PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

DIFFRACTION AND POLARISATION OF LIGHT

Numerical Examples

1. For producing a fraunhofer diffraction fringe, a screen is placed 2m away from a single narrow slit. If the width of slit is 0.2 mm, it is found that first minimum lies 5 mm on either side of the central maximum. Find the wavelength of the incident light.

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2. A single narrow slit of width 0.1 mm, is illuminated with a parallel beam of light of wavelength 600×10^{-9}m . An diffraction fringe is formed on a screen 40 cm away from the slit. At what distance, will the third minimum band be formed from the central maximum band?

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3. A fraunhofer diffraction pattern is formed by a light,of wavelength 600nm, through a slit if width 1.2 μm . Find the angular position of the first minimum and angular width of the central maximum.

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4. A fraunhofer diffraction pattern is being formed by light wave of frequency 5×10^{14} Hz through a slit of width 10^{-2} m . Find the angular width of central maximum [Velocity of light in vacuum = 3×10^{8} m. s^{-1}]

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5. A single narrow slit of width a is illuminated by monochromatic parallel ray of light of wavelength 700 nm. Find the value of a in each case following the given conditions-

(i) first minimum for 30° diffraction angle and

(ii) first secondary maximum for 30° diffraction angle.

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6. A star is observed through a telescope. The diameter of the objective of the telescope is 203.2 cm. The wavelength of the light, coming from the star to the telescope is 6600Å. Find the resolving power of the telescope.

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7. Find the Brewster angle for air to glass transmission.

(R.I of glass = 1.5)

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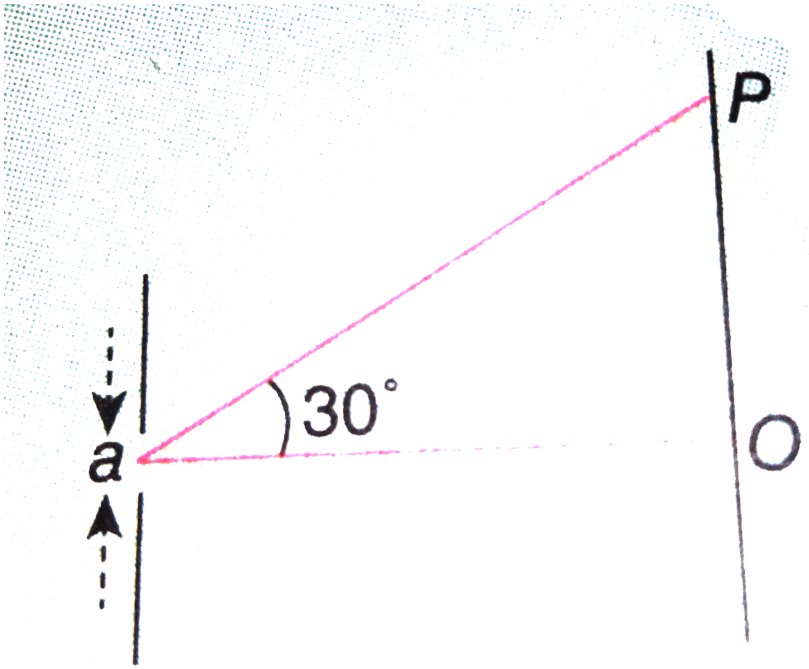
8. A single narrow slit of width a is illuminated by white light . For what value of a will the first minimum of a red light of wavelength 650 nm, lie at point p ? For what wavelength of the incident light will the first secondary maximum lie at point P?



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9. The refractive index of glass is 1.55 What is its polarising angle? Determine the angle of refraction for the polarising angle.

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10. The critical angle of a transparent crystal is 30° . What is the polarising angle of the crystal?

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11. Determine the polarising angle of the light ray moving from water of refractive index 1.33 to glass of refractive index 1.5.

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12. When sun ray is incident at an angle 37° on the water surface, the reflected ray gets completely plane polarised. Find the angle of refraction and refractive index of water.

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Section Related Questions

1. If wavelength of light = λ, width of aperture = a , then which one would show more distinct diffraction pattern among the following?

(i) When a = 5λ (ii) When a = 3λ, and

(iii) When a $\approx \lambda$

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2. The width of a narrow slit is a. Establish the condition of formation of first minima of the diffraction fringes, produced by illuminating the slit with a light of wavelength λ.

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3. Write down the expression of angular width of central maximum, formed by a narrow slit. If the breadth of the slit is increased, what would be the change in width?

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4. What is meant by the resolving power of an optical instrument?

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5. What is limit of resolution?

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6. What do you understand by resolving power of a microscope? Write down the expression for the power.

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7. What do you understand by resolving power of a astronomical telescope? Write down the expression for resolving power of an

astronomical telescope.

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8. Explain, on the basis of Rayleigh's criterion, how does the resolving power of telescope depend on wavelength of the light used?

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9. How will be resolving power of a microscope be changed, if -(a) the wavelength of the incident light decreases (b) diameter of the objective lens decreases? Give reasons, in support of your answer.

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10. You are given two thin sheets of tourmaline crystal. Explain, how you can show polarisation of light with their help

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11. Explain in brief: (i) Polariser (ii) Analyser (iii) Optical axis or crystallographic axis.

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12. What is the angle of polarisation?

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13. State and explain Brewster's law

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14. How is the angle of polarisation related to the refractive index of the reflecting medium?

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15. Discuss with a suitable diagram the procedure of production of polarised light using some glass plates.

