PHYSICS

BOOKS - U-LIKE PHYSICS (HINGLISH)

WAVE OPTICS

Ncert Textbook Exercises

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 .

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2. What is the shape of the wavelength 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 the wavelength of light from a distant star intercepted by the Earth.

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3. (a) The refractive index of glass is 1.5. what is the speed of light in glass ? (Speed of light in vacuum is $3.0 \times 10^8 ms^{-1}$)

(b) Is th 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 ?

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

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5. 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 light at a point where path difference is $\lambda/3$?

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6. 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.

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

(b) What is the least distance from the central maximum where the bright fringes due to both the wavelength coincide ?

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7. In a double-slit experiment the angular width of a 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 $\frac{4}{3}$.

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

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9. 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 ?

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

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Additional Exercise

1. 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.

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2. Let us list some of the factors, which could possible 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 factos, if any, does.

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3. In double-slit Experiment using light of wavelength 600 nm, the angular width of a fringe formed on a distance screen is 0.1°. What is the spacing between the two slits?

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4. 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?

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5. In what way is diffraction from each slit related to the interference pattern in a double-slit experiment?

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6. When a tiny circular obstacle is placed in the path of light from a distance source, a bright spot is seen at the centre of the shadow of the obstacle. Explain. Why?

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7. Two students are separated by a 7m 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 to see each other even though they ca converse easily.

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8. 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 small 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 ?

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9. 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 ?

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10. 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 at a distance of 2.5 mm from the centre of the screen. Find the width of the slit.

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

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12. 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 ?

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13. In deriving the single-slit diffraction pattern, it was states that the intensity is zero at angles $\frac{n\lambda}{a}$. Justify this by suitable dividing the slit to bring out the cancellation.

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Case Based Source Based Integrated Questions

1.

The adjoining Fig. Shows a plane surface XY separating two transparent media, medium 1 and medium 2. the lines AB and CD represent wavefronts of a light wave travelling in medium in medium 1 corresponding to times t and $(t + \Delta t)$ respectively. the lines EF and GF represent wavefronts of the light wave in medium 2 after refraction corresponding to the times t' and $(t' + \Delta t)$ respectively. On the basis of above figure and applying basic related concepts studied by you answer the following questions

Q. What is a wavefront ?

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following questions

Q. Which of the two media has greater optical density ?

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Q. What conclusion do you draw regarding speed of light in two media ?

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following questions

Q. Light travels as a

A. parallel beam in each medium

B. convergent beam in each medium

C. divergent beam in each medium

D. convergent beam in one medium and divergent beam in the other medium

Answer:

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following questions

Q. Let phases of the light wave at C, D, E and F be ϕ_C, ϕ_D, ϕ_E and ϕ_E respectively and it is given that $\phi_C \neq \phi_E$. Choose the correct relation out of the following :

A. ϕ_C cannot be equal to ϕ_D.

B. ϕ_D may be equal to ϕ_E

C. $(\phi_E - \phi_C)$ must be equal to $(\phi_F - \phi_D)$

D. $((\phi_E - \phi_C)$ cannot be equal to $(\phi_F - \phi_D)$

Answer:

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6.

Interference of light is based on the superposition principle according to which at a particular point in the medium the resultant displacement produced by two or more light waves is the vector sum of the displacement produced by the two individual light waves.

A British physicist Thomas Young made two pin holes S_1 and S_2, separated by a very very small distance 'd' on an opaque screen which were illuminated by another pin hole S lit by a monochromatic source of light. so S_1 and S_2 behaves as two coherent sources of light. spherical waves emanating from S_1 and S_2 produce interference fringes on the screen AB. if P be a point situated at a distance x from central point O of the screen, then path difference between the waves coming from the two sources is

$$S_2P - S_1P = \frac{xd}{D}$$

Bright fringe is obtained on the screen if path difference $\frac{xd}{D}$ is an integer multiple of wavelength λ. However, we get a dark fringe on the screen if the path difference is an odd multiple of $\frac{\lambda}{2}$.

Q. What is constructive interference ?

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Q. How are two coherent sources obtained in Young's experiment?

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Q. Will the central point O on the screen be bright or dark?

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Q. What is the shape of interference fringes?

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11. During your study in a junior school you were told that light travels in a straight line. But now you know that light travels as a wave and it can bend around objects.

In optical region light has a wavelength of about half a micrometre. If it encounters an obstacle of about this size, it may bend around it and can be seen on the other side. however, if the obstacle is much larger, light will not be able to bend to that extent and will not be seen on other side.

This is a general property of waves and can be

seen in sound waves too. the sound wave of our spech has a wavelength of about 50 cm-1m. if it meets an obstacle of the size of a few metres, it bends around it and reaches points behind the obstacle. but when it comes, across a larger obstacle of a few hundred metres, such as a hillock, most of it is reflected back and is heard as an echo.

Q. What is diffraction of light ?

View Text Solution

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Q. Under what condition can you observe diffraction of light ?

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Q. Why is diffraction so common is sound but not so common in light ?

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Q. Draw diffraction pattern obtained on a screen when a plane wavefront falls on a narrow slit.

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Q. In a single-slit diffraction experiment if width of the slit is made double of its original width, then what would be the effect on the central diffraction maximum observed on the screen?

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16. Light waves are electromagnetic waves and hence transverse in nature. The electric field in a light wave propagating in free space is perpendicular to the direction of propagation. But there are infinite number of directions perpendicular to the direction of propagation. but there are infinite number of directions perpendicular to the direction of propagation of light. for example if light propagates along x-axis, the electric field may be along y-axis or along the z-axis or along any direction in y-z plane in the ordinary light. However, if electric field $\vec{E}$ remains parallel to a fixed direction (say y-axis) then such light is called linearly polarised light.

