UNIT

2

Optics

POINTS TO REMEMBER

Speed of light : $c = 3\times 10^{8}\ ms^{-1}$.

Refraction : When light ray travels from one medium to another if deviates its path.

First law of refraction : The incident ray ,the refracted ray of light and the normal to the refracting surface all lie in the same plane.

Refractive index : The ratio of speed of light in vaccum to the speed of light in a medium.

Snell's law : The ratio of the sine of the angle of incidence and sine of the angle of refraction is equal to ratio of refractive indices of the two media.

$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$$

Dispersion of light : When a beam of white light is refracted through any transparent media, it is split into its component colours.

VIBGYOR : Violet, Indigo, Blue, Green, Yellow, Orange, Red.

Red : Angle of refraction is the smallest.

Violet : Angle of refraction is the highest.

Types of scattering : Elastic, Inelastic.

Scatterer : "Scattering is the phenomenon by which a beam of light is redirected in many different directions when it interacts with a constitutent particle of the atmosphere. The interacting particle of the atmosphere is called scatterer.

Elastic Scattering : If the energy of incident beam of light and scattered light beam are the same.

Inelastic Scattering : If the energy of incident beam of light and scattered light beam are not the same.

MIND MAP

Rayleigh scattering law	: The amount of scattering of light is inversely proportional to the fourth power of the wavelength.
Mie scattering	: It takes place when the diameter of the scatterer is similar to or larger than the wavelength of the incident light .It is also an elastic scattering.
Tyndall scattering	: The scattering of light rays by the colloidal particles in the colloidal solution.
Raman scattering	: The interaction of light ray with the particles of pure liquids or transparent solids, which leads to a change in wavelength or frequency.
Convex lens	: It is thicker at the centre than at the edge.
Concave lens	: It is thinner at the centre than at the edge.
Cornea	: Maximum refracting surface of eye.
Iris	: It controls amount of light entering into the pupil.
Retina	: It is a screen. Image is formed this screen.
Myopia	: Short sightedness – corrected using concave lens.
Hypermetropia	: Long sightedness – corrected using convex lens.
Presbyopia	: Both long and short sightedness corrected by bifocal lenses.
Microscope	: Help to see tiny objects.
Telescope	: Optical instrument to see the distant objects.

Formulae

Velocity of light	$C = \nu\lambda$
Snell's law	$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$
Rayleigh's Scattering Law	$S \alpha \frac{1}{\lambda^4}$
Lens formula	$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$
Magnification	$m = \frac{h'}{h} = \frac{v}{u} = \frac{\text{distance of the image}}{\text{distance of the object}}$
Power of lens	$P = \frac{1}{f}$ (f in meter)

Len's makers formula	$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$
Focal length of required concave lens for myopia	$f = \frac{xy}{x - y}$
Focal length of the required convex lens for hypermeteropia	$f = \frac{dD}{d - D}$
Visual angle, (tan θ)	$\frac{\text{height}}{\text{distance}}$
Angular magnification $M = \frac{\alpha}{\beta}$	α - angle subtended by the final image at the eye. β - angle substended by the object at the naked eye.
In simple microscope,	$M = 1 + \frac{D}{f}$ D → Least distance of distinct vision from the lens of eye
Compound microscope magnification	$M = (\frac{v}{f_0} - 1)(1 + \frac{D}{f_e})$ $M = M_0 \times M_e$
Astronomical telescope	Magnification $M = \frac{f_0}{f_e}$

Textbook Evaluation

I. Choose the most suitable answer from the given four alternatives and write the option code and corresponding answer:

1. **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**
   a) A b) B
   c) C d) D

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

3. **A small bulb is placed at the principal focus of a convex lens. When the bulb is switched on, the lens will produce** ★
   a) a convergent beam of light b) a divergent beam of light
   c) a parallel beam of light d) a coloured beam of light

4. **Magnification of a convex lens is**
   a) positive b) negative
   c) either positive or negative d) zero

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

6. **Power of a lens is –4D, then its focal length is** ★★
   a) 4m
   b) – 40m
   c) – 0.25 m
   d) – 2.5 m

7. **In a myopic eye, the image of the object is formed**
   a) behind the retina
   b) on the retina
   c) infront of the retina
   d) on the blind spot

8. **The eye defect 'presbyopia' can be corrected by**
   a) convex lens
   b) concave lens
   c) convex mirror
   d) Bi focal lenses

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 cm

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) $V_B < V_G > V_R$

Ans:

1.	a)	A	6.	c)	– 0.25 m
2.	b)	2f	7.	c)	infront of the retina
3.	c)	a parallel beam of light	8.	d)	Bifocal lenses
4.	c)	either positive or negative	9.	a)	A convex lens of focal length 5 cm
5.	b)	infinity	10.	b)	$V_B < V_G < V_R$

