Class XII

OPTICS

Class 12 - Physics

1. The frequencies of X-rays, γ-rays and ultra violet rays are respectively a, b and c. Then **[1]**

   a) a > b, b > c
   b) a < b, b < c
   c) a > b, b < c
   d) a < b, b > c

2. The temperature of an object that emits electromagnetic radiation must be **[1]**

   a) high enough for it to glow
   b) higher than 0 K
   c) higher than that of its surroundings
   d) higher than 0°C

3. Electromagnetic waves propagate **[1]**

   a) slower in a dielectric
   b) at the different speed in a dielectric
   c) at the same speed in a dielectric
   d) faster in a dielectric

4. Infrared radiations are detected by: **[1]**

   a) spectrometer
   b) pyrometer
   c) nanometer
   d) photometer

5. The electric and the magnetic fields, associated with an e.m. wave, propagating along the + z-axis, can be represented by **[1]**

   a) $\left[\vec{E} = E_0\hat{k}, \vec{B} = B_0\hat{i}\right]$
   b) $\left[\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{k}\right]$
   c) $\left[\vec{E} = E_0\hat{i}, \vec{B} = B_0\hat{j}\right]$
   d) $\left[\vec{E} = E_0\hat{j}, \vec{B} = B_0\hat{i}\right]$

6. How does a charge, q oscillating at a certain frequency produce electromagnetic waves? Sketch a schematic diagram depicting electric and magnetic fields for an electromagnetic wave propagating along the Z- direction. **[2]**

7. a. On what factors does the speed of an electromagnetic wave in a medium depend? **[2]**
   b. How is an electromagnetic wave produced?
   c. Sketch a schematic diagram depicting the electric and magnetic fields for an electromagnetic wave propagating along z-axis.

8. Why is the orientation of the portable radio with respect to the broadcasting station important? **[2]**

9. An e.m. wave is travelling in a medium with a velocity $v = v\hat{i}$. The electric field oscillations, of this e.m. wave, are along the y-axis. **[2]**
   a. Identify the direction in which the magnetic field oscillations are taking place, of the e.m. wave.
   b. How are the magnitudes of the electric field and magnetic fields in the electromagnetic wave related to each other?

10. i. Identify the part of the electromagnetic spectrum which is: **[2]**
    a. suitable for radar system used in aircraft navigation
    b. produced by bombarding a metal target by high speed electrons.

ii. Why does a galvanometer show a momentary deflection at the time of charging or discharging a capacitor? Write the necessary expression to explain this observation.

11. Which of the following is not due to total internal reflection? **[1]**

a) Difference between apparent and real depth of a pond

b) Mirage on hot summer days

c) Brilliance of diamond

d) Working of optical fibre

12. A concave lens of glass, refractive index 1.5, has both surfaces of the same radius of curvature R. On immersion in a medium of refractive index 1.75, it will behave as a **[1]**

a) divergent lens of focal length 3.5 R

b) divergent lens of focal length 3.0 R

c) convergent lens of focal length 3.0 R

d) convergent lens of focal length 3.5 R

13. The objective of a telescope has a focal length of 1.2 m. It is used to view a 10.0 m tall tower 2 km away. What is the height of the image of the tower formed by the objective? **[1]**

a) 4 mm

b) 2 mm

c) 6 mm

d) 8 mm

14. The phenomena involved in the reflection of radiowaves by ionosphere is similar to **[1]**

a) total internal reflection of light in the air during a mirage

b) dispersion of light by water molecules during the formation of a rainbow

c) scattering of light by the particles of air

d) reflection of light by a plane mirror

15. Write the relation for the refractive index μ of the prism in terms of the angle of minimum deviation δ_m and the angle A of prism. **[1]**

16. The magnifying power of an astronomical telescope is 24. In normal adjustment, distance between its two lenses is 150 cm. Find the focal length of the objective lens. **[1]**

