\frac{I}{2}$. Now another identical polarizer C is placed between A and B. The intensity beyond B is now found to be $\frac{I}{8}$. The angle between polarizer A and C is: **[2018]**

(A) 0°

(B) 30°

(C) 45°

(D) 60°

A & C

$I' = \frac{I}{2}\cos^2\theta$

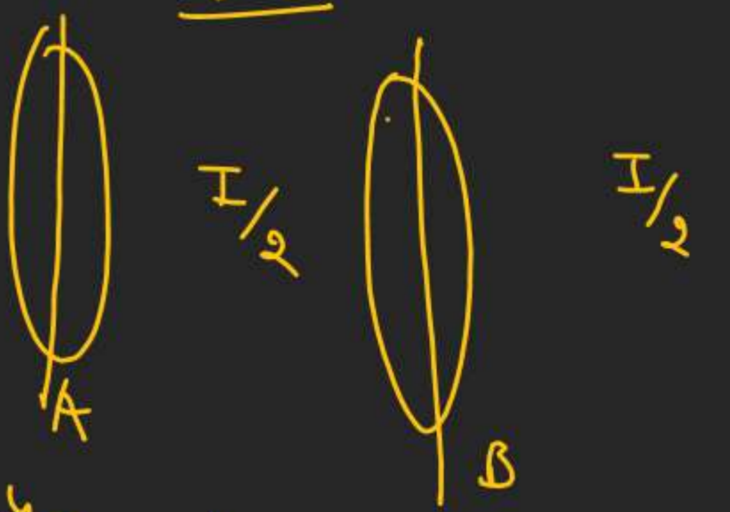
C & B

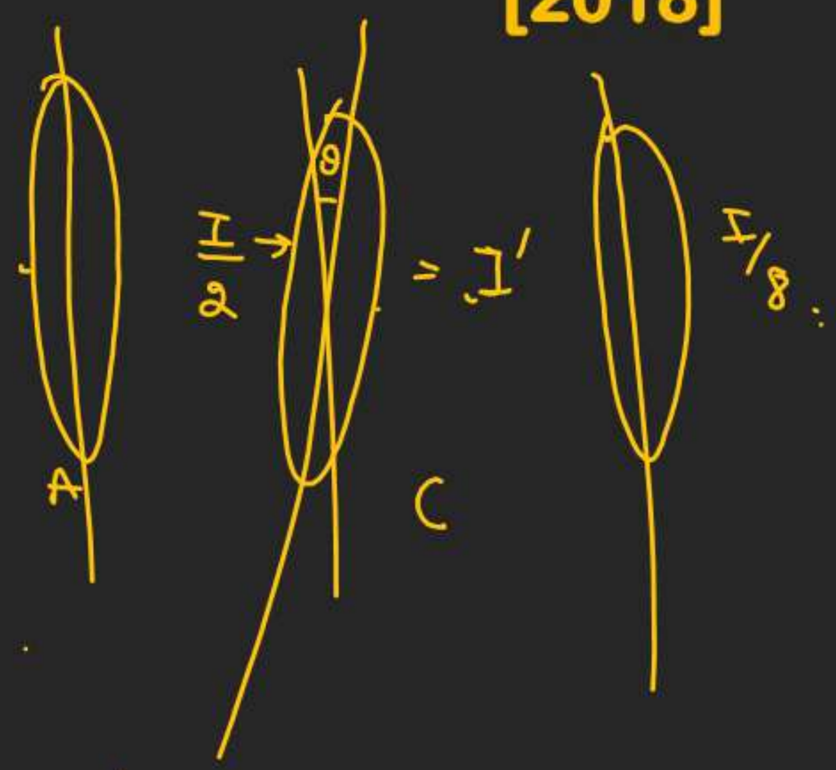
$I/8 = I'\cos^2\theta$

$\frac{I}{8} = \frac{I}{2}\cos^4\theta$

$\theta = 0^\circ$

I





$\cos^4\theta = \frac{1}{4}$

$\cos^2\theta = \frac{1}{2}$

$\cos\theta = \frac{1}{\sqrt{2}}$

$\theta = 45^\circ$

Q.10 Orange light of wavelength 6000×10^{-10} m illuminates a single slit of width 0.6×10^{-4} m. The maximum possible number of diffraction minima produced on both sides of the central maximum is_______. [NA Sep.04,2020.(II)]

$$d \sin\theta = n\lambda$$

$$n = \frac{d}{\lambda} \sin\theta$$

n_{max}, $\sin\theta = 1$

$$n_{max} = \frac{0.6 \times 10^{-4}}{6 \times 10^{-7}}$$

$$= 10^2$$

$$= 100.$$

Minima in one side = 99.