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 _____.** ★★

Ans:

1.	Ray	4.	wavelength
2.	One	5.	Iris
3.	Elastic		

III. State whether the following statements are true or false. Correct the statement if it is false:

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

IV. Match the following:

1. 1) Retina – a) Pathway of light (d)
   2) Pupil – b) Far point comes closer (a)
   3) Ciliary muscles – c) Near point moves away (e)
   4) Myopia – d) Screen of the eye (b)
   5) Hypermetropia – e) Power of accommodation (c)

V. Assertion & Reasoning

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 (A)** : If the refractive index of the medium is high (denser medium) the velocity of the light in that medium will be small
   Reason(R) : Refractive index of the medium is inversely proportional to the velocity of the light
   Ans: (a) If both assertion and reason are true and reason is the correct explanation of assertion

2. **Assertion (A)** : Myopia is due to the increase in the converging power of eye lens.
   Reason (R) : Myopia can be corrected with the help of concave lens.
   Ans: (a) If both assertion and reason are true and reason is the correct explanation of assertion.

VI. Answer briefly

1. What is refractive index? ★

The ratio of **speed of light in vacuum** to the **speed of light in a medium** is defined as refractive index (μ) of the medium.

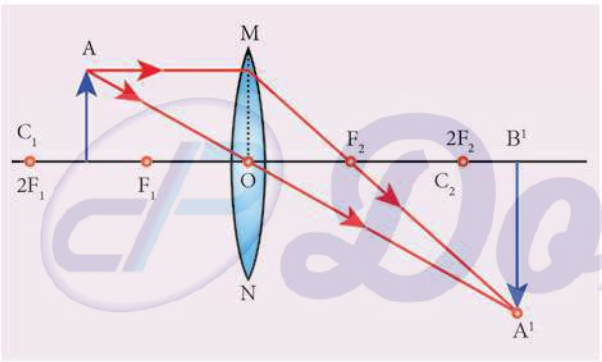
$$\mu = \frac{\sin i}{\sin r}$$

2. State Snell's law. ★★

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.

$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$$

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



4. Define dispersion of light.

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.

5. State Rayleigh's law of scattering. ★★

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 $'s' \propto \frac{1}{\lambda^4}$

6. Differentiate convex lens and concave lens. ★★

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.**

7. What is power of accommodation of eye?

The **ability of the eye** lens to focus **nearby** as well as the **distant objects** is called power of accommodation of the eye.

8. What are the causes of 'Myopia'?

- The focal length of eye lens is **reduced** or the distance between **eye lens** and **retina increases**.
- Hence the far point will not be infinity for such eyes and the far point has come closer, with this defect, **nearby object** can be **seen clearly** but distant objects cannot be seen clearly.

9. Why does the sky appear in blue colour?

- When sunlight passes through the atmosphere the blue colour (Shorter wavelength) is **scattered** to a **greater** extent than the red colour (larger wavelength).
- This scattering causes the sky to appear in blue colour.

10. Why are traffic signals red in colour? ✶

- The red colour has longer wavelength.
- So it can travel for longer distance and will be seen clearly. So red colour is used in traffic signals.

VII. Give the answer in detail:

1. List any five properties of light ✶ ✶

Properties of light:

- 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 vacuum.
- The speed of light in vacuum or air is, $\mathbf{c = 3 \times 10^8\ m/s}$
- Since, light is in the form of waves, it is characterized by **a wavelength** (λ) and a **frequency** (ν), which are related by the following equation: $c = \nu \lambda$ (c - velocity of light).

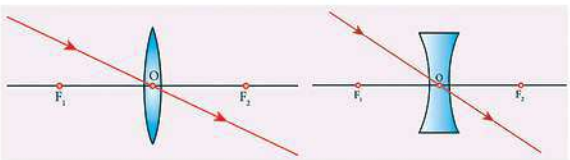
2. Explain the rules for obtaining images formed by a convex lens with the help of ray diagram. ✶ ✶

Rules for obtaining images:

- When an object is placed infront of a lens, the light rays from the object fall on the lens.
- The position, size and nature of the image formed can be understood only if we know certain basic rules.

