DPP – 1 (Wave Optics)

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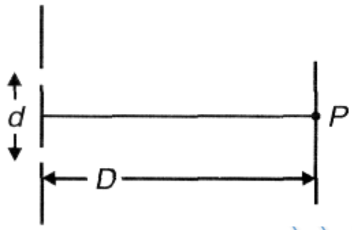
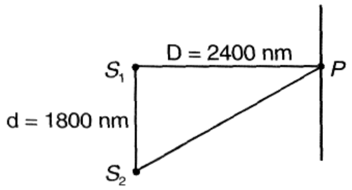
Q 1. In a Young's double slit experiment, two slits of equal width allow to pass light of equal intensity. If we cover one slit by dark strip intensity at point P



(a)Must decrease and becomes 1/2 times
(b)Must increase
(c)Must decrease and becomes 1/4 times
(d)Must increase and becomes 4 times

Q 2. In a YDSE apparatus, d=2 mm, λ = 600 nm, D = 1 m. The slits produce same intensity on the screen. Find the position of point where intensity is 3/4 times of maximum intensity
(a) 0.01 mm (b)13 × 10^{-4} mm (c) 0.05 mm (d)1.5×10^{-4} mm

Q 3. White light is used for interference, for how many waves, we get maximum at point P?



(a) 1 (b)2 (c) 3 (d)7

Q 4. Light waves travel in vacuum along the y-axis, which of the following may represent the wave fronts?
(a) y = c (b) x+ y= c (c) z = c (d) x = c

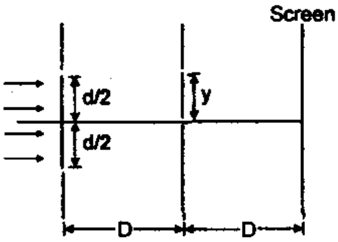
Q 5. In YDSE, how many maximas can be obtained on a screen including central maxima) in both sides of the central fringe if λ= 3000Å, d = 5000Å
(a) 2 (b)5 (c) 3 (d)1

Q 6. In a YDSE biochromatic light of wavelengths 400 nm and 560 nm are used. The distance between the slits is 0.1 mm and the distance between the plane of the slits and the screen is 1 m. The minimum distance between two successive regions of complete darkness is
(a) 4 mm (b)5.6 mm (c)14 mm (d)28 mm

Q 7. The maximum intensity in Young's double slit experiment is I_o Distance between the slits is d = 5λ, where λ is the wavelength of monochromatic light used in the experiment. What will be the intensity of light in front of one of the slits on a screen at a distance D = 10 d?

(a) $\frac{I_o}{2}$ (b) $\frac{3}{4}I_o$ (c) I_o (d) $\frac{I_o}{4}$

Q 8. In the Young's double slit experiment apparatus shown in figure, the ratio of maximum to minimum intensity on the screen is 9. The wavelength of light used is λ, then the value of y is:



(a) $\frac{\lambda D}{d}$ (b) $\frac{\lambda D}{2d}$ (c) $\frac{\lambda D}{3d}$ (d) $\frac{\lambda D}{4d}$

Q 9. In a Young's double slit experiment, 12 fringes are observed to be formed in a certain segment of the screen when light of wavelength 600 urn is used. If the wavelength of light is changed to 400 nm and distance between plane of slits and screen is increased to two times, number of fringes observed in the same segment of the screen is given by:

(a) 12 (b) 9 (c) 24 (d) 30

Q 10. Yellow light emitted by sodium lamp in Young's double slit experiment is replaced by monochromatic blue light of the same intensity –

(a) Fringe width will decrease
(b) Fringe width will increase
(c) Fringe width will remain unchanged
(d) Fringes will become less intense

Q 11. A double slit is illuminated by two wavelengths 450 nm and 600 nm. What is the lowest order at which the maxima of one wavelength coincides with the minima of the other wavelength ?

