JEE MAIN ANSWER KEY & SOLUTIONS

SUBJECT :- PHYSICS
CLASS :- 12th **PAPER CODE :- CWT-8**
CHAPTER :- WAVE OPTICS

ANSWER KEY

1.	(B)	**2.**	(C)	**3.**	(D)	**4.**	(C)	**5.**	(A)	**6.**	(D)	**7.**	(B)
8.	(D)	**9.**	(B)	**10.**	(D)	**11.**	(C)	**12.**	(D)	**13.**	(B)	**14.**	(C)
15.	(A)	**16.**	(C)	**17.**	(D)	**18.**	(A)	**19.**	(C)	**20.**	(D)	**21.**	3
22.	198	**23.**	30	**24.**	17	**25.**	5	**26.**	2	**27.**	3	**28.**	2
29.	3	**30.**	3										

SOLUTIONS

1. (B)

Sol. $I \propto A^2$

$$\frac{I_{max}}{I_{min}} = 16, \quad \frac{A_{max}}{A_{min}} = 4, \quad \Rightarrow \left(\frac{A_1 + A_2}{A_1 - A_2}\right) = \frac{4}{1}$$

Using component & divined.

$$\frac{A_1}{A_2} = \frac{5}{3} \Rightarrow \frac{I_1}{I_3} = \left(\frac{5}{3}\right)^2 = \frac{25}{9}$$

2. (C)

Sol. If a thin film of mica is placed in front of slit S_1 then the pattern is shifted upwards and if the thin mica sheet is place in front of S_2 then the pattern will shit downwards.

There will be no change in the fringe-width as there is no change in the distance D between the slits and the screen; no change in the distance d between the slits and the wavelength λ.

3. (D)

Sol. We have I_1 and I_2 as 16 and 9.

$$\frac{I_{max}}{I_{min}} = \frac{(\sqrt{I_1} + \sqrt{I_2})}{(\sqrt{I_2} - \sqrt{I_2})^2} = \frac{(4+3)^2}{(4-3)^2} = \frac{49}{1}$$

4. (C)

Sol. $w = \frac{2\lambda D}{a}$, $w_1 = \frac{2\lambda D}{a}$, $w_2 = \frac{\lambda D}{6.1 \times a}$

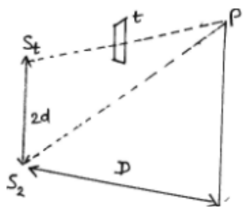
Then, $n = \frac{W_1}{W_2}$, $\Rightarrow n = \frac{\frac{2\lambda D}{a}}{\frac{\lambda D}{6.1 \times a}}$

$\Rightarrow n = 12.2$

Since n must be a whole number,
Therefore, n = 12.
Thus, the number of maxima of double-slit interference that will be observed within the width of central maxima of single-slit diffraction is n = 12.

5. (A)

Sol.



Displacement is due to extra path different

$$\frac{y(2d)}{D} = (\mu - 1)t, \quad y = \frac{2tD}{3(2d)} = \frac{tD}{3d}$$

$$y = \frac{tD}{3d}$$

6. (D)

Sol. Young's double slit experiment proved beyond a shadow of a doubt that light is a wave. The superposition of light from two slits produces an interference pattern.
Step 1 : Explanation
Light with a single wavelength is referred to as monochromatic.
As a result, the interference fringes created on the screen have a straight line shape.

7. (B)

Sol. Given - λr=6600Ao
The angular position of first minimum for red light of wavelength λr, is given by

$\sin\theta_1 = \frac{\lambda_r}{a}$ eq1

The angular position of first maximum for other light of wavelength λ is given by

$\sin\theta_1' = \frac{3\lambda}{2a}$ eq2

As given, the first minimum for red light coincides with the first maximum for other light, hence

$\sin\theta_1 = \sin\theta_1$

or $\frac{\lambda_r}{a} = \frac{3\lambda}{2a}$

or $\lambda = \frac{2\lambda_r}{3}$

or $\lambda = \frac{2 \times 6600}{3} = 4400\text{Å}$

8. (D)

Sol. In the arrangement shown, the unpolarised light is incident at polarising angle of 90° – 33° = 57°. The reflected light is thus plane polarised light. When plane polarised light is passed through a Polaroid (a polariser or analyser), the intensity gradually reduces to zero and finally increases.

