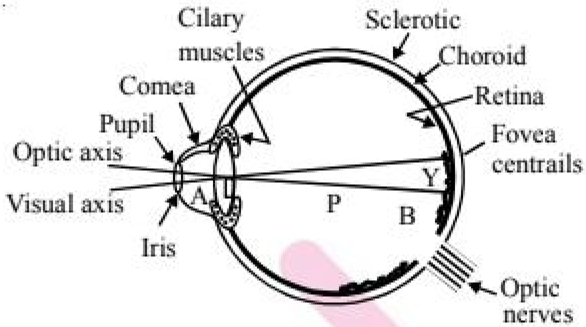
OPTICAL INSTRUMENTS

1. Human Eye

- **Introduction :** It is the most delicate and complicated natural optical instrument.
- **Diagram**



- **Construction :** Diagram shows the section of a human eye by a horizontal plane. It is a spherical ball of diameter about 2.5 cm. Its essential parts are described below :

➤ **Sclerotic :** It is the outermost coating of the eye ball. It is tough, hite and opaque and forms **white** of the eye. It keeps eye ball in spherical shape and protects it from shocks and injury. It becomes transparent at the front projected part of eye ball, called **cornea.**

➤ **Choroid :** It is the second coat under the sclerotic. It is a black membrane and forms black of the eye. Its function is to keep interior of the eye dark by absorbing diffused light falling on it. It forms coloured protion, called **iris**, behind the cornea.

➤ **Retina :** It forms innermost coat in the interior of the eye. It consists of a thin membrane which is rich in nerve fibres, containing two kinds of vision cells called **rods** and **cones** and blood vessels. It is sensitive to light, for it is a continuation of the optic nerves. It serves the purpose of a sensitive screen for the reception of the image formed by the lens system of the eye.

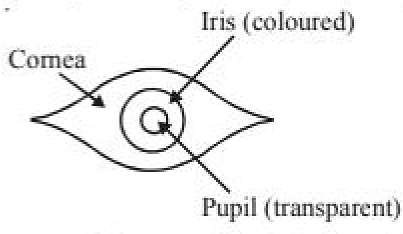
[The **rods** are responsible for vision in dim light (**Scotopic vision)**. The **cones** are responsible for vision under ordinary day light (**Photopic vision)**.

The retina posseses following two important spots :

(a) **Yellow spot :** The yellow spot Y. It is situated at the centre of the retina. It is a slightly raised spot with a minute depression in its peak. It is yellow in colour and most sensitive to light. The central region of the yellow spot is called the **fovea centralis.**

(b) **Blind spot :** The blind spot B. It is the spot where the optic nerves enter the eye. It is also slightly raised and insensitive to light, because it is not covered with choroid and retina.

➤ **Cornea :** It is the front buldged out part of eye ball covered by transparent sclerotic.



Cornea of the eye-front view.

➤ **Iris :** It is the coloured region under cornea formed by choroid. Its colour differs from person to person and country to country. It is this colour which is given to the eye of a person.

➤ **Pupil :** It is central circular aperture in the iris. Its normal diameter is **1 mm** but it can contract in excess light and expand in dim light, by means of two sets of involuntary muscular fibres.

- **Crystalline lens :** It is a double convex lens L immediately behind iris. Its back (inner) surface is more convex (R_2 = 6mm) than front (outer) surface (R_1 = 10 mm). This is made of transparent concentric layers whose optical density increases towards the centre of the lens. The average refractive index of crystalline lens is 1.437.

  The crystalline lens divides the interior of the eye ball into two spaces called **chambers.** The front chamber (towards cornea), is called the **anterior chamber** (A). The back chamber (towards retina) is called the **posterior chamber (P).**

- **Ciliary muscles :** The lense is connected of the sclerotic by the **ciliary muscles.** These muscles change thickness of the lense by relaxing and exerting pressure. The lens thickness is minimum (3.6 mm) when muscles are relaxed. The thickness becomes maximum (4 mm), when muscles exert maximum pressure (within elastic limit).

- **Aqueous humour :** Anterior chamber is filled with a transparent liquid of refractive index. The liquid is called the aqueous humour.

- **Vitreous humouf :** Posterior chamber is filled with a transparent watery liquid with little common salt having some refractive index. The liquid is called the vitreous humour.

- **Optic axis :** The straight line passing through the centre of the cornea and the lens, is called optic axis of the eye.

- **Visual axis :** The line passing through centre of the lens and fovea centralise is called visual axis of the eye. When an object is to be seen more minutely, it is brought on the visual axis to get its image on yellow spot which is most sensitive part of the retina.

- **Working (Action of the eye) :** The cornea and the aqueous humour both having same refractive index, form a single homogeneous medium. Rays of light entering the eye suffer **first** refraction in this region.

  The crystalline lens of mean refractive index. produces **second** refraction. The vitreous humour of refrative index produces third refraction.

  After these three refractions, light rays fall on retina forming a real and inverted image of object seen. The sensation produced on the eye is communicated to the brain by the optic nerves. The brain interprets this inverted image as erect.

- **Focussing by eye lens :** When seeing objects at infinity, ciliary muscles are perfectly relaxed and lens has least thickness of 3.6 mm. The image is formed at retina. The eye has its **far point (F)** at infinity.

  As object to be seen becomes nearer and nearer (**u** decreases), lens focal length must decreases (because v – distance between lens and retina – is constant). For this ciliary muscles exert pressure on lens and make it thick. The maximum, thickness of the eye lens may be **4 mm** for which muscles exert maximum pressure. This happens when object distance is **15 cm.** Hence a normal eye has it **near point (N)** at distance of 15 cm.

  The distance between the near point and the far point is called **range of vision** of the eye. Within the range of vision, there is one point where object placed are most distinctly visible. The distance of this point, from the eye, is called **least distance of distinct vision.** For normal eye this least distance is **25 cm.**

  The power (ability) of the eye to change the focal length of the eye lens with the change in the distance of the object, is called power of **accommodation** of the eye.

- **Power of accommodation :** (Range of variation of power) the power of accommodation is 4 dioptres.

  It is **proved** below.

  For object at far point. u_f = (infinite).

  For object at near point. $u_n = -25$ cm $= -0.25$ m.

  In both cases, image distance,

$$v = +2.5 \text{ cm} + 0.025 \text{ m}$$

($\because$ Diameter of eye ball is 2.5 cm)

From relation, $P(D) = \frac{1}{f(m)} = \frac{1}{u(m)} - \frac{1}{v(m)}$

$$P_f = \frac{1}{f_f} = \frac{1}{v} - \frac{1}{u_f} = \frac{1}{0.025} - \frac{1}{\infty} = 40 + 0$$

i.e., $P_f = 40D$.

For object at near point,

$$P_n = \frac{1}{f_n} = \frac{1}{v} - \frac{1}{u_n} = \frac{1}{0.025} - \frac{1}{-0.25} = 40 + 4$$

i.e., $P_n = 44$ D.

Power of accommodation(i.e., range of variation of power of eye lens),

$$P_A = P_n - P_f = 44 - 40 = 4$$

Power of accommodation,

$$\mathbf{P_A = 4D}.$$

2. Defects of vision, symptoms and remedy (correction)

- **Defects of Vision**

  The major **defects** of vision are :

1. Short sightedness or myopia.
2. Long sightedness or hypermetropia.

   The minor defects of vision are :

   (a) Presbyopia.

