PHYSICS

BOOKS - VIKRAM PUBLICATION (ANDHRA PUBLICATION)

WAVE OPTICS

Textual Examples

1. What speed should a galaxy move with respect to use so that the sodium line at 589.0

nm is oberved at 589.6 nm ?

2. When monochormatic light is incident on a surface separating two media, the reflected the same frequency as the incident frequency. Explain why?

3. When light travels from a rarer to a denser medium, the speed imply a reduction in the energy carried by the light wave?

4. In the wave picture of light, intensity of light is determined by the squar of the amplitude of the wave. What determines the intensity of light in. the photon picture of light.

5. Two slits are made one millimetre apart and the screen is placed one metre away. What is the fringe separation when blue- green light of wavelength 500 nm is used ?

6. What is the effect on the interference fringes in a Young's double-slit experiment due to each of the following operations :

the screen is moved away from the plane of the slits,

7. What is the effect on the interference fringes in a Young's double-slit experiment due to each of the following operations :

the (monochromatic) source is replaced by another (monochro- matic) source of shorter wavelength,

8. What is the effect on the interference fringes in a Young's double-slit experiment due to each of the following operations :

the separation between the two slits is increased,

9. What is the effect on the interference fringes in a Young's double-slit experiment due to each of the following operations :

the source slit is moved closer to the double-slit plane,

▶ View Text Solution

10. What is the effect on the interference fringes in a Young's double-slit experiment due to each of the following operations :

the width of the source slit is increased,

▶ View Text Solution

11. What is the effect on the interference fringes in a Young's double-slit experiment due to each of the following operations :

the monochromatic source is replaced by a source of white light ? (In each operation, take all parameters, other than the one specified, to remain unchanged.)

▶ View Text Solution

12. In Textual Example 3, what should the width of each slit be to obtain 10 maximam of the double slit pattern within the central maximum of the single slit pattern?

▶ **View Text Solution**

13. Assume that light of wavelength 6000 Å is coming from a star. What is the limit of resolution of a telescope whose objective has a diameter of 100 inch ?

14. For what distance is ray optics a good approximation when the aperture is 3 mm wide and the wavelength is 500 nm ?

15. Discuss the intensity of transmitted light when a polaroid sheet is rotated between two crossed polaroids ?

16. Unpolarised light is incident on a plane glass surface. What should be the angle of the incidence so that the reflected and refracted rays are perpendicular to each other ?

▶ **View Text Solution**

Very Short Answer Questions

1. What is Fresnel distance?

2. Give the justification for validity of ray optics.

3. What is polarisation of light ?

4. What is Malus' law.

▶ **Watch Video Solution**

5. Explain Brewster's law.

▶ **Watch Video Solution**

Short Answer Questions

1. Explain Doppler effect in, light. Distinguish between red shift and blue shift.

▶ View Text Solution

2. What is total internal reflection. Explain the phenomenon using Huygen's principle.

▶ View Text Solution

3. Derive the expression for the intensity at a point where interference of light occurs. Arrive at the conditions for maximum and zero intensity,

▶ View Text Solution

4. Does the principle of conservation of energy hold for interference and diffraction phenomena ? Explain briefly.

▶ View Text Solution

5. How do you determine the resolving power of your eye ?

▶ View Text Solution

Long Answer Questions

1. What is Huygen's Principle? Explain the optical phenomenon of refraction using Huygen's principle.

▶ View Text Solution

2. Distinguish between Cohernt and Incoherent addition of waves. Develop the theory of constructive interference.

▶ **View Text Solution**

3. Describe Young's experiment for observing interference and hence arrive at the expresion for 'fringe' width.

▶ **Watch Video Solution**

4. What is diffraction ? Discuss diffraction pattern obtainable from a single slit.

▶ **View Text Solution**

Textual Exerice

1. Monochromatic light of wavelength 589 nm is incident from air on a water surface. What are the wavelength, frequency and speed of (a)

reflected, and (b) refracted light ? Refractive index of water is 1.33.