9. (B)

Sol. Since the incident light is unpolarized, the intensity of transmitted light at an angle θ with respect to the polarizing axis is: $I=I_0\cos^2\theta$

Integrating over all angles between 0^0 and 360^0 is $I_0(\cos^2\theta)_{avg} = \frac{I_0}{2}$

Hence, the intensity of light not transmitted is $I_0 - \frac{I_0}{2} = \frac{I_0}{2}$

10. (D)

Sol. Here, $\upsilon = 1.2 \times 10^6$ m/s

As $\upsilon = \frac{\Delta\lambda}{\lambda} \times c$

$\therefore \frac{\Delta\lambda}{\lambda} = \frac{\upsilon}{c} = \frac{1.2\times10^6}{3\times10^8} = 0.4\times10^{-2}$

$= 0.4 \times 10^{-2} \times 100$

$= 0.4$ %

11. (C)

12. (D)

Sol. In such case we can find the resultant intensity by

$\vec{I} = \vec{I}_1 + \vec{I}_2$ where $|\vec{I}_1| = |\vec{I}_2|$

For first $\frac{\lambda}{3}$ corresponds to phase difference of $\frac{2\pi}{3}$. Thus resultant intensity will be equal to intensity of Interfering wave.

For second $\frac{\lambda}{6}$ corresponds to phase difference of $\frac{\pi}{3}$. Thus resultant intensity will be 3 to intensity of Interfering wave.

For third $\frac{\lambda}{4}$ corresponds to phase difference of $\frac{\pi}{2}$. Thus resultant intensity will be 2 to intensity of Interfering wave.

13. (B)

Sol. Since the value of 'μ' is maximum on the axis of the beam. Hence the speed of light in the medium is minimum on the axis of the beam.

14. (C)

Sol. The correct option is A 2:1

Given, path difference at point P, $\Delta x_1 = 0$

$\Rightarrow \Delta\phi_1 = 0°$

$\therefore I_1 = I_0 + I_0 + 2I_0\cos 0° = 4I_0$

Similarly, path difference at point Q, $\Delta x_2 = \frac{\lambda}{4}$

$\Rightarrow \Delta\phi_2 = \frac{2\pi}{\lambda}.\frac{\lambda}{4} = \left(\frac{\pi}{2}\right)$

$\therefore I_2 = I_0 + I_0 + 2I_0 \cos\left(\frac{\pi}{2}\right) = 2I_0$

$\therefore \frac{I_1}{I_2} = \frac{4I_0}{2I_0} = \frac{2}{1}$

15. (A)

Sol. Since $D_m = (\mu - 1)A$

& on increasing the

wavelength, μ decreases

Hence D_m decreases. Therefore correct answer is (B)

16. (C)

Sol. The correct option is A 0.853

Given, Path difference, $\Delta x = \frac{\lambda}{8}$

Phase differences, $\Delta\phi = \frac{2\pi}{\lambda}\Delta x = \frac{2\pi}{\lambda}\times\frac{\lambda}{8} = \frac{\pi}{4}$

Relation of intensity with phase difference is

$I = I_0\cos^2\left(\frac{\Delta\phi}{2}\right)$

Here I_0 is intensity of central bright fringe

On substitution,

$\Rightarrow \frac{I}{I_o} = \cos^2\left(\frac{\frac{\pi}{4}}{2}\right) = \cos^2\left(\frac{\pi}{8}\right)$

$\Rightarrow \frac{I}{I_o} = 0.853$

17. (D)

Sol. The intensity of light at maxima is :

$I_{max}=(I_1+I_2)^2$

$I_{max}=(I_o+I_o)^2$

$\Rightarrow I_{max}=4I_o$

18. (A)

19. (C)

Sol. $10\ \beta_1 = 10 \times \frac{\lambda D}{\mu d}$

in liquid

$\beta_2 = \frac{\lambda D}{d}$

$6\beta_2 = 10\beta_1$

$\frac{6\lambda D}{d} = \frac{10\lambda D}{\mu d}$

$\mu = \frac{10}{6} = 1.67$

20. (D)

Sol. Coherent sources produce light of same frequency and of constant phase difference.

21. k = 3

Sol. $W \propto I$

$\frac{I_1}{I_2} = \frac{4}{1}$

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

$\frac{I_{max}}{I_{min}} = \left(\frac{3}{1}\right)^2$

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

22. 198

Sol. For obtaining secondary minima at a point, path difference should be integral multiple of wavelength

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

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

For n to be maximum, $\sin\theta = 1$

$\therefore$ $n = \frac{d}{\lambda} = \frac{6\times 10^{-5}}{6\times 10^{-7}}$ =100

Total number of minima on one side =99

$\therefore$ Total number of minima =198.

