Physicsaholics

DPP – 1 (Wave Optics)

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Q 1. Two sources of light are said to be coherent if they emit light of
(a) same intensity (b) same amplitude
(c) same frequency (d) none of these

Q 2. Two coherent sources of light can be obtained by
(a) Two different lamps
(b) Two different lamps but of the same power
(c) Two different lamps of same power and having the same colour
(d) None of the above

Q 3. Two identical light sources S_1 and S_2 emit light of same wavelength λ. These light rays will exhibit interference if
(a) Their phase differences remain constant
(b) Their phases are distributed randomly
(c) Their light intensities remain constant
(d) Their light intensities change randomly

Q 4. Two coherent monochromatic light beams of intensities I and 4I are superposed. The maximum and minimum possible intensities in the resulting beam are
(a) 5I & I (b) 5I & 3I
(c) 9I & I (d) 9I & 3I

Q 5. Two coherent light sources S_1 and S_2 (λ=6000Å) are 1mm apart from each other. The screen is placed at a distance of 25cm from the sources. The width of the fringes on the screen should be
(a) 0.015 cm (b) 0.025 cm
(c) 0.010 cm (d) 0.030 cm

Q 6. In a YDSE setup, by using light of wavelength 5000Å, 5mm wide fringes are obtained on a screen 1.0m away from the coherent sources. The separation between the two coherent sources is
(a) 1 mm (b) 0.1 mm
(c) 0.05 mm (d) 0.01 mm

Q 7. Bi-chromatic light of wavelengths $\lambda_1 = 5000$ Å and $\lambda_2 = 7000$ Å are used in YDSE. Then,
(a) 14^{th} order maxima of λ_1 will coincide with 10^{th} order maxima of λ_2
(b) 21^{st} order maxima of λ_2 will coincide with 15^{th} order maxima of λ_1
(c) 11^{th} order minima of λ_1 will coincide with 8^{th} order minima of λ_2

(d) Both A & C

Q 8. Bi-chromatic light is used in YDSE having wavelengths λ_1 = 400nm and λ_2 = 700nm. Find minimum order of bright fringe of λ_1 which overlaps with bright fringe of λ_2.
(a) 7^{th} (b) 5^{th}
(c) 3^{rd} (d) 8^{th}

Q 9. Two wavelengths of light λ_1 and λ_2 are sent through Young's double slit experiment simultaneously. If the third order bright fringe of λ_1 coincides with fifth order dark fringe of λ_2, then
(a) $3\lambda_1 = 5\lambda_2$ (b) $2\lambda_1 = 3\lambda_2$
(c) $3\lambda_1 = 2\lambda_2$ (d) $5\lambda_1 = 3\lambda_2$

Q 10. The fringe width at a distance of 50 cm from the slits in young's experiment for light of wavelength 6000Å is 0.048cm. The fringe width at the same distance for λ = 5000Å will be
(a) 0.04 cm (b) 0.4 cm
(c) 0.14 cm (d) 0.45 cm

Q 11. In Young's double slit experiment, while using a source of light of wavelength 4500 Å , the fringe width obtained is 0.4 cm. If the distance between the slit and the screen is reduced to half , calculate the new fringe width.
(a) 0.4 cm (b) 0.8 cm
(c) 0.2 cm (d) 0.08 cm

Q 12. In Young's double-slit experiment using λ=6000Å, distance between the screen and the source is 1m. If the fringe-width on the screen is 0.06 cm, the distance between the two coherent sources is
(a) 0.01 mm (b) 1 cm
(c) 0.01 cm (d) 1 mm

Q 13. In the interference pattern, energy is
(a) Created at the position of maxima
(b) Destroyed at the position of minima
(c) Conserved but is redistributed
(d) None of the above

Q 14. The maximum intensity of fringes in Young's experiment is I. If one of the identical slit is closed, then the intensity at that place becomes I_o. Which of the following relation is true?
(a) $I = I_o$ (b) $I = 2I_o$
(c) $I = 4I_o$ (d) There is no relation between I and I_o