There are several methods to produce polarised light from the unpolarised light. now-a-days polaroid sheets are commonly used to produce linearly polarised light. a polaroid has long chain of hydrocarbons which become conducting at optical frequencies. when light falls normally on the polaroid sheet, the $\vec{E}$ parallel to the chains is absorbed in setting up electric currents in the chains but $\vec{E}$ perpendicular to the chain gets transmitted. so, light on passing through the polaroid i.e., the transmitted light become linearly polarised with $\vec{E}$ parallel to the transission (pass) axis of polaroid.

If linearly polarised light of intensity 'I' is incident on another polaroid whose pass axis is inclined at an angle θ from pass axis of first polaroid (or transmission axis of $\vec{E}$ of linearly polarised light) the intensity of transmitted light I_t is given as:

$I_t = I\cos^2\theta.$

Q. What is unpolarised light ?

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Q. Can sound waves be polarised ? Give reason for your answer.

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Q. What is the pass axis of a polaroid ?

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Q. Two polaroids P_1 and P_2 are set with their pass axis inclined at an angle 30°. if I_0 be the light incident on P_1, what is the intensity of light transmitted through P_2 ?

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Multiple Choice Questions

1. Light waves appear to travel in straight lines since

A. these are not absorbed by the atmosphere

B. these are reflected back by the atmosphere

C. their wavelength is small

D. their velocity is very large

Answer: C

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2. To demonstrate the phenomenon of interference we require two sources which emit radiation

A. of the same frequency and having a definite phase relationship

B. of nearly the same frequency

C. of the same frequency

D. of different wavelength

Answer: A

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3. In Young's experiment the distance between the slits is reduced to half and the distance between the slit and screen is doubled then the fringe width

A. will not change

B. will become half

C. will be doubled

D. will become four times

Answer: D

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4. In Young's double-slit experiment the distance between the slits is 1 mm and that between slit and screen is 1m. If 10th bright fringe is 5 mm away from the central bright fringe, then wavelength of light used will be

A. 5000 Å

B. 6000 Å

C. 4000 Å

D. 8000 Å

Answer: A

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5. In Young's double-slit experiment, 12 fringes are observed to be formed in a certain segment of the screen when light of wavelength 600 nm is used. If the wavelength of light is changed to 400 nm, number of fringes observed in the same segment of the screen is given by

A. 12

B. 18

C. 24

D. 30

Answer: B

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6. In a Young's double-slit experiment, the slit separation is 0.2 mm and the distance between the screen and double-slit is 1.0 m.

wavelength of light used is 5000 Å. The distance between two consecutive dark fringes is

A. 2.5 mm

B. 4.0 mm

C. 5.0 mm

D. 0.25 mm

Answer: A

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7. When a compact disc is illuminated by a source of white light, coloured lanes are observed. This is due to

A. dispersion

B. diffraction

C. interference

D. refraction

Answer: A

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8. For what distance is ray optics a good approximation when the aperture is 4mm wide and the wavelength is 500 nm ?

A. 32m

B. 64m

C. 16m

D. 8m

Answer: A

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9. A ray of light strikes a material's slab at an angle of incidence 60°. If the reflected and refracted rays are perpendicular to each other, the refractive index of the material is

A. $\frac{1}{\sqrt{3}}$

B. $\frac{1}{\sqrt{2}}$

C. $\sqrt{2}$

D. $\sqrt{3}$

Answer: D

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10. A mixture of light, consisting of wavelength 590 nm and an unknown wavelength, illuminates Young's double-slit and gives rise to two overlapping interference patterns on the screen. The central maximum of both lights coincide. Further, it is observed that the third bright fringe of known light concides with the 4th bright fringe of the unknown light. from this data, the wavelength of the unknown light is

A. 885.0 nm

B. 443.5 nm

C. 776.8 nm

D. 393.4 nm

Answer: B

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11. The angle of incidence at which reflected light is totally polarised for reflection from air to glass (refractive index n) is

A. $\sin^{-1}(n)$

B. $\sin^{-1}\left(\frac{1}{n}\right)$

C. $\tan^{-1}\left(\frac{1}{n}\right)$

D. $\tan^{-1}(n)$

Answer: D

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12. When an unpolarised light of intensity I_0 is incident on a polarising sheet, the intensity of the light which does not get transmitted is

A. zero

B. I_0

C. $\frac{1}{2}I_0$

D. $\frac{1}{4}I_0$

Answer: C

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13. The shape of the wavefront due to a light source situated at infinity is

A. spherical

B. plane

C. cylinderical

D. rectangular

Answer: B

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14. The phenomenon of interference is exhibited by

A. longitudinal waves only

B. transverse waves only

C. electromagnetic waves only

D. all sort of waves

Answer: D

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15. Two coherent monochromatic light beams of of intensities I and 4I are superposed. The maximum and minimum intensities in the resulting beam are

A. 5I and I

B. 5I and 3I

C. I and I

D. 9I and 3I

Answer: C

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16. Two light sources are called coherent if both of them

A. have the same amplitude of vibrations

B. have the same wavelength

C. emit waves of same wavelength having a constant originating phase difference

D. emit waves of same frequency travelling with same speed.

Answer: C

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17. Wave nature of light is verified by the phenomenon of

A. rectilinear propagation of light

B. refraction through a lens

C. interference of light

D. photoelectric effect

Answer: C

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18. The maximum intensity of fringes in Young's double-slit experiment is I. if one of the slit is closed, the intensity at that place becomes I_0. Which of the following relation is true ?