23. 30

Sol. Diameter d=2r=2×0.25=0.5cm,

The wavelength of light

is λ =500nm=5×10^{-7}m.

We have the formula $\sin\theta = \frac{1.22\lambda}{d}$

or

$\sin\theta = \frac{1.22\times5\times10^{-7}}{0.5\times10^{-2}} = 1.22\times10^{-4}$

Also D=25cm

Let x be the minimum separation between two objects that the human eye can resolve.

Thus $\sin\theta = \frac{x}{D}$

or

$x = D\sin\theta = .25\times1.22\times10^{-4} = 30\times10^{-6} = 30\mu m$

24. 17

Sol. Speed of observer $V = \frac{C}{2}$

where speed of Microwave is C

Original frequency of source is given as $f_0 = 10GH_2$

Using relativistic Doppler effect in case observer moves towards the stationary source.

Apparent frequency measured by observer $f' = f_0\sqrt{\frac{C+v'}{C-v'}}$

$f' = 10\sqrt{\frac{C+(C/2)}{C-(C/2)}}$

$f' = 10\sqrt{\frac{(3/2)C}{(1/2)C}}$

$F' = 10\times1.73GH_z$

$F' = 17.3GH_z$

25. 5

Sol. Limit of resolution of eye = $\theta = \frac{1.22\lambda}{D}$

$= \frac{1.22\times5\times10^{-7}}{3\times10^{-3}} = 2.03\times10^{-4}$ rad

$\theta = \frac{1mm}{x} = \frac{10^{-3}}{x}$ = 2.03×10^{-4} rad

$x = \frac{10^{-3}}{2.03\times10^{-4}} = 5m$

26. 2

Sol. Angular fringe width $\theta_\beta = \frac{\beta}{D} = \frac{\lambda}{d}$

According to the given condition

$$\frac{\lambda}{d} \geq \frac{\pi}{180 \times 60}$$

$$d < \frac{6 \times 10^{-7} \times 180 \times 60}{\pi}$$

$d_{max} = 2.06 \times 10^{-3}$ m

$d_{max} = 2.06$ mm

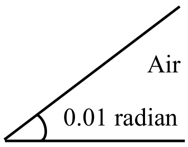
27. 3

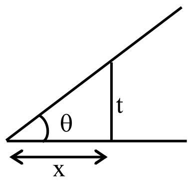
Sol. $\theta = 0.01$ radian

$n = 10$

$\lambda = 6000 \times 10^{-8}$ cm

$\Delta x = 2t = n\lambda$





$\theta = \frac{t}{x}$

$t = \theta x$

$2\theta x = n\lambda$

$x = \frac{n\lambda}{2\theta}$

$= 3 \times 10^{-1}$ cm

28. 2

Sol. When coherent then Δx at centre = 0

$\therefore I_{net} = 4I$

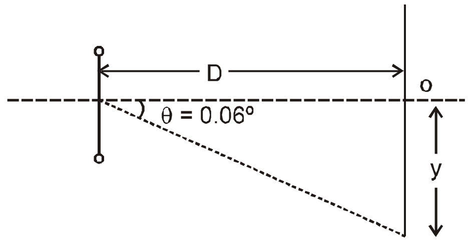
when Incoherent

$I'_{net} = I + I = 2I$

Ratio $= \frac{I_{net}}{I'_{net}} = \frac{2}{1} = 2$

29. 3

Sol.



Say 'n' fringes are present in the region shown by 'y'

$\Rightarrow \quad y = n\beta = \frac{n\lambda D}{d}$

$\Rightarrow \quad \frac{y}{D} \approx \tan(0.06^\circ) \approx \frac{0.06 \times \pi}{180} = \frac{n\lambda}{d}$

$\Rightarrow \quad n = \frac{10^3 \times \pi}{180} \times 0.06 = \frac{\pi}{3} > 1.$

Hence; only one maxima above and below point O. So total 3 bright spots will be present (including point 'O' i.e. the central maxima).

30. 3

Sol. At B; $\Delta P = 4\lambda$ (maxima)

At $x = \infty$; $\Delta P = 0$ (maxima)

Hence in between; the point at which path difference is either λ, or 2λ or 3λ $\rightarrow$ they will be maximas. Hence 3 maximas.