	INDIAN SCHOOL AL WADI AL KABIR	
CLASS: XII	**DEPARTMENT: SCIENCE 2025– 26** **SUBJECT: PHYSICS**	**DATE: 06/11/2025**
WORKSHEET NO: 9 **WITH ANSWERS**	**CHAPTER / UNIT: RAY OPTICS AND OPTICAL INSTRUMENTS**	**NOTE:** **A4 FILE FORMAT**
CLASS & SEC:	**NAME OF THE STUDENT:**	**ROLL NO.:**

MULTIPLE CHOICE QUESTIONS:

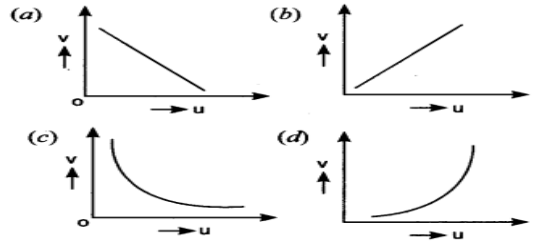
1. A compound microscope has an objective and an eyepiece of focal lengths *f*0 and *fe*, respectively. To obtain a large magnification of a small object, the microscope should have:
   (a) *f*0 and *fe* small, and *fe*>*f*0
   (b) *f*0 and *fe* small, and *f*0>*fe*
   (c) *f*0 and *fe* large, and *fe*>*f*0
   (d) *f*0 and *fe* large, and *f*0>*fe*
2. A converging lens is used to form an image on a screen. When the upper half of the lens is covered by an opaque screen.
   (a) half the image will disappear.
   (b) incomplete image will be formed.
   (c) intensity of image will decrease but complete image is formed.
   (d) intensity of image will increase but image is not distinct.
3. In optical fibres, the refractive index of the core is
   (a) greater than that of the cladding.
   (b) equal to that of the cladding.
   (c) smaller than that of the cladding.
   (d) independent of that of cladding.
4. Air bubble in water behaves as
   (a) sometimes concave, sometimes convex lens
   (b) concave lens
   (c) convex lens
   (d) always refracting surface
5. We combine two lenses, one is convex and other is concave having focal lengths f_1, and f_2 and their combined focal length is F. Combination of the lenses will behave like concave lens, if
   (a) $f_1 > f_2$ (b) $f_1 = f_2$ (c) $f_1 < f_2$. (d) $f_1 \leq f_2$
6. The length of an astronomical telescope for normal vision (relaxed eye) will be

   (a) $f_o - f_e$ (b) $\frac{f_o}{f_e}$

   (c) $f_o \times f_e$ (d) $f_o + f_e$

7. The focal length of a biconvex lens of radii of each surface 50 cm and refractive index 1.5, is
   (a) 40.4 cm (b) 75 cm (c) 50 cm (d) 80 cm
8. A metal coin is at bottom of a beaker filled with a liquid of refractive index = 4/3 to height of 6 cm. To an observer looking from above the surface of liquid, coin will appear at a depth
   (a) 1.5 cm (b) 6.75 cm (c) 4.5 cm (d) 7.5 cm

9. Two lenses of focal lengths ± 15 cm and ± 150 cm are available for making a telescope. To produce the largest magnification, the focal length of the eyepiece should be
(a) + 15 cm (b) + 150 cm (c) – 150 cm (d) – 15 cm
10. The refractive index of the material of an equilateral prism is $\sqrt{3}$. What is the angle of minimum deviation?
(a) 45° (b) 60° (c) 37° (d) 30°
11. In an experiment to find focal length of a concave mirror, a graph is drawn between the magnitude of u and v. The graph looks like