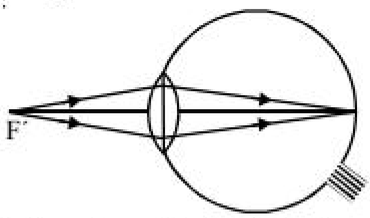
   (b) Astigmatism.

   (c) Phorias.

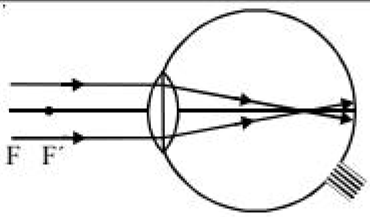
1. Short sightendness or myopia

➤ **Symptoms :** This defect is a born defect. With this defect, the eye can see near very clearly and distinctly, but distance objects ae not clearly visible. The defective eye cannot see clearly **beyond** a certain distance. It means that the far point of the defective eye has shifted from infinity to a finite distance ahead.

➤ **Reasons :** It is so because the image of distant objects is formed in front of the retina. It is shown in fig.



(a) seeing objects at its far point F′



(b) seeing objects at normal eye far point F

Fig. Myopic eye vision.

➤ **Causes :** It may be due to any one or both of the following two factors.

(i) The lens may be **thicker** (more converging) that the normal eye lens.

(ii) The eye ball may be **elongnated,** as shown in fig. Due to elongation, distance between lens and retina becomes more than that for normal eye.

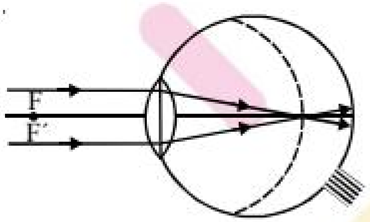


Fig. Elongated eye.

➤ **Correction :** The extra converging power of eye lens in compensated by using a concave (diverging) lens of proper power (focal length) as shown in fig.

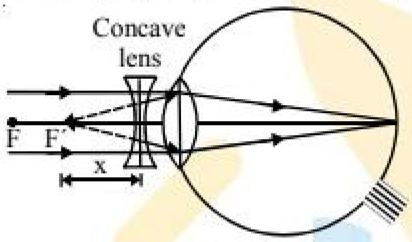


Fig. Myopia corrected by a concave lens

➤ **Explanation :** The cocave lens kept just in front of the eye, receives distant parallel rays and diverges them. On eye lens the rays fall as if coming from far point F' of the defective eye. The eye lens focusses them at retina. In a way, the concave lens used makes a virtual image of distant (out of range) object within range of vision.

➤ **Calculation :** Let distance of far point F' from eye = x. Then for lens to be used, u = ∝, ν = –x, f = ?

From lens formula,

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

$$\frac{1}{-x}=\frac{1}{f}$$

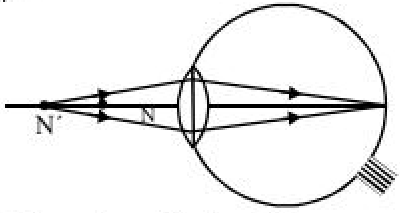
or $$\mathbf{f = -x}$$

The lens used must have focal length equal to the distance of the far point from the eye (–ve sign means concave lens).

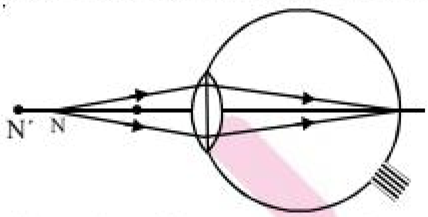
2. **Long sightedness or hypermetropia**

➤ **Symptoms :** This defect is a born defect. With this defect, the eye can see distant objects very clearly and distinctly, but near objects are not clearly visible. The defective eye cannot see clearly within a certain distance. It means that the near point of the defective eye has shifted from 25 cm to some more distance behind (away).

➤ **Reason :** It is so because the image of near objects is formed behind the retina. It is shown in fig.



(a) seeing objects at its near point N'



(b) seeing objects at normal eye near point N

Fig : Hypermetropic eye vision.

➤ **Causes :** It may be due to any one or both of the following two factors :

(i) The eye lens may be **thinner** (less converging) than the normal eye lens.

(ii) The eye ball may be **oval** as shown in fig. Due to oval shape, distance between lens and retina becomes less than that for normal eye.

➤ **Correction.** The deficiency in converging power of eye lens is compensated by using a convex (Converging) lens of proper power (focal length) as shown in fig.

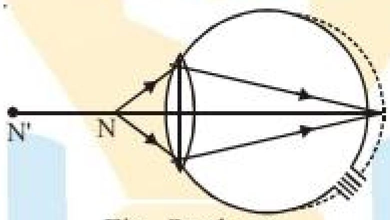


Fig. Oval eye.

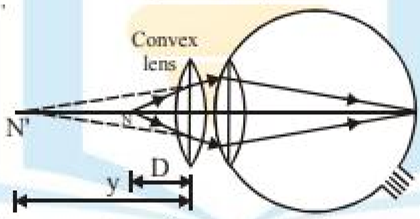


Fig : Hypermetropia corrected by a convex lens.

➤ **Calculation :** Let distance of near point N' from eye = y. Then, for lens to be used u = –D, v = –y, f = ?

From lens formula,

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

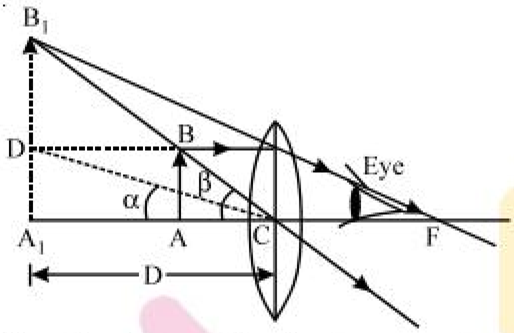
$$\frac{1}{-y}-\frac{1}{-D}=\frac{1}{f}$$

$$f=\frac{yD}{y-D} \text{ (which is positive } \because \text{ y > D)}$$

This is required expression for the focal length of the convex lens to be used.

3. Simple microscope (simple magnifier)

- **Principle :** A normal eye cannot see clearly the object lying nearer than 25 cm (least distance of distinct vision) from the eye. A single convex lens helps the eye in seeing the objects from much closer distances. It produces linear magnification by increasing the visual angle.
- **Diagram.**



- **Construction :** It is a single convex lens, held in a rim with a handle. It is also called a magnifying lens or a reading lens.
- **Working :** An object AB, very close to eye, is seen by putting convex lens between eye and the object. The lens makes its virtual image A_1B_1 at the least distance of distinct vision (D). Eye sees the object through its virtual image.
- **Calculation :** Object AB or image A_1B_1 subtend angle β at the eye. For seeing the object directly it must be in position A_1D subtending angle α.