17. Will the focal length of a lens for red light be more, same or less than that for blue light? **[1]**

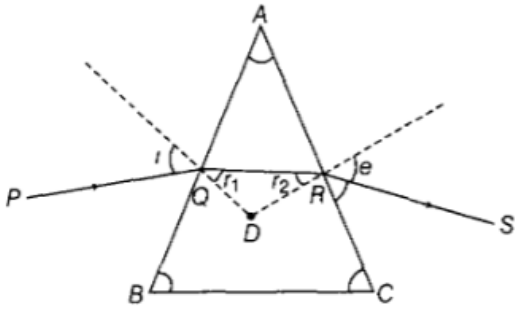
18. a. Explain briefly how the focal length of a convex lens changes with increase in wavelength of incident light. **[1]**

b. What happens to the focal length of convex lens when it is immersed in water? Refractive index of the material of lens is greater than that of water.

19. The figure shows a ray of light passing through a prism. If the refracted ray QR is parallel to the base BC, show that **[2]**

i. $r_1 = r_2 = \frac{A}{2}$ and

ii. Angle of minimum deviation, $D_m = 2i - A$

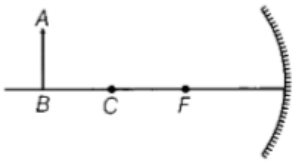


20. Define refractive index of a transparent medium. A ray of light phases through a triangular prism. Plot a graph showing the variation of the angle of deviation with the angle of incidence. **[2]**

21. i. Why does white light disperse when passed through a glass prism? **[2]**

ii. Using lens maker's formula, show how the focal length of a given lens depends upon the colour of light incident on it.

22. An object AB is kept in front of a concave mirror as shown in the figure. **[2]**



i. Complete the ray diagram showing the image formation of the object.

ii. How will the position and intensity of the image be affected if the lower half of the mirror's reflecting surface is painted black?

23. i. Write the necessary conditions for the phenomenon of total internal reflection to occur. **[2]**

ii. Write the relation between refractive index and critical angle for a given pair of optical media.

24. State two positions in which a concave mirror produces a magnified image of a given object. List two differences between the two images. **[2]**

25. a. Explain the working of a compound microscope with the help of a labelled diagram. **[2]**

b. Write the considerations that you keep in mind, while choosing lenses to be used as eyepiece and objective in a compound microscope.

26. Does the magnifying power of a microscope depend on the colour of the light used? Justify your answer. **[2]**

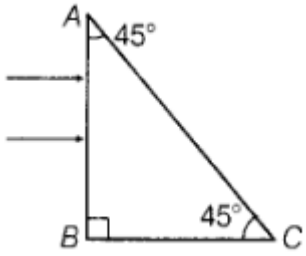
27. Which two of the following lenses L_1, L_2 and L_3 will you select as objective and eyepiece for constructing best possible (i) telescope (ii) microscope? Give reason to support your answer. **[2]**

Lens	Power(P)	Aperture(A)
L_1	6D	1 cm
L_2	3D	8cm
L_3	10D	1 cm

28. Using lens maker's formula, derive the thin lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ for a biconvex lens. **[2]**

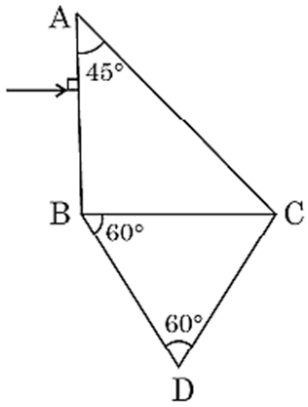
29. Draw a ray diagram to show the formation of an image at the least distance of distinct vision, by a compound microscope. Hence, obtain an expression for its angular magnification. **[3]**

30. Two monochromatic rays of light are incident normally on the face AB of an isosceles right-angled prism ABC. The refractive indices of the glass prism for the two rays 1 and 2 are respectively 1.35 and 1.45. Trace the path of these rays after entering through the prism. **[3]**



31. a. Write two necessary conditions for total internal reflection. **[3]**

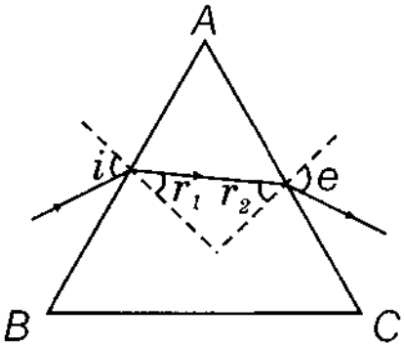
b. Two prisms ABC and DBC are arranged as shown in figure.



