THE GURUKUL INSTITUTE

PLOT 5C, 2ND FLOOR, GANAPATI COMPLEX, SEC-13, OPP. JAIPURIA SCHOOL, VASUNDHARA, GHAZIABAD (U.P)

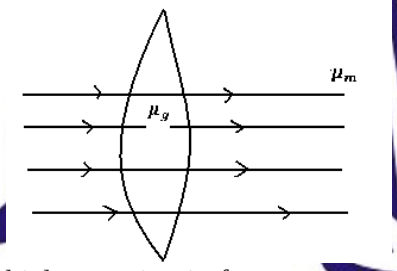
WAVE OPTICS

1. Define the term 'wave front'.
2. Give the ratio of velocities of light rays of wavelengths 4000A° and 8000A° in vacuum.
3. Sketch the variation of intensity of the interference pattern in Young's double slit experiment.
4. The ratio of intensity of maxima and minima in an interference pattern is 100: 64. Calculate the ratio of intensities of the coherent sources producing this pattern.
5. Name the type of wave front that will be associated with
   a. A beam of parallel rays
   b. Rays of light obtained by a linear source (such as slit) illuminated by another source behind it.
6. In a single slit diffraction experiment, the slit width is made double that of the original width. What would happen to the size and intensity of central diffraction band? Give reason for your answer.
7. What will be the effect on the interference fringes in a young's double slit experiment, if
   a. Monochromatic source is replaced by a source of white light.
   b. The screen is moved away from the slit? Justify your answer.
8. Laser light of wavelength 630nm 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. calculate the wavelength of the second light.
9. Two wavelengths of sodium light 590 nm, 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 maximum of the diffraction pattern obtained in the two cases.
10. What are coherent sources? How does the width of interference fringes in Young's double slit experiment change when
    a. The distance between the slits and screen is decreased?
    b. Frequency of the source is increased?
11. Using Hyugen's principle, explain the refraction of a plane wavefront at a plane surface. Hence prove Snell's law.
12. State two conditions to obtain sustained interference of light. In Young's double slit experiment, using light of wavelength 400 nm, interference fringes of width 'X' are obtained. The wavelength of light increased to 600 nm and the separation between the slits is halved. If one wants the observed fringe width on the screen to be the same in the two cases, find the ratio of the distance between the plane of the interfering sources in the two arrangements.
13. Two independent sources of light cannot be coherent. Why? Two coherent sources have intensities in the ratio 25: 16. Find the ratio of the intensities of maxima to minima, after interference of light occurs.
14. What should be the order of size of obstacle aperture for diffraction of light? Monochromatic light of wavelength 600 nm is incident normally on a slit of width 0.5 mm. Calculate (i) angular width (ii) linear width of the 1st order maximum. Assume the distance between the slits and screen to be 2 m.
15. Two slits in Young's double slit experiment are illuminated by two different lamps emitting light of the same wavelength. Will you observe the interference pattern? Justify your answer. Find the ratio of intensities at two points on a screen in Young's double slit experiment, when waves from the two slits have path difference of (i) 0 (ii) $\frac{\lambda}{4}$.

16. State the postulates of Huygen's wave theory. Sketch the wave front that corresponds to a beam of light (i) coming from a very far away source, and (ii) diverging radially from a point source.
17. What is the phenomenon of polarization? Derive the relation connecting the polarizing angle of a medium and its refractive index.
18. State the condition of diffraction of light to occur. In the diffraction at a single slit experiment , how would the width and the intensity of central maximum change, if (i) slit width is halved and (ii) visible light of longer wavelength is used?
19. A slit of width 'd' is illuminated by light of wavelength 6500 A°. For what value of'd' will the
    a. first minimum fall at an angle of diffraction of 30°?
    c. first maximum fall at an angle of diffraction of 30°?
20. What is interference of light? Write two essential conditions for sustained interference pattern to be produced on the screen. Draw a graph showing the variation of intensity versus the position on the screen in Young's experiment when (a) both the slits are opened and (b) one of the interference pattern in Young's double slit experiment when :
    i. Screen is moved closer to the plane slits?
    ii. Separation between the two slits is increased. Explain your answer in each case.

