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Wave Optics — CBSE Class 12 Physics Chapter Test

FREE CHAPTER TEST · CLASS XII · PHYSICS (042) · PATTERN OF THE CBSE SAMPLE QUESTION PAPER 2026-27

TIME ALLOWED	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
1½ hours	37	17 (A 8 · B 3 · C 3 · D 1 · E 2)	

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 17 questions. All questions are compulsory.
2. This question paper is divided into five sections: A, B, C, D and E.
3. Section A (Q1–8) contains 6 multiple choice questions and 2 assertion-reason based questions of 1 mark each.
4. Section B (Q9–11) contains short answer questions of 2 marks each.
5. Section C (Q12–14) contains short answer questions of 3 marks each.
6. Section D (Q15) contains case study based questions of 4 marks each, with four sub-parts of 1 mark.
7. Section E (Q16–17) contains long answer questions of 5 marks each.
8. There is no overall choice. However, an internal choice has been provided in 1 question in Section B, 1 question in Section C, 2 questions in Section E. Attempt only one of the alternatives in such questions.
9. Use of calculators is not allowed. You may use: $c = 3 \times 10^8$ m s^{-1}.
10. This chapter test follows the section structure, question types and marks per question of the CBSE Class XII Physics (042) Sample Question Paper 2026-27, at about half the length of the 70-mark board paper: 37 marks in 1½ hours.
11. The answer key and the marking scheme are at the end of this booklet. Attempt the paper in 1½ hours before you look at them.

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Chapter: Wave Optics · **Topics:** Huygens' principle · Coherent sources and interference · Young's double-slit experiment · Diffraction at a single slit · Polarisation, Malus law and Brewster law

SECTION A

This section comprises 8 questions of 1 mark each: 6 multiple choice questions (MCQs) and 2 assertion-reason based questions.

1. In a Young's double-slit experiment, $\lambda = 600$ nm, the slits are 0.30 mm apart and the screen is 1.2 m away. The fringe width is [1]

(A) 2.4 mm (B) 0.24 mm

(C) 24 mm (D) 4.8 mm

2. When light passes from air into glass, the quantity that does not change is its [1]

(A) wavelength (B) speed

(C) frequency (D) direction (for oblique incidence)

3. Two coherent sources each give an intensity I at a point. The largest possible intensity due to both there is [1]

(A) I (B) 2I

(C) zero (D) 4I

4. Light of wavelength 500 nm falls on a slit 0.20 mm wide. The width of the central maximum on a screen 1.0 m away is [1]

(A) 2.5 mm (B) 5.0 mm

(C) 0.50 mm (D) 10 mm

5. Unpolarised light of intensity I_0 passes through a polariser and then through an analyser whose axis makes 60° with that of the polariser. The intensity that comes out is [1]

(A) $I_0/2$ (B) $I_0/4$

(C) $3I_0/8$ (D) $I_0/8$

6. The Brewster angle for a glass of refractive index $\sqrt{3}$ is [1]

(A) 60° (B) 30°

(C) 45° (D) 90°

7. **Assertion (A) :** Light waves can be polarised but sound waves in air cannot. [1]
Reason (R) : Light travels much faster than sound.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

8. **Assertion (A) :** Two independent sodium lamps placed side by side cannot produce a sustained interference pattern. 1

Reason (R) : The two lamps emit light of different frequencies.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

SECTION B

This section comprises 3 short answer questions of 2 marks each.

9. In a Young's double-slit experiment, light of wavelength 500 nm is used, the slits are 0.25 mm apart and the screen is 1.0 m away. Find the distances of the third bright fringe and of the second dark fringe from the central bright fringe. 2

10. (a) Using Huygens' principle, derive Snell's law of refraction for a plane wave passing from a medium where its speed is v_1 into one where its speed is v_2. 2

OR

(b) Write two differences between the interference pattern of a double slit and the diffraction pattern of a single slit.

11. Two polaroids are crossed, so no light gets through them. A third polaroid is placed between them with its axis at 45° to each. What fraction of the unpolarised light falling on the first polaroid now comes out of the last one? 2

SECTION C

This section comprises 3 short answer questions of 3 marks each.

