WAVE OPTICS

1. In a Young's double slit experiment, the width of the one of the slit is three times the other slit. The amplitude of the light coming from a slit is proportional to the slit-width. Find the ratio of the maximum to the minimum intensity in the interference pattern.
(1) 1 : 4 (2) 3 : 1
(3) 4 : 1 (4) 2 : 1

2. 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 _______ Lumens.

3. If the source of light used in a Young's double slit experiment is changed from red to violet :
(1) consecutive fringe lines will come closer.
(2) the central bright fringe will become a dark fringe.
(3) the fringes will become brighter.
(4) the intensity of minima will increase.

4. Two coherent light sources having intensity in the ratio 2x produce an interference pattern. The ratio $\frac{I_{max}-I_{min}}{I_{max}+I_{min}}$ will be :
(1) $\frac{2\sqrt{2x}}{x+1}$ (2) $\frac{\sqrt{2x}}{2x+1}$
(3) $\frac{\sqrt{2x}}{x+1}$ (4) $\frac{2\sqrt{2x}}{2x+1}$

5. Consider the diffraction pattern obtained from the sunlight incident on a pinhole of diameter 0.1μm. If the diameter of the pinhole is slightly increased, it will affect the diffraction pattern such thtat :
(1) its size decreases, and intensity decreases
(2) its size increases, and intensity increases
(3) its size increases, but intensity decreases
(4) its size decreases, but intensity increases

6. In a Young's double slit experiment two slits are separated by 2 mm and the screen is placed one meter away. When a light of wavelength 500 nm is used, the fringe separation will be:
(1) 0.25 mm (2) 0.50 mm
(3) 0.75 mm (4) 1 mm

7. In Young's double slit arrangement, slits are separated by a gap of 0.5 mm, and the screen is placed at a distance of 0.5 m from them. The distance between the first and the third bright fringe formed when the slits are illuminated by a monochromatic light of 5890 Å is :-
(1) 1178×10^{-9} m (2) 1178×10^{-6} m
(3) 1178×10^{-12} m (4) 5890×10^{-7} m

8. A galaxy is moving away from the earth at a speed of 286 kms^{-1}. The shift in the wavelength of a red line at 630 nm is $x \times 10^{-10}$ m. The value of x, to the nearest integer, is_____.
[Take the value of speed of light c, as 3×10^8 ms^{-1}]

9. In the Young's double slit experiment, the distance between the slits varies in time as $d(t) = d_0 + a_0 \sin\omega t$; where d_0, ω and a_0 are constants. The difference between the largest fringe width and the smallest fringe width obtained over time is given as :
(1) $\frac{2\lambda D(d_0)}{(d_0^2 - a_0^2)}$ (2) $\frac{2\lambda D a_0}{(d_0^2 - a_0^2)}$
(3) $\frac{\lambda D}{d_0^2}a_0$ (4) $\frac{\lambda D}{d_0 + a_0}$

10. In Young's double slit experiment, if the source of light changes from orange to blue then :
(1) the central bright fringe will become a dark fringe.
(2) the distance between consecutive fringes will decrease.
(3) the distance between consecutive fringes will increase.
(4) the intensity of the minima will increase.

11. The difference in the number of waves when yellow light propagates through air and vacuum columns of the same thickness is one. The thickness of the air column is ______ mm. [Refractive index of air = 1.0003, wavelength of yellow light in vacuum = 6000 Å]

12. White light is passed through a double slit and interference is observed on a screen 1.5 m away. The separation between the slits is 0.3 mm. The first violet and red fringes are formed 2.0 mm and 3.5 mm away from the central white fringes. The difference in wavelengths of red and voilet light is .... nm.

13. 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 that the intensity of light on screen is I/2. P_2 should be rotated by an angle of .... (degrees) so that the intensity of light on the screen becomes $\frac{3I}{8}$.

14. The light waves from two coherent sources have same intensity $I_1 = I_2 = I_0$. In interference pattern the intensity of light at minima is zero.What will be the intensity of light at maxima ?

(1) I_0 (2) $2\ I_0$ (3) $5\ I_0$ (4) $4\ I_0$

15. A fringe width of 6 mm was produced for two slits separated by 1 mm apart. The screen is placed 10 m away. The wavelength of light used is 'x' nm. The value of 'x' to the nearest integer is ______.

