Chapter 2 Optics

I. Choose the correct answer.

Question 1.

(a) A

The refractive index of four substances A, B, C and D are 1.31,1.43,1.33, 2.4 respectively. The speed of light is maximum in:

(b) B (c) C (d) D Answer: (a) A Question 2. Where should an object be placed so that a real and inverted image of same size is obtained by a convex lens: (a) f (b) 2f (c) infinity (d) between f and 2f Answer: (b) 2f Question 3. Where should an object be placed so that a real and inverted image of the same size is obtained by a convex lens . (a) f (b) 2f (c) infinity (d) between f and 2f. Answer: (b) 2f Question 4.

Magnification of a convex lens is _____. (a) positive (b) negative (c) either positive or negative (d) zero. Answer: (b) negative

Question 5.
A convex lens forms a real, diminished point sized image at focus. Then the position of the object is at:

(a) focus
(b) infinity
(c) at 2f
(d) between f and 2f

Answer:

(b) infinity

Question 6.

Power of a lens is -4D, then its focal length is: (a) 4 m (b) -40 m (c) -0.25 m (d) -2.5 m Answer: (d) -2.5 m

- Question 7. In a myopic eye, the image of the object is formed _____. (a) behind the retina (b) on the retina (c) in front of the retina (d) on the blind spot. Answer: (c) in front of the retina
- Question 8. The eye defect 'presbyopia' can be corrected by: (a) convex lens (b) concave lens (c) convex mirror (d) Bi focal lenses Answer: (d) Bi focal lenses

Question 9.

Which of the following lens would you prefer to use while reading small letters found in a dictionary?

(a) A convex lens of focal length 5 cm

(b) A concave lens of focal length 5 cm

(c) A convex lens of focal length 10 cm

(d) A concave lens of focal length 10 cmAnswer:(d) A concave lens of focal length 10 cm

Question 10.

If V_B , V_G , V_R be the velocity of blue, green and red light respectively in a glass prism, then which of the following statement gives the correct relation?

(a) $V_B = V_G = V_R$ (b) $V_B > V_G > V_R$ (c) $V_B < V_G < V_R$ (d) $V_B < V_G > V_R$ Answer: (c) $V_B < V_G < V_R$

II. Fill in the blanks.

- 1. The path of the light is called as
- 2. The refractive index of a transparent medium is always greater than
- 3. If the energy of incident beam and the scattered beam are same, then the scattering of light is called as scattering
- 4. According to Rayleigh's scattering law, the amount of scattering of light is inversely proportional to the fourth power of its
- 5. Amount of light entering into the eye is controlled by

Answer:

- 1. ray
- 2. unity
- 3. elastic
- 4. wavelength
- 5. iris

III. True or False. If false correct it.

- 1. Velocity of light is greater in denser medium than in rarer medium.
- 2. The power of lens depends on the focal length of the lens.
- 3. Increase in the converging power of eye lens cause 'hypermetropia'
- 4. The convex lens always gives small virtual image.

Answer:

- 1. False Velocity of light is greater in rarer medium than in denser medium.
- 2. True

- 3. True
- 4. False The convex lens does not give small virtual image always.

IV. Match the following.

	Column - I		Column - II
1	Retina	a	Path way of light
2	Pupil	b	Far point comes closer
3	Ciliary muscles	с	near point moves away
4	Myopia	d	Screen of the eye
5	Hypermetropia	f	Power of accom- modation

Answer:

1. d

2. a

3. e 4. b

4. D 5. C

V. Assertion and reasoning type.

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 the correct explanation of assertion.

(c) Assertion is true but reason is false.

(d) Assertion is false but reason is true.

1. Assertion: If the refractive index of the medium is high (denser medium) the velocity of the light in that medium will be small

Reason: Refractive index of the medium is inversely proportional to the velocity of the light.