By definition magnifing power of visual optical instrument.

$$M = \frac{\text{size of image seen through the instrument}}{\text{size of object seen directly}}$$

When both are at same distance from the eye.

$$\text{Hence, } M = \frac{A_1B_1}{A_1D} = \frac{A_1B_2}{AB} = \frac{A_1C}{AC} = \frac{-v}{-u} = \frac{v}{u}$$

(For image on same side as object, v is –ve)

From lens formula, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

As v is –ve, $\frac{1}{-v} - \frac{1}{u} = \frac{1}{f}$ or $-1 - \frac{v}{u} = \frac{v}{f}$

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

i.e., $M = -\left(1+\frac{D}{f}\right)$

But here, $v = D$

Hence, $M = -\left(1+\frac{D}{f}\right)$

Negative M means that image is virtual.

In practice

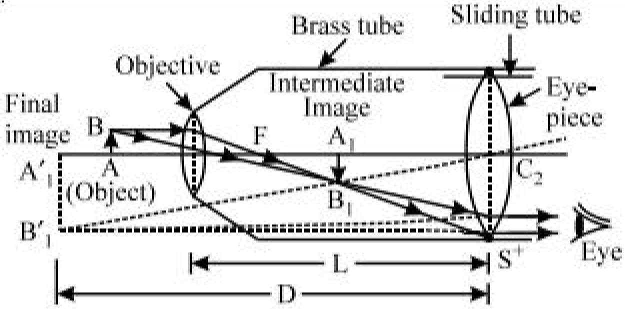
$v = D$

$v = f$

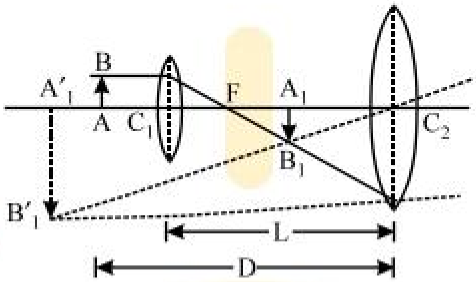
Hence $m = -\frac{v}{u} = -\frac{D}{f}$

4. Compound Microscope

- **Diagram :**



Compound Microscope



Compound microscope (Simple sketch diagram)

- **Construction :** It consists of two convex lenses (each an achromatic doublet). One convex lens of small focal length f_0 and small aperture is fitted at one end of a brass tube. This lens is near the object to be seen, hence it is called objective.

  The second convex lens of more focal length f_e and large aperture is fitted in a sliding tube. This tube can be moved in and out at other end of the brass tube by a screw S. This lens is near the eye, hence it is called eyepiece.

- **Calculation :** Magnifying power of compound microscope

  = magnifying power of objective × magnifying power of eyepiece

  i.e., $$M = m_0 \times m_e$$

  But $$m_0 = \frac{v_0}{u_0} = \frac{C_1A_1}{C_1A} = \frac{C_1C_2}{f_0} = \frac{L}{f_0}$$

  and $$m_0 = -\left(1+\frac{D}{f_e}\right) = -\frac{D}{f_e}$$

  Hence, $$M = m_0 \times m_e$$

  $$\boxed{M = -\frac{L}{f_0} \cdot \frac{D}{f_e}}$$

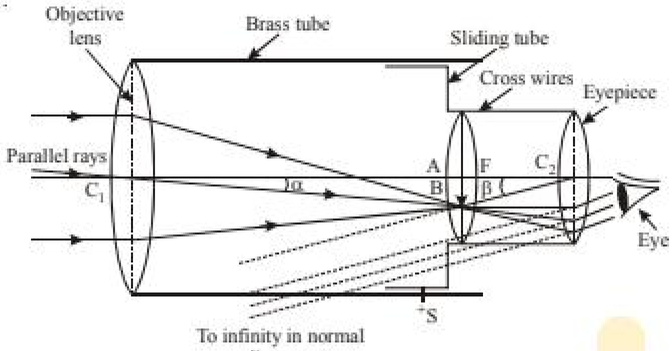
- **Merits :**

  (i) It has more magnifying power (about 200).

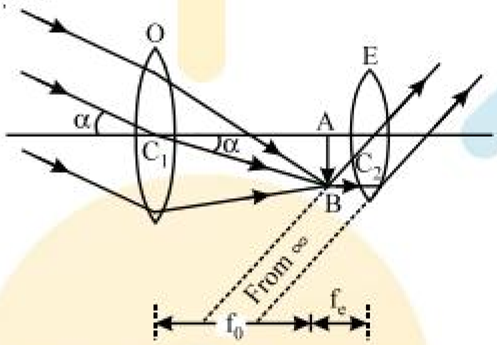
  (ii) It is free from effect of lens aberrations.

5. Astonomical telescope

➤ **Diagram :**



Astronomical telescope (Normal adustment)



Astronomical telescope (Normal adjustment) simple diagram.

➤ **Construction :** It consists of two convex lenses (each an achromatic doublet). One convex lens of large focal length f_0 and large aperture is fitted at one and end of a brass tube. This lens is towards the object to be seen, hence it is called objective.

The second convex lens of less focal length f_e and small aperture is fitted in a sliding tube. This tube can be moved in and out at the other end of the brass tube by a screw S. This lens is near the eye, hence it is called eyepiece. Two perpendicular thin wires **(cross wires)** are fixed in sliding tube in front of eyepiece at distance f_e.

Both lenses have a common axis, called axis of telescope.

➤ **Working :** The object at infinity sends parallel rays inclined to telescope axis. The objective forms its real inverted image AB at its focus F.

The eyepiece is moved inward to bring cross wires at image AB. The image comes at focus of the eyepiece. Final image is made at infinity. It is virtual, inverted and much enlarged. Since eye seeing the final image at infinity is normal, this adjustment of telescope is called normal adjustment.

The distance C_1C_2 between the objective and the eyepiece is called length of the telescope and is represented by L.

Since final image is inverted, the telescope cannot be used for seeing terrestrial objects (objects on earth) which have shape. It is used for seeing celestral heavenly objects which have no shape. Hence, it is called **Astronomical Telescope**.

➤ **Calculation :** Let the object subtend an angle α on the objective. Same can be taken as the angle subtended at the eye, only a few cm behind.

Let the image subtends an angle β on the eyepiece. Same is taken as the angle subtended at the eye just behind.

By definition,

Magnifying power

$$= \frac{\text{size of image at infinity seen by telescope}}{\text{size of object at infinity seen by eye}}$$

$$M = \frac{\text{tangent of visual angle of image}}{\text{tangent of visual angle of object}}$$

$$= \frac{\tan\beta}{\tan\alpha} = \frac{AB/AC_2 \text{ in } \Delta AC_2B}{AB/AC_1 \text{ in } \Delta AC_1B} [\because \text{A is at F}]$$

$$= \frac{AC_1}{AC_2} = \frac{FC_1}{FC_2}$$

or $\boxed{M = \frac{f_0}{f_e}}$

Also as $C_1C_2 = C_1F + FC_2$

Length of telescope,

$\boxed{L = f_0 + f_e}$

- **Merits:** It has a large field of view, because it uses a converging (convex) lens as eyepiece.
- **Demerits :**

(i) It makes final image inverted. hence not suitable for seeing terrestrial object which have shapes.

(ii) It has more length.

6. Dispersion of white light by a glass prism

- **Definition :** When a ray of white light (sunlight) enters a glass prism (denser medium). It emerges out from it broken into seven colours.

  This phenomenon, due to which different components of a white light are separated by a denser medium, is called dispersion (separation).

- **Explanation :** It is due to different velocities of different components of white light in the denser medium.

