

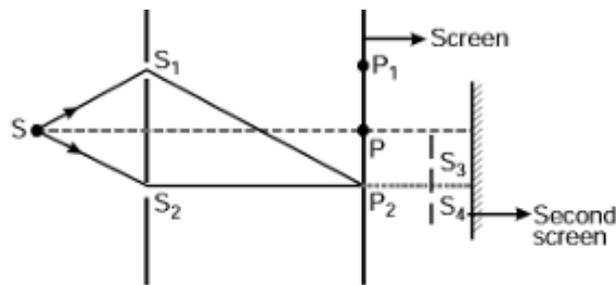
WAVE OPTICS

SECTION – A

Questions 1 to 10 carry 1 mark each.

1. A ray of monochromatic light propagating in air, is incident on the surface of water. Which of the following will be the same for the reflected and refracted rays?
(a) Energy carried (b) Speed (c) Frequency (d) Wavelength
2. In a Young's double slit experiment, the path difference at a certain point on the screen between two interfering waves is $\frac{1}{8}$ th of the wavelength. The ratio of intensity at this point to that at the centre of a bright fringe is close to:
(a) 0.80 (b) 0.74 (c) 0.94 (d) 0.85
3. The shape of the interference fringes in Young's double slit experiment when D (distance between slit and screen) is very large as compared to fringe width is nearly:
(a) straight line (b) parabolic (c) circular (d) hyperbolic
4. What happens, if the monochromatic light used in Young's double slit experiment is replaced by white light?
(a) No fringes are observed.
(b) All bright fringes become white.
(c) All bright fringes have colour between violet and red.
(d) Only the central fringe is white and all other fringes are coloured.
5. In Young's double-slit experiment, the intensity at the central maximum is I_0 if one of the slit is covered, then the intensity at the central maximum become:
(a) $\frac{I_0}{2}$ (b) $\frac{I_0}{\sqrt{2}}$ (c) $\frac{I_0}{4}$ (d) I_0
6. In a Young's double slit experiment, the source is white light. One of the holes is covered by a red filter and another by a blue filter. In this case
(a) there shall be alternate interference patterns of red and blue.
(b) there shall be an interference pattern for red distinct from that for blue.
(c) there shall be no interference fringes.
(d) there shall be an interference pattern for red mixing with one for blue.
7. Figure shows a standard two slit arrangement with slits S_1, S_2 . P_1, P_2 are the two minima points on either side of P (Figure). At P_2 on the screen, there is a hole and behind P_2 is a second 2- slit arrangement with slits S_3, S_4 and a second screen behind them.

CBSE ACADEMY PLUS



- (a) There would be no interference pattern on the second screen but it would be lighted.
(b) The second screen would be totally dark.
(c) There would be a single bright point on the second screen.
(d) There would be a regular two slit pattern on the second screen.
8. An interference pattern is observed by Young's double slit experiment. If now the separation between coherent sources is halved and the distance of screen from coherent sources is doubled, the new fringe width
- (a) becomes double
(b) becomes one-fourth
(c) remains the same
(d) becomes four times

In the following questions 9 and 10, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

- (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 but reason (R) is true.

9. **Assertion (A):** In interference and diffraction of light, light energy reduces in one region producing a dark fringe. It increases in another region and produces a bright fringe.
Reason (R): This happens because energy is not conserved in the phenomena of interference and diffraction.

10. **Assertion (A):** In Young's double slit experiment all fringes are of equal width.
Reason (R): The fringe width depends upon wavelength of light (λ) used, distance of screen from plane of slits (D) and slits separation (d).

SECTION – B

Questions 11 to 14 carry 2 marks each.

11. Draw the graph showing intensity distribution of fringes with phase angle due to diffraction through single slit.
12. What is the effect on the interference fringes in Young's double slit experiment due to each of the following operations? Justify your answers.
- (a) The screen is moved away from the plane of the slits.
(b) The separation between slits is increased.
(c) The source slit is moved closer to the plane of double slit.

OR

How will the interference pattern in Young's double-slit experiment be affected if:

- (a) the screen is moved away from the plane of the slits.
(b) the source slit is moved away from the plane of the slits.
(c) the phase difference between the light waves emanating from the two slits S_1 and S_2 changes from 0 to π and remains constant.

CBSE ACADEMY PLUS

13. Two coherent monochromatic light beams of intensities I and $4I$ superpose each other. Find the ratio of maximum and minimum intensities in the resulting beam.

OR

Find the intensity at a point on a screen in Young's double slit experiment where the interfering waves of equal intensity have a path difference of (i) $\lambda/4$, and (ii) $\lambda/3$.

14. In a Young's double slit experiment, the separation between the two slits is d and distance of the screen from the slits is $1000d$. If the first minima falls at a distance d from the central maximum, obtain the relation between d and λ .

OR

In Young's double-slit experiment, the two slits are separated by a distance equal to 100 times the wavelength of light that passes through the slits. Calculate:

- (a) the angular separation in radians between the central maximum and the adjacent maximum.
(b) the distance between these two maxima on a screen 50 cm from the slits.

SECTION – C

Questions 15 to 17 carry 3 marks each.

15. (a) Write three characteristic features to distinguish between the interference fringes in Young's double slit experiment and the diffraction pattern obtained due to a narrow single slit.
(b) A parallel beam of light of wavelength 500 nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1 m away. It is observed that the first minimum is a distance of 2.5 mm away from the centre. Find the width of the slit.

OR

What is the shape of the wavefront in each of the following cases:

- (a) light diverging from a point source.
(b) light emerging out of a convex lens when a point source is placed at its focus.
(c) the portion of a wavefront of light from a distant star intercepted by the earth.