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16. What is double refraction ? Define E -ray and O-ray

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17. What is the difference between the positive crystal and the negative crystal? Give examples of both types of crystals.

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18. What do you mean by optic axis? What are uniaxial and biaxial crystals?

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19. What is a dichroic crystal? What do you mean by dichroism?

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20. What is a polaroid? Mention some of its uses.

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Higher Order Thinking Skill Hots Questions

1. How will the diffraction pattern in a single slit be affected if

(i) the width of the slit is increased?

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2. How will the diffraction pattern in a single slit be affected if

(ii) the wavelength of the incident light is increased?

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3. What will be the effect on the diffraction pattern in a single slit if red light is used instead of violet light?

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4. Radio waves diffract strongly around big buildings but light waves do not. Why?

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5. If single slit is illuminated by white light, what will be the nature of colour of the diffraction pattern?

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6. A tourmaline crystal is placed in the path of a polarised beam of light. If it is rotated through one complete rotation, what change will be observed in the intensity of the transmitted light?

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7. How will you identify experimentally whether a given beam of light is plane polarised or unpolarised?

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8. Show that the width of central maximum is twice that of a secondary maximum and if the width of slit is increased, the width of diffraction fringes gets diminished.

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9. Results of two experiment on single slit diffraction:

How can the ratio of widths of two slits used in the experiment be evaluated from the given results?

Wavelength used	Half angular width of central maximum
λ	θ
$p\lambda$	$q\theta$

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10. If the diameter of the objective of a telescope is doubled, how will its resolving power change?

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11. If a ray of light is incident on a reflecting medium at the polarising angle, prove that the reflected and the refracted rays are at 90° to each other.

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12. Critical angle between a given transparent medium and air is θ_c. A ray of ligth in air enters the transparent medium at an angle of incidence equal to the polarising angle. Deduce a relation between angle of refraction r and critical angle θ_c.

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13. Deduce a relation between polarising angle and critical angle.

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Ncert Textbook Questions With Answer Hint

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

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2. When a small circular obstacle is placed in front of a white wall in the path of light rays coming from a distant source, a bright spot is observed at the centre of the shadow. Explain.

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3. In a 10 m high room a partition of height 7m separates two students on either side. Both light and sound waves can deviate from their path if they experience any obstruction. Then why is it that the two students can converse with each other even if one cannot see the other?

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4. Ray optics is based on the assumption that light travels in a straight line. Diffractions observed when light propagates through small apertures/slits or around small objects disproves 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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5. A parallel beam of light of 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. Calculate the width of the slit.

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Ncert Exemplear Questions With Answer Hint

1. A light beam is incident from air to a glass slab at Brewster's angle. A polaroid placed in the path of the reflected beam is being rotated about

an axis passing through the centre and perpendicular to the plane of the polariod.

A. For a particular orientation there shall be darkness as observer sees through the polaroid

B. the intensity of light as seen through the polaroid shall be independent of the rotation

C. the intensity of light as seen through the polaroid shall go through a minimum but not zero for two orientations of the polaroid

D. the intensity of light as seen through the polaroid shall go through a minimum for four orientations of the polaroid

Answer: C

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2. Consider the diffraction pattern of a small pinhole. As the size of the hole is increased the changes that occur in the pattern

A. the size decreases

B. the intensity increases

C. the size increases

D. the intensity decreases

Answer: A::B

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Exercise Multiple Choice Questions

1. Geometrical optics is valid when the dimensions of aperture are

A. of the same order as the wavelength of light

B. much smaller than the wavelength of light

C. much larger than the wavelength of light

D. of the order of 1Å

Answer: C

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2. Light appears to propagate in straight lines because

A. it is reflected by the upper part of the atmosphere

B. it is not absorbed in the atmosphere

C. its speed is very large

D. its wavelength is very small

Answer: D

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3. Which of the following does not support the corpuscular nature of light?

A. Photoelectic effect

B. diffraction

C. Compton effect

D. blackbody radiation

Answer: B

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4. Maximum diffraction takes place in case of

A. $\gamma - rays$

B. ultraviolet rays

C. infrared waves

D. radio waves

Answer: D

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5. Among the following conditions which one is an essential condition for Fresnel diffraction?

A. source and screen will remain at infinite distance from the slit

B. either source or screen will remain at infinite distance from the slit

C. neither source nor screen will remain at infinite distance from the slit

D. none of the above

Answer: C

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6. In single slit diffraction of light of wavelength λ, angular width of the central maximum (considering slit width d) will be

A. $\frac{d}{\lambda}$

B. $\frac{\lambda}{d}$

C. $\frac{2\lambda}{d}$

D. $\frac{2d}{\lambda}$

Answer: C

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7. In the diffraction of light of wavelength λ at a single slit of width a, the angle θ between the central maximum and first minimum on either side is

A. $\frac{\lambda}{a}$

B. $\frac{\lambda}{2a}$

C. $\frac{\lambda}{4a}$

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

Answer: A

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8. The width of single slit diffraction fringes varies

A. directly with the distance between the slit and the fringes

B. inversely with the wavelength of light

C. directly with the width of the slit

D. none of the above

Answer: A

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9. If width of the slit is increased, what changes would be there in linear width of central maximum?