(a) 1 (b) 2 (c) 3 (d) 4

Q 12. If the first minima in a Young's slit experiment occurs directly in front of one of the slits. (distance between slit & screen D = 12 cm and distance between slits d = 5 cm) then the wavelength of the radiation used is:

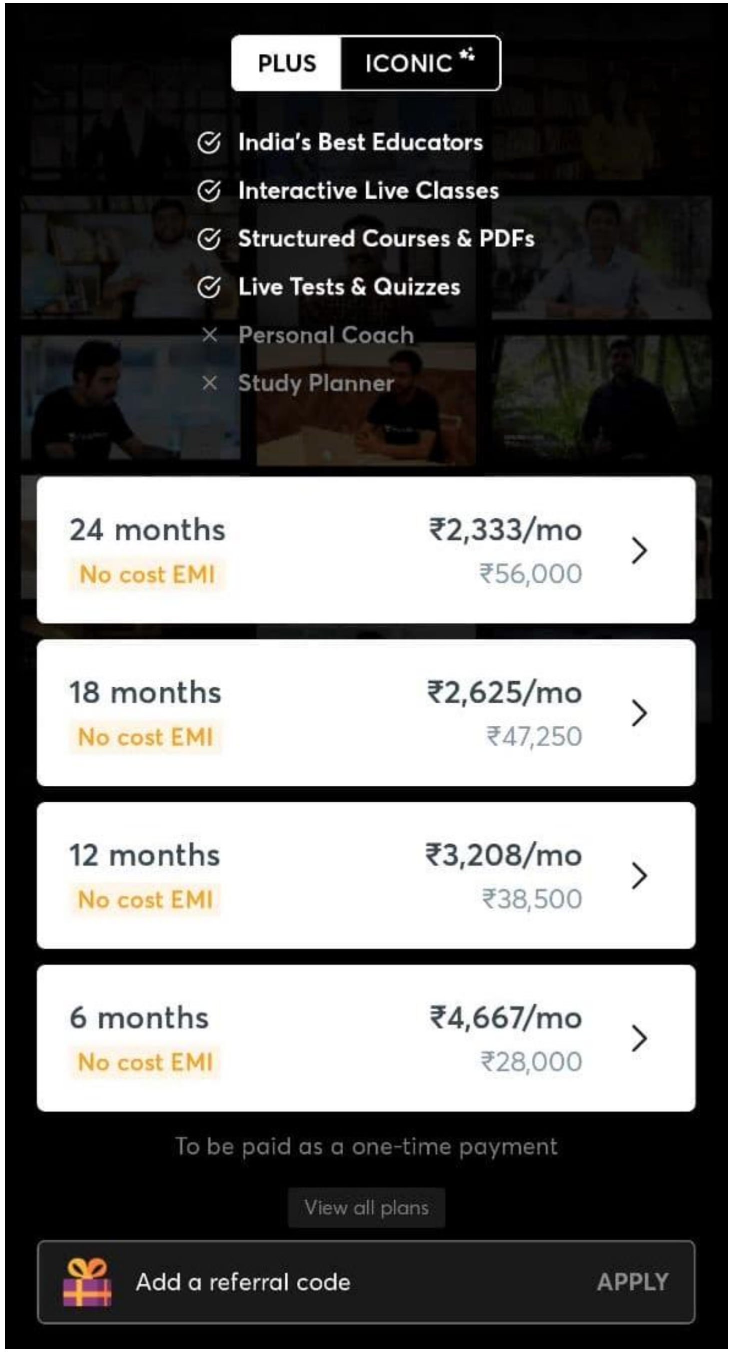
(a) 2 cm only (b) 4 cm only (c) 2cm, $\frac{2}{3}$cm, $\frac{2}{5}$ cm (d) 4 cm, $\frac{4}{3}$cm, $\frac{4}{5}$ cm

Q 13. In Y.D.S.E. if screen is extended to infinity and distance between slits is d = 20.3λ, where λ is wavelength of light used, Find total no of minima on screen?