12. A convex lens of refractive index 3/2 has a power of 2.5 D in air. If it is placed in a liquid of refractive index 2 then the new power of the lens is
(a) – 1.25 D (b) – 1.5 D (c) 1.25 D (d) 1.5 D
13. A double convex lens of refractive index μ_1 is immersed in a liquid of refractive index μ_2. The lens will act as transparent plane sheet when
(a) $\mu_1 = \mu_2$ (b) $\mu_1 > \mu_2$ (c) $\mu_1 < \mu_2$ (d) $\mu_1 = 1/\mu 2$
14. When a ray of light enters from one medium to another, then which of the following does not change?
(a) Frequency (b) Wavelength (c) Speed (d) Amplitude
15. A diver at a depth 12 m inside water (μ = 4/3) sees the sky in a cone of semi-vertical angle
(a) $\sin^{-1}\frac{4}{3}$ (b) $\tan^{-1}\frac{4}{3}$
(c) $\sin^{-1}\frac{3}{4}$ (d) 90°
16. The astronomical telescope consists of objective and eyepiece. The focal length of the objective is
(a) equal to that of the eyepiece.
(b) shorter than that of eyepiece.
(c) greater than that of eyepiece.
(d) five times shorter than that of eyepiece.
17. For a total internal reflection, which of the following is correct?
(a) Light travels from rarer to denser medium.
(b) Light travels from denser to rarer medium.
(c) Light travels in air only.
(d) Light travels in water only.
18. Mirage is a phenomenon due to
(a) refraction of light
(b) reflection of light
(c) total internal reflection of light
(d) diffraction of light.
19. A convex lens is dipped in a liquid whose refractive index is equal to the refractive index of the lens. Then its focal length will
(a) become zero
(b) become infinite
(c) become small, but non-zero
(d) remain unchanged
20. Two beams of red and violet colour are made to pass separately through a prism (angle of the prism is 60°). In the position of minimum deviation, the angle of refraction will be
(a) 30° for both the colours
(b) greater for the violet colour

(c) greater for the red colour
(d) equal but not 30° for both the colours

21. An astronomical refractive telescope has an objective of focal length 20 m and an eyepiece of focal length 2 cm. Then
(a) the magnification is 1000
(b) the length of the telescope tube is 20.02 m
(c) the image formed of inverted
(d) all of these

22. A short pulse of white light is incident from air to a glass slab at normal incidence. After travelling through the slab, the first colour to emerge is
(a) blue (b) green (c) violet (d) red

23. An object approaches a convergent lens from the left of the lens with a uniform speed 5 m/s and stops at the focus. The image
(a) moves away from the lens with a uniform speed 5 m/s.
(b) moves away from the lens with n uniform acceleration.
(c) moves away from the lens with a non-uniform acceleration.
(d) moves towards the lens with a non-uniform acceleration.

24. You are given four sources of light each one providing a light of a single colour – red, blue, green and yellow. Suppose the angle of refraction for a beam of yellow light corresponding to a particular angle of incidence at the interface of two media is 90°. Which of the following statements is correct if the source of yellow light is replaced with that of other lights without changing the angle of incidence?
(a) The beam of red light would undergo total internal reflection.
(b) The beam of red light would bend towards normal while it gets refracted through the second medium.
(c) The beam of blue light would undergo total internal reflection.
(d) The beam of green light would bend away from the normal as it gets refracted through the second medium.

25. The radius of curvature of the curved surface of a plano-convex lens is 20 cm. If the refractive index of the material of the lens be 1.5, it will
(a) act as a convex lens only for the objects that lie on its curved side.
(b) act as a concave lens for the objects that lie on its curved side.
(c) act as a convex lens irrespective of the side on which the object lies.
(d) act as a concave lens irrespective of side on which the object lies.

26. A car is moving with at a constant speed of 60 km h^{-1} on a straight road. Looking at the rear-view mirror, the driver finds that the car following him is at a distance of 100 m and is approaching with a speed of 5 km h^{-1}. In order to keep track of the car in the rear, the driver begins to glance alternatively at the rear and side mirror of his car after every 2 s till the other car overtakes. If the two cars were maintaining their speeds, which of the following statement (s) is/are correct?
(a) The speed of the car in the rear is 65 km h^{-1}.
(b) In the side mirror the car in the rear would appear to approach with a speed of 5 km h^{-1} to the driver of the leading car.
(c) In the rear view mirror the speed of the approaching car would appear to decrease as the distance between the cars decreases.
(d) In the side mirror, the speed of the approaching car would appear to increase as the distance between the cars decreases.