16. Derive an expression for the de-Broglie wavelength associated with an electron accelerated through a potential V . Draw a schematic diagram of a localised-wave describing the wave nature of the moving electron.

OR

Define the term wavefront. Using Huygen's wave theory, verify the law of refraction.

17. State Huygen's principle. With the help of a diagram, show how a plane wave is reflected from a surface. Hence verify the law of reflection.

OR

Explain the following, giving reasons:

- (i) When monochromatic light is incident on a surface separating two media, the reflected and refracted light both have the same frequency as the incident frequency.
(ii) When light travels from a rarer to a denser medium, the speed decreases. Does this decrease in speed imply a reduction in the energy carried by the wave?
(iii) In the wave picture of light, intensity of light is determined by the square of the amplitude of the wave. What determines the intensity in the photon picture of light?

SECTION – D

Questions 18 carry 5 marks.

18. Describe briefly how a diffraction pattern is obtained on a screen due to a single narrow slit illuminated by a monochromatic source of light. Hence obtain the conditions for the angular width of secondary maxima and secondary minima.

OR

CD SIR (Chandra Dev Singh)

Founder , Mentor , Subject Expert
& Career Counsellor at CBSE ACADEMY PLUS

SURYADEV SINGH (SURYA BHAIYA)

Data Scientist, IIT Guwahati | M.Sc (IIT Delhi)
Director & Educator at CBSE Academy Plus

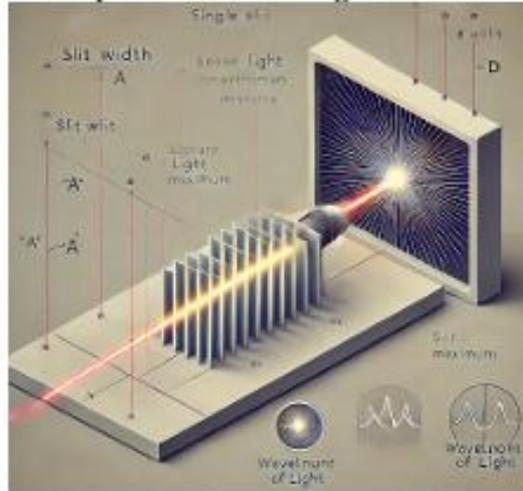
CBSE ACADEMY PLUS

Describe Young's double slit experiment to produce interference pattern due to a monochromatic source of light. Deduce the expression for the fringe width.

SECTION – E (Case Study Based Questions)

Questions 19 to 20 carry 4 marks each.

19. **Diffraction:** Diffraction of light is bending of light around the corners of an object whose size is comparable with the wavelength of light. Diffraction actually defines the limits of ray optics. This limit for optical instruments is set by the wavelength of light. An experimental arrangement is set up to observe the diffraction pattern due to a single slit.



- (i) The penetration of light into the region of geometrical shadow is called
(a) polarisation (b) interference (c) diffraction (d) refraction

- (ii) To observe diffraction, the size of an obstacle
(a) should be of the same order as wavelength
(b) should be much larger than the wavelength
(c) have no relation to wavelength
(d) should be exactly $\lambda/2$

- (iii) Both, light and sound waves produce diffraction. It is more difficult to observe diffraction with light waves because
(a) light waves do not require medium (b) wavelength of light waves is too small
(c) light waves are transverse in nature (d) speed of light is far greater

- (iv) Angular width of central maximum of a diffraction pattern of a single slit does not depend upon
(a) distance between slit and source (b) wavelength of light used
(c) width of the slit (d) frequency of light used

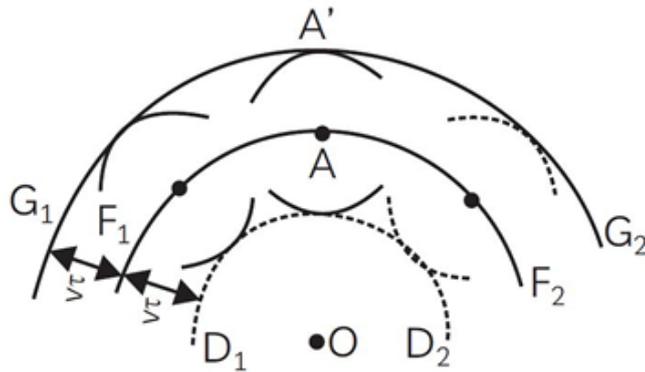
OR

- The diffraction effect can be observed in
(a) only sound waves (b) only light waves
(c) only ultrasonic waves (d) sound as well as light waves

20. Huygen's principle:

According to Huygen's principle, each point of the wavefront is the source of a secondary disturbance and the wavelets emanating from these points spread out in all directions with the speed of the wave. These wavelets emanating from the wavefront are usually referred to as secondary wavelets and if we draw a common tangent to all these spheres, we obtain the new position of the wavefront at a later time.

CBSE ACADEMY PLUS



(i) According to the Huygen's principle, light is a form of:

- (a) particle
- (b) rays
- (c) wave
- (d) particle and wave both

(ii) Huygen's wave theory allows us to know:

- (a) the wavelength of the wave
- (b) the velocity of the wave
- (c) the amplitude of the wave
- (d) the propagation of wavefronts

(iii) A 'wavefront' is the surface of constant:

- (a) phase (b) frequency
- (c) wavelength (d) amplitude

(iv) The wavefront due to a source situated at infinity is:

- (a) spherical (b) cylindrical
- (c) planar (d) rectilinear