A. increases

B. decreases

C. remains unchanged

D. none of the above

Answer: B

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10. In a single slit (width = a) diffraction of light of wavelength λ, fringes are produced with a diffraction angleθ. The condition of formation of first minimum is

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

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

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

D. $\lambda \cos \theta = a$

Answer: C

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11. In a single slit experiment, angular width of the first minimum obtained by using the light of wavelength 6980 Å is 2°. The width of the slit is

A. 2×10^{-5}mm

B. 0.02 mm

C. 0.2 mm

D. 2 mm

Answer: B

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12. A beam of light of wavelength 900 nm from a distant source falls on a single slit 0.5 mm wide and the resulting diffraction pattern is observed on a screen 2 m away. The distance of first minimum on either side of central maximum is

A. 2.4 mm

B. 4.8 mm

C. 9.6 mm

D. none of the these

Answer: D

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13. The width of diffraction band is

A. inversely proportional to the wavelength of the incident light

B. inversely proportional to the size of source which illuminates the slit.

C. directly proportional to the distance between slit and screen

D. directly proportional to the width of the slit

Answer: C

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14. In a single slit Fraunhofer diffraction experiment, the wavelength of the light used is 400 mm and the first minimum is obtained for diffraction angle 30°. The magnitude of θ for first secondary maximum is

A. $\sin^{-1}\left(\frac{2}{3}\right)$

B. $\sin^{-1}\left(\frac{3}{4}\right)$

C. $\sin^{-1}\left(\frac{1}{4}\right)$

D. $\tan^{-1}\left(\frac{2}{3}\right)$

Answer: B

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15. In a single slit experiment, a beam of parallel monochromatic light falls on a slit perpendicularly. A diffraction fringe is produced on a screen kept perpendicular to the direction of propagation of light. What would

be the phase difference of the two rays coming from two ends of the slit at the minimum of fringe.

A. 0

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

C. π

D. 2π

Answer: D

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16. In a single slit experiment, the width of the slit is reduced. The linear width of the central maximum

A. will increase but intensity will be reduced

B. will decrease but intensity will be increased more

C. will increase but intensity will be increased more

D. will decrease but intensity will be reduced

Answer: A

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17. In a single slit experiment, the width of the slit is reduced to half. To keep the width of central maximum same, what is to be done of the following?

A. the distance between the slit and the screen is to be reduced to half

B. the distance between the slit and the screen is to be reduced to one-fourth

C. the distance between the slit and the screen is to be doubled

D. nothing to be done, as width of centra maximum does not depend upon the width of the slit

Answer: A

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18. A narrow slit of 2 mm width is illuminated by a monochromatic light of wavelength 500 nm. What would be the intermediate distance between two first minima on either side of a screen kept 1m away?

A. 5 mm

B. 0.5 mm

C. 1 mm

D. 10 mm

Answer: B

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19. Resolving power of a microscope is

A. inversely proportional to the numerical aperture of the lens of the objective

B. directly proportional to the wavelength of the light

C. directly proportional to the square of the wavelength of the light

D. directly proportional to the numerical aperture of the lens of the objective

Answer: D

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20. For minimum angular distance between two stars, which a telescope can analyse, which of the following statements is true (here aperture means diameter of the objective of the telescope)?

A. angular distance decreases with the increase in aperture of the telescope

B. angular distance does not depend on the aperture of the telescope

.

C. angular distance increases linearly with the aperture of the telescope.

D. angular distance increases with second power of the aperture of the telescope

Answer: A

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21. An unpolarised light of intensity I_0 falls on a pair of Nicol prism. Angle between the two prisms is 60°. Intensity of the light emitted from the prism will be

A. I_0

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

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

D. $\frac{I_0}{8}$

Answer: D

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22. A polaroid is inclined at an angle 45° with the incident light of intensity I_0. After polarisation, intensity of the light emitted from the polaroid is

A. I_0

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

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

D. 0

Answer: B

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23. Amplitude of unpolarised light on a polariser is a. Amplitude of polarised light which passes through polariser is

A. $\frac{a}{2}$

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

C. $\frac{\sqrt{3}a}{2}$

D. $\frac{3a}{4}$

Answer: B

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24. When a light ray in air is incident on glass at 57°, the reflected ray is completely polarised. If the same ray is incident on water at an angle θ, also the reflected ray is completely polarised. Then

A. $\theta > 57^\circ$

B. $\theta < 57^\circ$

C. $\theta = 57^\circ$

D. $\theta = 90^\circ$

Answer: B

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25. The Brewster's law in polarisation of light is

A. $\mu \sin i_p = 1$

B. $\mu \cos i_p = 1$

C. $\mu \tan i_p = 1$

D. $\mu \cot i_p = 1$

Answer: D

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26. From Brewster's law it follows that the polarising angle depends on

A. wavelength of light

B. frequency

C. plane of polarisation

D. plane of vibration

Answer: A

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27. The tangent of the polarising angle is equal to the refractve indices of the reflecting medium. This is called

A. Brewster's law

B. law of Malus

C. Bragg's law

D. Grimaldi's law

Answer: A

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28. A ray of light is incident on a glass. The reflected ray gets totally polarised. The magnitude of incidence angle is (refractive index of glass = μ)

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

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

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

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

Answer: D

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29. Angle of polarisation for a medium is 60°. Critical angle for this will be

A. $\sin^{-1}\sqrt{3}$

B. $\tan^{-1}\sqrt{3}$

C. $\cos^{-1}\sqrt{3}$

D. $\sin^{-1}\sqrt{\frac{1}{3}}$

Answer: D

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30. An unpolarised ray of light is incident on water surface. The incident angle for which the reflected and refracted rays become perpendicular to each other is $\left(\mu_w = \frac{4}{3}\right)$