Rule-1:

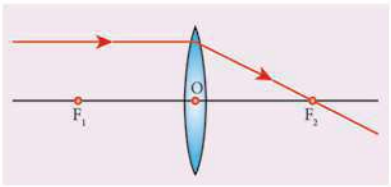
- When a ray of light strikes the convex lens obliquely at its **optical centre,** it continues to follow its path **without any deviation.**



Rays passing through the optical centre

Rule-2:

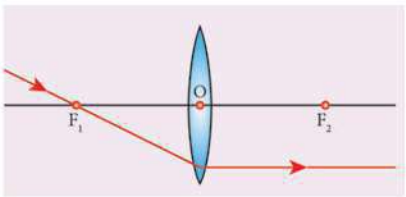
- When rays **parallel** to the **principal axis** strikes a convex lens, the **refracted rays** are **converged** to (convex lens) the **principal focus.**



Rays passing parallel to the optic axis

Rule-3:

- When a ray passing through (convex 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

3. Differentiate the eye defects: Myopia and Hypermetropia ✱

S.No	Myopia	Hypermetropia
1.	**Short** sightedness	**Long** sightedness
2.	Occurs due to **lengthening** of eye ball	Occurs due to **shortening** of eye ball.
3.	Nearby objects can be seen clearly	Nearby objects cannot be seen clearly
4.	Distant objects **cannot be seen** clearly	Distant objects **can be seen** clearly
5.	The focal length of eye lens is **reduced**	The focal length of eye lens is **increased**
6.	The **far points will not be infinity** for such eyes and the far points have come closer	The **near points will not be at 25 cm** for such eyes and the near point have moved farther
7.	The image of distant objects are formed **before the retina**	The image of nearby objects are formed **behind the retina**
8.	The defect can be corrected using **concave lens of negative power**	The defect can be corrected using **convex lens of positive power**

4. Explain the construction and working of a 'Compound Microscope'.

Compound microscope:

Construction:

- A compound microscope is used to see the **tiny objects** has **better magnification power** than simple microscope.
- 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 ($u > f_o$).
- 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** (A' 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.

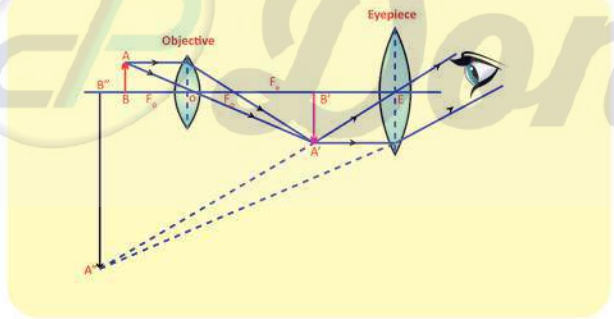


Image formation in compound microscope

VIII. Numerical Problems:

1. An object is placed at a distance 20cm from a convex lens of focal length 10cm. Find the image distance and nature of the image.

Solution:

Given:

$f = 10$ cm, $u = -20$ cm, $v = ?$

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

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

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

Formula used:

Image distance

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

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

$$\frac{1}{v} = \frac{2-1}{20} = \frac{1}{20}$$

$$v = 20 \text{ cm}$$

Image distance = 20 cm

Nature of image:

Real inverted is formed at the centre of curvature. The size of the image is same

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

Solution:

Given:

$f = -15$ cm, $u = -10$ cm, $v = ?$, $h = 3$ cm

Formula used:

Image distance

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

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

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

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

$$= \frac{1}{15} + \frac{1}{-10} - \left(\frac{1}{15} + \frac{1}{10}\right)$$

$$\frac{1}{v} = \frac{-(2+3)}{30} = \frac{-5}{30} = -\frac{1}{6}$$

v = –6 cm

Size of the image

$$\text{Magnification} = \frac{+v}{u} \quad \left(m = \frac{h'}{h}\right)$$

Formula used:

$$\text{Magnification} = \frac{+v}{u}$$

$$\frac{h'}{h} = \frac{-v}{u}$$

$$\frac{h'}{3} = \frac{-6}{-10} = 0.6$$

$$h' = 0.6 \times 3 = 1.8 \text{ cm}$$

Size of the image = 1.8 cm

IX. Higher Order Thinking Skills (HOTS)

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?

a) Yes he got the image. But the image is not clear.

b) No change in the focal length. Because no change in radius of curvature.

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

The eyes of the nocturnal birds like owl have a large cornea and a large pupil. These features increase their field of vision and also shows an increase in retinal surface and help them to collect more ambient light during night.