A. $I = I_0$

B. $I = 2I_0$

C. $I = 4I_0$

D. $I_0 = 2I$

Answer: C

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19. In Young's double-slit experiment, light of wavelength 400 nm is used to produce bright fringes of width 0.6 mm at a distance of 2 m. if whole apparatus is immersed in water of refractive index $\frac{4}{3}$, then fringe width will be

A. 0.6 mm

B. 0.45 mm

C. 0.8 mm

D. 0.3 mm

Answer: B

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20. In a Young's double-slit experiment, monochromatic light is replaced by white light. Then

A. all bright fringes will become white

B. all bright fringes may have different colours ranging from violet to red

C. only the central fringe is white and all other fringes are coloured one

D. no fringe pattern is formed on the screen

Answer: C

View Text Solution

21. The bending of a light beam around the edges of small obstacles and narrow apertures is called

A. reflection of light

B. diffraction of light

C. polarisation of light

D. optical rotation

Answer: B

View Text Solution

22. A beam of light of wavelength 600 nm from a distant source falls normally on a single-slit, 1 mm wide, and the resulting diffraction pattern is obtained on a screen 2.0 away. The distance between the first dark fringes on either side of the central bright fringe is

A. 1.2 mm

B. 1.2 cm

C. 2.4 cm

D. 2.4 mm

Answer: D

View Text Solution

23. A parallel monochromatic beam of light is incident normally on a narrow slit and the resulting diffraction pattern is formed on a screen placed perpendicular to the direction of incident beam. At the first minimum of the diffraction pattern, the phase diffraction between the waves coming from the edges of the slit is

A. 0

B. $\frac{\pi}{2}$

C. π

D. 2π

Answer: D

View Text Solution

24. Direction of the first secondary maximum in the diffraction pattern at a single-slit is given by (Here a=width of the slit and θ=angle of diffraction)

A. $a \sin \theta = \frac{\lambda}{2}$

B. $a \sin \theta = \lambda$

C. $a \sin \theta = \frac{3\lambda}{2}$

D. $a \cos \theta = \frac{3\lambda}{2}$

Answer: C

View Text Solution

25. Resolving power of a microscope depend on the wavelength (λ) of the light used to illuminate the object to be viewed as

A. $R.\,P.\ \propto \lambda$

B. $R.\,P.\ \propto \frac{1}{\lambda}$

C. $R.\,P.\ \propto \lambda^2$

D. $R.\,P.\ \propto \frac{1}{\lambda^2}$

Answer: B

View Text Solution

26. The aperture of objective lens of a telescope is made large so as to

A. increase its magnifying power

B. increse its resolving power

C. make the image free from aberrations

D. focus it on distant objects

Answer: B

View Text Solution

27. Light waves can be polarised as they are

A. transverse waves

B. longitudinal waves

C. having small wavelength

D. having very high speed in air

Answer: A

View Text Solution

28. Through which characteristic phenomenon we can distinguish the light waves from sound waves ?

A. Interference

B. Diffraction

C. Polarisation

D. Total internal refraction

Answer: C

View Text Solution

29. Polarising angle for water is 53°. If light is incident at polarising angle on the surface of water and is partly reflected, the angle of refraction will be

A. 53°

B. 37°

C. 127°

D. 30°

Answer: B

View Text Solution

30. Two polaroids are oriented with their principal planes making an angle of 60°. The percentage of incident unpolarised light, which passes through the system is

A. 1

B. 0.5

C. 0.25

D. $12.5\ \%$

Answer: D

View Text Solution

Fill In The Blanks

1. The wavefront coming from a point source of light is a _____wavefront.

View Text Solution

2. In a Young's double-slit experiment if blue light is replaced by red light then the fringe width will ____.

View Text Solution

3. The wave theory of light was put forward by ______.

View Text Solution

4. The light from two coherent sources, each of intensity I, having a phase difference ϕ superimpose then resultant intensity (I_R) of light is given as _____.

View Text Solution

5. Shape of interference fringes, in general is____.

View Text Solution

6. In a single-slit diffraction pattern the angular width of the central maxima is-___ of the angular width of subsequent maxima.

View Text Solution

7. If the light from an ordinary sodium lamp, having an intensity I, passes through a polaroid sheet, the intensity of emergent light is _____.

View Text Solution

8. The colours that one sees when a CD is viewed is due to ____effects.

View Text Solution

9. Polarisation phenomenon is exhibited by ____waves only.

View Text Solution

10. Continuous locus of all the points vibrating in same phase condition is called_____.

View Text Solution

11. In a single-slit diffraction experiment the angular width of central maxima is independent of _____.

View Text Solution

12. The angular resolution of a 1m diameter telescope at a wavelength of 500 nm is of the order of _____.

View Text Solution

13. A certain flint glass block has a refractive index of $\sqrt{3}$. The polarising angle for this block is ______.

View Text Solution

True Or False

1. In a Young's double-slit experiment the fringe width for dark fringes is different from fringe width for bright fringes.

View Text Solution

2. The fringes in the interference pattern become narrower if the entire double-slit experimental set up is immersed in water.

View Text Solution

3. In a Young's double-slit experiment performed with a source of white light, only black and white fringes are observed.

View Text Solution

4. In Young's double-slit experiment, the screen becomes uniformly bright if one of the slits is covered with a black paper.

View Text Solution

5. Two sources of light are said to be coherent if they emit light of same frequency, same wavelength and same intensity.

View Text Solution

6. In a diffraction pattern due to a single-slit, the angular size of the central maximum increases on decreasing the slit width.

View Text Solution

7. If polarised light of intensity I passes through a polaroid whose pass axis makes an angle θ from the vibration axis of polarised light, the intensity of emergent light is $I' = I \cos\theta$.

View Text Solution

Assertion Reason Type Questions

1. Assertion: No interference pattern is detected when two coherent sources are infinitesimally close to each other.

Reason: The fringe width is inversely proportional to the distance between the two slits.