A. $\sin^{-1}\frac{4}{3}$

B. $\tan^{-1}\frac{3}{4}$

C. $\tan^{-1}\frac{4}{3}$

D. $\sin^{-1}\frac{1}{3}$

Answer: C

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31. Critical angle of a medium is $\sin^{-1}(0.6)$. The polarising angle for that medium is

A. $\tan^{-1}(1.5)$

B. $\sin^{-1}(0.8)$

C. $\tan^{-1}(1.6667)$

D. $\tan^{-1}(0.6667)$

Answer: C

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32. Brewster's angle at glass-air interface is 54.74°. If a ray of light is incident on glass from air at an angle 45°, then the magnitude of the

refracted angle will be (given $\tan 54.74^\circ = \sqrt{2}$)

A. 60°

B. 30°

C. 25°

D. 54.74°

Answer: B

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33. If μ_O and μ_E be the refractive indices of the crystal for O-ray and E-ray respectively, then which of the following relations is correct for negative crystal

A. $\mu_E = \mu_O$

B. $\mu_E > \mu_O$

C. $\mu_E < \mu_O$

D. $\mu_E \geq \mu_O$

Answer: C

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34. In double refraction we get two refracted rays, i.e., O-ray and E-ray. Which one of the following statements is correct?

A. only O-ray is polarised

B. only E-ray is polarised

C. both O-ray and E-ray are polarised

D. none of the O-ray and E-ray is polarised

Answer: C

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35. When a polaroid, placed in the path of light is rotated , the intensity of light appears to vary but never reduces to zero. The light is

A. unpolarised

B. plane polarised

C. partially plane polarised

D. no conclusion can be drawn

Answer: C

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36. When a polariod, placed in the path of light, is rotated, there is no change of intensity of light. The incident light-

A. totatlly polarised

B. partially plane polarised

C. unpolarised

D. none of above

Answer: C

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Exercise Very Short Answer Type Questions

1. Do the sound waves show the property of diffraction ?

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2. what idea does diffraction of light give about the nature of light waves?

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3. Why do we feel more diffraction in sound wave than in light wave?

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4. While passing round the corner of an obstacle, the bending of light___with the increase of the wavelength of light

[Fill in the blank].

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5. Between sound and light, _____ bends more while passing round the corner of an obstacle [Fill in the blank].

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6. While passing round the tall buildings, radio wave produces___but___does not(fill in the blanks).

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7. Intensity of all fringes in diffraction pattern are ___ [Fill in the blank.]

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8. What is the phenomenon of diffraction more pronounced in single slit?

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9. What should be the nature of the incident wavefront in case of Fresnel's diffraction?

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10. Small spherical obstacle produces____diffraction [Fill in the blank].

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11. A single slit produces ___diffraction [Fill in the blank.]

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12. In Fresnel's diffraction, source of light is located at____ distance from the aperture (slit) [Fill in the blank.]

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13. If the wavelength of the incident light in a single slit is increased, the Fraunhofer's diffraction bands will be ____ [Fill in the blank.]

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14. In a single slit diffraction, the intensity of secondary maxima gradually____ [fil in the blank]

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15. Resolving power of a telescope____with the increase of the diameter of its objective [Fill in the blank.]

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16. How does the angular width of central maximum change when the slit width is increased?

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17. Instead of violet light if red light is used in the formation of diffraction pattern in a single slit, the diffraction band will be wider- is the statement correct?

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18. In a single slit diffraction, what is the condition for formation of first minimum point?

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19. In a single slit diffraction, what is the condition for formation of first secondary maximum?

Watch Video Solution

20. In a single slit diffraction, what is the expression of linear width of the central maximum?

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21. What is called the power of an optical instrument to produce distinctly separate image of two close objects?

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22. What does polarisation of light prove about the nature of light?

Watch Video Solution

23. Why does ultrasonic wave not exhibit polarisation?

Watch Video Solution

24. When light is polarised, how does its intensity change?

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25. Sunray, sodium light, head light of an automobile- which of these lights are polarised?

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26. What is the angle of between the plane of polarisation and the direction to propagation to polarised light?

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27. Tourmaline is a hexagonal crystal. The longest diagonal of the crystal is known as_____ [Fill in the blank.]

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28. If a beam of light its vibrations restricted to one plane instead of different planes, it is called___ of light [Fill in the blank.]

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29. The plane containing the direction of propagation of light and perpendicular to the plane of vibration is called ___ [Fill in the blank [Fill

in the blank.]

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30. A ray of light incident on a medium at polarising angle.what will be the angle between the reflected and the refracted rays?

Or, an unpolarised ray of light is incident on a rectangular glass block at Brewster's angle. What will be the angle between the reflected and the refracted rays?

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31. If the polarising angle for air-glass interface be 56°, what will be the angle of refraction in glass?

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32. What is the relation between polarising angle i_p and refractive index μ of the medium?

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33. For a slab, polarising angle is $\frac{\pi}{3}$ rad. What is the refractive index of the slab?

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34. The angle of polarisation for glass, is about_____ [Fill in the blank].

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35. The particular angle of incidence, for which the degree of polarisation by reflection is maximum, is called _____[Fill in the blank].

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36. If Brewster's angle be θ, then the magnitude of the critical angle is ____ [Fill in the blank]

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37. Give an example of a double refracting crystal.

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38. The ordinary ray i.e., O-ray obeys the general laws of refraction of light-is the statement correct?

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39. In case of negative crystals the velocity of E-ray is _____ than that of O-ray [Fill in the blank].

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40. Quartz is a ____crystal [fill in the blank].