Additional Questions

I. Choose the most suitable answer from the given four alternatives and write the option code and corresponding answer:

1. Speed of light in vacuum or air is _____. ★

a) 3×10^8 m/s b) 3×10^8 cm/s

c) 3×10^8 m/hr d) 3×10^8 cm/hr

2. The angle of refraction is smallest in _____ colour.

a) green b) blue

c) red d) violet

3. _____ lens is thicker at the centre than at the edge.

a) Concave b) Convex

c) Spherical d) Bifocal

4. When an object is placed in _____ the collected image size is bigger than that of an object. ★

a) at infinity

b) behind centre of curvature

c) at the centre of curvature

d) between the centre of curvature and principal focus

5. _____ lenses are used as camera lenses.

a) Convex b) Concave

c) Bifocal d) None of these

6. _____ lenses are used to correct the defect of myopia.

a) Convex b) Concave

c) Bifocal d) None of these

7. _____ is the correct lens formula for spherical lenses.

a) $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ b) $\frac{1}{f} = \frac{1}{u} - \frac{1}{v}$

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

8. Among the following _____ is the coloured part of eye.

a) cornea b) pupil c) Iris d) Redina

9. _____ helps to change the focal length of the eye lens

a) Retina b) Ciliary muscle
c) Pupil d) Eye lens

10. A normal human eye can clearly see all the object placed between _____ and infinity.

a) 25 cm b) 25 mm c) 25 m d) 30 cm

11. _____ can be corrected by bifocal lenses.

a) Myopia b) Hypermetropia
c) Presbyopia d) Astigmatism

12. An _____ telescope is used to view heavenly bodies like stars and planets. ✱

a) refracting b) astronomical
c) terrestrial d) galilean

Ans:

1.	a)	3×10^8 m/s	7.	a)	$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$
2.	c)	Red	8.	c)	Iris
3.	b)	Convex	9.	b)	Ciliary muscle
4.	d)	between the centre of curvature and principal focus	10.	a)	25 cm
5.	a)	Convex	11.	c)	Presbyopia
6.	b)	Concave	12.	b)	astronomical

II. Fill in the blanks:

1. Light does not need any medium for its _____.
2. The band of colours is termed as _____.
3. Angle of refraction is the highest for _____colour.
4. _____ scattering is responsible for the white appearance of the clouds. ✱
5. _____ lens is thinner at the centre than at the edges.
6. Convex lenses are used as _____ lenses.
7. Convex lenses are _____ lenses.
8. _____ is the most sensitive part of human eye.
9. _____ lens is made of a flexible, jelly like material.

10. Astigmatism can be corrected by using _____ lenses.
11. Travelling microscope is work based on the principle of _____.
12. _____ is an optical instrument to see the distant objects. ★
13. The SI unit of power of lens is _____.

Ans:

1.	propagation	8.	Retina
2.	spectrum	9.	Eye
3.	violet	10.	Torrid
4.	Mie	11.	Vernier
5.	Concave	12.	Telescope
6.	magnifying	13.	dioptre
7.	converging		

III. State whether the following statements are true or false. Correct the statement if it is false:

1. **Different coloured lights have different wavelength and frequency.** **True**
2. **A convex lens is thinner at the centre than at the edge.** ★ **False**
   A concave lens is thinner at the centre than at the edge.
   (OR)
   A convex lens is thicker at the centre than at the edge.
3. **When an object is placed at the focus, a real image is formed at the centre of curvature.** **False**
   When an object is placed at the focus, a real image is formed at infinity.
4. **Concave lenses are used as eye lens of Galilean Telescope.** **True**
5. **According to Cartesian sign convention the distances measured against the direction of incident light are taken as positive.** **False**
   According to Cartesian sign convention the distances measured against the direction of incident light are taken as negative.
6. **In human eye, a tough membrane called Iris protects the internal parts of the eye.** **False**
   In human eye, a tough membrane called sclera protects the internal parts of the eye.
7. **Hypermetropia occurs due to lengthening of eye ball.** ★ **False**
   Hypermetropia occurs due to shortening of eye ball.
   (OR)
   Myopia occurs due to lengthening of eye ball.
8. **Compound microscope is an optical instrument to see the distant objects.** **False**
   Telescope is an optical instrument to see the distant objects.

IV. Match the following:

1.

1) Velocity of light	–	a) Violet	(d)
2) Law of refraction	–	b) Snell's law	(b)
3) Spectrum	–	c) Red	(e)
4) Angle of refraction is smallest	–	d) 3×10^8 m/s	(c)
5) Angle of refraction is highest	–	e) VIBGYOR	(a)

2

1) Diverging lens	–	a) Optical nerves ★★	(d)
2) Converging lens	–	b) Enlarged image	(c)
3) Sign Convention	–	c) Convex lens	(e)
4) Image to brain	–	d) Concave lens	(a)
5) Microscope	–	e) Cartesian	(b)

3.

Object Placed		Image Formed ★	
1) At infinity	–	a) Centre of curvature	(d)
2) Beyond C (>2F)	–	b) At infinity	(e)
3) At C	–	c) Behind centre of curvature	(a)
4) Between F and C	–	d) Principal focus	(c)
5) At the principal Focus (F)	–	e) Between C and F	(b)

4.