View Text Solution

2. Assertion: For best contrast between maxima and minima in the interference pattern of young's double-slit experiment the intensity of light emerginig out of the two slits should be equal.

Reason: The intensity of light is proportional to square of its amplitude.

View Text Solution

3. Assertion: Polaroids are used to polarise as well as analyse place polarised light.

Reason: Polaroids reduce the intensity of light to zero.

View Text Solution

4. Assertion: Light waves can be polarised but sound waves cannot be polarised.

Reason: Sound waves in air are longitudinal in nature.

View Text Solution

5. Assertion: Coloured spectrum is see when we look at a distant light source through a fine muslin cloth.

Reason: It is due to the diffraction of white light on passing through fine slits present between the threads of muslin cloth.

View Text Solution

Very Short Answer Questions

1. When monochromatic light travels from one medium to another its wavelength changes but frequency remains the same. Explain.

View Text Solution

2. Differentiate between a ray and a wavefront.

View Text Solution

3. Draw the shape of the wavefront coming out of a concave mirror when a plane wave is incident on it.

View Text Solution

4. What are coherent sources of light ?

View Text Solution

5. State the reason, why two independent sources of light cannot be considered as coherent sources.

View Text Solution

6. Is the law of conservation of energy obeyed by interference phenomenon of light ?

View Text Solution

7. State the conditions which must be satisfied for two light sources to be coherent.

View Text Solution

8. How does the fringe width in Yougn's double slit experiment change when the distance of separation 'D' between the slits and screenn in doubled?

View Text Solution

9. How does the fringe width of interference fringes change, when the whole apparatus of Young's experiment is kept in a liquid of refractive index 1.3 ?

View Text Solution

10. How does the angular separation of interference fringes change in Young's experiment, if the distance between the slits is increased ?

View Text Solution

11. What happens to the interference pattern if one of the slits in Young's double-slit experiment is closed ?

View Text Solution

12. How would the angular separation of interference fringes in Young's double-slit experiment change when the distance between the slits and screen is doubled ?

View Text Solution

13. When light travels from a rares to a denser medium, the speed of light decreases. Does the reduction in speed imply a reduction in the energy ?

View Text Solution

14. A parallel beam of monochromatic light falls normally on a single narrow slit, how does the angular width of the principal maximum in the resulting diffraction pattern depend on width of the slit ?

View Text Solution

15. Draw an intensity distribution graph for diffraction due to a single slit.

View Text Solution

16. For a given single-slit, the diffraction pattern is obtained on a fixed screen by using red light and then with blue light. In which case, will the central maxima, in observed diffraction pattern, have a larger angular width ?

View Text Solution

17. In a single-slit diffraction experiment, the width of the slit is reduced to half its original width. How would this afffect the size and intensity of the central maxima ?

View Text Solution

18. Sketch the variation of intensity of the interference pattern in Young's double-slit experiment.

View Text Solution

19. Which of the following waves can be polarised (i) Heat waves (ii) Sould waves ? Give reason to support your answer.

View Text Solution

20. What is upolarised light ?

View Text Solution

21. What is plane polarised light ?

View Text Solution

22. Draw the graph showing the variation of intensity of polarised light transmitted by an analyser.

View Text Solution

23. In what way is plane polarised light different from an unpolarised light ?

View Text Solution

24. What does a polaroid consist of ?

View Text Solution

25. Unpolarised light is incident on a plane surface of glass of glass of refractive index n at angle i. If the reflected light gets totally polarised, write the relation between the angle i and refractive index n.

View Text Solution

26. At what angle of incidence should a light beam strike a light beam strike a glass slab of refractive index $\sqrt{3}$, such that the reflected and refracted rays are perpendicular to each other ?

View Text Solution

27. The refractive index of a medium is $\sqrt{3}$. What is the angle of refraction, if the unpolarised light is incident on it at the polarising angle of the medium ?

View Text Solution

28. What is the speed of light in a denser medium of polarising angle 30° ?

View Text Solution

29. If the angle between the pass axis of polariser and the analyser is 45°, write the ratio of the intensities of original light and the transmitted light after passing through the analyser.

View Text Solution

30. How does resolving power of a telescope change in decresing the aperture of its objective lens ? Justify your answer.

View Text Solution

31. The objective lenses of two telescopes have the same aperture but their focal lengths are in the ratio 1:2. compare the resolving powers of the two telescopes.

View Text Solution

Short Answer Questions

1. Define a wavefront. Use Huygen's principle to show diagrammatically the propagation of a wave-front from the instant $t_1 = 0$ to a later time $t_2 = t$.

View Text Solution

2. (a) Write the conditions under which light sources can be said to be coherent.

(b) Why is it necessary to have coherent sources in order to produce an interference pattern ?

View Text Solution

3. Based on Huygen's construction, draw the shape of a plane wavefront as it gets refracted on passing through (a) a thin prism, and (b) a thin convex lens.

View Text Solution

4. Show that the superposition of the waves originating from two coherent sources s_1 and s_2 having displacement $y_1 = a\cos\omega t$ and $y_2 = a\cos(\omega t + \phi)$ at a point produce a result intensity

$I_R = 4a^2 \cos^2 \frac{\phi}{2}$. Hence, write the conditions for the appearance of dark and bright fringes.

View Text Solution

5. What is the effect on the interference fringes in a Young's double-slit experiment if monochromatic source is replaced by source of white light ?

View Text Solution

6. Laser light of wavelength 630 nm incident on a pair of slits produces an interference pattern in which the bright fringes are separated by 8.1 mm. a second light produces an interference pattern in which the fringes are separated by 7.2 mm. calculated the wavelength of the second light.