RAY OPTICS AND OPTICAL INSTRUMENTS

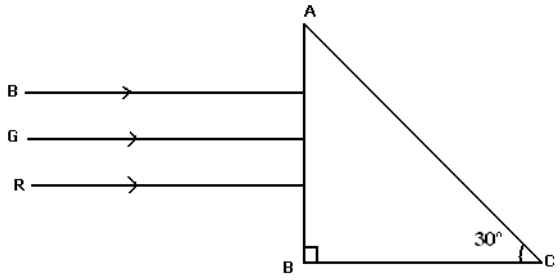
1. How does the intensity 'I' of scattered light vary with the wavelength '$\boldsymbol{\lambda}$' of incident light?
2. In the given figure, path of a parallel beam of light passing through a convex lens of refractive index μ_g kept in a medium of refractive index μ_m is shown. Is (i)$\mu_g = \mu_m$ (ii) $\boldsymbol{\mu_g > \mu_m}$ or (iii) $\mu_g < \mu_m$?



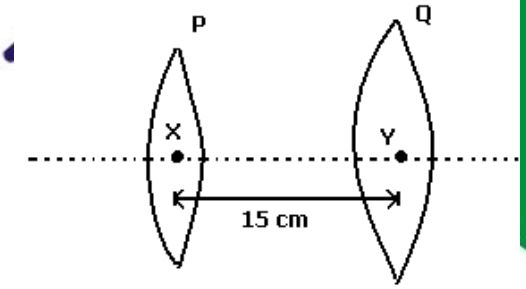
3. Vehicles moving in foggy weather use yellow color headlights. Why?
4. How does the frequency of a beam of ultraviolet light change when it goes from air into glass?
5. At what angle of incidence should a light beam strike a glass slab of refractive index$\sqrt{3}$, such that the reflected and the refracted rays are perpendicular to each other?
6. Refractive index of glass for light of yellow, green and red colors areμ_y, μ_g and μ_r respectively. Rearrange these symbols in an increasing order of values.
7. A concave lens is placed in water. Will there be any change in focal length? Give reason.
8. Calculate the focal length of the combination of a convex lens of focal length 30 cm in contact with a concave lens of focal length 20 cm. is the system a converging or a diverging lens?
9. Write two conditions for total internal reflection to take place.
10. A converging and a diverging lens of equal lengths are placed coaxially in contact. Find the power and the focal length of the combination.
11. Explain why does a convex lens behave as a converging lens when immersed in water ($\mu = 1.33$) and as a diverging lens, when immersed in carbon disulphide ($\mu = 1.6$).
12. Draw a ray diagram showing how the final image of a distant object is formed using an astronomical telescope in the near point position.
13. A compound microscope with an objective of 2.0 cm focal length and an eye-piece of 4.0 cm focal length has a tube length of 40 cm. Calculate the magnifying power of the microscope, if the final image is formed at the near point of the eye.
14. Which of the two main parts of an optical fibre has a higher value of refractive index?

15. Two thin lenses of power +7D and -3D are in contact. What is the focal length of the combination?
16. Draw a labeled ray diagram of a reflecting type telescope. Write its any one advantage over refracting telescope.
17. The image of a candle is formed by a convex lens on a screen. The lower half of the lens is painted black to make it completely opaque. Draw the ray diagram to show the image formation. How will this image be different from the one obtained when the lens is not painted black?
18. The magnifying power of an astronomical telescope in the normal adjustment position is 100. The distance between the objective and the eye-piece is 101 cm. Calculate the focal lengths of the objective and of the eye-piece.
19. Give reasons for the following observations made from Earth:
    a. Sun is visible before the actual sunrise.
    b. Sun looks reddish at sunset.
20. A convex mirror and a convex lens are held separately in water. What changes, if any , do you expect in the focal length of either?
21. If the wavelength of incident light on a (i) concave mirror (ii) convex lens is increased, how will the focal length of each of these change?
22. A ray of light passes through an equilateral glass prism, such that the angle of incidence is equal to that of angle of emergence. If the angle of prism, calculate the refractive index of the glass prism.
23. A converging lens has a focal length of 20 cm in air. It is made of a material of refractive index 1.6. If it is immersed in a liquid of refractive index 1.3, what will be its new focal length? How does the nature of the lens change if this lens is immersed in a liquid of refractive index 1.8?
24. What is the effect of increasing the diameter of the objective of a telescope on its (i) magnifying power (ii) resolving power?
25. Draw a labeled ray diagram to show the formation of the image of a distant object through a reflecting telescope.
26. A convex lens made up of a glass of refractive index 1.5 is dipped, in turn, in:
    i. Medium A of refractive index 1.65
    ii. Medium B of refractive index 1.33