1) Myopia	–	a) Torrid lens	(c)
2) Hypermetropia	–	b) Bifocal lens	(d)
3) Presbyopia	–	c) Concave lens	(b)
4) Astigmatism	–	d) Convex lens	(a)

V. Assertion & Reasoning

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 (A)** : When light travels from one medium into another medium it deviates in both.

   Reason(R) : It takes place due to the difference in the velocity of light in different mediums.

   Ans: a) Both A and R are correct.

2. **Assertion (A)** : Sunlight is a composite light which consists of various colours or wavelengths.
   Reason (R) : The amount of scattering is independent of wavelength.
   Ans: c) Assertion is true but reason is false.

3. **Assertion (A)** : Convex lenses are used in slide projectors.
   Reason (R) : The image is formed between optical centre and principal focus
   Ans: c) Assertion is true but reason is false.

4. **Assertion (A)** : Concave lenses are used on the main door of houses.
   Reason (R) : They are used in wide angle spy hole in doors.
   Ans: a) If both assertion and reason are true and reason is the correct explanation of assertion.

5. **Assertion (A)** : Power of lens is numerically defined as the reciprocal of its focal length.
   Reason (R) : The power of concave lens is taken as positive ✱
   Ans: c) Assertion is true but reason is false.

6. **Assertion (A)** : Myopia is also known as long sightedness
   Reason (R) : The images of distant objects are formed before retina in myopia eyes.
   Ans: d) Assertion is false but reason is true.

VI. Answer briefly

1. Define refraction. ✱

When a ray of light **travels from one medium to another** if path of light undergoes deviation. This deviation of ray of light is called refraction.

2. Write the first law of refraction.

The incident ray, the refracted ray of light and the normal to the refracting surface **all lie in the same plane.**

3. List the types of scattering

According to the initial and final energy of the light beam.

They are classified into two types.

- Elastic Scattering
- Inelastic Scattering

The nature and size of scatter results they are divided into,

- Rayleigh scattering
- Mie scattering
- Tyndall scattering
- Raman Scattering

4. Define Elastic scattering.

If the energy of the **incident beam of light and the scattered beam of light are same.** Then it is called elastic scattering.

5. Define Tyndall effect. ★

The **scattering of light rays by the colloidal particles** in the colloidal solution is called Tyndall scattering or Tyndall effect.

6. Define Raman scattering.

Raman scattering is defined as "The **interaction of light ray with the particles of pure liquids** or transparent solids which leads to a change in wavelength or frequency".

7. Differentiate Rayleigh lines and Raman lines.

Rayleigh lines	Raman lines
The spectral lines having **frequency equal to the incident ray frequency**	The spectral lines which are having **frequencies other than the incident ray frequency**

8. Define Plano-convex lens and Plano-concave lens.

Plano-convex lens

- One of the faces of a **biconvex lens** is plane

Plane-concave lens

- If one of the faces of a **biconcave lens** is plane

9. Define-magnification of a lens. ★★

It is defined as the ratio of the height of the image to the height of an object

$$m = \frac{\text{height of the image}}{\text{height of the object}} = \frac{h'}{h}$$

10. Write the lens makers equation. ★

$$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

μ = Refractive index of the material

R_1, R_2 = Radii of the curvature of the two faces of the lens.

11. Define power of lens. Give its unit.

The power of a lens can be defined as the **degree of convergence or divergence** of light rays. It is numerically defined as the reciprocal of the focal length.

$$p = \frac{1}{f}$$

The SI unit of power of lens is dioptre

12. Differentiate far points and near points of human eye.

Far points	Near points
Minimum distance is required to see the objects distinctly without strain.	The **maximum distance** upto which the eye can see objects clearly.
The **near point is 25 cm** for normal human eye.	Its **far point is infinity** for normal eye.

13. What are the causes of presbyopia?

Due to ageing, ciliary muscles become weak and the eye lens become rigid and so the eye loses its power of accommodation.

14. What is the purpose of bifocal lenses? Why?

- Lenses are used for the upright of eye sight.
- The eye loses its power due to many reasons including ageing.
- Hence their vision becomes defective, to correct these defects bifocal lenses are used.

15. What is Astigmatism?

- In this defect, the eye **cannot see parallel and horizontal lines** clearly.
- It may be inherited or acquired.
- It is due to the **imperfect structure of eye lens** due to the **development of cataract** on the lens, ulceration of cornea, injury to the refracting surfaces, etc.
- It is **corrected by cylindrical lenses** (Torrid lenses).

16. List the uses of simple microscope.

It is used

- by watch repairers and jewellers
- to read small letters clearly
- to observe parts of flowers, insects, etc.
- to observe finger prints in the field of forensic sciences.