16. In a Young's double slit experiment, the slits are separated by 0.3 mm and the screen is 1.5 m away from the plane of slits. Distance between fourth bright fringes on both sides of central bright is 2.4 cm. The frequency of light used is_____$\times 10^{14}$ Hz.

17. The width of one of the two slits in a Young's double slit experiment is three times the other slit. If the amplitude of the light coming from a slit is proportional to the slit-width, the ratio of minimum to maximum intensity in the interference pattern is x : 4 where x is _______.

SOLUTION

1. Official Ans. by NTA (3)

Sol. Amplitude $\propto$ Width of slit

$\Rightarrow A_2 = 3A_1$

$$\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{I_1}+\sqrt{I_2}}{|\sqrt{I_1}-\sqrt{I_2}|}\right)^2$$

$\because$ Intensity $I \propto A^2$

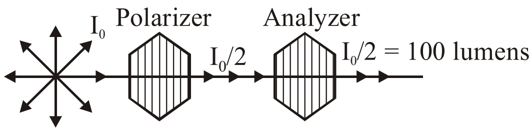
$$\Rightarrow \frac{I_{max}}{I_{min}} = \left(\frac{A_1+A_2}{|A_1-A_2|}\right)^2$$

$$= \left(\frac{A_1+3A_1}{|A_1-3A_1|}\right)^2$$

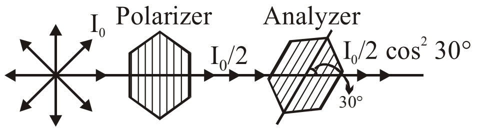
$$= \left(\frac{4A_1}{2A_1}\right)^2 = 4 : 1$$

2. Official Ans. by NTA (75)

Sol.



Assuming initially axis of Polarizer and Analyzer are parallel



Now emerging intensity = $\frac{I_0}{2}\cos^2 30°$

$$= 100\left(\frac{\sqrt{3}}{2}\right)^2 = 100 \times \frac{3}{4} = 75$$

Ans. 75

3. Official Ans. by NTA (1)

Sol. $\beta = \frac{\lambda.D}{d}$

$\lambda_R > \lambda_V$

$\beta_R = \frac{\lambda_R D}{d}$ and $\beta_V = \frac{\lambda_V D}{d}$

$\beta_R > \beta_V$

Fringe pattern will shrink.

Option (1) is correct.

4. Official Ans. by NTA (4)

Sol. Given that, $\frac{I_1}{I_2} = 2x$

We know,

$I_{max} = \left(\sqrt{I_1}+\sqrt{I_2}\right)^2$ & $I_{min} = \left(\sqrt{I_1}-\sqrt{I_2}\right)^2$

$$\therefore \frac{I_{max}-I_{min}}{I_{max}+I_{min}} = \frac{2\sqrt{I_1 I_2}}{I_1+I_2} = \frac{2\sqrt{I_1/I_2}}{\frac{I_1}{I_2}+1} = \frac{2\sqrt{2x}}{2x+1}$$

5. Official Ans. by NTA (4)

Sol. $\sin\theta = \frac{m\lambda}{a}$

when a increases, θ decreases,

width decreases

width decreases so intensity will increases

6. Official Ans. by NTA (1)

Sol. $\beta = \frac{\lambda D}{d} = \frac{500\times10^{-9}\times1}{2\times10^{-3}}$

$\beta = \frac{5}{2}\times10^{-4}\,m = 2.5\times10^{-1}\,mm$

b = 0.25 mm

7. Official Ans. by NTA (2)

Sol. $\beta = \frac{\lambda D}{d} = \frac{5890\times10^{-10}\times0.5}{0.5\times10^{-3}}$

$= 589 \times 10^{-6}$ m

Distance between first and third bright fringe is

$2\beta = 2\times589\times10^{-6}$ m

$= 1178\times10^{-6}$ m Ans. (2)

8. Official Ans. by NTA (6)

Sol. $\frac{\Delta\lambda}{\lambda}c = v$

$\Delta\lambda = \frac{v}{c}\times\lambda = \frac{286}{3\times10^5}\times630\times10^{-9}$