The critical angles for the two prisms with respect to air are 41.1^o and 45^o respectively. Trace the path of the ray through the combination.

32. Consider a convex spherical surface of radius of curvature R, separating two media of refractive indices n_1 and n_2 (> n_1). A point object is placed at a distance u in front of the surface in medium of refractive index n_1. Its real image is formed at a distance v. Obtain a relation between u and v in terms of n_1, n_2 and R. **[3]**

33. In the given figure, for what value of ∠i should a ray of light be incident on the face of a prism of refracting angle 60°, so that it just suffers total internal reflection at other face? (For prism, μ = 1.524) **[3]**



34. With the help of a ray diagram explain the working of a reflecting telescope. Mention two advantages of a reflecting telescope over a refracting telescope. **[3]**

35. i. Using the necessary ray diagram, derive the mirror formula for a concave mirror. **[3]**
ii. In the magnified image of a measuring scale (with equidistant markings) lying along the principal axis of a concave mirror, the markings are not equidistant. Explain.

36. At what angle should a ray of light be incident on the face of a prism of refracting angle 60° so that it just suffers total internal reflection at the other face? The refractive index of the material of the prism is 1.524 **[3]**

37. i. Draw a schematic labelled ray diagram of a reflecting type telescope (cassegrain). **[5]**
ii. The objective of a telescope is of larger focal length and of larger aperture (compared to the eyepiece). Why? Give reasons.

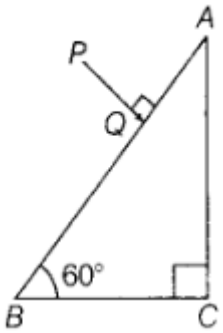
38. i. Name the phenomenon on which the working of an optical fibre is based. **[5]**
ii. What are the necessary conditions for this phenomenon to occur?
iii. Draw a labelled diagram of an optical fibre and show how light propagates through the optical fibre using this phenomenon.

39. i. Draw a labelled ray diagram to obtain the real image formed by an astronomical telescope in normal adjustment position. Define its magnifying power. **[5]**
ii. You are given three lenses of power 0.5 D, 4D and 10 D to design a telescope.

a. Which lenses should be used as objective and eyepiece? Justify your answer.

b. Why is the aperture of the objective preferred to be large?

40. A ray PQ incident normally on the refracting face BA is refracted in the prism BAC made of material of refractive index 1.5. Complete the path of ray through the prism. From B which face will the ray emerge? Justify your answer. **[5]**



41. Draw a ray diagram to show the formation of real image of the same size as that of the object placed in front of a converging lens. Using this ray diagram establish the relation between u, v and f for this lens. **[5]**

42. The shape of the wavefront of the portion of the wavefront of light from a distant star intercepted by the earth is **[1]**

a) plane

b) spherical

c) conical

d) hyperboloid

43. In Young's double-slit experiment the separation d between the slits is 2 mm, the wavelength λ of the light used is 5896 $\mathring{A}$ and distance D between the screen and slits is 100 cm. It is found that the angular width of the fringes is 0.20^{o}. To increase the fringe angular width to 0.21° (with same λ and D) the separation between the slits needs to be changed to **[1]**

a) 2.1 mm

b) 1.7 mm

c) 1.8 mm

d) 1.9 mm

44. Consider a ray of light incident from air onto a slab of glass (refractive index n) of width d, at an angle θ. The phase difference between the ray reflected by the top surface of the glass and the bottom surface is **[1]**

a) $\frac{4\pi d}{\lambda}\left(1-\frac{1}{n^2}\sin^2\theta\right)^{1/2}$

b) $\frac{4\pi d}{\lambda}\left(1-\frac{1}{n^2}\sin^2\theta\right)^{1/2}+2\pi$

c) $\frac{4\pi d}{\lambda}\left(1-\frac{1}{n^2}\sin^2\theta\right)^{1/2}+\frac{\pi}{2}$