2. Assertion: Myopia is due to the increase in the converging power of eye lens. Reason: Myopia can be corrected with the help of concave lens. Answer:

1. (a)

2. (a)

VI. Answer Briefly.

Question 1. What is refractive index? Answer: Refractive index gives us an idea of how fast or how slow light travels in a medium.

Question 2. State Snell's law. Answer: The ratio of the sine of the angle of incidence and sine of the angle of refraction is equal to the ratio of refractive indices of the two media. This law is also known as Snell's law. $\frac{sini}{sinr} = \frac{\mu^2}{\mu 1}$

Question 3.

Draw a ray diagram to show the image formed by a convex lens when the object is placed between F and 2F.

Answer:



Object placed between F and C

Question 4. Define dispersion of light. Answer:

When a beam of white light or composite light is refracted through any transparent media such as glass or water, it is split into its component colours. This phenomenon is called as 'dispersion of light'.

Question 5. State Rayleigh's law of scattering. Answer: Rayleigh's scattering law states that, "The amount of scattering of light is inversely proportional to the fourth power of its wavelength".

Amount of scattering 'S' $\propto \frac{1}{\lambda^4}$

Question 6.

Differentiate convex lens and concave lens. Answer:

S. No	Convex Lens	Concave Lens
1	A convex lens is thicker in the middle than at edges.	A concave lens is thinner in the middle than at edges.
2	It is a converging lens.	It is a diverging lens.
3	It produces mostly real images.	It produces virtual images.
4	It is used to treat hypermeteropia.	It is used to treat myopia.

Question 7.

What is the power of accommodation of the eye? Answer:

- The ability of the eye lens to focus nearby as well as the distant objects is called the power of accommodation of the eye.
- This is achieved by changing the focal length of the eye lens with the help of ciliary muscles.

Question 8. What are the causes of 'Myopia'? Answer:

- 1. The lengthening of eye ball.
- 2. The focal length of eye lens is reduced.
- 3. The distance between eye lens and retina increases.
- 4. The far point will not be at infinity.
- 5. The far point comes closer.

Question 9.

Why does the sky appear blue in colour? Answer:

When sunlight passes through the atmosphere, the blue colour (shorter wavelength) is scattered to a greater extent than the red colour (longer wavelength). This scattering causes the sky to appear blue in colour.

Question 10. Why are traffic signals red in colour? Answer:

- Red light has the highest wavelength.
- It is scattered by atmospheric particles.
- So red light is able to travel the longest distance through a fog, rain etc.

VII. Give the answer in detail.

Question 1. List any five properties of light? Answer:

- Light is a form of energy.
- Light always travels along a straight line.
- Light does not need any medium for its propagation. It can even travel through a vacuum.
- The speed of light in vacuum or air is, $c = 3 \times 10^8 \text{ ms}^{-1}$
- Since light is in the form of waves, it is characterized by a wavelength (λ) and a frequency (v), which are related by the following equation: $c = v\lambda$ (c = velocity of light).
- Different coloured light has a different wavelength and frequency.

Question 2.

Explain the rules for obtaining images formed by a convex lens with the help of ray diagram.

Answer:

Rule-1: When a ray of light strikes the convex or concave lens obliquely at its optical centre, it continues to follow its path without any deviation.



Rays passing through the optical centre

Rule-2: When rays parallel to the principal axis strikes a convex or concave lens, the refracted rays are converged to (convex lens) or appear to diverge from (concave lens) the principal focus.



Rays passing parallel to the optic axis

Rule-3: When a ray passing through (convex lens) or directed towards (concave lens) the principal focus strikes a convex or concave lens, the refracted ray will be parallel to the principal axis.



Rays passing through or directed towards the principal focus

Question 3.