View Text Solution

7. In a Young's double-slit experiment fringes are obtained on a screen placed at certain distance away from the slits. If the screen is moved by 5 cm towards the slit, the fringe width changes by $30\mu m$. Given that the slits are 1 mm apart. Calculate the wavelength of the light red.

View Text Solution

8. Laser light of wavelength 640 nm incident on a pair of slits produces an interference pattern in which the bright fringes are separated by 7.2 mm. calculated the wavelength of another source of light which produces interference fringes separated by 8.1 mm using same arrangement. Also find the minimum value of the order (n) of bright fringes of shorter wavelength which coincides with that of the longer wavelength.

View Text Solution

9. In a single-slit diffraction experiment, a monochromatic source of light of wavelength $'\lambda'$ illuminates a narrow slit of width 'a'. Show, giving appropriate reasoning, that the half angular width of the central maximum in the observed pattern is (nearly) equal to $\frac{\lambda}{a}$.

View Text Solution

10. Draw the intensity pattern for single-slit diffraction and double-slit interference. Hence, state two differences between interference and diffraction pattern.

View Text Solution

11. Yellow light $(\lambda = 6000 \text{Å})$ illuminates a single-slit of width 1×10^{-4}m. calculate (i) the distance between two dark lines on either side of the central maximum when the diffraction pattern is viewed on a screen kept 1.5 m away from the slit, (ii) the angular spread of the first diffraction minima.

View Text Solution

12. Give two differences between interference and diffraction.

View Text Solution

13. State one feature by which the phenomenon of interference can be distinguished from that of the diffraction.

A parallel beam of light of wavelength 600 nm is incident normally on a slit of width 'a'. If the distance between the slit and the screen is 0.8m and the distance of second order maximum from the centre of the screen 15 mm, calculate the width of the slit.

View Text Solution

14. Does the appearance of bright and dark fringes in the interference pattern violate, in any way, conservation of energy ? Explain.

View Text Solution

15. For a single-slit of width "a", the first minimum of the interference pattern of a monochromatic light of wavelength λ occurs at an angle of $\frac{\lambda}{a}$. At the same angle of $\frac{\lambda}{a}$, we get a maximum for two narrow slits separated by a distance "a". explain.

View Text Solution

16. In the diffraction due to a single-slit experiment, the aperture of the slit is 3mm. If monochromatic light of wavelength 620 mm is incident normally on the slit, calculate the separation between the first order minima and the 3rd order maxima on one side of the screen. the distance between the slit and the screen is 1.5 m.

View Text Solution

17. how can one distinguish between an unpolarised light beam and a linearly polarised light beam using a polaroid ?

View Text Solution

18. Differentiate between polarised and un-polarised light. How are these represented ?

View Text Solution

19. Explain, with the help of diagram, how plane polarised light is obtained by scattering.

View Text Solution

20. What does a polaroid consist of ? Using polaroid show that light waves are transverse in nature ?

View Text Solution

21. Show that when a light beam is incident on a refractive surface at the polarising angle, the reflected and refracted beams are mutually perpendicular to each other.

View Text Solution

22. Show using a proper diagram how unpolarised light can be linearly polarised by reflection from a transparent glass surface.

View Text Solution

23. State Brewster's law.

The value of Brewster angle for a transparent medium is different for light of different colours. Give reason.

View Text Solution

24. Unpolarised light is passed through a polaroid P_1. When this polarised beam passes through another polaroid P_2 and if the pass axis of P_2 makes angle θ with the pass axis of P_1, the write the expression for the polarised beam passing through P_2. Draw a plot showing the variation of intensity when θ varies from 0 to 2π.

View Text Solution

25. The speed of a certain monochromatic light, in a given transparent medium, is $2.25 \times 10^8 ms^{-1}$. What is the (a) critical angle of incidence, (b) polarising angle for this medium ?

View Text Solution

26. When are two objects just resolved ? Explain. How can the resolving power of a compound microscope be incresed ? Use relevant formula to support your answer.

View Text Solution

27. Define resolving power of a compound microscope. How does the resolving power of a compound microscope change when :

(i) refractive index of the medium between the object and objective lens increases,

(ii) wavelength of the radiation used is increased?

View Text Solution

28. Two convex lenses of same focal length but of aperture A_1 and $A_2 (A_2 < A_1)$, are used as the objective lenses in two astronomical telescopes having indentical eyepieces. What is the ratio of their resolving power ? Which telescope will you prefer and why ? Give reason.

View Text Solution

29. Define the term resolving power of a telescope. How does it get affected on

(i) increasing the aperture of the objective lens,

(ii) Increasing the focal length of the objective lens ?

View Text Solution

Long Answer Questions I

1. (a) Define a wavefront. How is it different from a ray ?

(b) Depict the shape of a wavefront in each of the following cases:

(i) Light diverging from a piont source.

(ii) Light emerging out of a convex lens when a point source is placed at its focus.

View Text Solution

2. Define a wavefront. Using Huygen's principle, verifyi the laws of reflection at a plane surface.

View Text Solution

3. Define a wavefront. Use huygen's principle to verify the laws of defraction.

View Text Solution

4. Use Huygen's principle to show how a plane wavefront propagates from a denser to rarer medium. Hence, verify snell's law of refraction.

View Text Solution

5. Using Huygen's principle construct a refracted wavefront when a plane wavefront is incident on plane surface from an optically denser meidum side. Using this figure, obtain the condition of critical angle and total internal reflection.

View Text Solution

6. Explain the following giving reasons:

(a) 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. Explain why.

(b) When light travels from a rarer to a denser medium, the speed decreases. does the reduction in speed imply a reduction in the energy carried bythe light wave ?

(c) In the wave picture of light, intensity of light is determined by the square of the amplitude of the wave, what determines the intensity of light in the photon pisture of light ?