d) $\frac{4\pi d}{\lambda}\left(1-\frac{1}{n^2}\sin^2\theta\right)^{1/2}+\pi$

45. In Young's double-slit experiment the intensity at the centre of the screen is I. If one of the slits is closed, the intensity at centre now will be **[1]**

a) I

b) $\frac{I}{3}$

c) $\frac{I}{2}$

d) $\frac{I}{4}$

46. Light of wavelength 5000 $\mathring{A}$ propagating in the air gets partly reflected from the surface of the water. How will the wavelengths and frequencies of the reflected and refracted light be affected? **[1]**

47. Two light waves superposing at the midpoint of the screen are coming from coherent sources of light of phase difference 3π radian. Their amplitude are 1 cm each. What will be the resultant amplitude at the given point? **[1]**

48. Why does the intensity of the secondary maximum become less as compared to the central maximum? **[2]**

49. Draw the intensity pattern for single slit diffraction and double slit interference. Hence, state two differences between interference and diffraction patterns. **[2]**

50. Define the term wavefront? What are the assumptions on which Huygens' principle is based? Describe Huygens' geometrical construction for the propagation of wavefronts in a medium. **[2]**

51. A thin film of thickness 4×10^{-5} cm and $\mu = 1.5$ is illuminated by white light incident normal to its surface. What wavelength in the visible range be intensified in the reflected beam? **[2]**

52. Define secondary wavelets and how can we construct new wavefront with them? **[2]**

53. Light, from a monochromatic source, is made to fall on a single slit of variable width. An experimentalist records the following data for the linear width of the principal maxima on a screen kept at a distance of 1 m from the plane of the slit. **[2]**

S. No.	Width of Slit	Linear width of principal maxima
1	0.1 mm	6 mm
2	0.2 mm	3 mm
3	0.3 mm	1.98 mm
4	0.4 mm	15 mm
5	0.5 mm	1.2 mm

Use any two observations from this data to estimate the value of the wavelength of light used.

54. What will be the effect on the interference fringes in Young's double-slit experiment when, **[2]**

i. the width of the source slit is increased?

ii. the monochromatic sources is replaced by another monochromatic source of shorter wavelength?

iii. monochromatic source is replaced by a source of white light?

55. What is the effect on the interference fringes in Young's double-slit experiment if **[2]**

i. the separation between the slits is halved, and

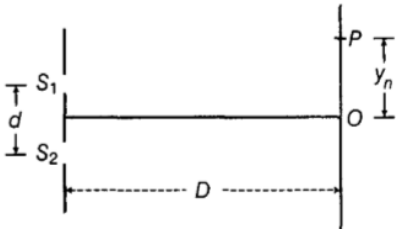
ii. the source slit is moved closer to the double-slit?

Justify your answer.

56. How is Huygen's principle used to obtain the diffraction pattern due to a single slit? Show the plot of the variation of intensity with angle and state the reason for the reduction in the intensity of secondary maxima compared to the central maximum. **[2]**

57. In Young's experiment, the interference pattern is obtained on a screen at a distance of 1 m from slits separated by 0.05 cm and illuminated by sodium light of wavelength 5893 $\mathring{A}$. Calculate distance between 4th bright fringe on one side and 3rd bright fringe on other side of the central fringe. **[2]**

58. The intensity at the central maxima (O) in a Young's double slit setup in Fig. is I_0. If the distance OP equals one-third of fringe width of the pattern, then show that the intensity at point P would be $\frac{I_0}{4}$. **[3]**



59. Give reasons for the following : **[3]**

i. Astronomers prefer to use telescopes with large objective diameters to observe astronomical objects.

ii. Two identical but independent monochromatic sources of light cannot be coherent.

iii. The value of the Brewster angle for a transparent medium is different for lights of different colours.

60. Two narrow slits are illuminated by a single monochromatic source. Name the pattern obtained on the screen. One of the slits is now completely covered. What is the name of the pattern now obtained on the screen? Draw intensity pattern obtained in the two cases. Also, write two differences between the patterns obtained in the above two cases. **[3]**

61. i. Compare Maxwell's electromagnetic theory with the Huygens wave theory of light. **[3]**
ii. Define the incident angle of a light wave.