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41. If refractive indices of a positive crystal for O-ray and E-ray are μ_o and μ_E respectively, then μ_E will be ___ than μ_o [Fill in the blank].

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42. Use of ___ instead of glass in high quality sunglasses is more pleasant for eyes [Fill in the blank].

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Exercise Short Answer Type Questions I

1. What are the conditions of formation of maxima and minima of diffraction fringes in Fraunhofer diffraction in a single slit?

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2. What will be the effect on the diffraction pattern in a single slit if red light is used instead of violet light?

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3. A light is incident on a glass -block at a polarisation angle How does this polarisation angle change with the wavelength of light?

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Exercise Short Answer Type Questions Ii

1. The two rays we obtain from double refraction are plane polarised but their polarisation planes are mutually perpendicular. Why are the two rays called ordinary and extaordinary ray?

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2. A rainbow ordinarily show a range of colours. But if the water droplets that from the rainbow are small enough, the rainbow will appear white. Explain why, using diffraction ideas. How small do you think the raindrops would have to be for this to occur?

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3. In a diffraction experiment with waves of wavelength λ, if the slit width is small enough there will be no intensity minima i.e., no dark fringes. What is the maximum slit width for which this occurs? Explain your answer.

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4. The predominant sound waves used in human speech have wavelengths in the range from 1.0 to 3.0 meters. Using the ideas of diffraction, explain how it is possible to hear a person's voice even when he is facing away from you.

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5. A salesperson at a bargain counter claims that a certain pair of sunglasses has polaroid filters, you suspect that the glasses are just tinted plastic. How could you find out for sure?

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6. When unpolarised light is incident on two crossed polarisers, no light it transmitted. A student asserted that if a third polariser is added

transmission of light will occur. Does this make sense? How can adding a third filter increase transmission?

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7. How can you determine the direction of the polarising axis of a single polariser?

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8. It has been proposed that automobile windshields and headlights should have polarising filters to reduce the glare of oncoming lights during night driving. Would this work? How should the polarising axes be arranged? What advantages would this scheme have? what disadvantages?

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Problem Set I

1. A screen is placed 40 cm from a narrow slit. Parallel light rays of wavelength 5890 Å fall on the slit. First minimum is formed 2 mm on either side of central maximum.Find the width of the narrow slit.

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2. A diffraction fringe pattern of slit width 0.2 mm is formed by a lens of focal length 50 cm. Find the distance between first minimum and the centre of the fringe pattern. The wavelength of the light used: 6×10^{-5} cm.

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3. A narrow slit of width 0.14 mm is illuminated by monochromatic light. On the screen, placed 2 m away, a diffraction fringe is observed. If the second black band lies 16 mm away from the central bright band, then what is the wavelength of the light used?

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4. In a single narrow slit of width 0.01 mm, rays of light of wavelength 589.3 nm, are allowed to fall parallally. Find the angular width of the central maximum 1m away from the slit.

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5. Monochromatic parallel light rays of wavelength 500 nm are incident on a narrow slit normally. If the angular spread of central maximum of Fraunhofer diffraction is 60°, then what is the width of the slit?

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6. Width of a narrow slit is 0.25 mm. On it, ray of light of wavelength 5890 Å is incident normally. What is the angular distance between central maximum and first secondary maximum produced in the diffraction fringe?

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7. A ray of light incidenting at an angle 60° at the reflect surface of diamond is refracted inside it at an angle 12°. Find the polarising angle of diamond.

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8. At what angle above the horizon, is the sun to be located so that its rays, reflected on a calm surface of a water tank, get totally polarised? The refractive index of water μ_w = 1.327 and $\tan 53^\circ = 1.327$.

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9. A beam of light travelling in water falls on a glass plate immersed in water. When the incidence angle is 51°, the reflected beam of light gets

totally plane polarised. Calculate the refractive index of glass. Given, refractive index of water $= \frac{4}{3}$.

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Problem Set Ii

1. A narrow slit of width 'a' is illuminated by a light of wavelength 6000Å. For what value of 'a' do the following events occur?-

i. first maximum falls at an angle of diffraction of 30°

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2. A narrow slit of width 'a' is illuminated by a light of wavelength 6000Å. For what value of 'a' do the following events occur?-

ii. First minimum falls at an angle of diffraction of 30°

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3. A monochromatic light of wavelength 600 nm is emitted from slit of thickness 1 mm. if the distance between the slit and the screen is 2m. Then calculate the gap between the two adjacent first maximum points of the central maximum.

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4. A narrow slit of width 0.025 cm is placed in front of a convex lens. The slit is illuminated by a light of wavelength 5896Å and an diffraction fringe pattern is formed on the focal plane of the lens. The third minimum on the left is 3 mm away from the third minimum on the right. Calculate the focal length of the lens.

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5. A light of wavelength λ falls on a narrow slit of width d.A diffraction fringe is formed on a screen placed at distance D from the slit. If the

linear width of the central maximum equals to the width of the slit, will be the value of D?

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6. A light of wavelength 6000Å from a distant source falls on a narrow slit of width 0.5 mm. As a result, a diffraction fringe pattern is formed on a screen placed at a distance 2.0 m from the slit. What is the distance between first two minima points formed on the either side of central maximum of this fringe pattern.

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7. A beam of parallel light rays are incident on a surface of a glass plate at angle 60°. If the reflected rays from the glass surface get totally poarised- (i) What would be the magnitude of refracted angle? (ii) What is the refractive index of glass?