27. A magnifying glass is used, as the object to be viewed can be brought closer to the eye than the normal near point. This results in
(a) a larger angle to be subtended by the object at the eye and hence viewed in greater detail.
(b) the formation of a real inverted image.
(c) increase in the field of view.
(d) infinite magnification at the near point.

28. An astronomical refractive telescope has an objective of focal length 20 m and an eyepiece of focal length 2 cm. Which one of the following is not correct?

(a) The length of the telescope tube is 20.02 m.
(b) The magnification is 1000.
(c) The image formed is inverted.
(d) An objective of a larger aperture will increase the brightness and reduce chromatic aberration of the image.

ASSERTION - REASON BASED QUESTIONS

Direction: - In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as:

(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not correct explanation of assertion.
(c) If assertion is true, but reason is false.
(d) If both assertion and reason are false.

29. Assertion (A): The magnifying power of a compound microscope is negative.
Reason (R): The final image formed is erect with respect to the object.
30. Assertion (A): A convex lens, when immersed in a liquid, disappears.
Reason (R): The refractive indices of material of the lens and the liquid are equal.
31. Assertion (A): The resolving power of a telescope is more if the diameter of the objective lens is more.
Reason (R): Objective lens of large diameter collects more light.
32. Assertion (A) : Higher is the refractive index of a medium or denser the medium, lesser is the velocity of light in that medium.
Reason (R) : Refractive index is inversely proportional to velocity.
33. Assertion (A): The focal length of a concave lens is positive.
Reason (R)**:** A concave lens diverges light rays and forms a virtual image, which requires a positive focal length.

CASE STUDY QUESTIONS

34. Refraction of light is the change in the path of light as it passes obliquely from one transparent medium to another medium. According to law of refraction , $\frac{\sin i}{\sin r} = {}_1\mu_2$, where ${}_1\mu_2$ is called refractive index of second medium with respect to first medium. From refraction at a convex spherical surface, we have $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$ .Similarly, from refraction at a concave spherical surface when object lies in the rarer medium, we have $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$ and when object lies in the denser medium, we have $\frac{\mu_1}{v} - \frac{\mu_2}{u} = \frac{\mu_1 - \mu_2}{R}$.
    (i) Refractive index of a medium depends upon which factors?
    (ii) A ray of light of frequency 5×10^{14} Hz is passed through a liquid. The wavelength of light measured inside the liquid is found to be 450×10^{-9} m. What is the refractive index of the liquid?
    (iii) A ray of light is incident at an angle of 60° on one face of a rectangular glass slab of refractive index 1.5. What will be the angle of refraction?
    (iv) When light is refracted into a rarer medium, what will be change in its wavelength and frequency?

35. A lens is a transparent medium bounded by two surfaces, with one or both surfaces being spherical. The focal length of a lens is determined by the radii of curvature of its two surfaces and the refractive index of its medium with respect to that of the surrounding medium. The power of a lens is reciprocal of its focal length. If a number of lenses are kept in contact, the power of the combination is the algebraic sum of the powers of the individual lenses.

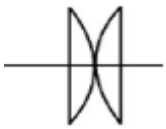
    (i) A double-convex lens, with each face having same radius of curvature R, is made of glass of refractive index n. Its power is:

(A) $\frac{2(n-1)}{R}$ (B) $\frac{(2n-1)}{R}$ (C) $\frac{(n-1)}{2R}$ (D) $\frac{(2n-1)}{2R}$

(ii) A double-convex lens of power P, with each face having same radius of curvature, is cut into two equal parts perpendicular to its principal axis. The power of one part of the lens will be:

(A) 2P (B) P (C) 4P (D) $\frac{P}{2}$

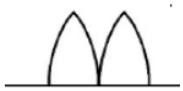
(iii) The above two parts are kept in contact with each other as shown in the figure. The power of the combination will be:



(A) $\frac{P}{2}$ (B) P (C) 2P (D) $\frac{P}{4}$

(iv) (a) A double-convex lens of power P, with each face having same radius of curvature, is cut along its principal axis. The two parts are arranged as shown in the figure. The power of the combination will be:

(A) 0 (B) P (C) 2P (D) $\frac{P}{4}$



OR

(b) Two convex lenses of focal lengths 60 cm and 20 cm are held coaxially in contact with each other. The power of the combination is:

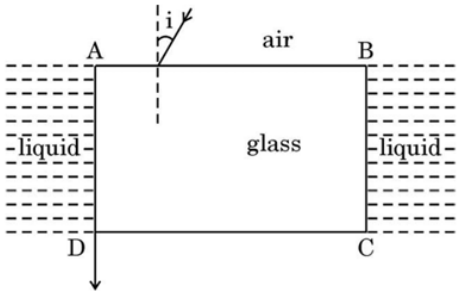
(A) 6·6 D (B) 15 D (C) $\frac{1}{15}$ D (D) $\frac{1}{80}$ D

SHORT ANSWER TYPE QUESTIONS (2 marks)

36. A ray of monochromatic light passes from medium (1) to medium (2). If the angle of incidence in medium (1) is θ and the corresponding angle of refraction in medium (2) is θ/2, which of the two media is optically denser? Give reason.
37. For the same value of angle of incidence, the angles of refraction in three media A, B and C are 15°, 25° and 35° respectively. In which medium would the velocity of light be minimum?
38. A concave lens of refractive index 1.5 is immersed in a medium of refractive index 1.65. What is the nature of the lens?
39. A lens behaves as a converging lens in air and a diverging lens in water (μ = 4/3). What will be the condition on the value of refractive index (μ) of the material of the lens?
40. An air bubble is formed inside water. Does it act as a converging lens or a diverging lens?
41. The image of an object formed by a lens on the screen is not in sharp focus. Suggest a method to get the clear focussing of the image on the screen without disturbing the position of the object, the lens or the screen.
42. Can absolute value of refractive index of a medium be less than unity?
43. For which material the value of refractive index is (i) minimum and (ii) maximum?
44. How do the increasing (i) wavelength and (ii) intensity of light affect the speed of light in glass?
45. Why is there no dispersion in the light refracted through a rectangular glass slab?

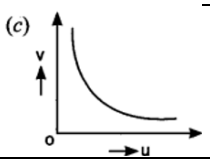
SHORT ANSWER TYPE QUESTIONS (3 marks)

46. A ray of light incident on one of the faces of a glass prism of angle A has angle of incidence 2A. The refracted ray in the prism strikes the opposite face which is silvered, the reflected ray from it retracing its path. Trace the ray diagram and find the relation between the refractive index of the material of the prism and the angle of the prism.
47. Does the magnifying power of a microscope depend on the colour of the light used? Justify your answer.
48. A rectangular glass slab ABCD (refractive index 1.5) is surrounded by a transparent liquid (refractive index 1·25) as shown in the figure. A ray of light is incident on face AB at an angle i such that it is refracted out grazing the face AD. Find the value of angle i.

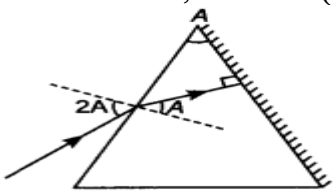


LONG ANSWER TYPE QUESTIONS

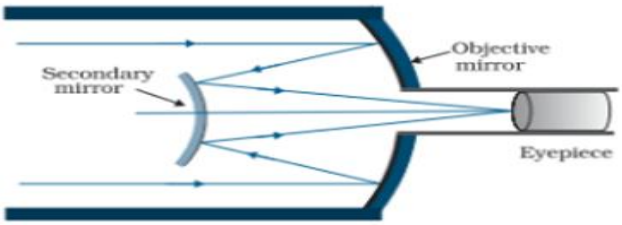
49. **(i)** Draw a ray diagram of a reflecting telescope (Cassegrain) and explain the formation of image. State two important advantages that a reflecting telescope has over a refracting telescope.
(ii) In a refracting telescope, the focal length of the objective is 50 times the focal length of the eyepiece. When the final image is formed at infinity, the length of the tube is 102 cm. Find the focal lengths of the two lenses.
50. **(i)** Write any two advantages of a compound microscope over a simple microscope. Draw a ray diagram for the image formation at the near point by a compound microscope and explain it.
(ii) A thin planoconcave lens with its curved face of radius of curvature R is made of glass of refractive index n_1. It is placed coaxially in contact with a thin equiconvex lens of same radius of curvature of refractive index n_2. Obtain the power of the combination lens.
51. Derive an expression for the magnification of compound microscope. Explain why the objective and eyepiece of a compound microscope must have short focal lengths.
52. Describe a reflecting type telescope. What are its advantages over refracting telescope?
53. State and prove prism formula.
54. Discuss briefly refraction from denser to rarer medium at convex refracting surface. Derive the relation for the same.
55. Derive lens maker's formula for convex lens.
56. Obtain an expression for focal length of a combination of thin lenses in contact.