    Explain giving reasons, whether it will behave as a converging lens or a diverging lens in each of these two media.
27. A figure divided into four squares, each of size 1 mm^2, is being viewed at a distance of 9 cm through a magnifying lens of focal length 10 cm, held close to the eye.
    a) Draw a ray diagram showing the formation of the image.
    b) When is the magnification produced by the lens? How much is the area of each square in the virtual image?
    c) What is the angular magnification of the lens?
28. Three rays of light – red (R), green (G) and blue (B) – are incident on the face AB of a right angled prism ABC. The refractive indices of the material of the prism for red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively. Trace the path of the rays through the prism. How will the situation change if these rays were incident normally on one of the faces of an equilateral prism?



29. Draw a graph to show that the variation of the angle of deviation 'D' with that of the angle of incidence 'i' for a monochromatic ray of light passing through a glass prism of refracting angle 'A'. Hence deduce relation: $= \frac{\sin\left(\frac{Dm+A}{2}\right)}{\sin\left(\frac{A}{2}\right)}$.
30. Show that a convex lens produces N times magnified image when the object distances, from the lens, have magnitudes ($f \pm \frac{f}{N}$). Hence f is the magnitude of the focal length of the lens. Hence find the two values of object distance, for which a convex lens, of power 2.5 D, will produce an image that is four times as large as the object?
31. Define the critical angle with reference to total internal reflection. Calculate the critical angle for glass –air surface, if a ray of light which is incident in air on the glass surface is deviated through 15^0 when angle of incidence is 45^0.
32. Two convex lenses P and Q of an astronomical telescope having focal lengths 4 cm and 16 cm respectively are arranged as shown in the figure.
    a. Which one of the two lenses will you select to use as the objective lens and why?
    b. What should be the change in the distance between the lenses to have the telescope in its normal adjustment position?
    c. Calculate the magnifying power of the telescope in the normal adjustment position.



33. A convex lens made of a material of refractive index n_1 is kept in medium of refractive index n_2. Parallel rays of light are incident on the lens. Complete the path of the rays of light emerging from the convex lens if (i) $n_1 > n_2$, (ii) $n_1 = n_2$ (iii) $n_1 < n_2$.
34. A compound lens is made of two lenses in contact having powers +12.5D and -2.5 D. an object is placed at 15 cm from this compound lens. Find the position and nature of this image formed.
35. Draw a labeled ray diagram of an astronomical telescope for the near point adjustment. You are given three lenses of powers 0.5 D, 4 D, 10 D. State with reason, which two lenses will you select for constructing a good astronomical telescope. Calculate the resolving power of this telescope, assuming the diameter of the objective lens to be 6 cm Type equation here.and the wavelength of light used to be 540 nm.
36. Show by a diagram the image formation of a pint by a thin double convex lens having radii of curvature R_1 and R_2. Hence derive the formula $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$, where f is the focal length and n is refractive index of material of the lens.
37. With the help of a ray diagram, show the formation of image of a point object by refraction of light at a spherical surface separating two media of refractive indices n_1 and n_2 ($n_2 > n_1$)

respectively. Using the diagram, derive the relation $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$. Write the sign conventions used. What happens to the focal length of convex lens when it is immersed in water?

38. Draw a ray diagram for the formation of image of a distant object by an astronomical telescope in normal adjustment position.
Deduce the expression for its magnifying power. How does the resolving power of a telescope change if (i) the size of the aperture of the objective lens is increased (ii) the focal length of the objective lens is decreased.