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Hots Numerical Problems

1. A parallel beam of light of $\lambda = 5 \times 10^{-7}$ m is incident normally on a narrow slit of width 0.2 mm. The diffraction pattern is observed on a screen at the focal plane of a convex lens of f = 50 cm. Find the distance between the first two minima and the first two maxima on the screen.

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2. A beam of monochromatic parallel rays is incident normally on a narrow slit. A diffraction fringe pattern is formed on a screen, placed normally to the incident rays. Find the phase difference between two rays coming from two ends of the slit at the first minimum formed in the diffraction fringe.

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3. A narrow slit of width d is placed in front of a convex lens of focal length 0.5 m. the slit is illuminated normally by a light of wavelength 5.89×10^{-7}m. If the distance between two first minima on the either side of central maximum is 2×10^{-3}m, calculate the width d of the slit.

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4. The angular width of central maximum of a Fraunhofer diffraction fringe formed by a narrow slit is measured. For this, the slit is illuminated by a light of wavelength 6000 Å. When the slit is illuminated by light of another wavelength, it is found that the angular width decreases by 30%. Find the wavelength of the light used in the second case. Now, in the first case, the total set-up of the experiment is immersed in a liquid. It is found that, the angular width of central maximum decreases by same amount. Calculate the refractive index of the liquid.

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5. A microwave of wavelength 2 cm falls normally on a narrow slit of width 5 cm.

what is the angular width of central maximum on either side of it?

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6. A microwave of wavelength 2 cm falls normally on a narrow slit of width 5 cm.

if the microwave falls at angle 15°, with the normal drawn in the plane of the slit, then what would be the angular width of the central maximum on either side of it? Given, $\sin 23^\circ 35' = 0.4, \sin 15^\circ = 0.2588, \sin 41^\circ 13' = 0.6588$ and $\sin 8^\circ 7' = 0.$

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Entrance Corner

1. Statement I : To observe diffraction of light, the size of obstacle or aperture should be of the order of 10^{-7}m.

Statement II : 10^{-7} m is the order of wavelength of visible light.

A. Statement I is true, Statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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2. Statement I : We cannot get diffraction pattern from a wide slit illuminated by monochromatic light.

Statement II: In diffraction pattern all the bright bands are not of the same intensity.

A. Statement I is true, Statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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3. Statement I : Resolving power of a telescope increases on decreasing the aperture of its objective lens.

Statement II : Resolving power of a telescope, R = $\frac{a}{1.22\lambda}$.

A. Statement I is true, Statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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4. Statement I : In single slit experiment, greater is the wavelength of the light used, greater is the width of central maximum.

Statement II : Width of central maximum is directly proportional to the wavelength of light used.

A. Statement I is true, Statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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5. Statement I: The value of polarising angle is independent of the colour of incident light.

Statement II: Polarising angle depeds on the refractive index of the medium.

A. Statement I is true, Statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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6. Statement I : The electromagnetic waves of all wavelengths can be polarised.

Statement II: Polarisation is independent of the wavelength of electromagnetic waves.

A. Statement I is true, Statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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7. Statement I: Diffracton can be seen clearly if the edge of obstacle or slit is very sharp.

Statement II: As the size of the slit is much larger than the wave-length, so it is very difficult to capture the effect of diffraction by naked eyes.

A. Statement I is true, Statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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Multiple Correct Answer Type

1. Which of the following undergoes larger diffraction?

A. $\gamma - rays$

B. ultraviolet light

C. sound waves

D. radio waves

Answer: C::D

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2. The width of single slit diffraction fringes varies

A. Directly as the distance between the slit and the screen

B. directly as the width of the slit

C. inversely as the width of the slit

D. inversely as the wavelength of light

Answer: A::B::C

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3. Diffraction pattern can be observed with

A. two narrow slits

B. large number of narrow slits

C. one narrow slit

D. one wide slit

Answer: A::D

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4. Interference differs from diffraction in that:

A. it cannot be observer with white light

B. unlike diffraction, the interference fringes are of verying intensity

C. interference minima are perfectly dark and those of diffraction may not be dark

D. interference fringes may or may not be of same width but diffraction fringes are never of the same width

Answer: A::C

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5. Ordinary light falling at polarising angle on a glass slab placed in air is partly reflected in air and partly refracted in the slab, Then,

A. the reflected light is completely polarised

B. the reflected light is partially polarised

C. the refracted light is completely polarised

D. the refracted light is partially polarised

Answer: C::D

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Comprehension Type

1. A slit of width a is illuminated by red light of wavelength 650 nm. The first diffraction minimum is observed at an angle $\theta_1 = 5.2^\circ$ from the direction of the incident beam.

The width of the slit a in mm is

A. 5.12×10^{-3}

B. 7.17×10^{-3}

C. 3.21×10^{-7}

D. 4.25×10^{-7}

Answer: B

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2. A slit of width a is illuminated by red light of wavelength 650 nm. The first diffraction minimum is observed at an angle $\theta_1 = 5.2^\circ$ from the direction of the incident beam.

The angle θ_2 at which the second minimum is observed is

A. 10.4°

B. 8.6°

C. 7.5°

D. 9.5°

Answer: A

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3. Light of wavelength 6500 Å passes through a slit 0.1 cm wide and forms a diffraction pattern on a screen 1.8 m away.

The width of the central maximum in mm is

A. 2.5

B. 1.32

C. 2.34

D. 1.72

Answer: C

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4. Light of wavelength 6500 Å passes through a slit 0.1 cm wide and forms a diffraction pattern on a screen 1.8 m away.