17. Give the types of Telescope.

According to optical property two types of telescopes are used:

- Refracting Telescope
- Reflecting telescope

According to the things which one observes

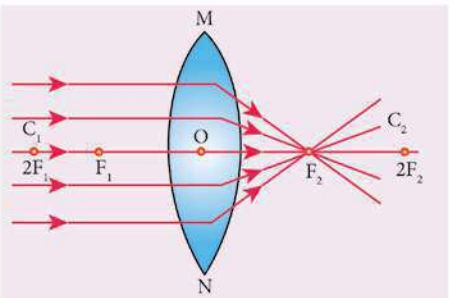
- Astronomical telescope
- Terrestrial telescope

VII. Give the answer in detail:

1. Draw the ray diagram for following object placed at i) At infinity ii) beyond C iii) placed at 'C' iv) between C and F v) at the principle focus (F) then write the position, nature and size of the image ★★

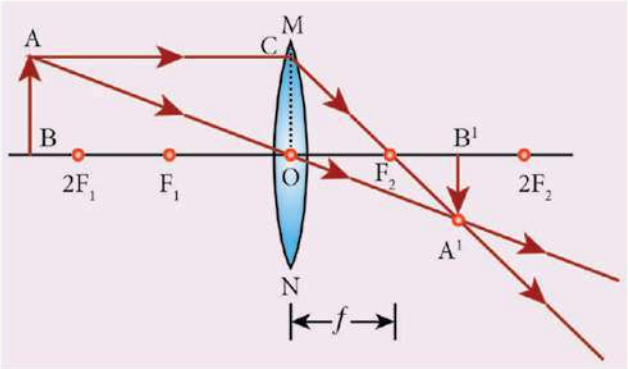
i) Object at infinity:

- When an object is placed at infinity, a **real image is formed at the principal focus.**
- The size of the image is much smaller than that of the object.



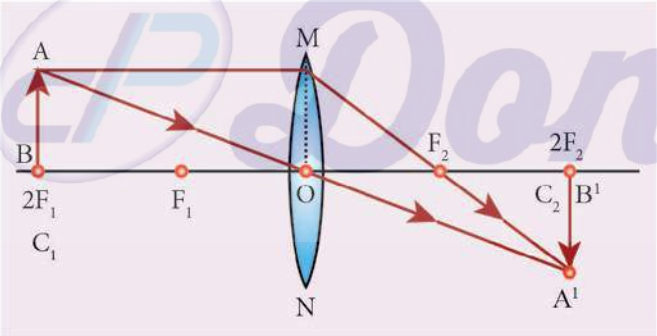
ii) Object placed beyond C (>2F)

- When an object is placed behind the center of curvature (beyond C), a **real and inverted image is formed between the center of curvature** and the principal focus.
- The size of the image is the same as that of the object.



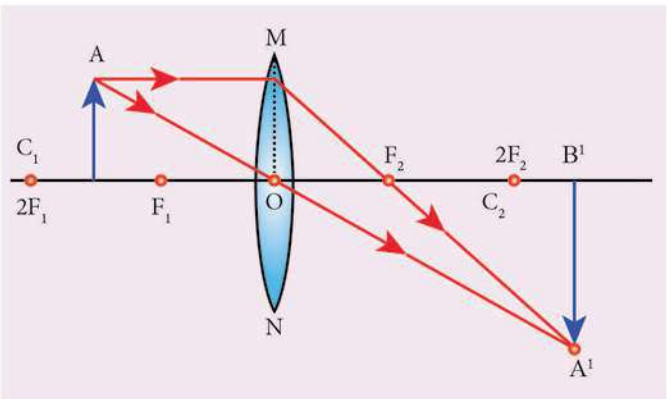
iii) Object placed at C

- When an object is placed at the center of curvature, **a real and inverted image is formed at the other center of curvature.**
- The size of the image is the same as that of the object.



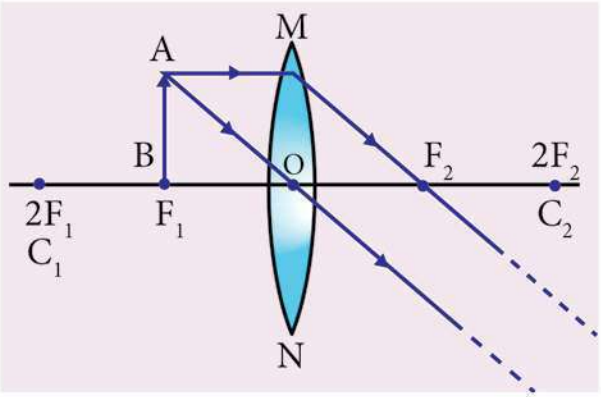
iv) Object placed between F and C

- When an object is placed in between the center of curvature and principal focus, **a real and inverted image is formed behind the center of curvature.**
- The size of the image is bigger than that of the object.



v) Object placed at the principal focus F

- When an object is placed at the focus, **a real image is formed at infinity.**
- The size of the image is much larger than that of the object.