Q 15. In Young's double slit experiment the amplitudes of two sources are 3a and a respectively. The ratio of intensities of bright and dark fringes will be
(a) 3 : 1 (b) 4 : 1
(c) 2 : 1 (d) 9 : 1

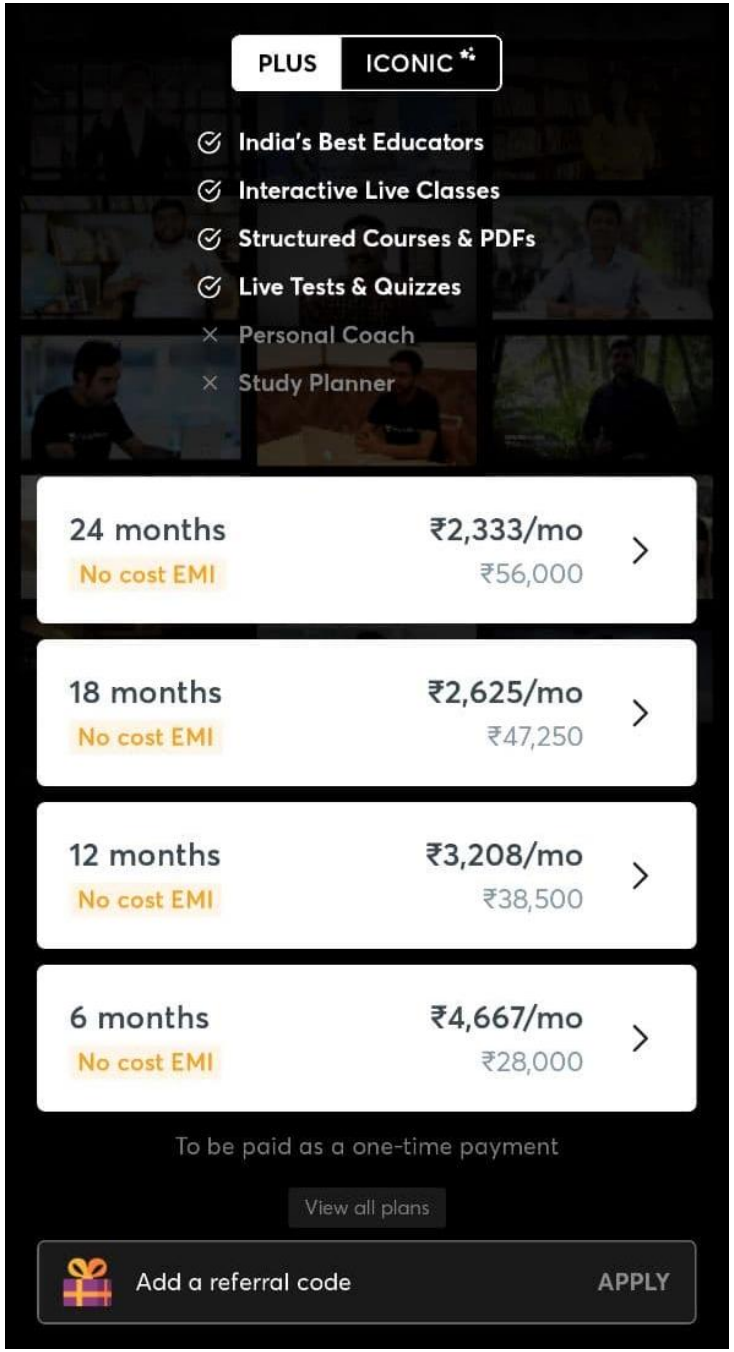
Q 16. In Young's double slit experiment, the ratio of maximum and minimum intensities in the fringe system is 9:1 the ratio of amplitudes of coherent sources is
(a) 9 : 1 (b) 3 : 1
(c) 2 : 1 (d) 1 : 1

Q 17. The ratio of intensities of minima to maxima in Young's double slit experiment is 9:25. Find the ratio of width of two slits.
(a) 16 : 1 (b) 4 : 1
(c) 8 : 1 (d) 9 : 25