Total Minima on the screen = 99×2

$= 198.$

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Q.11 Consider the diffraction pattern obtained from the sunlight incident on a pinhole of diameter $0.1\mu m$. If the diameter of the pinhole is slightly increased, it will affect the diffraction pattern such that **[Feb.25,2021.(II)]**

(A) Its size decreases, and intensity decreases

(B) Its size in~~c~~reases, and intensity increases

(C) Its size ~~in~~creases, but intensity decreases

(D) Its size decreases, but intensity increases

$\omega = \left(\frac{2\lambda}{a}\right)$

$\downarrow \omega \propto \frac{1}{a} \uparrow$

Q.12 Unpolarized light of intensity I_0 is incident on surface of a block of glass at Brewster's angle. In that case, which one of the following statements is true?

[Online April 11,2015]

(A) reflected light is completely polarized with intensity less than $\frac{I_0}{2}$ ✓

(B) transmitted light is completely polarized with intensity less than $\frac{I_0}{2}$

(C) transmitted light is partially polarized with intensity $\frac{I_0}{2}$

(D) reflected light is partially polarized with intensity $\frac{I_0}{2}$

Q.13 A single slit of width b (d) is illuminated by a coherent monochromatic light of wavelength λ. If the second and fourth minima in the diffraction pattern at a distance 1 m (D) from the slit are at 3 cm (y_2) and 6 cm (y_4) respectively from the central maximum, what is the width of the central maximum?

(i.e. distance between first minimum on either side of the central maximum)

[Online April 8,2017]

(A) 1.5 cm

(B) ~~3.0 cm~~

(C) 4.5 cm

(D) 6.0 cm

$\frac{dy_2}{D} = d\sin\theta = \overset{n=2}{2\lambda}$ (2nd Minima)

$\frac{dy_4}{D} = d\sin\theta = \overset{n=4}{4\lambda}$ (4th Minima)

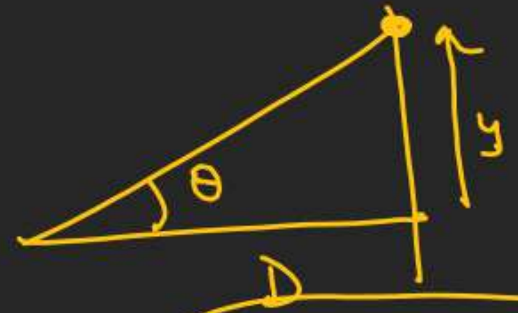
$y_2 = \frac{2D\lambda}{d}$

$y_4 = \frac{4D\lambda}{d}$

$y_4 - y_2 = \frac{2D\lambda}{d}$

$\left[\frac{1}{D}(y_4 - y_2)\right] = \frac{2\lambda}{d} \rightarrow \omega$

ω = width of central Maxima.



$d\sin\theta = d\tan\theta = \frac{dy}{D}$

Q.14 In an experiment of single slit diffraction pattern, first minimum for red light coincides with first maximum of some other wavelength. If wavelength of red light is 6600Å, then wavelength of first maximum will be:

[Online April 12,2014]

$\lambda_R = 6600\,\text{Å}$

(A) 3300Å

(B) ~~4400Å~~

(C) 5500Å

(D) 6600Å

$d\sin\theta = \lambda_R \quad (n=1)$

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

$n=1$

$d\sin\theta = \frac{3\lambda}{2} \quad n=1$ for 1st Maxima.

$\lambda_R = \frac{3}{2}\lambda$

$\lambda = \frac{2}{3}\lambda_R = \frac{2}{3}\times 6600$

Q.15 The first diffraction minimum due to the single slit diffraction is seen at $\theta = 30^\circ$ for a light of wavelength 5000 Å falling perpendicularly on the slit. The width of the slit is **[Online May 12,2012]**

(A) 2.5×10^{-5} cm

(B) 1.25×10^{-5} cm

(C) 10×10^{-5} cm

(D) 5×10^{-5} cm

$a \sin 30^\circ = \lambda \quad n=1$

$a = 2\lambda$

$a = 2 \times 5 \times 10^{-7}$

$= 10 \times 10^{-7}$ m