ANSWER KEY	
1	(a) $f0$ and fe small, and $fe>f0$
2	(c) intensity of image will decrease but complete image is formed.
3	(a) greater than that of the cladding.
4	(b) concave lens
5	(a) $f_1 > f_2$
6	(d) $f_o + f_e$
7	(c) 50 cm
8	(c) 4.5 cm
9	(a) + 15 cm
10	(b) 60°
11	
12	(a) – 1.25 D
13	(a) $\mu_1 = \mu_2$
14	(a) Frequency
15	(c) $\sin^{-1}\frac{3}{4}$ $\theta_c = \sin^{-1}\left(\frac{1}{\mu}\right) = \sin^{-1}\left(\frac{3}{4}\right)$

16	(c) greater than that of eyepiece.
17	(b) Light travels from denser to rarer medium.
18	(c) total internal reflection of light
19	(b) become infinite
20	(a) 30° for both the colours
21	(d) all of these
22	(d) red
23	(c) moves away from the lens with a non-uniform acceleration.
24	(c) The beam of blue light would undergo total internal reflection.
25	(c) act as a convex lens irrespective of the side on which the object lies.
26	(d) In the side mirror, the speed of the approaching car would appear to increase as the distance between the cars decreases.
27	(a) a larger angle to be subtended by the object at the eye and hence viewed in greater detail.
28	(d) An objective of a larger aperture will increase the brightness and reduce chromatic aberration of the image.
29	(c) If assertion is true, but reason is false.
30	(a) If both assertion and reason are true and reason is the correct explanation of assertion.
31	(a) If both assertion and reason are true and reason is the correct explanation of assertion.
32	(a) If both assertion and reason are true and reason is the correct explanation of assertion.
33	(d) If both assertion and reason are false.
34	(i) Refractive index of a medium depends upon nature and temperature of the medium and wavelength of light. (ii) Given, $v = 5 \times 10^{14}$ Hz; $\lambda = 450 \times 10^{-9}$ m, $c = 3 \times 10^8\ \text{ms}^{-1}$ Refractive index of the liquid, $\mu = \frac{c}{v} = \frac{c}{v\lambda} = \frac{3 \times 10^8}{5 \times 10^{14} \times 450 \times 10^{-9}} = 1.33$ (iii) $\mu = \frac{\sin i}{\sin r}$ $\sin r = \frac{\sin i}{\mu} = \frac{\sin 60^\circ}{1.5} = \frac{0.866}{1.5}$ $\sin r = 0.5773$ or $r = \sin^{-1}(0.58)$ (iv) Its wavelength increases but frequency remains unchanged.
35	(i) (A) $2(n-1)/R$ (ii) (D) P/2 (iii) (B) P (iv) (a) (C) 2P OR (b) (A) 6.6 D
36	Given: $i = \theta$, $r = \frac{\theta}{2}$ $\because \quad \frac{\sin i}{\sin r} = \frac{n_2}{n_1}$ i.e. $\sin r < \sin i \Rightarrow n_2 > n_1$ Hence, 2nd medium is optically denser.
37	$\because \quad n = \frac{\sin i}{\sin r} = \frac{c}{v}$ Thus, the medium for which angle of refraction is of 15°, the speed of light is minimum

