IIT-JEE / MEDICAL

PHYSICS

QUESTIONS

OPTICS

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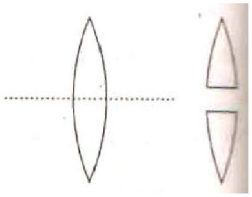
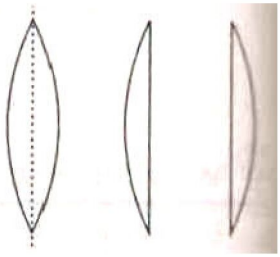
VERY SHORT ANSWER QUESTIONS

1. A coin is at the bottom of a transparent liquid at a depth of 12 cm from the surface . When viewed normally its image appears to be displaced 4 cm upward . What is the refractive index of the liquid .
   [**Ans :** 1.5]
2. What happens to the focal length of a (i) concave mirror (ii) convex lens, when immersed in water?
3. Which has greater refractive index : blue color , or yellow colour or red colour ?
4. Which has larger critical angle for total internal reflection : blue color , or yellow colour or red colour ?
5. Which has larger critical angle for a ray going from glass to air or water to air?
6. Why are there two focal points of a lens?
7. What is the relation between two focal points of a lens when the medium on either side is same ?
8. When a ray enters from glass (n = 1.5) to air at an angle of incidence 45^0 , what will be the angle of deviation?
   [**Ans :** $\delta_m = 90^0$]
9. Can virtual image be taken on a screen ? Can it be photographed?
10. Why does dispersion take place?
11. Why does dispersion take place?
12. Define the limit of resolution of a telescope. How is it related to its resolving power?
13. Write expression for resolving power of a telescope?
14. Define limit of resolution of a microscope. How is it related to its resolving power?
15. Write expression for resolving power of a microscope?
16. Name two factors on which resolving power of a telescope depend?
17. Name two factors on which resolving power of a microscope depend?
18. What is the difference between the resolving power and limit of resolution?
19. What do you mean by magnifying power?
20. What is the unit of magnifying power?
21. The aperture of an objective of a telescope is increased ; what will be the effect on (i) resolving power and (ii) magnifying power of a telescope?
22. What is the additional advantage of using concave mirror as objective in place of convex lens?
23. A convex lens of focal length *f* is cut into two halves along the axis as shown . What is the focal length of each part?



[**Ans :** f , f]

24. A convex lens of focal length f is cut into two halves such that one surface of each is plane . What is the focal length of each half?



[**Ans :** $2f$, $2f$]

25. A convex lens of a glass (n=1.5) is placed in water ($n = \frac{4}{3}$) ; what will be the ratio of its focal length in water and in air?
[**Ans :** 4]
26. A convex lens of glass (n=1.5) is placed in a transparent liquid such that it becomes invisible. What is the refractive index of liquid?
[**Ans :** 1.5]
27. An object is placed at a distance f from a (i) Convex lens (ii) Concave lens , where will the image be formed?
[**Ans :** (i) at infinity on other side (ii) at distance $\frac{f}{2}$ towards the side of the object]
28. Can a convex lens behave as a diverging lens ? If yes , state the condition.
29. What is numerical aperture of a microscope?
30. What is meant by angular resolution of a telescope?
31. Name the type of wavelength for a line source?
32. What is the main condition for observing interference of light?
33. What is diffraction?
34. What is the cause of diffraction?
35. Why sky appears blue as viewed from earth and dark as viewed from moon?
36. Can longitudinal waves be polarized?
37. Why the two sources in two slit interference experiment be narrow?
38. What is the path difference between two waves for (i) constructive interference (ii) destructive interference ?
39. On what factors does the fringe width in interference pattern of double slit experiment depend?
40. How is the fringe width in interference pattern of double slit experiment depend?
41. Can two 60 W bulbs be used as source to produce interference ?
42. Which special characteristic of light is demonstrated only by the phenomenon of polarization .
43. What is Polaroid?
44. What is Brewster's law?
45. What is Malus law?
46. Which types of wave can exhibit polarization?
47. Can sound waves show polarization?

48. The refractive index of a transparent medium is 1.732 . What is the angle of polarization for this medium?
    [**Ans :** 60^0]
49. What should be the dimensions of obstacle for producing diffraction?
50. A linearly polarized beam is made to fall on a rotating Polaroid. What changes will you observe in the transmitted light?