(a) 41 (b) 42 (c) 40 (d) 44

Answer Key

Q.1 c	Q.2 c	Q.3 a	Q.4 a	Q.5 c
Q.6 d	Q.7 a	Q.8 c	Q.9 b	Q.10 a
Q.11 d	Q.12 a	Q.13 c		



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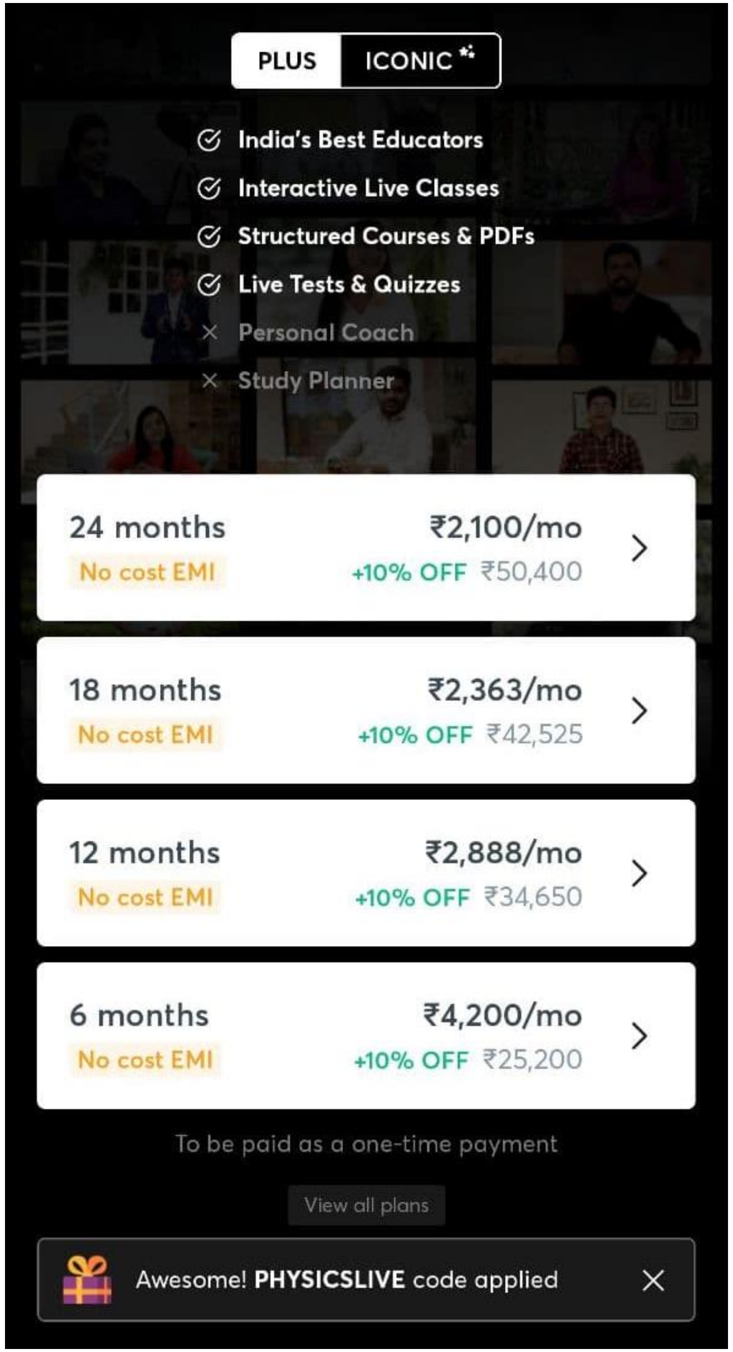