  White light has seven colours, namely, violet indigo, blue, green, yellow, orange and red (remembered by the word **VIBGYOR**). In air (strictly in vacuum) light waves of all colours have same velocity (3×10^8 m/s).

  But in a denser medium, their velocities become less and different. Red light waves, being longest in length, travel fastest and have maximum velocity. Violet light waves, being shortest in length, travel slowest and have minimum velocity in the denser medium.

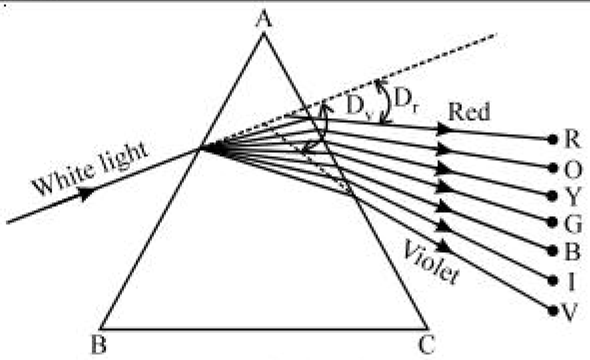
  The refractive index (μ)of a medium for a wave is given by the relation.

$$\mu = \frac{\text{Velocity of wave in air (or vacuum)}}{\text{Velocity of wave in the medium}} = \frac{c}{v}$$

(Wave nature of light)

Since v is maximum for red light waves and minimum for violet light waves. μ is minimum for red light and maximum for violet light.

The prism produces deviation (change in direction) in a light wave. The angle of deviation 'D' produced by a prism of angle 'A' is given by $D = (\mu - 1) A$. Red light waves suffer least deviation, whereas violet light waves suffer maximum deviation. [Fig.]



Dispersion of white light
by a glass prism

Due to difference in deviation, waves of different colours emerge out from the prism indifferent directions and are said to have been dispersed (separated).

When the dispersed white light is made to fall on a white screen, we get a seven coloured band or light. This coloured band is called spectrum.

7. Colours Theory

❑ Colours

- **Primary Colours :** Red green and blue colours are called primary (of basic or elementary) colours. All the other colours can be obtained by mixing these three colours in suitable proportion.
- **Compound Colours :** Mixture of two primary colours forms compound colours.

  They are :

(i) Yellow is mixture of red and green.

(ii) Peacock blue (cyan) is mixture of green and blue.

(iii) Magenta is mixture of red and blue.

- **Complimentary Colours :** Colours whose mixture forms a white colour, are called complementary colours. They are -

(i) Red, green and blue

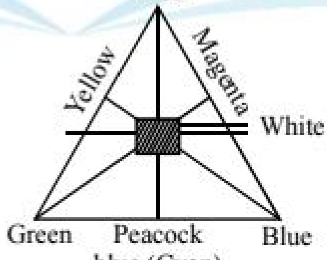
(ii) Red and peacock blue (cyan)

(iii) Green and magenta

(iv) Blue and yellow

❑ Colour triangle

- **Introduction :** It helps in identifying different colour combinations.



Colour triangle

- **Description :**

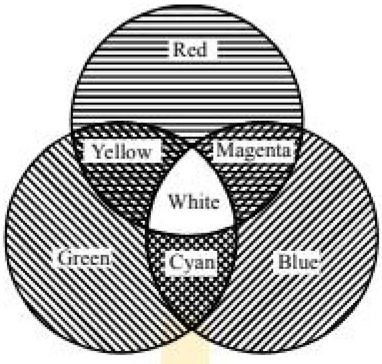
  Red, green and blue at the vertex of the triangle are the primary (or elementary or basic) colours.

  Colours represented bythe sides are compound colours.

  Red, green and blue together form a white colour. They are the complemetnary colours.

  Also pair of colours represented by vertex and oppostie side become complementary colours.

➤ **Colour Circles :** Various colour combinations can also be shown through colour circles as given below fig.



Colour circles
Primary colours—red, green and blue
Compound colours—yellow, cyan and magenta

❑ **Colour of Non-Luminous objects**

1. Colour of Transparent Non-luminous Objects

➤ **Rule :** Colour of a transparent object depends upon the colour of light transmitted through it and falling on the eye. If no colour light is tranmitted through an object, the object appears black. (Black is no colour, it is absence of colour)

➤ **Examples :**

(i) A red glass piece appears deep red in red light because it transmits through it the red light of the source which illuminates it.

(ii) A red glass piece appears light red in white light because it transmits only red light through it and absorbs all other colours of white light.

(iii) A red glass piece appears dark in light that does not contain red light component.

(A red coloured glass appears dark in mercury-tube light because it contains no red light component.)

2. Colours of Opaque Non-luminous Objects

➤ **Rule :** Colour of an opaque object depends upon the colour of light diffusely reflected by it and falling on the eye. If no colour light is diffusely reflected by an object, the object appears black.

➤ **Examples :**

(i) A red rose appears deep red in red light because it diffusely reflects from it the red light of the source which illuminates it.

(ii) A red rose appears light red in white light because it diffusely reflects only red light from it and absorbs all other colours of white light.

(iii) A red rose appears dark in light that does not contain red light component. (A red coloured cloth appears dark in mercury-tube light because it contains no red light compnent.)

❑ **Colour of Pigments**

➤ A pigment can be minerals, vegetable, animal of synthetic origin.

➤ They are colouring material of parmament nature.

➤ The subtractive method is used in mixing of pigments of produce various coloured points.

➤ Nauter, yellow and cyan are three subtractive primary colours of pigment they are reffured as
Red ← Magneta = Red + Blue
Yellow ← Yellow = Red + Green
Blue ← Cyan = Blue + Green

SOLVED EXAMPLES

Ex.1 A person cannot see objects lying beyond 2.5 m from the eye. Calculate the power of the corrective lens he should use.

Sol. Since he cannot see the objects lying beyond 2.5 m, he is suffering from myopia. The corretive lens he should use is a concave lens of focal length, f = –2.5 m.

$\therefore$ Power of the lens $= -\frac{1}{f} = -\frac{1}{2.5} = -0.4D$

Ex.2 A person cannot see objects closer than 75 cm from the eye. Calculate the power of the corrected lens should he use.

Sol. Since the person cannot objects lying closer than 75 cm, he suffers from hypermetropia. His near point has shifted from 25 cm to 75 cm. The focal length of the corrective lens can be calculated by considering u = –25 cm, v = – 75 cm, f = ?

Now, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{-75} - \frac{1}{-25}$

or $\frac{1}{f} = \frac{2}{75}$ or $f = \frac{75}{2}$ cm $= \frac{0.75}{2}$ m

$\therefore$ Power $= \frac{1}{f} = \frac{2}{0.75} D = +\frac{8}{3} D = 2.66D$

Ex.3 The far point of a myopic person is 80 cm in front of the eye. What is the nature and power of the lens required to enable him to see very disant objects distinctly?

Sol. Since the person suffers from myopia, concave lens of focal length 80 cm = –0.80 m should be used.

$\therefore$ $P = \frac{1}{-0.80} = -1.25D$

Ex.4 A compound microscope has an objective of foal length 1 cm and an eyepice of focal length 4 cm. If tube length is 20 cm, calculate the magnification of the compound microscope.