$= 6\times10^{-10}$

9. Official Ans. by NTA (2)

Sol. Fringe Width, $\beta = \frac{\lambda D}{d}$

$\beta_{max} \Rightarrow d_{min}$ and $\beta_{min} \Rightarrow d_{max}$

$d = d_0 + a_0 \sin\omega t$

$d_{max} = d_0 + a_0$ and $d_{min} = d_0 - a_0$

$\therefore \beta_{min} = \frac{\lambda D}{d_0+a_0}$ and $\therefore \beta_{max} = \frac{\lambda D}{d_0-a_0}$

$$\beta_{max}-\beta_{min} = \frac{\lambda D}{d_0-a_0}-\frac{\lambda D}{d_0+a_0} = \frac{2\lambda D a_0}{d_0^2-a_0^2}$$

10. Official Ans. by NTA (2)

Sol. Fringe width = $\lambda D/d$

as λ decreases, fringe width also decreases

11. Official Ans. by NTA (2)

Sol. Thickness $t = n\lambda$

So, $n\,\lambda_{vac} = (n+1)\,\lambda_{air}$

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

$$n = \frac{1}{\mu_{air}-1} = \frac{10^4}{3}$$

$t = n\lambda$

$$= \frac{10^4}{3}\times 6000\text{Å} = 2\text{ mm}$$

12. Official Ans. by NTA (300)

Sol. Position of bright fringe $y = n\frac{D\lambda}{d}$

$$y_1 \text{ of red} = \frac{D\lambda_r}{d} = 3.5\text{mm}$$

$$\lambda_r = 3.5\times10^{-3}\frac{d}{D}$$

Similarly $\lambda_v = 2\times10^{-3}\frac{d}{D}$

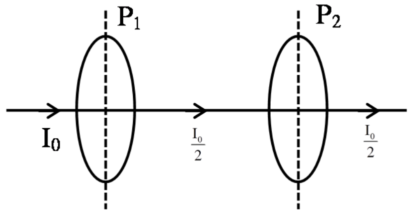
$$\lambda_r - \lambda_v = \left(1.5\times10^{-3}\right)\left(\frac{0.3\times10^{-3}}{1.5}\right)$$

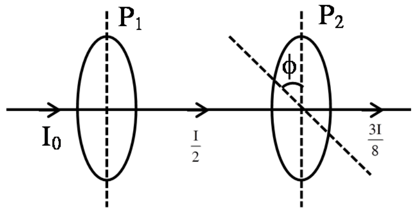
$= 3\times10^{-7} = 300$ nm

Ans. 300.0

13. Official Ans. by NTA (30)

Sol. $I = \frac{I_0}{2}\cos^2\phi$





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

$$\cos^2\phi = \frac{3}{4}$$

$$\cos^2\phi = \frac{\sqrt{3}}{2} \Rightarrow \phi = 30$$

Ans. 30

14. Official Ans. by NTA (4)

Sol. $I_{max} = \left(\sqrt{I_1}+\sqrt{I_2}\right)^2 = 4I_o$

15. Official Ans. by NTA (600)

Sol. $\beta = \frac{\lambda D}{d}$; $\lambda = \frac{\beta d}{D}$

$$\lambda = \frac{6\times10^{-3}\times10^{-3}}{10}$$

$\lambda = 6\times10^{-7}$ m $= 600\times10^{-9}$ m

$\lambda = 600$ nm

16. Official Ans. by NTA (5)

Sol. $8\beta = 2.4$ cm; $\frac{8\lambda\Delta}{d} = 2.4$ cm

$$\frac{8\times1.5\times c}{0.3\times10^{-3}\times f} = 2.4\times10^{-2}$$

$f = 5\times10^{14}$ Hz

17. Official Ans. by NTA (1)

Sol. Given amplitude $\propto$ slit width

Also intensity $\propto$ (Amplitude)^2 $\propto$ (Slit width)^2

$$\frac{I_1}{I_2} = \left(\frac{3}{1}\right)^2 = 9 \Rightarrow I_1 = 9I_2$$

$$\frac{I_{min}}{I_{max}} = \left(\frac{\sqrt{I_1}-\sqrt{I_2}}{\sqrt{I_1}+\sqrt{I_2}}\right)^2 = \left(\frac{3-1}{3+1}\right)^2 = \frac{1}{4} = \frac{x}{4}$$

$\Rightarrow x = 1.00$