The width of the central maximum in mm when the apparatus is immersed water of refractive index $\frac{4}{3}$ is

A. 2.12

B. 1.53

C. 2.54

D. 1.755

Answer: D

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Integer Answer Type

1. A parallel light beam of wavelength 6000Å passes through a slit 0.2 mm wide and forms a diffraction pattern on a screen 1.0 m away from the slit. Find the width of the central maximum in mm on the screen.

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2. Light of wavelength 5000Å is diffracted through a slit 0.2 mm wide and forms a diffraction pattern on a screen. It is found that the first minima lie at 5mm on either side of the central maximum on the screen. Determine the distance of the screen in metre from the slit.

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1. If a light of wavelength λ falling on a single slit of width a diffracts at an angleθ, the condition of first minima will be

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

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

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

D. $\lambda \cos \theta = a$

Answer:

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Examination Archive With Solutions Wbchse

1. What is understood by diffraction of light? In a single slit experiment, if the width of the slit increases, what will be the change of angular width of the central maxima? State Brewster's law.

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2. Which of the following phenomenon does not occur to both sound and light waves ?

A. interference

B. diffraction

C. coherence

D. polarisation

Answer:

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3. Define resolving power of an optical instrument.

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4. The resolving power of a microscope at 6000 Å is 10^4. What is its resolving power at 4000 Å

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5. The optic axis of two polaroids are inclined at an angle of 45° with each other. Unpolarised light of intensity I_0 being incident on the first polaroid emerges from the second polaroid. Find the intensity of the emergent light.

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6. The cirtical angle of a transparent crystal for green light is 30°. Find the angle of polarisation of that crystal.

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7. Which one does not change in polarisation of light?

A. Intensity

B. Phase

C. Frequency

D. None of these

Answer:

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8. (i) State Brewster's law. (ii) An unpolarised light is incident at angle of polarisation on a reflector. Determine the angle between the reflected and the transmitted rays.

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9. Why are polaroids used in sunglasses?

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10. Find the angular width of the central maxima of Fraunhofer diffraction pattern due to single slit.

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11. How does the angular width of the central maxima in a single slit Fraunhofer diffraction experiment change when the distance between

the slit and screen is doubled?

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12. In Fraunhofer diffraction experiment, the first minima of red light $(\lambda = 600nm)$ if formed on the first maxima of another light of wavelength λ'. Find the value of λ'.

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Examination Archive With Solutions Wbjee

1. Find the right condition (s) for Fraunhoffer diffraction due to a single slit.

A. source is at infinite distance and the incident beam has converged at the slit.

B. Source is near to the slit and the incident beam is parallel.

C. Source is at infinity and the incident beam is parallel.

D. Source is near to the slit and the incident beam has converged at the slit.

Answer:

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Examination Archive With Solutions Jee Main

1. Two beams, A and B, of plane polarized light with mutually perpendicular planes of polarization are seen through a polaroid. From the position when the beam A has maximum intensity (and beam B has zero intensity), a rotation of polaroid through 30° makes the two beams appear equally bright. If the initial intensities of the two beams are I_A and I_B respectively, then I_A / I_B equals:

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

B. 3

C. $\frac{3}{2}$

D. 1

Answer:

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2. Assuming human pupil to have a radius of 0.25 cm and a comfortable viewing distance of 25 cm, the minimum separation between two objects that human eye can resolve at 500 nm wavelength is

A. 1 μm

B. 30μm

C. $100\mu m$

D. 300μm

Answer:

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3. The box of a pin hole camera of length L, has a hole of radius a. It is assumed that when the hole is illuminated by a parallel beam of light of wavelength λ, the spread of the spot (obtained on the opposite wall of camera) is the sum of its geometrical spread and the spread due to diffraction. The spot would have its minimum size (say $b_{\min}$) when.

A. $a = \frac{\lambda^2}{L}$ and $b_{\min} = \frac{2\lambda^2}{L}$

B. $a = \sqrt{\lambda L}$ and $b_{\min} = \frac{2\lambda^2}{L}$

C. $a = \sqrt{\lambda L}$ and $b_{\min} = \sqrt{4\lambda L}$

D. $a = \frac{\lambda^2}{L}$ and $b_{\min} = \sqrt{4\lambda L}$

Answer:

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4. Unpolarised light of intensity I passes through an ideal polariser A. Another identical polariser B is placed behind A. The intensity of light beyond B is found to be $\frac{I}{2}$. Now another identical polariser C is placed between A and B. The intensity beyond B is now found to be $\frac{I}{8}$. the angle between polariser A and C is

A. 45°

B. 60°

C. 0°

D. 30°

Answer:

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5. The angular width of central maximum in a single slit diffraction pattern is 30°. The width of the slit is 1μm. the slit is illuminated by monochromatic plane waves. If another slit of same width is made near it,

Young's fringes can be observer on a screen placed at a distance 50 cm from the slits. If the observed fringe width is 1 cm, what is slit separation distance? (i.e., distance between the centres of each slit)

A. 75μm

B. $100\mu m$

C. 25μm

D. 50 μm

Answer:

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Examination Archive With Solutions Aipmt

1. A beam of light of λ = 600 nm from a distant source falls on a single slit 1 mm wide and the resulting diffraction pattern is observed on a screen 2 m away. The distance between first dark fringes on either side of the central bright fringe is

A. 1.2 cm

B. 1.2 mm

C. 2.4 cm

D. 2.4 mm

Answer:

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2. For a parallel beam of monochromatic light of wavelength λ, diffraction is produced by a single slit whose width a is of the order of the wavelength of the light. If D is the distance of the screen from the slit, the width of the central maxima will be

A. $\frac{2D\lambda}{a}$

B. $\frac{D\lambda}{a}$

C. $\frac{Da}{\lambda}$

D. $\frac{2Da}{\lambda}$

Answer:

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3. In a double slit experiment, the two slits are 1 mm apart and the screen is placed 1 m away. A monochromatic light of wavelength 500 mm is used.what will be the width of each slit for obtaining ten maxima of double slit within the central maxima of single slit pattern?