Sol. Magnifying power of a compound microscope is given by

$M = \frac{L}{f_0} \times \frac{D}{f_e}$

Here, L = 20 cm, $f_0 = 1$, $f_e = 4$ cm, D = 25 cm

$\therefore$ $M = \frac{20}{1} \times \frac{25}{4} = 125.$

Ex.5 A stamp collector uses a convex lens with a focal length of 6.2 cm to examine a stamp.What is the magnification produced by teh convex lens? Take the least distance of distinct vision as 25 cm.

Sol. The magnification produced by a simple magnifier is given by

$M = 1 + \frac{D}{f}$

Here, D = 25 cm, f = 6.2

$\therefore$ $M = 1 + \frac{25}{6.2} = 1 + 4.03 = 5.03$

Ex.6 A compound microscope has an objective of focal length 0.5 cm and a tube length of 20 cm. If it produces a magnification of 250, calculate the focal length of the eyepiece.

Sol. The magnification, $M = \frac{L}{f_0} \times \frac{D}{f_e}$

Here, $L = 20$ cm, $f_0 = 0.5$ cm, $D = 25$ cm, $M = 250$.

$\therefore \quad 250 = \frac{20}{0.5} \times \frac{25}{f_e}$

or $\quad f_e = 4\text{cm}$

Ex.7 A telescope has an objective of focal length 140 cm and an eyepiece of focal length 5 cm. Calculate the magnification of the telescope for viewing distant objects for normal adjustment and the separation between the objective lens and the eyepiece.

Sol. If f_0 is the focal length of the objective and f_e is the focal length of the eyepiece, then magnification of a telescope for normal adjustment is given by

$$M = \frac{f_0}{f_e} = \frac{140}{5} = 28$$

Length of the telescope, $L = f_0 + f_e = 140 + 5$

$= 145$ cm

Ex.8 The objective of a telescope has a focal length of 200 cm and the eyepiece has a focal length of 2 cm. Calculate the magnification and tube length of this telescope for normal adjustment.

Sol. For the normal adjustment the magnification of telescope is

$$M = \frac{f_0}{f_e} = \frac{200}{2} = 100$$

Length of the telescope,

$$L = f_0 + f_e = 200 + 2 = 202 \text{ cm}$$

Ex.9 The far point of a person suffering from myopia is 2 m from the eye. Calculate the focal length and the power of the corrective lens.

Sol. The far point lies at 2 m. Therefore, a concave lens of focal length 2 m should be used so that the objects lying at infinity can be focussed at the far point.

$\therefore$ For corrective lens, focal length, $f = -2$ m

$\therefore$ Power, $\quad P = \frac{1}{-2} = -0.5\text{D}$

Ex.10 The near point of an elderly person lies at 50 cm from the eye. Calculate the focal length and power of the corrective lens.

Sol. The person suffers from hypermetropia. His near point lies at 50 cm. Therefore, a convex lens should be used for the correction of his vision. The focal length of the corrective lens is calculated by

$$\frac{1}{-25} - \frac{1}{-50} = \frac{1}{f}$$

or $\quad \frac{1}{f} = \frac{1}{50}$

or $\quad f = 50 \text{ cm} = 0.5 \text{ m}$

∴ Power of the corrective lens,

$$P = \frac{1}{f} = \frac{1}{0.5} = +2D$$

Ex.11 The lens of a simple magnifier has a focal length of 2.5 cm. Calculate the angular magnification produced when the image is at D and at infinity.

Sol. When the image s formed at D, the least distance of distinct vision, the angular magnification is

$$M = 1 + \frac{D}{f} = 1 + \frac{25}{2.5} = 11$$

When the final image is at infinity, the angular magnification is

$$M = \frac{D}{f} = \frac{25}{2.5} = 10$$

Ex.12 The convex lens used in a simple microscope produces a magnification of 5. The image is formed at the least distance of distinct vision. Calculate the focal length of the lens.

Sol. When the image is formed at least distance of vision, the angular magnification is

$$M = 1 + \frac{D}{f}$$

or $5 = 1 + \frac{25}{1}$

or $4 = \frac{25}{f}$

or $f = \frac{25}{4} = 6.25 \text{ cm}$

Ex.13 A 12 cm long microscope has an objective of focal length 1 cm and eyepiece of focal length 4 cm. What is the magnification for normal adjustment?

Sol. For the normal adjustment, the magnification of the compound microscope is

$$M = \frac{L}{f_0} \times \frac{D}{f_e}$$

Here, L = 12 cm, f_0 = 1 cm, f_e = 4 cm, D = 25 cm

∴ $M = \frac{12}{1} \times \frac{25}{4} = 75$

Ex.14 An astronomical telescope has an objective of length 40 cm and eyepiece of focal length 2 cm. Calculate the magnifying power and length of the telescope.

Sol. Magnifying power of telescope,

$$M = \frac{f_0}{f_e} = \frac{40}{2} = 20$$

Length of telescope, $L = f_0 + f_e = 40 + 2 = 42$ cm

Ex.15 A telescope is set for normal adjustment. It has magnifying power 16 and length 85 cm. Calculate the focal length of the objective and eyepiece.

Sol. Magnifying power, $M = \frac{f_0}{f_e} = 16$ ...(1)

Length, $L = f_0 + f_e = 85$ ...(2)

From equation (1), $f_0 = 1 + f_e$

Equation (2) gives

$$16 f_e + f_e = 85 \text{ or } f_e = 5 \text{ cm}$$

$$\therefore \quad f_0 = 5 \times 10 = 80 \text{ cm.}$$

- **Important points to be remember**

- **Cornea :** A transparent spherical membrane which refracts light into the eye is called cornea.
- **Iris :** A dark muscular diaphragm that controls the size of the pupil is called iris.
- **Pupil :** A small circular opening in the centre of the iris is called pupil. Pupil appears black because no light if reflected from it.
- **Eye lens :** A converging lens made of a transparent jelly-like proteinaceous material behind the pupil is called the eye lens.
- **Retina :** The inside surface of the real (back) part of the eye ball where the light which enters the eye is focussed is called retina. The surface of the retina consists of about 125 million light-sensitive receptors. These receptors are called **rods** and **cones**. The rods are sensitive to the intensity of light, while cones are sensitive to the colour of light.
- **Colour blindness :** It is a defect of the eye due to which person is not able to distinguish between certain colours. Colour blindness is a g enetic disorder.
- **Near point :** The nearest point up to which an eye can see clearly is called its near point
- **Far point :** The farthest point up to which an eye can see clearly is called its far point. For a normal eye, the far point is at infinity.
- **Least distance of distinct vision :** The minimum distance up to which an eye can see clearly is called the least distance of distinct vision.

  For a normal eye of an adult, the least distance of distinct vision in 25 cm.
- **Accommodation power of the eye :** The property due to which the eye lens is able to change its focal length is called accommodation of the eye. When the eye is focussed on any distant object, the ciliary muscle is most tense (strained).
- **Myopia (shortsightedness) :** The defect on eye due to which eye is not able to see the distant objects clearly though it can see the nearby objects clearly is called myopia or shorsightedness.