2. What is the shape of the wavelength in case

Light diverging from a point source.

3. What is the shape of the wavelength in case

Light emerging out of a convex lens when a

point source is placed at its focus.

4. What is the shape of the wavelength in case The portion of the wavefront of light from a distant intercepted by the Earth.

5. The refractive index of glass is 1.5. What is the speed of light in glass ? (Speed of light in

vacuum is $3.0 \times 10^{\circ} ms^{-1}$)

> ▶ **Watch Video Solution**

6. Is the speed of light in glass independent of the colour of light ? If not, which of the two colours red and violet travels slower in a glass prism ?

> ▶ **Watch Video Solution**

7. In a Young's double-slit experiment, the slits are separated by 0.28 mm and the screen is placed 1.4m away. The distance between the central bright fringe and the fourth bright fringe is measured to be 1.2 cm . Determine the wavelength of light used in the experiment.

▶ **Watch Video Solution**

8. In Young's double-slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path difference is λ, is K units. What is the intensity of lgight at a point where path difference is $\dfrac{\lambda}{3}$.

▶ Watch Video Solution

9. A beam of light consisting of two wavelengths, 650 nm and 520 nm, is used to

obtain interference fringes in a Young's double-slit experiment.

Find the distance of the third bright fringe on the screen from the central maximum for wavelength 650 nm.
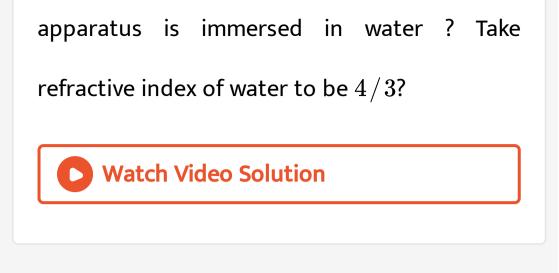
10. A beam of light consisting of two wavelengths, 650 nm and 520 nm, is used to obtain interference fringes in a Young's double-slit experiment.

Find the distance of the third bright fringe on the screen from the central maximum for wavelength 650 nm.

11. In a double-slit experiment the angular width of the fringe is found to be $0.2°$ on a screen placed 1 m away. The wavelength of light used is 600 nm. What will be the angular width of the fringe if the entire experimental

apparatus is immersed in water ? Take refractive index of water to be $4/3$?

▶ **Watch Video Solution**

12. What is the Brewster angle for air to glass transition ? (Refractive index of glass = 1.5.)

▶ **Watch Video Solution**

13. Light of wavelength 5000 Å falls on a plane reflecting surface. What are the wavelength

and frequency of the reflected light ? For what angle of incidence is the reflected ray normal to the incident ray?

> ▶ Watch Video Solution

1. Estimate the distance for which ray optics is good approximation for an aperture of 4 mm and wavelength 400 nm.

> ▶ Watch Video Solution

2. The 6563 Å Ha line emitted by hydrogen in a star is found to be red-shifted by 15 Å. Estimate the speed with which the star is receding from the Earth.

> ▶ **View Text Solution**

3. Explain how Corpuscular theory predicts the speed of light be greater than the speed of light in vacuum. Is the prediction confirmed by experimental determination of the speed of

light in water? If not, which alternative picture of light is consistent with experiment ?

4. You have learnt in the text how Huygens' principle leads to the laws of reflection and refraction. Use the same principle to deduce directly that a point object placed in front of a plane mirror produces a virtual image whose distance from the mirror is equal to the object distance from the mirror.

5. Let us list some of the factors, which could possibly influence the speed of wave propagation :

(i) nature of the source ii) direction of propagation (iii) motion of the source and/or observer iv) wavelength v) intensity of the wave On which of these factors, if any, does the speed of light in vacuum

6. Let us list some of the factors, which could possibly influence the speed of wave propagation :

(i) nature of the source ii) direction of propagation (iii) motion of the source and/or observer iv) wavelength v) intensity of the wave On which of these factors, if any, does the speed of light in a medium (say, glass or water), depend ?