Q 18. In a double slit experiment, 5th dark fringe is formed opposite to one of the slits. The wavelength of light is :
(a) $\frac{d^2}{6D}$ (b) $\frac{d^2}{5D}$
(c) $\frac{d^2}{15D}$ (d) $\frac{d^2}{9D}$

Answer Key

Q.1 c	**Q.2 d**	**Q.3 a**	**Q.4 c**	**Q.5 a**
Q.6 b	**Q.7 d**	**Q.8 a**	**Q.9 b**	**Q.10 a**
Q.11 c	**Q.12 d**	**Q.13 c**	**Q.14 c**	**Q.15 b**
Q.16 c	**Q.17 a**	**Q.18**		



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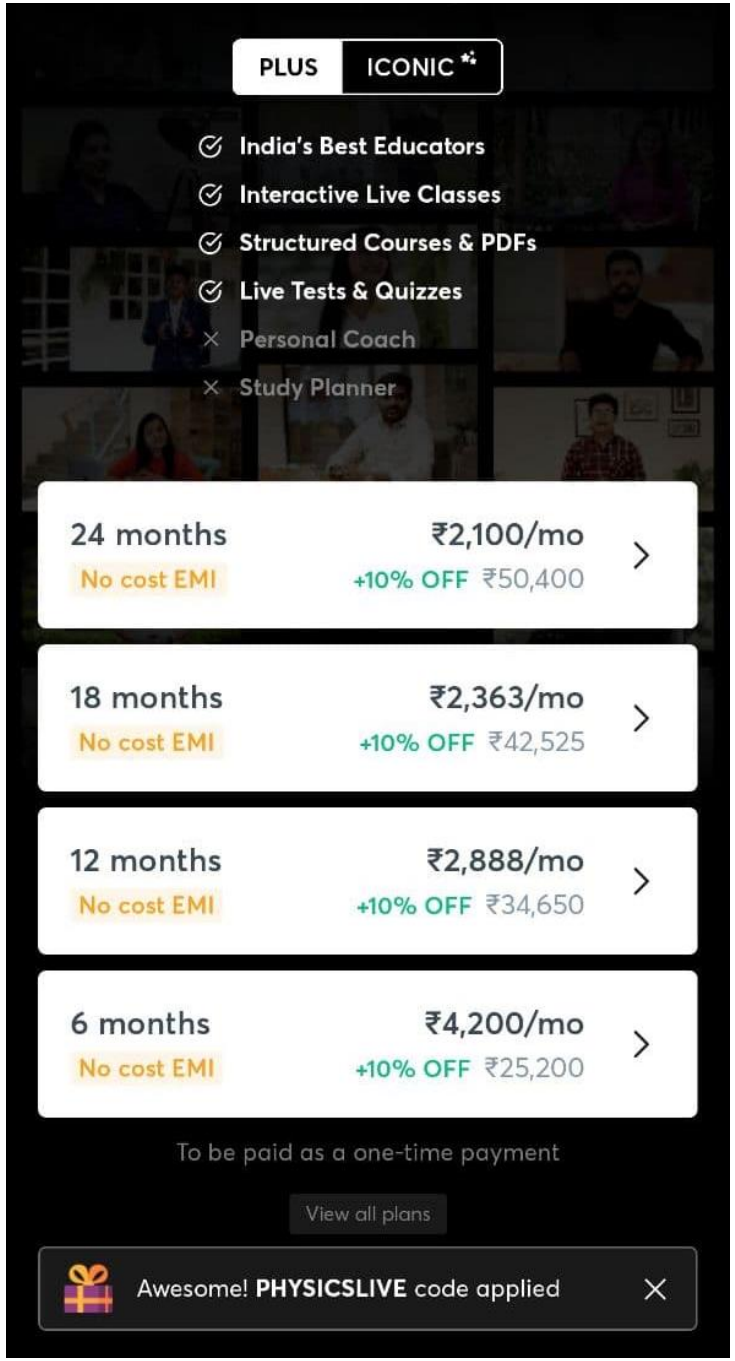

Written Solution

DPP-1 Wave Optics: Interference, YDSE

By Physicsaholics Team

Solution: 1

For coherent sources frequency must be same and phase difference must be constant.