SHORT ANSWER QUESTIONS

1. A convex lens of refractive index 1.5 is immersed in a transparent liquid of refractive index (i) 1.3 (ii) 1.5 (iii) 1.6. How does the lens behave in each case ?
2. Derive the relation $n = \frac{1}{\sin C}$.
3. Explain why does a convex lens behave as a converging lens when immersed in water(h=1.33) and as a diverging lens when immersed in carbon – disulphide(n=1.6).
4. Explain how a ray of white light is dispersed?
5. Why are there two angles of incidence of a light ray on a prism deviation. When will the deviation be minimum?
6. For a prism show that $i_1 + i_2 = A+\delta$ where symbols have their usual meanings.
7. Why does a hollow prism not show dispersion?
8. What is the change in interference pattern in two slit experiments if white light is used in place of monochromatic yellow light?
9. Comment on the statement that interference pattern in double slit experiment is the superposition of two diffraction patterns at the two slits?
10. Define resolving power of an optical instrument .How is it related to diffraction?
11. State the necessary conditions for obtaining sustained interference of light.
12. Define resolving power of a telescope .How would it change with the increase of (i) aperture of the objective and (ii) wavelength of light ?
13. If A_1 and A_2 are amplitudes of two coherent waves , then show that the resultant intensity at a point where path difference between two waves is x is given by

$$I = A_1^2 + A_2^2 + 2A_1A_2 \cos\left(\frac{2\pi x}{\lambda}\right)$$

14. Two sources of intensities I_1 and I_2 undergoes interference in double slit experiment , show that the ratio of maximum and minimum intensities in interference pattern will be given by

$$\frac{I_{max}}{I_{min}} = \left[\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}}\right]^2$$

15. Why do soap bubbles show beautiful colors when illuminated by white light?
16. Show that at Brewster's angle of incidence , the reflected rays are mutually perpendicular.

17. How will you distinguish between interference and diffraction patterns?
18. What is the different between reflection and total internal reflection ? For same intensity of incident light , in which case will the intensity of reflected ray be more ? Why ?
19. Draw the path of rays incident on air bubble immersed in water. Explain you ray diagram.
20. How will you distinguish between ordinary and linearly polarized light?
21. Derive an expression for angular spread of central maxima in single- slit diffraction pattern.
22. If the wavelength of incident light on a convex lens is increased , how does the focal length of lens change?
23. How will you demonstrate that light waves are transverse ?
24. State and explain Huygen's principle of wave theory. Name the type of wave front corresponding to a beam of light coming from a (i) point sources (ii) line source and (iii) distant source ?
25. Write lens maker's formula and show that the focal length of a planoconvex lens is given by $f = \frac{R}{n-1}$ where R= radius of curvature of curved surface.
26. What does the statement " that the lighted emitted from sun is unpolarised" mean in term of direction of electric vector? Explain briefly how plane polarized light can be produced by reflection at the interface separating two media.
27. Draw a ray to show image formation by a Cassegrain reflecting telescope. What is its magnifying power?

LONG ANSWER QUESTIONS

1. Define the relation ?

$$\frac{n_2}{v} - \frac{n1}{u} = \frac{n_2 - n_1}{R}$$

for a spherical surface separating two media of refractive indices n_1 and n_2 .

2. Derive the relation between the focal length of convex lens in terms of radii of curvature of two surfaces and refractive index of the material. Write two assumptions used to derive this relation.
3. A convex lens of focal length f and refractive index n_g is immersed in a liquid of refractive index n_l . Find an expression for the focal length of lens in liquid .Explain the behavior of lens when (i) $n_l < n_g$ (ii) $n_l > n_g$ and (iii) $n_l = n_g$.
4. Why does a prism produce dispersion and deviation both ? How will you arrange two prism to get (i) dispersion without deviation and (ii) deviation without dispersion.
5. Draw a ray diagram to show the formation of the image of a distant object by an astronomical telescope in the normal adjustment position .Obtain an expression for the magnifying power of the telescope in this adjustment.

6. Define magnifying power. Draw the ray diagram of image formation in a compound microscope and derive the expression for its magnifying power in normal adjustment.
7. What do you mean by resolving power of a telescope ? How can it be increased ?
8. What do you mean by resolving power of a microscope ? How can it be increased ?
9. What is a wavefront ? What is the geometrical shape of a wavefront of light emerging out of a convex lens when a point source is placed at its focus ? Show that angle of incidence is equal to angle of refraction using Huygen's principle.
10. Define the term 'Wavefront' .Draw the wavefront and corresponding rays in the case of (i) diverging spherical wave (ii) plane wave.
    Using Huygen's assumption , explain refraction of a plane wavefront at a plane surface and hence verify Snell's law.
11. What is the necessary of coherent sources in interference . Derive expression for fringe width in Young's double slit experiment .Hence discuss on what factors does it depend?
12. What is diffraction .Draw the diffraction pattern of a single slit . How does the angular width of central maximum in their diffraction pattern change when
    (i) Slit width is decreased
    (ii) The distance between the slit and the screen is increased
    (iii) Light of smaller wavelength is used?

    Justify your answer.
13. Explain the phenomenon of diffraction of light at a single slit to show the formation of diffraction fringes. Show graphically the variation of intensity with angle in this single slit diffraction pattern.
14. Distinguish clearly between linearly polarized light and unpolarised light. Light is incident at Brewster's angle from air into a transparent medium .How are the resulting reflected and refracted rays oriented with respect to each other . Obtain a relation between the refractive index of medium and the Brewster angle. What is the nature of polarization , of the reflected light in this case.
15. Explain polarization by reflection ; hence deduce Brewster's.