12. (a) Derive the expression for the fringe width in Young's double-slit experiment. 3

OR

(b) (i) Write the expression for the resultant intensity at a point where two coherent waves of intensities I_1 and I_2 meet with phase difference φ.

(ii) Two coherent sources have intensities in the ratio 9 : 1. Find the ratio of the maximum to the minimum intensity in their interference pattern.

13. Light of wavelength 600 nm falls normally on a slit 0.10 mm wide, and the diffraction pattern is seen on a screen 2.0 m away. Find (i) the distance of the first minimum from the centre, (ii) the width of the central maximum and (iii) the width of the central maximum if the slit is made half as wide. 3

14. In a Young's double-slit experiment, what happens to the interference pattern when (i) the separation between the slits is doubled, (ii) the monochromatic source is replaced by a source of white light, and (iii) one of the slits is covered? 3

SECTION D

This section comprises 1 case study based question of 4 marks, with four sub-parts of 1 mark each.

15. Sunlight reflected from the surface of a lake causes glare. The reflected light is partly polarised, and at one particular angle of incidence it is completely polarised, with its vibrations parallel to the water surface. Polaroid sunglasses, with their transmission axis vertical, cut out most of this glare. (Refractive index of water = 1.33.)

(I) The angle of incidence at which the reflected light is completely polarised is about
(A) 37° (B) 41° (C) 53° (D) 90° [1]

(II) The electric vibrations in this completely polarised reflected light are
(A) perpendicular to the plane of incidence (B) in the plane of incidence (C) along the reflected ray (D) in all directions equally [1]

(III) At this angle, the angle between the reflected ray and the refracted ray is
(A) 0° (B) 45° (C) 180° (D) 90° [1]

(IV) Unpolarised light of intensity I_0 falls on one lens of the sunglasses. The intensity that passes through is
(A) I_0 (B) $I_0/2$ (C) $I_0/4$ (D) zero [1]

SECTION E

This section comprises 2 long answer questions of 5 marks each.

16. (a) (i) State Huygens' principle. Using it, show that the angle of reflection equals the angle of incidence for a plane wave reflected by a plane surface. What happens to the speed, wavelength and frequency of light when it is refracted into a denser medium? 5
(ii) Light of wavelength 600 nm in air enters glass of refractive index 1.5. Find its wavelength, speed and frequency in glass.

OR

(b) (i) What are coherent sources? Why are they needed for a sustained interference pattern?
(ii) A beam containing light of wavelengths 600 nm and 480 nm is used in a Young's double-slit experiment with slits 0.40 mm apart and the screen 1.0 m away. Find the distance of the third bright fringe of the 600 nm light from the central maximum, and the least distance from the central maximum where bright fringes of the two wavelengths coincide.
(iii) How would the fringe width change if the whole apparatus were placed in water (refractive index 4/3)?

17. (a) (i) Explain the formation of the diffraction pattern due to a single slit of width a. Show that the minima occur at $a \sin\theta = n\lambda$, and explain why the secondary maxima become weaker. 5
(ii) Light of wavelength 550 nm falls normally on a narrow slit, and the first minimum is seen at an angle θ with $\sin\theta = 0.20$. Find the width of the slit and the angle of the second minimum.

OR

(b) (i) What is plane polarised light? Explain how a polaroid polarises light, and state Malus' law.
(ii) Unpolarised light of intensity I_0 passes through two polaroids, and the intensity that comes out is $I_0/8$. Find the angle between the axes of the polaroids. At what angle would no light come out?

END OF THE QUESTION PAPER

ANSWER KEY — SECTION A

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
(A)	(C)	(D)	(B)	(D)	(A)	(B)	(C)

MARKING SCHEME AND WORKED SOLUTIONS

Marks for each step are shown in brackets, as in the CBSE marking scheme. Any correct alternative method earns full marks.

Q1. Answer (A). $\beta = \lambda D/d = 600 \times 10^{-9} \times 1.2/(0.30 \times 10^{-3}) = 2.4 \times 10^{-3}$ m.

Q2. Answer (C). The frequency is fixed by the source; speed and wavelength both fall by the factor n.

Q3. Answer (D). In phase the amplitudes add: $(2a)^2 = 4a^2$, i.e. 4I.