Ans. c

Solution: 2

The coherent source cannot be obtained from two different light sources.

Ans. d

Solution: 3

For interference pattern phase difference must be constant.

Ans. a

Solution: 4

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

$$= \left(\sqrt{I} + \sqrt{4I}\right)^2$$

$$= \left(3\sqrt{I}\right)^2$$

$$\boxed{I_{max} = 9I}$$ Ans.

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

$$= \left(\sqrt{I} - \sqrt{4I}\right)^2$$

$$= \left(\sqrt{I} - 2\sqrt{I}\right)^2$$

$$= \left(-1\sqrt{I}\right)^2$$

$$\boxed{I_{min} = I}$$ Ans.

Ans. c

Solution: 5

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

$$\beta = \frac{6000 \times 10^{-10} \times 25 \times 10^{-2}}{1 \times 10^{-3}}$$

$$\beta = 6 \times 25 \times 10^{-6}$$

$$\beta = 150 \times 10^{-6}\ m$$

$$\beta = 0.150 \times 10^{-3}\ m$$

$$\boxed{\beta = 0.150\ mm}$$

Ans.

or

$$\boxed{\beta = 0.015\ cm}$$

Ans. a

Solution: 6

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

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

$$d = \frac{5000 \times 10^{-10} \times 1}{5 \times 10^{-3}}$$

$$d = 10^{-4}\ m$$

$$\boxed{d = 0.1\ mm}$$ Ans.

Ans. b

Solution: 7

$$n\beta_1 = m\beta_2$$

$$n\left(\frac{d_1 D}{d}\right) = m\left(\frac{d_2 D}{d}\right)$$

$n\lambda_1 = m\lambda_2$ (for overlapping maxima)

$$\frac{n}{m} = \frac{d_2}{d_1} = \frac{7000\ \text{Å}}{5000\ \text{Å}}$$

$$\boxed{\frac{n}{m} = \frac{7}{5}}$$ Ans.

$$\frac{n}{m} = \frac{7}{5} = \frac{14}{10}, \frac{21}{15} \cdots$$

when; $n = 14$

then; $m = 10$ Ans.

for overlapping minima

$$(2n-1)\frac{d_1 D}{2d} = (2m-1)\frac{d_2 D}{2d}$$

$$(2n-1)d_1 = (2m-1)d_2$$

$$\frac{2n-1}{2m-1} = \frac{d_2}{d_1} = \frac{7}{5}$$

$$\frac{2n-1}{2m-1} = \frac{7}{5} = \frac{14}{10} = \frac{21}{15} \cdots$$

when; $2n-1 = 21 \Rightarrow n = 11$

then; $2m-1 = 15 \Rightarrow m = 8$] Ans.

Ans. d

Solution: 8

for maxima overlap

$$n\lambda_1 = m\lambda_2$$

$$\frac{n}{m} = \frac{\lambda_2}{\lambda_1} = \frac{700\,nm}{400\,nm}$$

$$\boxed{\frac{n}{m} = \frac{7}{4}}$$

$$\boxed{n_{min} = 7^{th} \text{ maxima}}$$ Ans.

7^{th} maxima of λ_1 overlaps with 4^{th} maxima λ_2.

Ans. a

Solution: 9

given; $n = 3^{rd}$ maxima

$m = 5^{th}$ minima

$y_1 = y_2$

$n \frac{\lambda_1 D}{d} = (2m-1) \frac{\lambda_2 D}{2d}$

$3 \lambda_1 = (2\times5-1) \frac{\lambda_2}{2}$

$3 \lambda_1 = \frac{9\lambda_2}{2}$

$6 \lambda_1 = 9 \lambda_2$

$\Rightarrow \boxed{2\lambda_1 = 3\lambda_2}$

Ans. b

Solution: 10

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

$\beta \propto \lambda$ [if D & d are same]