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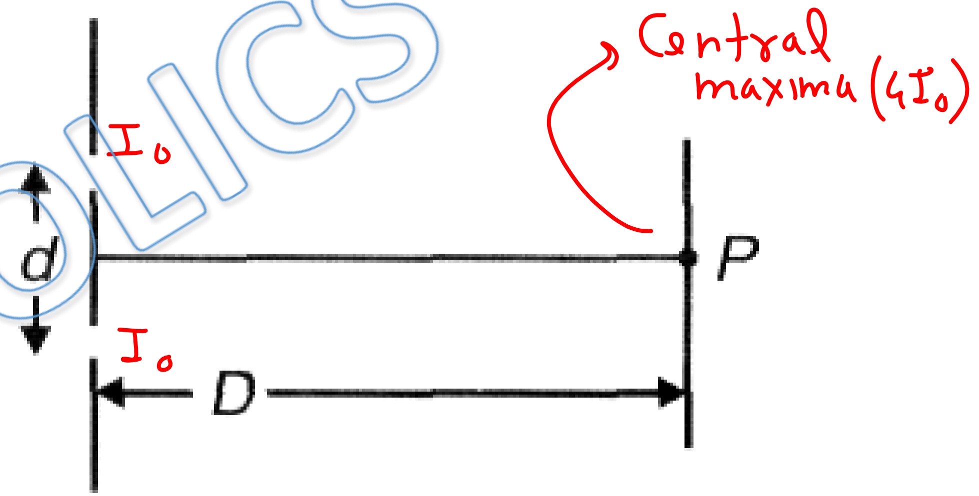
Written Solution

DPP-1 Wave Optics: Wavefront, Interference, Standard YDSE

By Physicsaholics Team

Q1) In a Young's double slit experiment, two slits of equal width allow to pass light of equal intensity. If we cover one slit by dark strip intensity at point P

initial intensity = $4I_0$
final ,, = I_0



(a)Must decrease and becomes 1/2 times

(b)Must increase

(c)Must decrease and becomes 1/4 times ✓

(d)Must increase and becomes 4 times

Q2) In a YDSE apparatus, d=2 mm, λ = 600 nm, D = 1 m. The slits produce same intensity on the screen. Find the position of point where intensity is 3/4 times of maximum intensity