View Text Solution

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

View Text Solution

8. What is the effect on the interference pattern observed in a Young's double-slit experiment in the following cases:

(i) screen is moved away from the plane of the slits,

(ii) separation between the slits is increased,

(iii) width of the slits are doubled.

Give reason for your answer.

View Text Solution

9. In Young's double-slit experiment, the two slits 0.15 mm apart are illuminated by monochromatic light of wavefront 450 nm.

The screen is 1.0 m away from the slits.

(a) Find the distance of the second (i) bright fringe, (ii) dark fringe from the central maximum.

(b) How will the fringe pattern change if the screen is moved away form the slits?

View Text Solution

10. In a modified set up of Young's double slit experiment, it is given that $SS_2 - SS_1 = \frac{\lambda}{4}$ i.e., the source S is not equidistant from the slits S_1 and S_2.

(a) Obtain the condition for constructive and destructive interference at any point P on the screen in terms of the path difference $\Delta = S_2P - S_1P$.

(b) Does the observed central bright fringe lie above or below O ? Give reason in support of your answer.

View Text Solution

11. If one of two identical slits producing interference in Young's experiment is covered with glass, so that the light intensity passing through it is reduced 50 50%, find the ratio of the maximum and minimum intensity of the fringe in the interference pattern.

(b) What kind of fringes do you expect to observe if white light is used instead of monochromatic light ?

View Text Solution

12. In Young's double-slit experiment,, monochromatic light of wavelength 630 nm illuminates the pair of slits and produces an interference pattern in which two consecutive bright fringes are separated by 8.1mm. Another source of monochromatic light produces the interference pattern in which the two consecutive bright fringes are separated by7.2 mm. find the wavelength of light from the second source.

What is the effect on the interference fringes if the monochromatic source is replaced by a source of white light ?

View Text Solution

13. (a) Ratio of widths of two slits in Yougn's double-slit experiment is 4:1. evaluate the ratio of intensity at maxima and minima in the interference pattern.

(b) Does the appearance of bright and dark fringes in the interference pattern violate, in any way, conservation of energy ? Explain.

View Text Solution

14.

The figure, drawn here, show sthe geometry of path difference for diffraction by a single-slit of width 'a'. Give appropriate reasoning to explain why the intensity of light is :

(a) maximum at the central point C on the screen.

(b) nearly zero for point P on the screen when $\theta = \frac{\lambda}{a}$.

Hence, write an expression for the total linearm width of the central maximum on a screen kept at a distance 'D' from the plane of the slit.

View Text Solution

15. Explain, using Huygen's principle, how diffraction is produced by a narrow slit which is illuminated by a monochromatic light. Show that central maximum is twice as wide as the other maxima and the pattern becomes narrower as the width of the slit is increased.

View Text Solution

16. In a single-slit diffraction pattern, how does the angular width of central maximum change, when

(i) slit width is decreased,

(ii) distance between the slit and screen is increased, and

(iii) light of smaller visible wavelength is used ?

Justify your answer in each case.

View Text Solution

17. (a) In what way is diffraction from each slit related to the interference pattern in a double-slit experiment?

(b) Two wavelengths of sodium light 590 nm and 596 nm are used, in turn, to study the diffraction taking place at a single slit of aperture $2 \times 10^{-4} m.$ the distance between the slit and the screen is 1.5m. calculate the separation between the positions of first maxima of the diffraction pattern obtained in the two cases.

View Text Solution

18. (a) Describe briefly, with the help of suitable diagram, how the transverse nature of light can be demonstrated by the phenomenon of polarisation.

(b) When unpolarised light passes from air to a transparent medium, under what condition does the reflected light is plane polarised ?

View Text Solution

19. (a) In a single-slit diffraction experiment, a slit of width 'd' is illuminated by red light of wavelength 650 nm. For what value of 'd' will

(i) the first minimum fall at an angle of diffraction of 30° and

(ii) the first maximum fall at an angle of diffraction of 30° ?

View Text Solution

20. What is an unpolarised light ? Explain with the help of suitable ray diagram how an unpolarised light can be polarised by reflected from a transparent medium. Write the expression for Brewster angle in terms of the refractive index of denser medium.

View Text Solution

21. (a) What is linearly polarised light ? Describe briefly using a diagram how sunlight is polarised

(b) Unpolarised light is incident on a polaroid. How would the intensity of transmitted light change when the polaroid is rotated ?

View Text Solution

22. Distinguish between unpolarised and plane polarised light. An unpolarised light is incident on the boundary between two transparent media. State the condition when the reflected wave is totally plane polarised. Find out the expression for the angle of incidence in this case.

View Text Solution

23. Briefly explain Malus law about the intensity of polarised light.

View Text Solution

24. (i) State law of Malus.

(ii) Draw a graph showing the variation of intensity (I) of polarised light transmitted by an analyser with angle (θ) between polariser and analyser.

(iii) What is the value of refractive index of a medium of polarising angle 60° ?

View Text Solution

25. (a) When an unpolarised light of intensity I_0 is passed through a polaroid, what is the intensity of the linearly polarised light ? Does it depend on the orientation of the polaroid ?

Explain your answer.

(b) A plane polarised beam of light is passed through a polaroid. show graphically the variation of the intensity of the transmitted light with angle of rotation of the polaroid in complete one rotation.

View Text Solution

26. How does an unpolarised light get polarised when passed through a polaroid ? Two polaroids are set in crossed position. A third polaroid is placed between the two making an angle θ with the pass axis of the first polaroid. Write the expression for the intensity of light transmitted from the second polaroid. in what orientations will the transmitted intensity be (i) minimum and (ii) maximum ?

