

Wave Optics — CBSE Pattern Test 1

Class 12 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 1 — CBSE Pattern (90 minutes, 40 marks)

Class 12 Physics · Wave Optics · Narayan Gurukul Academy (ClassApna)

General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.

(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.

(3) For MCQ questions choose the single correct option; for VSA answers write a single line.

(4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

1. Huygens' principle states that every point on a wavefront acts as a

- (A) source of secondary wavelets
- (B) sink of energy
- (C) node
- (D) antinode

2. For sustained interference, the two sources must be

- (A) coherent
- (B) incoherent
- (C) of different frequencies
- (D) of different amplitudes

3. The fringe width in an interference pattern is

- (A) $\beta = \lambda D/d$
- (B) $\beta = \lambda d/D$
- (C) $\beta = Dd/\lambda$
- (D) $\beta = \lambda dD$

4. If the slit separation is doubled, the fringe width

- (A) halves
- (B) doubles
- (C) remains the same
- (D) becomes four times

5. The condition for a minimum in single-slit diffraction is

- (A) $a \sin\theta = m\lambda$
- (B) $a \sin\theta = (2m+1)\lambda/2$
- (C) $a \cos\theta = m\lambda$
- (D) $a \sin\theta = \lambda$

6. The width of the central maximum in single-slit diffraction is

- (A) $2\lambda D/a$
- (B) $\lambda D/a$
- (C) $\lambda D/2a$
- (D) aD/λ

7. Polarisation of light shows that light waves are

- (A) transverse

- (B) longitudinal
 - (C) stationary
 - (D) mechanical
8. When unpolarised light passes through a polariser, its intensity
- (A) becomes half
 - (B) remains the same
 - (C) doubles
 - (D) becomes zero
9. State Huygens' principle.
10. What are coherent sources?

Section B — Short Answer I ($4 \times 2 = 8$ marks)

11. In YDSE the slits are 2 mm apart and the screen is 1 m away. If the wavelength is 600 nm, find the fringe width.
12. A single slit of width 0.1 mm is illuminated by 500 nm light. Find the angular width of the central maximum.
13. State Brewster's law and write the relation between the polarising angle and the refractive index.
14. State the conditions for a bright and a dark fringe in terms of path difference.

Section C — Short Answer II ($4 \times 3 = 12$ marks)

15. State Huygens' principle and use it to derive Snell's law of refraction.
16. Derive the expression for the fringe width in Young's double-slit experiment.
17. Derive the conditions for minima and secondary maxima in single-slit diffraction.
18. Explain polarisation by reflection and derive Brewster's law.

Section D — Long Answers ($2 \times 5 = 10$ marks)

19. Describe Young's double-slit experiment. Derive the condition for constructive and destructive interference and obtain the expression for the fringe width. State how the pattern changes when the apparatus is immersed in water.
20. What is diffraction of light? Derive the conditions for the minima and the secondary maxima in the single-slit diffraction pattern and obtain the expression for the width of the central maximum.

Answer Key (Marking Scheme)

- Q1 — (A) source of secondary wavelets. Q2 — (A) coherent. Q3 — (A) $\beta = \lambda D/d$. Q4 — (A) halves.
- Q5 — (A) $a \sin \theta = m\lambda$. Q6 — (A) $2\lambda D/a$. Q7 — (A) transverse. Q8 — (A) becomes half.
- Q9 — Every point on a wavefront is a source of secondary wavelets that spread out; the envelope gives the new wavefront.
- Q10 — Sources with a constant phase difference and the same frequency.
- Q11 — $\beta = \lambda D/d = 0.3$ mm.
- Q12 — $\theta = \lambda/a = 500 \times 10^{-9} / 0.1 \times 10^{-3} = 5 \times 10^{-3}$ rad.
- Q13 — At the polarising angle the reflected and refracted rays are perpendicular; $\tan i_p = n$.
- Q14 — Bright: path difference = $m\lambda$; dark: path difference = $(2m-1)\lambda/2$.
- Q15 — Draw secondary wavelets; the common tangent gives the refracted wavefront; geometry gives $\sin i / \sin r = v_1/v_2 = n$.

Q16 — Path difference = $d \sin \theta = dx/D$; bright $dx/D = m\lambda$, dark $dx/D = (2m-1)\lambda/2$; $\beta = \lambda D/d$.

Q17 — Divide the slit into parts; path difference $a \sin \theta$; minima at $a \sin \theta = m\lambda$, secondary maxima at $a \sin \theta = (2m+1)\lambda/2$.

Q18 — At the polarising angle the reflected light is fully polarised; using Snell's law with $i_p + r = 90^\circ$ gives $\tan i_p = n$.

Q19 — See Q16; bright/dark conditions and $\beta = \lambda D/d$; in water λ decreases, so β decreases by the factor n .

Q20 — See Q17; central maximum width = $2\lambda D/a$.