Let intensity due to each slit = I_0

max intensity = $4I_0$

$\frac{3}{4}$ of max intensity = $4I_0 \times 3/4 = 3I_0$

$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$$

$$3I_0 = I_0 + I_0 + 2\sqrt{I_0 I_0}\cos\phi$$

$$I_0 = 2I_0\cos\phi$$

$$\cos\phi = 1/2$$

$$\phi = 2n\pi \pm \pi/3$$

$$\frac{2\pi}{6\times10^{-7}}\delta x = \left(2n\pi \pm \pi/3\right)$$

$$\delta x = 3\times10^{-7}\left(2n \pm 1/3\right)$$

$$\frac{x \times 2\times10^{-3}}{1} = 3\times10^{-7}\left(2n \pm 1/3\right)$$

$$x = \frac{3}{2}\times10^{-4}\left(2n \pm 1/3\right)\ m$$

$$x_{min} = \frac{3}{2}\times10^{-4}\times\frac{1}{3}\ m$$

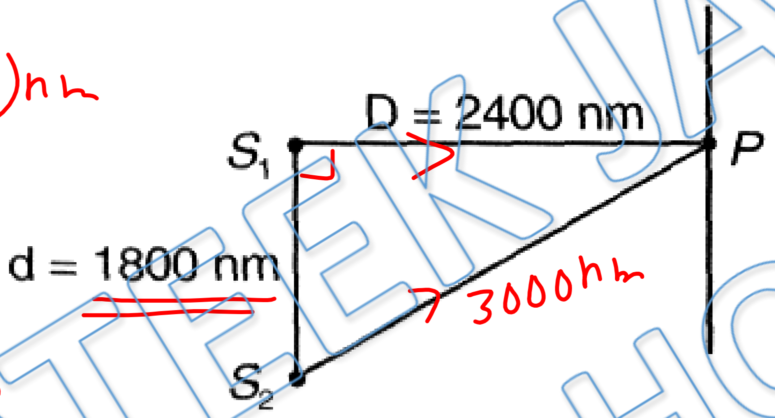
$$= 0.5\times10^{-4}\ m$$

$$= .05\ mm$$

(a) 0.01 mm (b) 13×10^{-4} mm

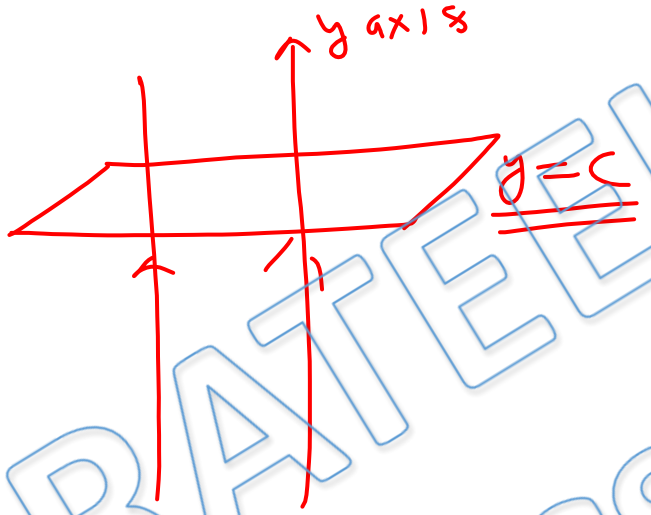
(c) 0.05 mm ✓ (d) 1.5×10^{-4} mm

Q3) White light is used for interference, for how many waves, we get maximum at point P?



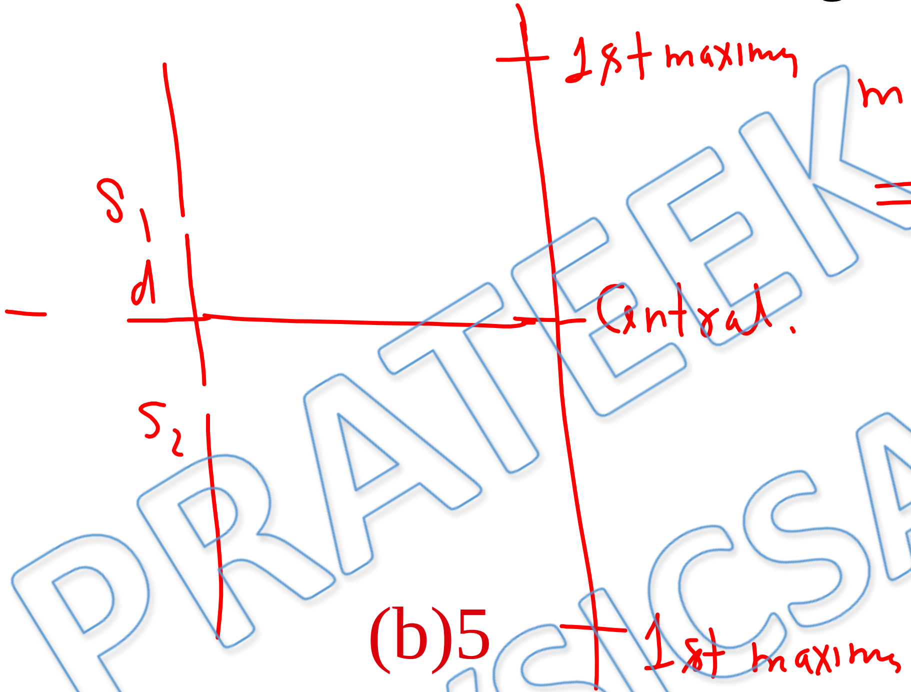
(a) 1 (b)2 (c) 3 (d)7

Q4) Light waves travel in vacuum along the y-axis, which of the following may represent the wave fronts?