View Text Solution

27. Two polaroids P_1 and P_2 are set up so that their pass axis are crossed with respect to each other. A third polaroid P_3 is now introduced between these two so that its pass axis makes an angle θ with the pass axis of P_1. A beam of unpolarised light of intensity I_0 is incident on P_1. if the intensity of light, that gets transmitted through the combination of three polaroids, be I find the ratio $\frac{I}{I_0}$ when θ equals.

(i) 30°,

(ii) 45°.

View Text Solution

28. (a) Using the phenomenon of polarisation, show how transverse nature of light can be demonstrated.

(b) Two polaroids P_1 and P_2 are placed with their pass axes perpendicular to each other. Unpolarised light of intensity I_0 is incident on P_1. a third polaroid P_3 is kept in between P_1 and P_2 such that its pass axis makes an angle of 30° with that of P_1. determine the intensity of light transmitted through P_1, P_2 and P_3.

View Text Solution

29. Explain the following giving reason for each:

(a) How does a polaroid work to produce a linearly polarised light from an unpolarised beam of light ?

(b) Why is it that light waves can be polarised but sound waves cannot be ?

(c) Why are sun goggles made of polaroids preferred over those using coloured glasses ?

View Text Solution

30. State clearly how an unpolarised light gets linearly polarised when passed through a polaroid.

(i) Unpolarised light of intensity I_0 is incident on a polaroid P_1 which is kept near another polaroid P_2 whose pass axis is parallel to that of P_1. how will the intensities of light, I_1 and I_2, transmitted by the polaroids P_1 and P_2 respectively, change on rotating P_1 without disturbing P_2 ?

(ii) Write the relation between the intensities I_1 and I_2.

View Text Solution

31. (a) Light, from a sodium lamp, is passed through two polaroid sheets, P_1 and P_2 kept one after the other. Keeping P_1 fixed , P_2 is rotated so that its pass-axis can be at different angles θ, with respect to the pass-axis of P_1. An experimentalist records the following data for the intensity of light coming out of P_2 as a function of the angles θ.

[$I_0 =$ Intensity of beam falling on P_1]

One of these observations is not in agreement with the expected theoretical variation of I. Identify this observation and write the correct expression.

(b) Define Brewster angle and write the expression for it in terms of the refractive index of the medium.

View Text Solution

Long Answer Questions Ii

1. (a) In Young's double-slit experiment, derive the condition for

(i) constructive interference and (ii) destructive interference ata point on the screen.

(b) A beam of light consisting of two wavelenths, 800 nm and 600 nm is used to obtain the interference fringes in a Young's double-slit experiment on a screen placed 1.4m away. if the two slits are separated by 0.28 mm, calculate the least distance from the central bright maximum where the bright fringes of the two wavelengths coincide.

View Text Solution

2. (a) (i) 'Two independent monochromatic sources light cannot produce a sustained interference pattern.' Give reasons.

(ii) Light waves each of amplitude "a" and freuency "ω", emanating from two coherent light sources superpose at a point. If the displacement due to these waves is given by

$y_1 = a\cos\omega t$ and $y_2 = a\cos(\omega t + \phi)$ where ϕ is the phase difference between the two, obtain the expression for the resultant intensity at the point.

(b) 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. Find out the intensity of light at a point where path difference is $\lambda/3$.

View Text Solution

3. State the importance of coherent sources in the phenomenon of interference.

In Young's double-slit experiment to produce interference pattern, obtain the conditions for constructive and destructive interference.

Hence, deduce the expression for the fringe width.

How does the fringe width get affected, if the entire experimental apparatus of Young's is immersed in water ?

View Text Solution

4. State Huygen's principle. Show, with the help of s suitable diagram, how this principle is used to obtain the diffraction pattern by a single-slit.

Draw a plot of intensity distribution and explain clearly why the secondary maxima become weaker with increasing order (n) of the secondary maxima.

View Text Solution

5. (a) When a plane wavefront of wavelength λ is incident on a narrow slit, an infensity distribution pattern of the form shown in observed on a screen suitable kept behind the slit.

(i) Name the phenomenon observed.

(ii) Obtain the conditions for the formation of central maxima and secondary maxima and the minima.

(b) Why is there significant fall in intensity of the secondary maxima compared to the central maxima ?

(c) When the width of the slit is made double the original width, how is the size of the central band affected ?

View Text Solution

6. (a) 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.

(b) Two wavelengths of sodium light of 590 nm and 596 nm are used in turn to study the diffraction taking place at a single-slit of aperture 2×10^{-6}m. the distance between the slit and the screen is 1.5m. calculate the separation between the positions of first maxima of the diffraction pattern obtained in the two cases.

View Text Solution

7. (a) Explain two features to distinguish between the interference patternn in Young's double-slit experiment with the diffraction pattern obtained due to a single-slit.

(b) A monochromaticlight of wavelength 500 nm is incident normally on a single-slit of width 0.2mm to produce a diffraction pattern. find the angular width of the central maximum obtained on the screen.

Estimate the number of fringes obtained in Young's double-slit experiment with fringe width 0.5mm, which can be accommodated within the region of total angular apread of the central maximum due to single-slit.

View Text Solution

8. (a) Define a wavefront. Using Huygen's principle, verify the laws of reflection at a plane surface.

(b) 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?

Explain.

(c) When a tiny circular obstacle is placed in the path of light from a distant source, a bright spot is seen at the centre of the obstacle. explain why.

View Text Solution

9. (a) (i) How does an unpolarised light incident on a polaroid get polarised ?

(ii) Describe briefly, with the help of a necessary diagram, the polarisation of light by reflection from a transparent medium.

(b) Two polaroids 'A' and 'B' are kept in crossed position. how should a third polaroid 'C' be placed between them so that the intensity of polarised light transmitted by polaroid B reduces to 1/8th of the intensity of unpolarised light incidennt on A?

