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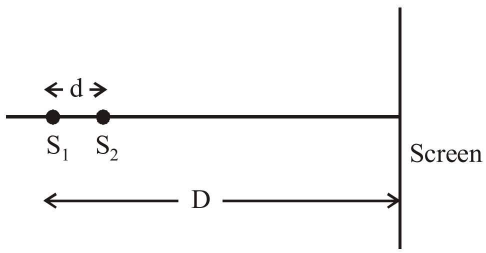
WAVE OPTICS

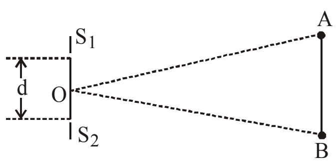
Diagram Based Questions :

1. Two coherent point sources S_1 and S_2 are separated by a small distance 'd' as shown in figure. The fringes obtained on the screen will be



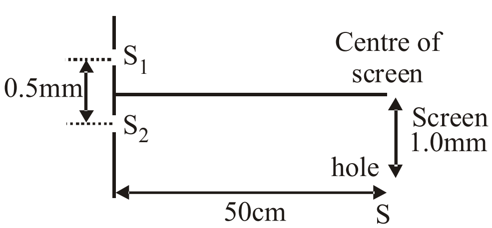
(a) points (b) straight lines
(c) semi-circles (d) concentric circles

2. Figure shows two coherent sources S_1 and S_2 vibrating in same phase. AB is an irregular wire lying at a far distance from the sources S_1 and S_2. Let $\frac{\lambda}{d} = 10^{-3}$ and $\angle BOA = 0.12°$. How many bright spots will be seen on the wire, including points A and B?



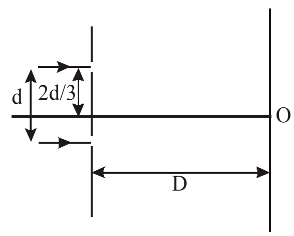
(a) 5 (b) 4
(c) 3 (d) 7

3. In Young's double slit experiment shown in figure S_1 and S_2 are coherent sources and S is the screen having a hole at a point 1.0mm away from the central line. White light (400 to 700nm) is sent through the slits. Which wavelength passing through the hole has strong intensity?



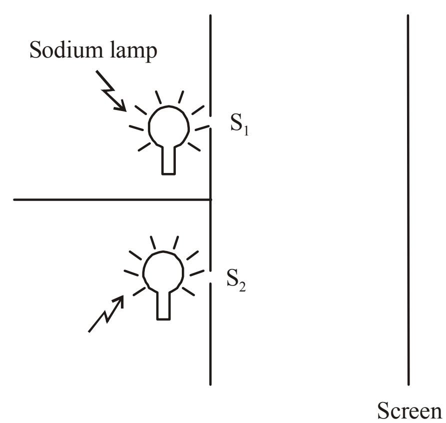
(a) 400 nm (b) 700 nm
(c) 500 nm (d) 667 nm

4. In the figure shown if a parallel beam of white light is incident on the plane of the slits then the distance of the
nearest white spot on the screen from O is d/A. Find the value of A. (assume d << D, λ << d]



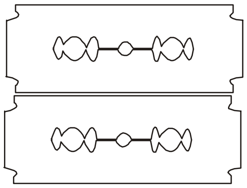
(a) 3 (b) 5
(c) 6 (d) 4

5. For the given arrangement, the screen will have



(a) interference pattern with central maxima
(b) interference pattern with central minima
(c) two separate interference patterns with central maxima
(d) doubly illuminated screen with no interference pattern at all

6. A single-slit-diffraction pattern, through following arrangement using an electric bulb as the source of light only will be



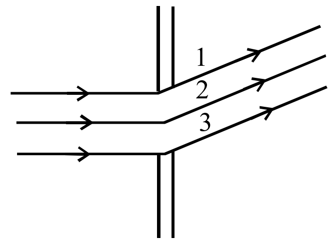
(a) central dark fringe followed by bright fringe of red colour

(b) central bright fringe followed by dark fringe than bands of varying intensity

(c) central bright fringe followed by dark fringe then wider red fringes and narrower blue fringes.

(d) central bright fringe followed by dark fringe then wider blue fringes followed by narrower red fringes.

7. The figure shows Fraunhoffer's diffraction due to a single slit. If first minimum is obtained in the direction shown, then the path difference between rays 1 and 3 is



(a) 0 (b) $\lambda/4$

(c) $\lambda/2$ (d) λ

Solution

1. **(d)** It will be concentric circles.

2. **(c)** Angular width $= \frac{\lambda}{d} = 10^{-3}$ (given)

$\therefore$ No. of fringes within 0.12° will be

$$n = \frac{0.12 \times 2\pi}{360 \times 10^{-3}} \cong [2.09]$$

$\therefore$ The number of bright spots will be three.

3. **(c)** Wavelength for which maximum obtained at the hole has the maximum intensity on passing. So,

$$x = \frac{n\lambda D}{d}$$

$$\lambda = \frac{xd}{nD} = \frac{1 \times 10^{-3} \times 0.5 \times 10^{-3}}{n \times 50 \times 10^{-2}}$$

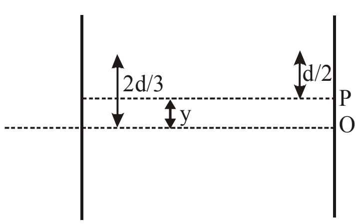
$$= \frac{1 \times 10^{-6}}{n} = \frac{1000\text{nm}}{n}$$

$n = 1$, $\lambda = 1000$ nm $\rightarrow$ Not in the given range

$n = 2$, $\lambda = 500$nm

4. **(c)** The nearest white spot will be at P, the central maxima.

$$\therefore\ y = \frac{2d}{3} - \frac{d}{2} = \frac{d}{6}$$



5. **(d)** Light waves coming out of two independent sources do not have any fixed phase difference as they undergo phase changes in time of the order of 10^{-10}s.
Hence, the sources are incoherent and the intensities on the screen just add up. Hence no interference fringer will be observed on the screen.

6. **(c)** The position of all the bands depends on the wavelength, higher the wavelength, wider is the band.

7. **(c)** In Fraunhoffer diffraction, for minimum intensity,

$$\Delta x = m\frac{\lambda}{2}$$

For first minimum, m = 1

$$\therefore\ \Delta x = \frac{\lambda}{2}$$