NUMERICAL QUESTIONS

1. A double convex lens of glass of refractive index 1.5 has its both surface if equal radii of curvature 20 cm each . An object of height 5 cm is placed at a distance of 15 cm from the lens. Calculate the size of the image formed.
   [**Ans :** 20 cm]
2. A diverging lens of refractive index 1.5 and of focal length 20 cm in air has the same radii of curvature for both side . If it is immersed in a liquid of refractive index 1.7 , calculate the focal length of lens in the liquid.
   [**Ans :** -8.5 cm]

3. A convex lens of focal length 40 cm and a concave lens of focal length -25 cm are kept in contact with each other . What is the value of power of this combination?
   [**Ans :** -1.5 D]
4. The distance between two point sources is 24 cm. Find the position of a converging lens of focal length 9 cm so that the image of both the sources are formed at the same point.
   [**Ans :** 8 cm from either source]
5. 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 the eye-piece.
   [**Ans :** $f_o = 100cm, f_e = 1cm$]
6. An astronomical telescope consists of two thin lenses set 36 cm apart and has a magnifying power 8. Calculate the focal length of the two lenses . Can you use these lenses to form a compound microscope ? Justify your answer.
   [**Ans :** $f_o = 32cm, f_e = 4cm$, No]
7. A compound microscope with an objective of 2.0.cm focal length and 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 (i) near point of eye (ii) infinity.
   [**Ans :** (i) 270 (ii) 250]
8. The focal lengths of an objective lens and eye-piece of a compound microscope are 5 mm and 30 mm respectively. The length of the tube is 150 mm. If the final image be formed at infinity and the least distance of distinct vision is 250 mm. Find the magnifying power of the microscope.
   [**Ans :** M=-191.7]
9. The focal lengths of an objective and eye –piece of a telescope are 0.72 m and 0.012 m. Finds its angular magnification and focal length for relaxed eye.
   [**Ans :** 60 , 0.732 m]
10. A converging lens of focal length 50 cm is placed co-axially in constant with another lens of unknown focal length. If the combination behaves like a diverging lens of focal length 50 cm , find the power and the nature of the second lens.
    [**Ans :** $f = -25cm, P = -4D$]
11. Monochromatic light of wavelength 589 nm is incident from air to water . What are the values of wavelength frequency and speed of (i) reflected light (ii) refracted light . Refractive index of water = 4/3.
    [Ans : (*i*) λ=589 nm , $v = 5.1\times10^{14}$ Hz , c= 3×10^{8} m/s
    (*ii*) λ=444 nm , $v = 5.1\times10^{14}$ Hz , v= 2.25×10^{8} m/s]
12. A rays of light passes through an equilateral prism, such that the angle of incidence is equal to angle of emergence . If the angle of emergence is ¾ times the angle of prism , calculate the refractive index of the glass prism.
    [**Ans :** n=1.414]

13. The refractive index of a plastic prism of prism angle 60^0. For yellow light is $\sqrt{2}$. In the position of minimum deviation , find
    (i) Angle of minimum deviation
    (ii) Angle of incidence
    (iii) Angle of refraction within the prism

    [**Ans :** $\delta_m = 30^0$ (ii) 45^0 (iii) 30^0]

14. In a double slit experiment with monochromatic light , fringes are obtained on a screen placed at some distance from the slits . If the screen is moved by 5 x 10^{-2} m towards the slits , the change in fringe width is 3 x 10^{-5} m .
    [**Ans :** 6000 A^0 .]
    [**Hint :** $\beta = \frac{D\lambda}{d} = \Delta\beta = \frac{\lambda}{d}\Delta D$]

15. In Young's experiment the distance between the slits is 1.0 m . When light of wavelength 6000 A^0 is made incident on the slits , the fringe width of fringes is 2.0 mm. Find
    (i) Separation between slits and
    (ii) New fringe width if wavelength of light is changed to 4800 A^0.

    [**Ans :** (i) 3 x 10^{-4} m (ii) 1.6 nm]

16. Light of wavelength 5900 A^0 falls normally on a slit of width 11.8 x 10^{-7} m. The resulting diffraction pattern is received on a screen . Calculate the angular position of the first minimum.
    [**Ans :** 30^0 , 60^0]

17. Calculate the limit of resolution of a 100 cm telescope with visible light of wavelength λ=5500 A^0.
    [**Ans :** 6.71 x 10^{-7} radian =0.14 arc second]

18. Slit of width 'a' is illuminated by monochromatic light of wavelength 550 nm at normal incidence . Calculate the value of ' a' for position of (i) first minimum at an angle of 30^0. (ii) first maximum at an angle of 30^0.
    [**Ans : (i)** 1.1 x 10^{-6} m (ii) 1.65 x 10^{-6} m]

19. Calculate the resolving power of an astronomical telescope assuming the diameter of the objective lens to be 6 cm and the wavelength of light to be 540 nm.
    [**Ans :** 9.11 x 10^4]

Note : if any mistake on this, kindly inform on the mail id :

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Your Observation! Our Correction !!