  Myopia is caused by a decrease in the focal length of the eye lens. It can be corrected by using spectacles made from concave lenses of suitable focal length.
- **Hypermetropia (Iongsightedness) :** The defect of the eye due to which eyes is not able to see clearly the nearby objects through it can see the distant objects clearly is called hypermetropia or longsightedness. Hypermetropia (longsightedness) is caused by an increase in the focal length of the eye lens. It can be corrected by using spectacles made from convex lenses of suitable focal lengths.
- **Astigmatism :** The defect of the eye due to which the rays of light coming from the horizontal and vertical planes of an object do not come to focus at the same point is called astigmatism. Astigmatism occurs when the cornea or the eye lens or both are not perfectly spherical. This can be corrected by using cylindrical lenses.
- **Dispersion of white light :** The process of splitting white light into its seven constituent colours is called dispersion of white light. The band of seven colours is called spectrum of visible light.

  Rainbows are formed due to the dispersion of white light by small droplets of water hanging in the air after the rain.
- **Rainbow :** Rainbow is a band of seven colours across the sky produced due to the dispersion of white light by small raindrops hanging in the air after the rain.

- **Atmospheric refraction :** The optical density of our atmosphere decreases with altitude. Thus a ray of light entering any layer of the atmosphere suffers refraction as it travels through the other layers. This is called atmospheric refraction. Many interesting natural phenomena occur due to atmospheric refraction.
- **Scattering of light :** The earth's atmosphere consists of gases, and many different kinds of particulate matter. When light falls on such particles, it get scattered in all direction. Smaller particles scatter blue light to a larger extent than the red light.

  Larger particles scatter light of longer wavelengths, such as orange/red. In the case of very larger particles, the scattered light appears white.

EXERCISE - 1

A. VERY SHORT ANSWER TYPE QUESTIONS.

Q.1 Define the range of vision of a normal eye.

Q.2 Define the magnitude of the least distance of distinct vision.

Q.3 Explain the magnitude of near point and far point of a normal eye.

Q.4 Give the phenomenon on which the working of an eye lens depend.

Q.5 What kind of lens is present in the human eye?

Q.6 Give the usual name of (i) the screen on which the image if formed in the eye, (ii) the part which controls the amount of light entering the eye.

Q.7 Name four common defects of the eye.

Q.8 What kind of lens should a person suffering from myopia and hypermetropia use?

Q.9 A child sitting in a classroom on the back seat is not able to view what is written on blackboard. What defect of vision does he suffer from? What types of lens should be provided to him to correct the defect?

Q.10 The spectacles of a person have concave lenses. Which defect of vision is he suffering from?

Q.11 Which defect of vision is corrected by using a convex lens?

Q.12 Whice defect of vision is corrected by using cylindrical lens?

Q.13 Which type of retinal cells respond to the intensity of light?

Q.14 Which type of retinal cells respond to colours?

Q.15 Which type of lens is used as a simple microscope?

Q.16 Which of the two will produce a greater magnification —a convex lens so as to use it as a simple microscope?

Q.17 Where should an object be placed in front of a convex lens so as to use it as a simple microscope?

Q.18 Write down the expression for the magnification produced by a simple microscope.

Q.19 In a compound microscope, which lens has a smaller focal length.

Q.20 In a compound microscope, which lens has a smaller aperture?

Q.21 In an astronomical telescope, which lens has a smaller focal length?

Q.22 In an astronomical telescope, which lens has a small aperture?

Q.23 Two convex lenses of focal lengths 2 cm and 50 cm are given. Which lens will you use for the objective of an astronomical telescope and which lens for the eyepiece?

Q.24 What type of final image is obtained in a compound microscope?

Q.25 What type of final image is formed in an astromical telescope?

B. SHORT ANSWER TYPE QUESTIONS

Q.1 Draw a well-labelled diagram of the human eye.

Q.2 How does a normal eye view near as well as distant objects clearly?

Q.3 Explain the term least distance of distinct vision.

Q.4 Define the term power of accommodation of the eye. Explain the function of ciliary muscles.

Q.5 How does the human eye adjust itsself to varying intensities of light?

Q.6 When we enter a cinema hall from bright sunshine, we cannot see our surroundings. Explain why.

Q.7 What kind of lens is present in the human eye?

Q.8 What is meant by persistence of vision? How is this phenomenon utilized in cinematography?

Q.9 How do we see colours?

Q.10 What is meant by colour blindness? What kind of retinal cells are lacking in a person suffering from this defect?

Q.11 Hens can see in bright light but cannot see in dim light. Explain why. What type of retinal cells are lacking in their retina.

Q.12 Name the two types of light-sensitive cells on the retina of human eye. Which one of them responds to intensity of light and which responds to colour?

Q.13 Define blind spot and yellow spot of the eye.

Q.14 What is astigmatism? How is it corrected?

Q.15 Why does an object look smaller when it is placed at a longer distance from the eye than when it is near to the eye?

Q.16 What do you understand by angular magnification?

Q.17 What are the two common defects of eye? How are they corrected?

Q.18 Explain myopia with the help of a well-labelled diagram. How is it corrected by a lens?

Q.19 Explain hypermetropia with the help of a well-labelled diagram. How is it corrected by a lens?

Q.20 Define presbiopia. How is it corrected?

Q.21 Draw a ray diagram for a simple microscope.

Q.22 What type of lens is used in a magnifying glass? What should be the position of a stamp paper when viewed through a magnifying glass?

Q.23 Draw a ray diagram to show the function of a compound microscope.

Q.24 In a compound microscope which lens has a large aperture, objective or eyepiece?

Q.25 State the formula for magnification of a compound microscope.

Q.26 In a compound microscope where should the object be placed with respect to the objective lens? Also discuss where should the eyepiece be placed with respect to the first image.

Q.27 Draw a well-labelled diagram for the functioning of an astronomical telescope.

Q.28 State the formula for magnification of an astronomical telescope. Which lens should have a larger focal length—objective or eyepiece?

Q.29 Explain why the objective lens of a telescope is taken of larger aperture.

Q.30 What is a terrestrial telescope? Does it form an erect image or an inverted image?

C. LONG ANSWER TYPE QUESTIONS

Q.1 Describe the construction of the human eye with a well-labelled diagram. Explain the functioning of its various parts.

Q.2 Explain the power of accommodation of the eye.

Q.3 What are rods and cones? Define their roles.

Q.4 What do you understand by persistance of vision? Give their applications in theatre.

Q.5 What is myopia? How is it corrected?

Q.6 Define hypermetropia. How does it get corrected?

Q.7 Explain the working of a simple microscope.

Q.8 Explain the working of a compound microscope with the help of a ray diagram.

Q.9 Describe the construction and working of an astronomical telescope with the help of a ray diagram. Write the expression of magnification produced by an astronomical telescope for normal adjustment.

Q.10 Define the power of accommodation of the eye. Define near and far points of the eye.