62. Briefly explain how bright and dark fringes are formed on a screen due to the diffraction at a single slit. Hence, explain why the intensity at the bright fringes decreases sharply as their order (n) increases. **[3]**

63. What is the effect on the interference fringes in Young's double-slit experiment due to each of the following operations? Justify your answers. **[3]**
i. The screen is moved away from the plane of the slits.
ii. The separation between slits is increased.
iii. The source slit is moved closer to the plane of double slit.

64. Explain by drawing a suitable diagram that the interference pattern in a double-slit is actually a superposition of single-slit diffraction from each slit. **[3]**
Write two basic features that distinguish the interference pattern from those seen in a coherently illuminated single slit.

65. How will the interference pattern in Young's double-slit experiment be affected if: **[3]**
a. The screen is moved away from the plane of the slits.
b. The source slit is moved away from the plane of the slits.
c. The phase difference between the light waves emanating from the two slits S_1 and S_2 changes from 0 to π and remains constant.

66. a. Explain the formation of the fringes due to diffraction at a single slit, when path difference of light waves from the ends of the slit on reaching a point on the screen is **[3]**
i. λ, and
ii. $\frac{3\lambda}{2}$.
b. Show the intensity distribution in the fringes due to diffraction at a single slit.

67. In Young's double slit experiment, the slit separation is 1 mm and the screen is 1 m away from the slits. For a monochromatic light of wavelength 500 nm, find **[3]**
a. the distance of third minima, and
b. the distance of second maxima,
from the central maxima.

68. i. Define a wavefront. How is it different from a ray? **[5]**
ii. Depict the shape of a wavefront in each of the following cases.
a. Light diverging from point source.
b. Light emerging out of a convex lens when a point source is placed at its focus.
c. Using Huygen's construction of secondary wavelets, draw a diagram showing the passage of a plane wavefront from a denser into a rarer medium.

69. i. State Huygens' principle. Using it, construct a ray diagram for a plane wavefront getting incident on a denser medium. **[5]**
ii. Use Huygens' principle to prove the laws of reflection of light.

70. i. A plane wavefront approaches a plane surface separating two media. If medium 1 is optically denser and medium 2 is optically rarer, using Huygens' principle, explain and show how a refracted wavefront is constructed? Verify Snell's law. **[5]**

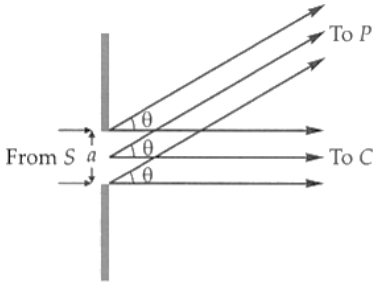
ii. When a light wave travels from a rarer to a denser medium, the speed decreases. Does it imply a reduction in its energy? Explain.

71. In Young's double slit experiment, deduce the condition for (a) constructive and (b) destructive interference at a point on the screen. Draw a graph showing a variation of intensity in the interference pattern against position x on the screen. **[5]**

72. State the importance of coherent sources in the phenomenon of interference. **[5]**

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 is immersed in water?

73. a. Figure shows the geometry of path differences for diffraction by a single slit of width a. Give appropriate 'reasoning' to explain why the intensity of light is **[5]**



i. maximum at the central point C on the screen.

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

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

b. Diffraction defines the limit of the ray optics. Give a brief explanation of this statement.

74. Describe diffraction of light due to a single slit. Explain formation of a pattern of fringes obtained on the screen and plot showing variation of intensity with angle θ in single slit diffraction. **[5]**

75. a. What are coherent sources of light? Two slits in Young's double slit experiment are illuminated by two different sodium lamps emitting light of the same wavelength. Why is no interference pattern observed? **[5]**

b. Obtain the condition for getting dark and bright fringes in Young's experiment. Hence write the expression for the fringe width.

c. If S is the size of the source and its distance from the plane of the two slits, what should be the criteria for the interference fringes to be seen?