2. Write about Cartesian sign conventions.

Cartesian sign conventions are used for measuring the various distances in the ray diagrams of spherical lenses. According to Cartesian sign convention:

- The object is always placed on the left side of the lens.
- All the distances are measured from the optical centre of the lens.
- The distances measured in the same direction as that of incident light are taken as positive.
- The distances measured against the direction of incident light are taken as negative.
- The distances measured upward and perpendicular to the principal axis is taken as positive.
- The distances measured downward and perpendicular to the principal axis is taken as negative.

3. Describe the structure of eye and working of human eye. ★★★

Structure of the eye

- The eye ball is approximately spherical in shape with a diameter of about 2.3 cm.
- It consists of a tough membrane called sclera, which protects the internal parts of the eye.

Important parts of human eye are as follows:

Cornea:

- This is the thin and transparent layer on the front surface of the eyeball.
- It is the main refracting surface.
- When light enters through the cornea, it refracts or bends the light on to the lens.

Iris:

- It is the coloured part of the eye.
- It may be blue, brown or green in colour.
- Every person has a unique colour, pattern and texture.
- Iris controls amount of light entering into the pupil like camera aperture.

Pupil:

- It is the centre part of the Iris.
- It is the pathway for the light to retina.

Retina:

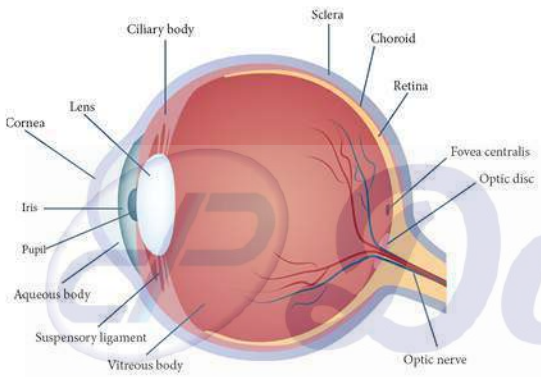
- This is the back surface of the eye.
- It is the most sensitive part of human eye, on which real and inverted images of objects is formed.

Ciliary muscles:

- Eye lens is fixed between the ciliary muscles.
- It helps to change the focal length of the eye lens according to the position of the object.

Eye Lens:

- It is the important part of the human eye. It is convex in nature.



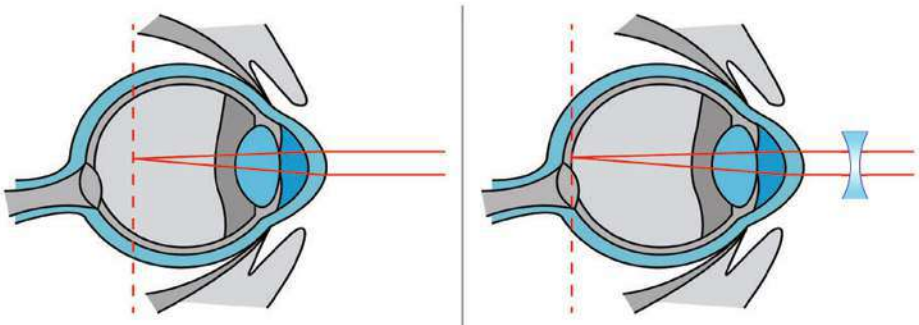
Working of the eye:

- The transparent layer cornea bends the light rays through the pupil located at the centre part of the Iris.
- The adjusted light passes through the eye lens. Eye lens is convex in nature.
- So, the light rays from the objects are converged and a real and inverted image is formed on the retina.
- Then, the retina passes the received real and inverted image to the brain through optical nerves. Finally, the brain senses it as an erect image.