D. MULTIPLE CHOICE QUESTIONS

Q.1 A presbyopic patient has near point as 30 cm and far point as 40 cm. The dioptric power for the corrective lens for seeing distant objects is–

(A) 40 D (B) 4 D

(C) –2.5 D (D) 0.25 D

Q.2 A person is suffering from myopic defect. He is able to see clear objects placed at 15 cm. What type and of what focal length of lens he should use to see clearly the object placed 60 cm away–

(A) Concave lens of 20 cm focal length

(B) Convex lens of 20 cm focal length

(C) Concave lens of 12 cm focal length

(D) Convex lens of 12 cm focal length

Q.3 A man is suffering from colour blindness for green colour. To remove this defect, he should use goggles of –

(A) Green colour glasses

(B) Red colour glasses

(C) Smoly colour glasses

(D) None of the above

Q.4 A short sighted person can see distinctly only those objects which lie between 10 cm and 100cm from him. The power of the spectacle lens required to see a distant object is –

(A) + 0.5 D (B) – 1.0 D

(C) – 10 D (D) + 4.0 D

Q.5 A man with defective eyes cannot see distinctly object at the distance more than 60 cm from his eyes. The power of the lens to be used will be–

(A) + 60 D (B) – 60 D

(C) – 1.66 D (D) $\frac{1}{1.66}$ D

Q.6 Two parallel pillars are 11 km away from an observer. The minimum distance between the pillars so that they can be seen separately will be–

(A) 3.2 m (B) 20.8 m

(C) 91.5 m (D) 183 m

Q.7 A person is suffering from the defect astigmatism. Its main reason is –

(A) Distance of the eye lens from retina is increased

(B) Distance of the eye lens from retina is decreased

(C) The cornea is not spherical

(D) Power of accommodation of the eye is decreased

Q.8 The human eye can focus objects at different distances by adjusting the focal length of the eye lens due to.

(A) persistence of vision

(B) near-sightedness

(C) accommodation

(D) far-sightedness

Q.9 A parallel beam of light falling on the eye gets focussed on the retina because of refractions at-

(A) the cornea

(B) the eye lens

(C) the aqueous humour

(D) various surface in the eye

Q.10 The human eye forms the image of an object at its-

(A) cornea (B) pupil

(C) iris (D) retina

Q.11 The least distance of vision for the normal vision is-

(A) 25 cm (B) 25 m

(C) 2.5 cm (D) 2.5 m

Q.12 The combination responsible for admitting different amounts of light into the eye is-

(A) ciliary muscles and the eye lens

(B) ciliary muscles and pupil

(C) iris and pupil

(D) cornea and pupil

Q.13 When the human eye is focussed on an object very far away, the focal length of the eyelens is-

(A) maximum

(B) minimum

(C) 25 cm

(D) half of its maximum focal length

Q.14 The muscles of the iris control the

(A) focal length of the eye lens

(B) opening of the pupil

(C) shape of the eye lens

(D) optic nerves

Q.15 The change in focal length of an eye lens to focus the image of objects at varying distances is done by the action of the

(A) pupil (B) retina

(C) ciliary muscles (D) blind spot

Q.16 The final image formed by a compound microscope is

(A) real and erect (B) virtual and erect

(C) real and inverted (D) virtual and inverted

Q.17 The final image formed by an astronomical telescope is.

(A) real and erect (B) virtual and erect

(C) real and inverted (D) virtual and inverted

Q.18 The optical instrument used to view near and tiny objects is called-

(A) microscope (B) telescope

(C) spectroscope (D) thermoscope

Q.19 The optical instrument used to view distant objects is called

(A) microscope (B) telescope

(C) spectroscope (D) spectrometer

Q.20 If f_0 is the focal length of the objective and f_e is the focal length of the eyepiece, the magnification produced by an astronomical for normal adjustment is-

(A) $f_0 \times f_e$ (B) $f_0 + f_e$ (C) $\frac{f_0}{f_e}$ (D) $\frac{f_0 f_e}{f_0 + f_e}$

Q.21 The length of an astronomical telescope for the normal adjustment is-

(A) $f_0 \times f_e$ (B) $f_0 + f_e$ (C) $\frac{f_0}{f_e}$ (D) $\frac{f_0 f_e}{f_0 + f_e}$

Q.22 The power of two convex lenses A and B are 8 diopters and 4 diopters respectively. If they are to be used as a simple microscope, the magnification of –

(A) B will be greater than A

(B) A will be greater than B

(C) The information is incomplete

(D) None of the above

Q.23 In order to increase the magnifying power of a compound microscope –

(A) The focal lengths of the objective and the eye piece should be small

(B) Objective should have small focal length and the eye piece large

(C) Both should have large focal lengths

(D) The objective should have large focal length and eye piece should have small

Q.24 The objective lens of a compound microscope produces magnification of 10. In order to get an overall magnification of 100 when image is formed at 25 cm the eye, the focal length of the eye lens should be –

(A) 4 cm (B) 10 cm (C) $\frac{25}{9}$ cm (D) 9 cm

Q.25 In a compound microscope, if the objective produces an image I_0 and the eye piece produces an image I_e, then –

(A) I_0 is virtual but I_e is real

(B) I_0 is real but I_e is virtual

(C) I_0 and I_e are both real

(D) I_0 and I_e are both virtual

Q.26 In a compound microscope, the focal lengths of two lenses are 1.5 cm and 6.25 cm an object is placed at 2cm form objective and the final image is formed at 25 cm from eye lens. The distance between the two lenses is –

(A) 6.00 cm (B) 7.75 cm

(C) 9.25 cm (D) 11.00 cm

Q.27 A compound microscope has two lenses. The magnifying power of one is 5 and the combined magnifying power of the other lens is –

(A) 10 (B) 20 (C) 50 (D) 25

Q.28 A photograph of the moon was taken with telescope. Later on, it was found that a housefly was sitting on the objective lens of the telescope. In photograph –

(A) The image of housefly will be reduced

(B) There is a reduction in the intensity of the image

(C) There is an increase in the intensity of the image

(D) The image of the housefly will be enlarged

E. FILL IN THE BLANKS TYPE QUESTION

Q.1 Least distance of distinct vision is ....

Q.2 For a normal eye, the near point lies at .... and far point at ....

Q.3 In order to focus both the near and distant objects, the focal length of the eye lens is charged with the help of ....

Q.4 Intensity of light entering the eye is controlled by .... and ....

Q.5 In a human eye, the image is formed at ....

Q.6 The sensation of the image is conveyed to the brain by ....

Q.7 The retinal cells which respond to colours are ....

Q.8 The retinal cells which respond to intensity of high are ....

Q.9 A person cannot see objects lying beyond 4 m. This defect is called .... and is corrected by using a .... lens.

Q.10 A person cannot read a book placed nearer than 75 cm. This defect is called .... and is corrected by using a .... lens.

Q.11 Astigmatism is corrected by using .... lens.

Q.12 The focal length of the objective in a compound microscope is .... than the focal length of the eyepiece.

Q.13 The focal length of the objective is an astronomical telescope is .... than the focal length of the eyepiece.

Q.14 The formula for magnifying power of an astronomical telescope for normal adjustment is ....

F. NUMERICAL PROBLEMS

Q.1 A person cannot see objects beyond 2.5 m clearly. What is the defect and how can it be corrected?

Q.2 A person cannot see objects lying beyond 100 cm. Calculate the power of the corrective lens.

Q.3 The magnifying power of a simple microscope is 13.5. Calculate the focal length of the lens.

Q.4 The length of a simple microscope is 9 cm. The focal lengths of the objective and the eyepiece are 2 cm and 3 cm respectively.

Q.5 The focal lengths of the objective and the eyepiece in an astronomical telescope are 90 cm and 5 cm. Calculate the magnifying power and length of the telescocpe.