Q4. Answer (B). Width $= 2\lambda D/a = 2 \times 500 \times 10^{-9} \times 1.0/(0.20 \times 10^{-3}) = 5.0 \times 10^{-3}$ m.

Q5. Answer (D). After the polariser $I_0/2$; Malus: $(I_0/2)\cos^2 60° = I_0/8$.

Q6. Answer (A). $\tan i_B = n = \sqrt{3}$, $i_B = 60°$.

Q7. Answer (B). A is true: light is transverse, sound in air is longitudinal. R is true but has nothing to do with polarisation. Answer (B).

Q8. Answer (C). A is true. R is false: they emit the same frequencies, but the phase of each changes randomly about every 10^{-10} s, so they are not coherent. Answer (C).

Q9. (2 marks) Answer: 6.0 mm; 3.0 mm.
$\beta = \lambda D/d = 500 \times 10^{-9} \times 1.0/0.25 \times 10^{-3} = 2.0$ mm. Third bright: $y = 3\beta = 6.0$ mm. [1]
Second dark: $y = (2 - ½)\beta = 1.5\beta = 3.0$ mm. [1]

Q10. (2 marks) Answer: (a) $\sin i/\sin r = v_1/v_2$; (b) any two differences.
(a) Wavefront AB meets the surface at A at angle i. While the wave from B travels $BC = v_1\tau$ to the surface, the secondary wavelet from A spreads a distance $AE = v_2\tau$ in the second medium; the tangent CE is the refracted wavefront, at angle r. [1]
$\sin i = BC/AC = v_1\tau/AC$ and $\sin r = AE/AC = v_2\tau/AC$, so $\sin i/\sin r = v_1/v_2 = n_2/n_1$ (constant): Snell's law. [1]
OR (b) Any two, e.g. [2]: interference fringes are all of about equal width, diffraction fringes are not (the central one is twice as wide); in interference the bright fringes are all of nearly the same intensity, in diffraction the intensity falls off rapidly away from the centre; interference is the superposition of waves from two coherent sources, diffraction of wavelets from different parts of one wavefront.

Q11. (2 marks) Answer: 1/8.
After the first: $I_0/2$. After the middle one (45°): $(I_0/2)\cos^2 45° = I_0/4$. [1]
After the last (45° to the middle one): $(I_0/4)\cos^2 45° = I_0/8$, i.e. one-eighth. [1]

Q12. (3 marks) Answer: (a) $\beta = \lambda D/d$; (b) $I = I_1 + I_2 + 2\sqrt{(I_1 I_2)}\cos\varphi$; 4 : 1.
(a) Slits S_1, S_2 a distance d apart, screen at distance D. At a point P at height y: path difference $S_2P - S_1P = (S_2P^2 - S_1P^2)/(S_2P + S_1P) = 2yd/2D = yd/D$ (for y, d ≪ D). [1]
Bright fringe when $yd/D = n\lambda$: $y_n = n\lambda D/d$; dark fringe when $yd/D = (n + ½)\lambda$. [1]
Fringe width $\beta = y_{n+1} - y_n = \lambda D/d$, the same for bright and dark fringes. [1]
OR (b) (i) $I = I_1 + I_2 + 2\sqrt{(I_1 I_2)}\cos\varphi$, φ being the phase difference. [1]
(ii) Amplitudes in the ratio $\sqrt{9} : \sqrt{1} = 3 : 1$. $I_{max}/I_{min} = (3 + 1)^2/(3 - 1)^2 = 16/4 = 4$. [2]

Q13. (3 marks) Answer: (i) 12 mm; (ii) 24 mm; (iii) 48 mm.
(i) $a \sin\theta = \lambda$: $y = \lambda D/a = 600 \times 10^{-9} \times 2.0/0.10 \times 10^{-3} = 12$ mm. [1]
(ii) Width $= 2\lambda D/a = 24$ mm. [1]
(iii) Width $\propto 1/a$: it doubles, to 48 mm. [1]