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10. What is plane polarised light ? Two polaroids are placed at 90° to each other and the transmitted intensity is zero. What happens when one more polaroid is placed between these two, bisecting the angle between them ? How will the intensity of transmitted light vary on further rotating the third polaroid ?

(b) If a light beam shows no intensity variation when transmitted through a polaroid, which is rotated, does it mean that the light is unpolarised ? Explain briefly.

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11. (a) Distinguish between unpolarised light and linearly polarised light. How does one get linearly polarised light with the hel of a polaroid ?

(b) A narrow beam of unpolarised light of intensity I_0 is incident on a polaroid P_1. The light transmitted by it is then incident on a second polaroid P_2 with its pass axis making angle of 60° relative to the pass axis of P_1. find the intensity of the light transmitted by P_2.

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12. (a) In Young's double-slit experiment, describe briefly how bright and dark fringes are obtained on the screen kept in front of a double-slit. Hence obtain the expression for the fringe width.

(b) The ratio of the intensities at minima to the maxima in the Young's double-slit experiment is 9:25. find the ratio of the widths of the two slits.

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Self Assessment Test Section A Multiple Choice Questions

1. Huygen's principle of secondary wavelets can be used to

A. ind out speed of light in a medium

B. explain the particle nature of light

C. find the new position of the wavefront

D. explain the wave nature of light

Answer: C

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2. Monochromatic green light of wavelength 500 nm illuminates a pair of slits 1 mm apart. Separation between the two consecutive bright fringes on the interference pattern formed on a screen 2 m away is

A. 0.25mm

B. 0.1mm

C. 1.0mm

D. 0.01mm

Answer: C

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3. The slits in Young's double-slit experiment have equal width's and the light source is placed symmetrically relative to the slits. The intensity of the central fringe's is I_0.if one of the slits is closed, the intensity at the point will be

A. I_0

B. $\frac{I_0}{2}$

C. $\frac{I_0}{4}$

D. $4I_0$

Answer: C

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4. A parallel beam of monochromatic light of wavelength 5000 Å is incident normally on a single narrow slit of width 0.001 mm. the emergent light is focussed by a convex lens on a screen placed at its focal plane. The first minimum will be formed for the angle of diffraction θ

A. 0°

B. 15°

C. 30°

D. 60°

Answer: C

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5. Two polaroids are placed in the path of unpolarised light of intensity I_0 such that no light is emitted from the second polaroid. If a third polaroid, whose pass axis makes an angle θ with the pass axis of first polaroid, is placed between these polaroid then the intensity of the light emerging from the last polaroid will be

A. $\frac{I_0}{8}\sin^2 2\theta$

B. $\frac{I_0}{4}\sin^2 2\theta$

C. $\frac{I_0}{2}\cos^4 \theta$

D. $I_0 \cos^2 \theta$

Answer: A

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6. A telescope of diameter 2 m uses light of wavelength 5000 Å for viewing stars. The minimum angular separation between two starts, whose image is just resolved by this telescope, is

A. $4.0 \times 10^{-4} rad$

B. $0.25 \times 10^{-6} rad$

C. $5.0 \times 10^{-3} rad$

D. $0.31 \times 10^{-6} rad.$

Answer: D

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Self Assessment Test Section A Fill In The Blanks

1. A beam of light is incident normally upon a polaroid and the intensity of the emergent beam is found to be unchanged when the polaroid is rotated about an axiis perpendicular to its pass axis. The incident beam is ____in nature.

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2. In a single-slit diffraction experiment if the slit width is doubled then intensity of central fringe increases to ____the original intensity.

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Self Assessment Test Section B Very Short Answer Questions

1. A narrow slit is illuminated by a parallel beam of monochromatic light of wavelength λ equals to 6000 Å and the angular width of the central maxima in the resulting diffraction pattern is measured. When the slit is next illuminated by light of wavelength λ, the angular width decreases by 30%. calculate the value of the wavelength λ.

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Self Assessment Test Section C Very Short Answer Questions

1. (a) Explain how an unpolarised light gets polarised when incident on the interface separating the two transparent media.

(b) Green light is incident at the polarising angle on a certain transparent medium. The angle of refraction is 30°. Find

(i) Polarising angle, and

(ii) refractive index of the medium.

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2. (a) In what way is diffraction from each slit related to the interference pattern in a double-slit experiment?

(b) Two wavelengths of sodium light 590 nm and 596 nm are used, in turn, to study the diffraction taking place at a single slit of aperture 2×10^{-4}m. the distance between the slit and the screen is 1.5m. calculate the separation between the positions of first maxima of the diffraction pattern obtained in the two cases.

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3. Explain, with the help of a diagram, how plane polarised light can be produced by scattering of light from the Sun.

Two polaroids P_1 and P_2 are placed with their pass axes perpendicular to each other. Unpolarised light of intensity I is incident on P_1. a third polaroid P_3 is kept between

P_1 and P_2 such that its pass axis makes an angle of 45° with that of P_1. calculate the intensity of light transmitted through P_1, P_2 and P_3.

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4. (a) Derive the relation $a \sin \theta = \lambda$ for the first minimum of the diffraction pattern produced due to a single-slit of width 'a' using light of wavelength λ.

(b) State with reason, how the linear width of central maximum will be affected if (i) monochromatic yellow light is replaced with red light, and (ii) distance between the slit and the screen is increased.

(c) using the monochromatic light of same wavelength in the experimental set-up of the diffraction pattern as well as in the interference pattern where the slit separation is 1mm, 10 interference fringes are found to be within the central maximum of the diffraction pattern. determine the width of the single-slit, if the screen is kept at the same distance from the slit in the two cases.

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