Differentiate the eye defects: Myopia and Hypermetropia. Answer:

Myopia	Hypermetropia
It is due to the lengthening of the eye ball.	It is due to the shortening of the eye ball.
With this defect, distant objects cannot be seen clearly.	With this defect, nearly objects cannot be seen clearly.
The focal length of the eye lens is reduced.	The focal length of eye lens is increased.
The far point will not be at infinity.	The near point will not be at 25 cm.
The far point has come closer.	The near point has moved further.
The image of distant objects are formed before the retina.	The image of nearby objects are formed behind the retina.
It can be corrected by using concave lens.	It can be corrected by using convex lens.
This defect is known as myopia.	This defect is known as hypermeteropia.

Question 4.

Explain the construction and working of a 'Compound Microscope'. Answer:

Construction : A compound microscope consists of two convex lenses. The lens with the shorter focal length is placed near the object, and is called as 'objective lens' or 'objective piece'. The lens with larger focal length and larger aperture placed near the observer's eye is called as 'eye lens' or 'eye piece'. Both the lenses are fixed in a narrow tube with adjustable provision.

Working : The object (AB) is placed at a distance slightly greater than the focal length of objective lens ($u > F_0$). A real, inverted and magnified image (A'B') is formed at the other side of the objective lens. This image behaves as the object for the eye lens. The position of the eye lens is adjusted in such a way, that the image (B'B') falls within the principal focus of the eye piece. This eye piece forms a virtual, enlarged and erect image (A"B") on the same side of the object.



Compound microscope has 50 to 200 times more magnification power than simple microscope.

VIII. Numerical Problems.

Question 1. An object is placed at a distance 20 cm from a convex lens of focal length 10 cm. Find the image distance and nature of the image. Answer: Distance of an object u = 20 cm Focal length of a convex lens f = 10 cm Let the image distance be v We know

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

$$\frac{1}{20} + \frac{1}{v} = \frac{1}{10}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{20}$$

$$\frac{1}{v} = \frac{20 - 10}{200}$$

$$= \frac{10}{200} = \frac{1}{20}$$

v = 20 cm

Magnification m = $\frac{v}{u} = \frac{20}{20} = 1$ Hence a real image of same size is formed at 20 cm. Image distance = 20 cm

Question 2.

An object of height 3 cm is placed at 10 cm from a concave lens of focal length 15 cm. Find the size of the image.

Answer:

Object distance u = 10 cmFocal length of a concave lens f=-15 cmLet v be the image distance,

$$\frac{1}{u} + \frac{1}{v} = -\frac{1}{f}$$

$$\frac{1}{10} + \frac{1}{v} = -\frac{1}{15}$$

$$\therefore \frac{1}{v} = -\frac{1}{15} - \frac{1}{10}$$

$$= -\frac{25}{30}$$

$$= -\frac{5}{30}$$

$$\therefore v = -\frac{30}{5} = -6 \text{ cm}$$

Distance of image v = 6 cm Magnification m = $\frac{v}{u} = \frac{6}{10} = 0.6$ And Magnification m = h'/h Where h' – height of image h – height of object $0.6 = \frac{h'}{3}$ ∴ h' = 3 × 0.6 = 1.8 cm ∴ Height of image = 1.8 cm

IX. Higher order thinking (HOT) questions.

Question 1.

While doing an experiment for the determination of focal length of a convex lens, Raja Suddenly dropped the lens. It got broken into two halves along the axis. If he continues his experiment with the same lens,

(a) can he get the image?

(b) Is there any change in the focal length?

Answer:

(a) He can get the image.

(b) The focal length of the lens will be doubled.

Question 2.

The eyes of the nocturnal birds like owl are having a large cornea and a large pupil. How does it help them?

Answer:

- The large pupil opens wider and allows the maximum amount of light to enter the eye in the dark.
- Their lens is large and situated near the retina. This also allows a lot of light to register on the retina. The retina contains 2 types of light-sensing cells rods and cones.
- Cones are responsible for the coloured vision and require bright, focused light.
- Rods are extremely sensitive to light and have a photosensitive pigment called rhodopsin which plays a vital role in night vision.