4. Describe the following i) Myopia, ii) Hypermeteropia ✶✶

Myopia:

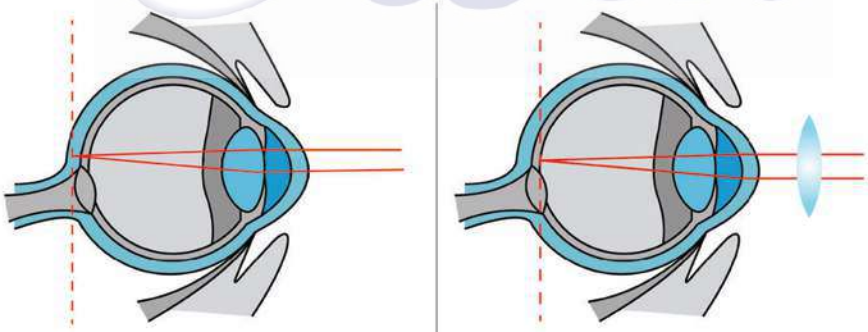
- Myopia, also known as **short sightedness**, occurs due to the **lengthening of eye ball.**
- With this defect, **nearby objects can be seen clearly** but distant objects cannot be seen clearly.
- The **focal length of eye lens is reduced** or the distance between eye lens and retina increases.
- Hence, the **far point will not be at infinity** for such eyes and the far point has come closer.
- Due to this, the **image of distant objects** are formed **before the retina.**
- This defect can be **corrected using a concave lens.**



(a) Myopia (b) Myopia corrected eye

Hypermeteropia:

- Hypermeteropia, also known as **long sightedness**, occurs due to the **shortening of eye ball.**
- With this defect, **distant objects can be seen clearly** but nearby objects cannot be seen clearly.
- The **focal length of eye lens is increased** or the distance between eye lens and retina decreases.
- Hence, the **near point will not be at 25cm** for such eyes and the near point has moved farther.
- Due to this, the **image of nearby objects** are formed **behind the retina.**
- This defect can be **corrected using a convex lens.**



(a) Hypermeteropia (b) Hypermeteropia corrected eye

VIII. Numerical Problems:

1. The focal length of the concave lens is 7 m. Calculate the power of lens.

Solution:

Given: $f = -7$ m

Formula used:

$$\text{Power of lens} = \frac{1}{f}$$

$$\text{Power of lens} = \frac{1}{f} = \frac{1}{-7}$$

P = –0.14 dioptre

2. A light ray enter into the medium 'A' its angle of incident is 45° then enters into medium 'B' angle of refraction is 30°. Find the refraction index. ★

Solution:

Given: Incident ray (i) = 45°

Refraction ray (r) = 30°

According to snells law

Formula used:

snell's law

$$\mu = \frac{\sin i}{\sin r}$$

$$\mu = \frac{\sin i}{\sin r}$$

$$= \frac{\sin 45°}{\sin 30°} = \frac{1/\sqrt{2}}{1/2} = \frac{1}{\sqrt{2}} \times \frac{2}{1} = \sqrt{2}$$

$$\mu = 1.414$$

Refractive index = 1.414

3. A person with hypermeteropia eye can see object beyond the distance 20 m. suppose he went to see the closer object at 1.5 m. Find the focal length and power of the convex lens he must wear.

Solution:

Given: d = 20 m, D = 1.5 m

Formula used:

focal length $f = \frac{dD}{d-D}$

Power of lens $= \frac{1}{f}$

According to the formula $f = \frac{dD}{d-D}$

$$f = \frac{20 \times 1.5}{20 - 1.5} = \frac{30}{18.5} = 23.2$$

Power of correction lens $= \frac{1}{f} = \frac{1}{23.2}$ = **0.04 dioptre**

Time : 1 hr Marks : 30

Unit Test - 2

Optics

Time : 1 hr Marks : 30

I. Choose the most suitable answer and write the code with the corresponding answer. 5 × 1 = 5

1. 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

2. In a myopic eye, the image of the object is formed
   a) behind the retina b) on the retina
   c) infront of the retina d) on the blind spot

3. When an object is placed in _____ the collected image size is bigger than that of an object.
   a) at infinity b) behind centre of curvature
   c) at the centre of curvature
   d) between the centre of curvature and principal focus

4. _____ can be corrected by bifocal lenses.
   a) Myopia b) Hypermetropia
   c) Presbyopia d) Astigmatism

5. An _____ telescope is used to view heavenly bodies like stars and planets.
   a) refracting b) astronomical
   c) terrestrial d) galilean

II. Answer the following questions in one or two lines. 5 × 2 = 10

1. State Snell's law.
2. Define power of lens. Give its unit.
3. What is Astigmatism?
4. List the uses of simple microscope.
5. Define refraction.

III. Answer the fllowing questions in brief: 2 × 4 = 8

1. Differentiate convex lens and concave lens.
2. i) What is Astigmatism?
   ii) State Rayleigh's law of scattering.

IV. Answer the fllowing questions in detail: 1 × 7 = 7

1. i) Explain the construction and working of a 'Compound Microscope'.
   ii) An object is placed at a distance 20cm from a convex lens of focal length 10cm. Find the image distance and nature of the image.