38	The nature of the lens is converging.
39	The refractive index p of the lens is less than the refractive index of water, i.e. $4/3 > \mu_L > 1$.
40	An air bubble behaves as a diverging lens inside the water.
41	The image of an object formed by a lens can be brought to a sharp focus on a unfixed screen by changing the focal length of the lens by any of the following methods: (i) By placing another lens of suitable focal length in contact with the previous lens. (ii) By immersing the given lens in a liquid of appropriate refractive index.
42	As the speed of light is maximum in vacuum, therefore absolute value of refractive index cannot be less than unity as it is given by the relation n = c/v.
43	(i) Refractive index is minimum for vacuum ($\mu = 1$). (ii) Refractive index is maximum for diamond.
44	(i) $\because v \propto \lambda$; $\therefore$ speed of light increases on increasing the wavelength in glass. (ii) There is no effect on speed of light on changing the intensity.
45	A glass slab can be considered as two glass prisms placed together and the position of one prism is inverted w.r.t. another. Therefore, the various colours of white light dispersed by the first prism are again combined to form white light.
46	Given: i = 2 A, r = 90° – (90° – A) = A  $n = \frac{\sin i}{\sin r} = \frac{\sin 2A}{\sin A}$ $= \frac{2 \sin A \cos A}{\sin A}$ $\therefore$ n = 2 cos A
47	Magnifying power of a microscope, $m = -\frac{L}{f_o}\left(1 + \frac{D}{f_e}\right)$ Since the focal length of a convex lens depends on the refractive index, and refractive indices for different colours are different, so according to the lens maker's formula $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ The magnifying power of a microscope depends on the colour of the light used
48	For glass- liquid interface $\sin i_c = \frac{1}{n_{21}}$ $= \frac{1.25}{1.5}$ $= \frac{5}{6}$ $i_c + r = 90^0$ $\sin r = \sqrt{1-\cos^2 r} = \frac{\sqrt{11}}{6}$ Since $\frac{Sin\ i}{Sin\ r} = n$ Therefore, $Sin\ i = \frac{\sqrt{11}}{4}$ or $i = Sin^{-1}\frac{\sqrt{11}}{4}$

49 (i)



The parallel rays from a distant object are reflected by a large concave mirror. These rays are then reflected by a convex mirror placed just before the focus of concave mirror and are converged to a point outside the hole. The final image is viewed through eye piece.

Advantages (any two)

1) No chromatic aberration.
2) Less spherical aberration
3) Less mechanical support required
4) Brighter Image
5) High resolving power.
6) High magnifying power

(ii) For image at infinity

$$|f_o| + |f_e| = L$$

According to question

$$f_o = 50 \times f_e$$

$$f_e + 50fe = 102$$

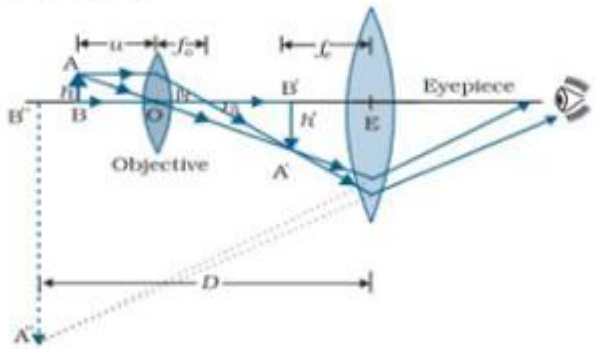
$$f_e = 2 \text{ cm}$$

$$f_o = 100 \text{ cm}$$

50 (i) Advantages (any two)

1) Larger magnification
2) Brighter image

Any other valid advantage



(deduct ½ mark for not showing arrow for ray diagram)

The lens nearest the object, called the objective, forms a real, inverted, magnified image of the object. This serves as the object for the second lens, the eye piece, functions like a simple microscope and produces final image which is enlarged and virtual.

(ii) Power of plano concave lens $= P_1 = \frac{-(n_1-1)}{R}$

Power of convex lens $= P_2 = (n_2-1)\left(\frac{2}{R}\right)$

$$P = P_1 + P_2$$

$$= \frac{(2n_2 - n_1 - 1)}{R}$$

Questions 51-56- refer notes

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