(a) y = c (b) x+ y= c (c) z = c (d) x = c

Q5) In YDSE, how many maximas can be obtained on a screen including central maxima) in both sides of the central fringe if $\lambda = 3000Å$, $d = 5000Å$



max order of maxima $= \left[\frac{d}{\lambda}\right] = \left[\frac{5}{3}\right] = 1$

(a) 2 (b)5 (c) 3 (d)1

n_1^{th} min $\quad n_2^{th}$ minima

Q6) In a YDSE biochromatic light of wavelengths 400 nm and 560 nm are used. The distance between the slits is 0.1 mm and the distance between the plane of the slits and the screen is 1 m. The minimum distance between two successive regions of complete darkness is

minima of both

$$x = (2n_1 - 1)\frac{400 D \text{ nm}}{2d} = (2n_2 - 1)\frac{560 D \text{ nm}}{2d}$$

$$\frac{2n_1 - 1 \text{ (odd)}}{2n_2 - 1 \text{ (odd)}} = \frac{560}{400} = \frac{14}{10} = \frac{7}{5} = \frac{14}{10} = \frac{21}{15} = \ldots$$

for first position of complete darkness $2n_1 - 1 = 7 \Rightarrow n_1 = 4$

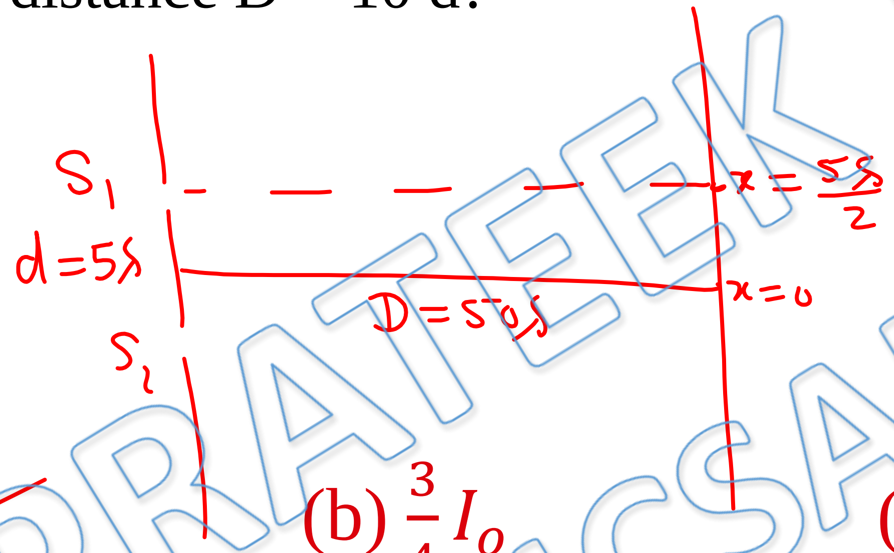
(a) 4 mm (b)5.6 mm (c)14 mm (d)28 mm ✓

for Second position of " " $2n_1 - 1 = 21 \Rightarrow n_1 = 11$

Distance b/w 4^{th} & 11^{th} minima of 400 nm

$$= \frac{7}{2}\frac{\lambda_1 D}{d} \sim \frac{21}{2}\frac{\lambda_1 D}{d} = \frac{7\lambda_1 D}{d} = \frac{7 \times 4 \times 10^{-7} \times 1}{10^{-4}} = 28 \times 10^{-3}\text{ m} = 28\text{ mm}$$

Q7) The maximum intensity in Young's double slit experiment is I_o Distance between the slits is d = 5λ, where λ is the wavelength of monochromatic light used in the experiment. What will be the intensity of light in front of one of the slits on a screen at a distance D = 10 d?