▶ **Watch Video Solution**

7. For sound waves, the Doppler formula for frequency shift differs slightly between the two situations : (i) source at rest, observer moving and (ii) source moving, observer at rest. The exact Doppler formulas for the case of light waves in vacuum are, however, strictly identical for these situations. Explain why this should be so. Would you expect the formulas to be strictly identical for the two situations in case of light travelling in a medium?

8. In double-slit experiment using light of wavelength 600 nm, the angular width of a fring formed on a distant screen is $0.1°$. What is the spacing between the two slits ?

9. Answer the questions :

In a single slit diffraction experiment, the width of the slit is made double the original width. How does this affect the size and intensity of the central diffraction band ?

10. Answer the questions :

In what way is diffraction from each slit related to the interference pattern in a doutler slit experiment ?

11. Answer the questions :

When a tiny circular obstacle is placed in the path of light from a distant soureR, a bright

spot is seen at the centre of the shadow of the obstacle, Explain why ?

12. Answer the questions :

Two students are separated by a 7 m partition wall in a room 10 m high. If both light and sound waves can bend around obstacles, how is it that the students are unable so see each other even though they can converse easily.

13. Answer the questions :

Ray optics is based on the assumption that light travels in a straight line. Diffraction effects (observed when light propagates through small apertures/slits or around sauall obstacles) disprove this assumption. Yet the ray optics assumption is so commonly used in understanding location and several other properties of images in optical instruments. What is the justification ?

> ▶ View Text Solution

14. Two towers on top of two hills are 40 km apart. The line joining them passes 50 m above a hill halfway between the towers. What is the longest wavelength of radio waves, which can be sent between the towers without appreciable diffraction effects ?

15. A parallel beam of light of wavelength 500 nm falls on a narrow slit and the resulting

diffraction pattern is observed on a screen 1m away. It is observed that the first minimum is at a distance of 2.5 mm from the centre of the screen. Find the width of the slit.

▶ **Watch Video Solution**

16. Answer the questions :

When a low flying aircraft passes overhead, we sometimes notice a slight shaking of the picture on our TV screen. Suggest a possible explanation.

17. Answer the questions :

As you have learnt in the text, the principle of linear superposition of wave displacement is basic to understanding intensity distributions in diffraction and interference patterns. What is the justification of this principle ?

18. In deriving the single slit diffraction pattern, it was stated that the intensity is zero at angles of $n\lambda/a$. Justify this by suitable dividing the slit to bring out the cancellation.

> ▶ **View Text Solution**

Problems

1. What spped should a galaxy move with respect to us so that the sodim line at

589.0nm is observed at 589.6nm?

View Text Solution

2. Unpolarised light is incident on a plane glass surface. What should be the angle of the incidence so that the reflected and refracted rays are perpendicular to each other?

View Text Solution

3. What is the Brewster angle for air to glass transition ? (Refractive index of glass = 1.5.)

4. In Young's double-slit experiment using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path difference is λ, is K units. What is the intensity of lgight at a point where path difference is $\frac{\lambda}{3}$.

5. Assume that light of wavelength 6000 Å is coming from a star. What is the limit of resolution of a telescope whose objective has a diameter of 100 inch ?

6. In a Young's double-slit experiment, the slits are separated by 0.28 mm and the screen is placed 1.4m away. The distance between the

central bright fringe and the fourth bright fringe is measured to be 1.2 cm . Determine the wavelength of light used in the experiment.

> ▶ **Watch Video Solution**

1. When does a monochromatic beam of light incident on a reflective surface get completely transmitted ?

2. Discuss the intensity of transmitted light when a polaroid sheet is rotated between two crossed polaroids.

3. What is resolving power of Optical Instruments ? Derive the condition under which images are resolved.