A. 0.2 mm

B. 0.1 mm

C. 0.5 mm

D. 0.02 mm

Answer:

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1. In a diffraction pattern due to a single slit of width a, the first minimum is observed at an angle 30° when light of wavelength 5000Å is incident on the slit. The first secondary maximum is observed at an angle of

A. $\sin^{-1}\left(\frac{2}{3}\right)$

B. $\sin^{-1}\left(\frac{1}{2}\right)$

C. $\sin^{-1}\left(\frac{3}{4}\right)$

D. $\sin^{-1}\left(\frac{1}{4}\right)$

Answer:

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2. A parallel beam of light of wavelength λ is incident normally on a single slit of width d. Diffraction bands are obtained on a screen placed at a

distance D from the slit. The second dark band from the central bright band will be at a distance given by

A. $\frac{2\lambda D}{d}$

B. $\lambda d D$

C. $\frac{\lambda D}{2d}$

D. $\frac{2\lambda d}{D}$

Answer:

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3. Unpolarised light is incident from air on a plane surface of a material of refractive index μ. At a particular angle of incidence I, it is found that the reflected and refracted rays are perpendicular to each other. Which of the following options is correct for this situation?

A. $i = \sin^{-1}\left(\frac{1}{\lambda}\right)$

B. Reflected light is polarised with its electric vector perpendicular to the plane of incidence

C. Reflected ligth is polarised with its electric vector parallel to the plane of incidence

D. $i = \tan^{-1}\left(\frac{1}{\mu}\right)$

Answer:

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Cbse Scanner

1. How does the angular separation between fringes in single slit diffracton experiment change when the distance of separation between the slit and screen is doubled ?

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2. How does an upolarised light incident on a polaroid get polarised? Describe briefly, with the help of a necessary diagram, the polarisation of ligtht by reflection from a transparent medium.

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3. Two polaroids A and B are kept in crossed position. How should a third polaroid C be placed between them so that the intensityof polarised light transmitted by polaroid B reduces to 1/8 th of the intensity of upolarised light incident on A?

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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. A parallel beam of light of 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. Calculate the width of the slit.

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6. What is linearly polarised light? Describe briefly using a diagram how sunlight is polarised.

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

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8. Two polaroids P_1 and $P(2)$ are placed with pass axes perpendicular to each other. Unpolarised light of intensity I_0 is incident on P_1. A thrid polaroid P_3 is kept in between P_1 and P_2 such that its pass axis makes an angle of 45° with that of P_1. Determine the intensity of light transmitted through P_1, P_2andP_3.

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9. Two wavelength 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 1.5 m. Calculate the separation between the positions of first maxima of the diffraction pattern obtained in the two cases.

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10. Show, giving a suitable diagram, how unpolarised light can be polarised by reflection.

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11. In what way is dffraction from each slit related to the interference pattern in a double slit experiment?

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12. 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 shadow of the obstacle. Explain why.

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13. How does the resolving power of a microscope depend on

(i) the wavelength of the light used and (ii) the medium used between the object and the objective lens?

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14. The light from a clear blue portion of the sky shows a rise and fall of intensity when viewed through a polaroid which is rotated. Describe, with the help of a suitable diagram, the basic phenomenom/process which occurs to explain this observation.

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15. Show how light reflected from a transparent medium gets polarised. Hence deduce Brewster's law.

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16. Why does unpolarised light from a source show no variation in intensity when viewed through a polariod which is rotated? Show with the help of a diagram, how unpolarised light from sun gets linearly polarised by scattering.

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17. Three identical polariod sheets P_1, P_2 and P_3 are oriented so that the pass axis of P_2 and P_3 are inclined at angles of 60° and 90° respectively with the pass axis of p_1. A monochromatic source S of unpolarized light of intensity I_0 is kept in front of the polaroid sheet P_1 as shown in the figure. Determine the intensities of light as observed by the observer at O. When polaroid P_3 is rotated with respect to P_2 at angles $\theta = 30^\circ$ and 60°.

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

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

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20. Explain two features to distinguish between the interference pattern in Young's double slit experiment with the diffraction pattern obained due to a single slit.

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21. A monochromatic light of wavelength 500 nm is incident normally on a single slit of width 0.2 mm to produce a diffraction pattern. Find the angular width of the central maximum obained on the screen.

Estimate the number of fringes obatined in Young's double slit experiment with fringe width 0.5 mm, which can be accommodated within

the region of total angular spread of the central maximum due to single slit.

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22. Unplarised 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, then 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.

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23. Distinguish between unpolarised light and linearly polarised light. How does one get linearly polarised light with the help of a polaroid?

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24. 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 60° relative to the pass axis of P_1. Find the intensity of the light transmitted by P_2.

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25. How is linearly polarised light obtained by the process of scattering of light? Find the Brewster angle for air-glass interface, when the refractive index of glass = 1.5

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26. 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.

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27. 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.

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