



Attempt all questions before checking the answer key.
Use small-angle approximations for Young's experiment.
Draw labelled wavefront/ray sketches.

A. Very short answers - 1 mark each

1. Define a wavefront and give one example.
2. What are coherent sources?
3. Why cannot two independent lamps normally give a sustained interference pattern?
4. What happens to fringe width if slit separation is doubled in Young's experiment?
5. Why is diffraction appreciable only when aperture size is comparable to wavelength?

B. Short answers / practice - 2 marks each

6. Distinguish wavefronts from rays and show their relative orientation.
7. In Young's experiment, $\lambda = 600 \text{ nm}$, $D = 2 \text{ m}$ and slit spacing $= 0.5 \text{ mm}$. Find fringe width.
8. State the path-difference conditions for constructive and destructive interference.
9. What happens to a Young's interference pattern when the arrangement is immersed in water of refractive index $4/3$?
10. Explain why the central maximum in single-slit diffraction is wider than secondary maxima.
11. Can coherent sources have different frequencies?
12. Find fringe width for $\lambda = 500 \text{ nm}$, $D = 2 \text{ m}$, $d = 1 \text{ mm}$.
13. A dark fringe has path difference $3\lambda/2$. Find phase difference.
14. What changes in Young's pattern if one slit is closed?
15. Find wavelength if fringe width is 1.2 mm , $d = 0.5 \text{ mm}$ and $D = 1 \text{ m}$.
16. Does interference violate energy conservation?
17. Two equal waves each have intensity 2 units. Find maximum combined intensity.
18. Explain the wavefront shape produced by a point source far from the observer.
19. If screen distance is halved, how does fringe width change?
20. State the phase difference at a bright fringe.

C. Short answers - 3 marks each

21. Two coherent sources of equal intensity I_0 have phase difference $\pi/3$ at a point. Find resultant intensity and compare it with the maximum.

22. Young's fringes are 2 mm wide at screen distance 1.5 m for slit spacing 0.45 mm . Find wavelength and position of the third bright fringe from the central bright fringe.

23. A thin transparent sheet is inserted before one slit in Young's experiment. Explain why the pattern shifts, which way it shifts and why spacing remains unchanged.

24. Describe the effects on single-slit diffraction when slit width is reduced, wavelength is increased and the screen is moved farther away.

25. Compare interference and diffraction patterns in terms of origin, spacing and intensity distribution.

D. Long answers - 5 marks each

26. State Huygens' principle and use it to prove the laws of reflection at a plane surface. Draw the construction and identify incident and reflected wavefronts.
27. Use Huygens' construction to derive Snell's law of refraction. Relate refractive index to wave speed and explain bending towards the normal.
28. Describe Young's experiment, the conditions for sustained interference and the fringe-width formula (without deriving it). Calculate spacing for $\lambda = 500 \text{ nm}$, $D = 1.2 \text{ m}$ and $d = 0.3 \text{ mm}$, then discuss doubling λ or d .
29. Explain single-slit diffraction qualitatively using secondary wavelets. Sketch intensity distribution and discuss how the central width changes with wavelength and slit width.
30. Two coherent slits produce waves with individual intensities I and $4I$. Obtain maximum and minimum resultant intensities and their ratio. Explain why the minima are not dark and what changes if the sources lose coherence.

ANSWER KEY - Numerical / short answers

- 4) It halves. 7) 2.4 mm . 9) Fringe width becomes $3/4$ of its original value. 11) No, sustained coherence requires the same frequency and a constant phase difference. 12) 1 mm . 13) 3π radians, equivalent to π modulo 2π . 15) 600 nm . 16) No; energy is redistributed. 17) 8 units. 19) It halves. 20) $2n\pi$, n an integer. 21) $3I_0$; $3/4$ of maximum $4I_0$. 22) 600 nm ; third bright fringe at $\pm 6 \text{ mm}$. 28) 2 mm ; doubling λ doubles width, doubling d halves width. 30) $I_{\text{max}} = 9I$; $I_{\text{min}} = I$; ratio $9:1$; incoherent mean intensity $= 5I$.