max intensity $= I_0$

intensity due to one slit $= I_0/4$

$\Delta x = \frac{xd}{D} = \frac{5\lambda \times 5\lambda}{2 \times 50\lambda} = \lambda/4$

$\phi = \frac{2\pi}{\lambda}\Delta x = \pi/2$

(a) $\frac{I_o}{2}$ (b) $\frac{3}{4}I_o$ (c) I_o (d) $\frac{I_o}{4}$

$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$

$= \frac{I_0}{4} + \frac{I_0}{4} + 2\sqrt{\frac{I_0}{4}\frac{I_0}{4}}\cos\pi/2$

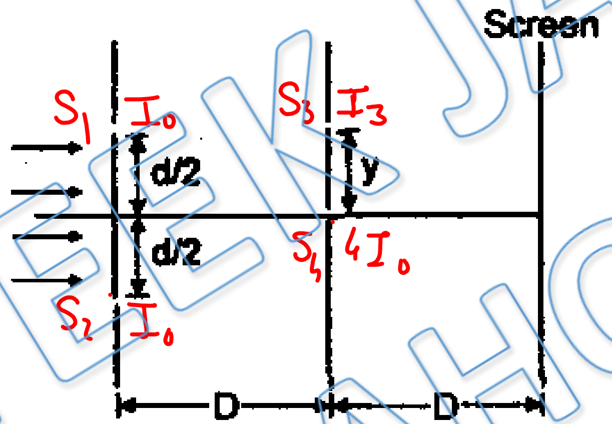
$= I_0/2$

Q8) In the Young's double slit experiment apparatus shown in figure, the ratio of maximum to minimum intensity on the screen is 9. The wavelength of light used is λ, then the value of y is:

Let ϕ is phase difference at $S_3 \rightarrow$

$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$

$I_0 = I_0 + I_0 + 2I_0\cos\phi$



$\frac{I_{max}}{I_{min}} = \frac{9}{1}$

$\left(\frac{\sqrt{I_3} + \sqrt{4I_0}}{-\sqrt{I_3} + \sqrt{4I_0}}\right)^2 = 9$

(a) $\frac{\lambda D}{d}$ (b) $\frac{\lambda D}{2d}$ (c) $\frac{\lambda D}{3d}$ (d) $\frac{\lambda D}{4d}$

$\cos\phi = -\frac{1}{2}$

$\phi = 2\pi/3 = \frac{2\pi}{\lambda}\Delta x \Rightarrow \Delta x = \lambda/3$

$\frac{xd}{D} = \lambda/3 \Rightarrow x = \frac{\lambda D}{3d}$

$\frac{\sqrt{I_3} + 2\sqrt{I_0}}{2\sqrt{I_0} - \sqrt{I_3}} = 3$

$\sqrt{I_3} + 2\sqrt{I_0} = 6\sqrt{I_0} - 3\sqrt{I_3}$

$4\sqrt{I_3} = 4\sqrt{I_0}$

$I_3 = I_0$

Q9) In a Young's double slit experiment, 12 fringes are observed to be formed in a certain segment of the screen when light of wavelength 600 ~~um~~ nm is used. If the wavelength of light is changed to 400 nm and distance between plane of slits and screen is increased to two times, number of fringes observed in the same segment of the screen is given by:

no of fringes $= \dfrac{\ell d}{\lambda D}$ → length of segment of screen

$N = \dfrac{\ell d}{\lambda D}$

$\dfrac{N_1}{N_2} = \dfrac{\lambda_2 D_2}{\lambda_1 D_1}$

(a) 12 (b) 9 (c) 24 (d) 30

$\dfrac{12}{N_2} = \dfrac{400}{600} \times 2$

$N_2 = 9$

Q10) Yellow light emitted by sodium lamp in Young's double slit experiment is replaced by monochromatic blue light of the same intensity -

$$W = \frac{\lambda D}{d}$$

$$\lambda_{blue} < \lambda_y$$

(a) Fringe width will decrease ✓

(b) Fringe width will increase

(c) Fringe width will remain unchanged

(d) Fringes will become less intense

V
I
B
G
Y
O
R

Increasing λ ↓

n_1th maxima n_2th minima

Q11) A double slit is illuminated by two wavelengths 450 nm and 600 nm. What is the lowest order at which the maxima of one wavelength coincides with the minima of the other wavelength ?