Q14. (3 marks) Answer: (i) halved; (ii) white centre, coloured fringes; (iii) single-slit pattern.
(i) $\beta = \lambda D/d$: the fringe width is halved. [1]
(ii) The central fringe is white (zero path difference for all colours); on either side there are a few coloured fringes, the nearest edge of each being blue/violet (smaller λ), and then the pattern merges into uniform illumination. [1]
(iii) Interference stops; only the single-slit diffraction pattern of the open slit is seen (a broad central maximum with fainter bands). [1]

Q15. (4 marks) Answer: (I) C; (II) A; (III) D; (IV) B.
(I) (C) Brewster's law $\tan i_B = 1.33$, $i_B \approx 53°$. [1]
(II) (A) Parallel to the surface means perpendicular to the plane of incidence. [1]
(III) (D) At the Brewster angle $i_B + r = 90°$, so the reflected and refracted rays are perpendicular. [1]
(IV) (B) A polaroid passes half the intensity of unpolarised light. [1]

Q16. (5 marks) Answer: (a) 400 nm; 2.0×10^8 m s^{-1}; 5.0×10^{14} Hz; (b) 4.5 mm; 6.0 mm; ¾ of the value.
(a) (i) Every point of a wavefront is a source of secondary wavelets, spreading with the speed of the wave; the new wavefront is their common tangent (forward envelope). [½] Incident wavefront AB at angle i; while the wave from B travels BC = $v\tau$ to the mirror, the wavelet from A spreads AE = $v\tau$. Triangles ABC and CEA are congruent (right angles at B and E, common hypotenuse AC, BC = AE), so i = r. [1½] Into a denser medium the speed and the wavelength decrease (by the factor n) and the frequency is unchanged. [1]
(ii) $\lambda' = 600/1.5 = 400$ nm; $v = 3 \times 10^8/1.5 = 2.0 \times 10^8$ m s^{-1}; $\nu = c/\lambda = 5.0 \times 10^{14}$ Hz (unchanged). [2]
OR (b) (i) Coherent sources keep a constant phase difference; they must also have the same frequency (and preferably nearly equal amplitudes, for good contrast). [1]
(ii) $\beta = \lambda D/d$: third bright fringe for 600 nm: $3 \times 600 \times 10^{-9} \times 1.0/0.40 \times 10^{-3} = 4.5$ mm. [1] Bright fringes coincide when $n_1 \times 600 = n_2 \times 480$, least at $n_1 = 4$, $n_2 = 5$: $y = 4 \times 600 \times 10^{-9} \times 1.0/0.40 \times 10^{-3} = 6.0$ mm. [2]
(iii) In water λ becomes λ/n, so β becomes three-quarters of its value in air. [1]

Q17. (5 marks) Answer: (a) 2.75 µm; ≈ 23.6°; (b) $I = I_0 \cos^2\theta$; 60°; 90°.
(a) (i) Divide the slit into two halves; for each point in the upper half there is a point a/2 below it. At angle θ with $a \sin\theta = \lambda$, each such pair differs in path by $\lambda/2$ and cancels: a minimum. [1] Dividing the slit into 2n parts in the same way gives minima at $a \sin\theta = n\lambda$. [1] At $a \sin\theta = (n + ½)\lambda$ the slit divides into 2n + 1 parts of which only one is not cancelled; as n grows this part is a smaller fraction of the slit, so the maxima get weaker. [1]
(ii) $a = \lambda/\sin\theta = 550$ nm$/0.20 = 2.75$ µm. [1] Second minimum: $\sin\theta_2 = 2\lambda/a = 0.40$, $\theta_2 \approx 23.6°$. [1]
OR (b) (i) In plane polarised light the electric vibrations are confined to one direction (perpendicular to the direction of travel). [1] A polaroid passes only the component of the vibrations along its transmission axis. [1] Malus' law: the intensity passed by an analyser at angle θ to the polarised light is $I = I_0 \cos^2\theta$. [1]
(ii) $(I_0/2)\cos^2\theta = I_0/8$, so $\cos^2\theta = ¼$ and $\theta = 60°$. [1] No light at $\theta = 90°$. [1]

All questions are original and © Master Testing Agency. Free to download and use for personal practice; not for resale. Every answer in this paper was checked independently by computer: fringes by adding the two waves along the screen, single-slit minima by summing wavelets across the slit, polaroid chains by applying Malus' law to random unpolarised light.