$$\Rightarrow \frac{\beta_1}{\beta_2} = \frac{\lambda_1}{\lambda_2}$$

$$\frac{0.04}{\beta_2} = \frac{6000}{5000}$$

$$\beta_2 = \frac{5}{6} \times 0.048$$

$$\beta_2 = 0.04 \text{ cm} \quad \text{Ans.}$$

Ans. a

Solution: 11

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

$$\beta \propto D$$

$$\frac{\beta_1}{\beta_2} = \frac{D_1}{D_2}$$

if $D_1 = D$

then $D_2 = D/2$

so $\frac{\beta_1}{\beta_2} = \frac{D}{D/2} = 2$

$\beta_2 = \beta_1/2$

$\beta_2 = 0.4/2$

$\beta_2 = 0.2\ cm$ Ans

Ans. c

Solution: 12

$\lambda = 6000\ \text{Å}$

$D = 1\ m$

$\beta = 0.06\ cm$

$d = ?$

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

$$0.06 \times 10^{-2} = \frac{6000 \times 10^{-10} \times 1}{d}$$

$$d = \frac{6000 \times 10^{-10} \times 1}{6 \times 10^{-4}}$$

$$d = 10^{-3}\ m$$

$$\boxed{d = 1\ mm}$$ Ans.

Ans. d

Solution: 13

In interference of light the energy is transferred from the region of destructive interference to the region of constructive interference. The average energy being always equal to the sum of the energies of the interfering waves. Thus the phenomenon of interference is in complete agreement with the law of conservation of energy.

Ans. c

Solution: 14

$\because \quad I_1 = I_2 = I_0$

then; $I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

$I_{max} = I$

$I = \left(\sqrt{I_0} + \sqrt{I_0}\right)^2 = \left(2\sqrt{I_0}\right)^2$

$\boxed{I = 4I_0}$

Ans. c

Solution: 15

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

$$\frac{I_{max}}{I_{min}} = \left(\frac{3a + a}{3a - a}\right)^2 = \left(\frac{4a}{2a}\right)^2$$

$$\boxed{\frac{I_{max}}{I_{min}} = \frac{4}{1}}$$ Ans.

Ans. b

Solution: 16

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

$$\frac{I_{max}}{I_{min}} = \left(\frac{a_1 + a_2}{a_1 - a_2}\right)^2$$

$$\frac{9}{1} = \left(\frac{\frac{a_1}{a_2} + 1}{\frac{a_1}{a_2} - 1}\right)^2$$

$$\frac{3}{1} = \frac{a_1/a_2 + 1}{a_1/a_2 - 1}$$

$$\Rightarrow 3\frac{a_1}{a_2} - 3 = \frac{a_1}{a_2} + 1$$

$$2\frac{a_1}{a_2} = 4$$

$$\Rightarrow \boxed{\frac{a_1}{a_2} = \frac{2}{1}}$$ Ans

Ans. c

Solution: 17

$$\frac{I_{min}}{I_{max}} = \left(\frac{\sqrt{I_1} - \sqrt{I_2}}{\sqrt{I_1} + \sqrt{I_2}}\right)^2 = \frac{9}{25}$$

$$\Rightarrow \quad \frac{\sqrt{I_1} - \sqrt{I_2}}{\sqrt{I_1} + \sqrt{I_2}} = \frac{3}{5} \Rightarrow 5\sqrt{I_1} - 5\sqrt{I_2} = 3\sqrt{I_1} + 3\sqrt{I_2}$$

$$\Rightarrow \quad 2\sqrt{I_1} = 8\sqrt{I_2} \Rightarrow I_1 = 16 I_2$$

$I \propto$ width of slit

$$\Rightarrow \frac{w_1}{w_2} = \frac{I_1}{I_2} = \frac{16}{1}$$

Ans (a)

Solution: 18

Dark fringe:

$$y = (2n-1)\frac{\lambda}{2}\frac{D}{d}$$

5th dark

$$y = (2\times5-1)\frac{\lambda}{2}\frac{D}{d}$$

$$y = \frac{9\lambda D}{2d}$$

given $y = \frac{d}{2}$

then $\frac{d}{2} = \frac{9\lambda D}{2d}$

$$d^2 = 9\lambda D$$

$$\boxed{\lambda = \frac{d^2}{9D}}$$ Ans

Ans. d

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