$$x = \frac{n_1\, 450\,\text{nm}\, D}{d} = \frac{(2n_2-1)\, 600\,\text{nm}\, D}{2d}$$

$$\frac{n_1}{2n_2-1} = \frac{600}{450} = \frac{4}{3} = \frac{12}{9} = \frac{20}{15} = \cdots$$

integer (n_1), odd ($2n_2-1$)

(a) 1   (b) 2   (c) 3   (d) 4

$n_1 = 4$

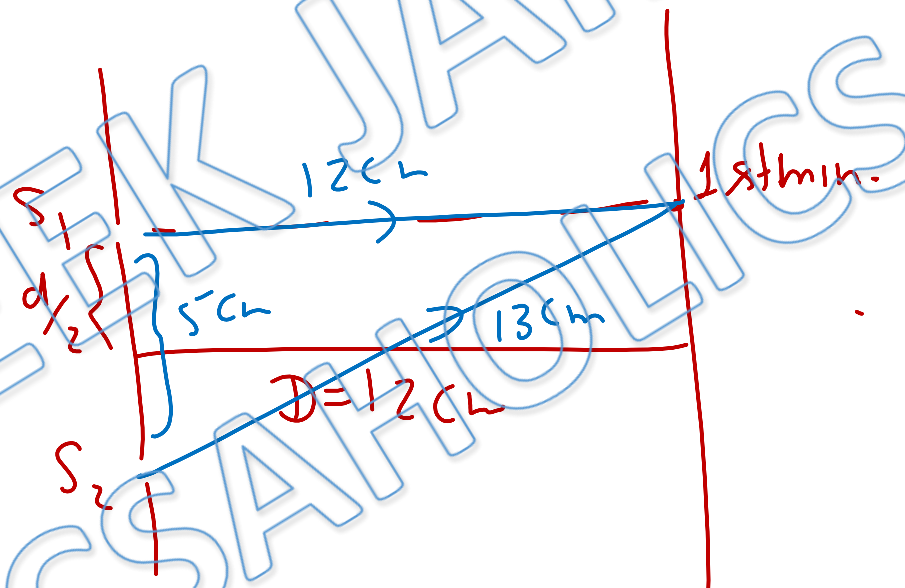
Q12) If the first minima in a Young's slit experiment occurs directly infront of one of the slits. (distance between slit & screen D = 12 cm and distance between slits d = 5 cm) then the wavelength of the radiation used is :

(a) 2 cm only ✓

(b) 4 cm only

(c) 2cm, $\frac{2}{3}$cm , $\frac{2}{5}$ cm

(d) 4 cm, $\frac{4}{3}$cm, $\frac{4}{5}$ cm



Hence D is not very much greater than d

$\Delta x = 13 - 12 = 1$ cm

for first minima $\Delta x = \lambda/2 = 1$ cm

$\lambda = 2$ cm

Q13) In Y.D.S.E. if screen is extended to infinity and distance between slits is d = 20.3λ, where λ is wavelength of light used, Find total no of minima on screen?

(a) 41

(b) 42

(c) 40

(d) 44

Let n^{th} minima is at $x = \infty$

at ∞, $\Delta x = d = (2n-1)\lambda/2$

$2n-1 = \frac{2d}{\lambda} = 2 \times 20.3 = 40.6$

$2n = 41.6$

$n = 20.8$

max order of minima $= [20.8] = 20$

total no of minima $= 40$

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