Q.6 A telescope is set for normal adjustment. Its magnifying power is 20 and length is 63 cm. Calculate the focal lengths of the objective and the eyepiece.

Q.7 Calculate the magnifying power of a lens when the focal length of the objective is 5 m and the focal length of the eyepiece is 10 cm.

Q.8 an astronomical telescope consists of two thin lenses set 36 cm apart and has magnifying power of 8. Calculate the focal lengths of both its lenses.

Q.9 The far point of a myopic is 40 cm. What type of lens should he wear so as to see the distant objects clearly. Calculate the focal length and the power of the lens he should use.

Q.10 An object and a screen are kept fixed. A convex lens is placed between the object of the screen which forms an image on the screen with a magnification of 3/2. When lens is moved through 16 cm, another image is formed on the screen with a magnification of 2/3. Calculate the focal length of the lens.

G. TRUE OR FALSE

Q.1 The lens in the human eye is convex.

Q.2 Least distance of distinct vision is 25 cm.

Q.3 Near point of a normal eye lies at 25 cm.

Q.4 Far point of a normal eye lies at 25 cm.

Q.5 For a myopic eye, the near point is shifted away from the eye.

Q.6 For a myopic eye, the far point is shifted towards the eye.

Q.7 For a hypermetropic eye, the near point is more than 25 cm.

Q.8 For a hypermetropic eye, the far point is shifted towards the eye.

Q.9 Myopia is corrected by using a suitable convex lens.

Q.10 Hypermetropia is corrected by using a suitable concave lens.

Q.11 Astigmatism is corrected by using cylindrical lenses.

Q.12 The pupil and iris control the intensity of light entering the eye.

Q.13 The power of accommodation of the ee is adjusted with the help of ciliary muscles

Q.14 The retinal cells which respond to intensity are cones.

Q.15 The retinal cells which respond to colours are rods.

Q.16 The lens used in a simple microscope should be of large focal length.

Q.17 In a compound microscope, the focal length of the objective is smaller than that of the eyepiece.

Q.18 In an astronomical telescope, the focal length of the objective is smaller than that of the eyepiece.

Q.19 In a compound microscope, the objective is taken large aperture.

Q.20 In an astronomical telescope, the objective is taken of large aperture.

EXERCISE - 2

A. MORE THAN ONE OPTIONS IS CORRECT TYPES QUESTIONS :

Q.1 If the image of distant objects is formed in front of the retain, the defect of vision may be :

(A) myopia (B) hyperopia

(C) presbyopia (D) astigmatism

Q.2 Which of the following statement are true about a pinhole camera?

(A) The so called 'image' formed by a pinhole camera is neither a shadow nor a true image.

(B) If the size of hole becomes greater than an optimum value, the image becomes blurred.

(C) If the size of hole becomes smaller than an optimum value, the image becomes blurred.

(D) Objects of different size may form images of same size if properly placed.

Q.3 In which of the following instruments is final image erect?

(A) Simple microscope

(B) Compound microscope

(C) Astronomical telescope

(D) Galilean telescope

Q.4 In which of the following instruments is the final image inverted?

(A) Projector (B) Camera

(C) Microscope (D) Telescope

Q.5 In which of the following instruments is the final image virtual?

(A) Projector (B) Camera

(C) Microscope (D) Telescope

Q.6 Large aperture objective is used in telescopes as it helps in-

(A) increasing the resolving power

(B) reducing spherical aberration

(C) increasing field of view

(D) increasing intensity by gathering more light

Q.7 An astronomical telescope has an angular magnification of magnitude 5 for distant objects. The separation between the objective and the eye-piece is 36 cm and the final image is formed at infinity. The focal length f_0 of the objective and the length f_e of the eye-piece are :

(A) f_o = 45 cm and f_e = –9 cm

(B) f_o = 50 cm and f_e = 10 cm

(C) f_o = 7.2 cm and f_e = 5 cm

(D) f_o = 30 cm and f_e = 6 cm

Q.8 An optical instrument used for angular magnification has a 25 D objective and a 20 D eye-piece. The tube length is 25 cm when the eye is least strained. Which of the following is correct?

(A) The instrument is a telescope

(B) The instrument is a microscope

(C) The angular magnification produced is 10

(D) The angular magnification produced is 20

Q.9 In which of the following the final image is erect?

(A) Simple microscope

(B) Compound microscope

(C) Astronomical telescope

(D) Galilean telescope.

B. PASSAGE BASED

Passage - 1 (Qus. 10 to Qus. 14)

A microscope is a device which is used to view tiny objects. A compound microscope consists of two converging lenses called the objective and the eyepiece. The tiny object to be examined is placed just beyond the first focus of the objective. The position of the eyepiece is adjusted till the image due to the objective is within the first focus of the eyepiece. The highly enlarged final image is seen by the eye which is held close to the eyepiece.

Answer the following questions.

Q.10 In a compound microscope, the intermediate image (i.e. image of the object due to the objective) is –

(A) Real, inverted and magnified

(B) Real, inverted and diminished

(C) Virtual, erect and magnified

(D) Virtual, erect and diminished

Q.11 In a compound microscope, the final image is –

(A) Real, inverted and magnified

(B) Real, erect and magnified

(C) Virtual, erect and magnified

(D) Virtual, inverted and magnified

Q.12 The magnifying power of a compound microscope is high if –

(A) Both the objective and the eyepiece have short focal lengths.

(B) Both the objective and the eyepiece have long focal lengths

(C) The objective has a short focal length and the eyepiece has a long focal length

(D) The objective has a long focal length and the eyepiece has a short focal length.

Q.13 The resolving power of a compound microscope is increased if.

(A) light of a shorter wavelength is used to illuminate the object.

(B) the objective of a bigger diameter is used

(C) the objective of a higher focal length is used

(D) the eyepiece of a shorter focal length is used

Q.14 If the aperture of the objective of a microscope is increased,

(A) its resolving power will increase

(B) its magnifying power will decrease

(C) the intensity of the final image will increase

(D) the eyepiece of a shorter focal length is used.

Passage - 2 (Qus. 15 to Qus. 19)

A telescope is an optical instrument that is used to examine distant objects. Two types of telescopes are in use-refracting and reflecting telescopes. A refracting astronmical telescope consists of two converging lenses called the objective and the eyepiece. The objective faces the distant object. The image of the object is formed at the foca l plane of the objective. The position of the eyepiece is adjusted till this image is within the first focus of the eyepiece. A highly magnified final image is formed which is seen by the eye held close to the eyepiece. If both the object and the final image are at infinity, the telescope is said to be in normal adjustment.

Answer the following questions.

Q.15 If a refracting astronomical telescope, the intermediate image is.

(A) real, inverted and magnified

(B) real, inverted and diminished

(C) virtual, erect and magnified

(D) virtual, inverted and diminished

Q.16 In a refracting astronomical telescope, the final image is-

(A) real, inverted and magnified

(B) real, erect and magnified

(C) virtual, erect and magnified

(D) virtual, inverted and magnified

Q.17 The magnifying power of a telescope is high if.

(A) both the objective and the eyepiece have short focal lengths

(B) both the objective and the eyepiece have long focal length

(C) the objective has a short focal length and the eyepiece has a long focal length

(D) the objective has a long focal length and the eyepiece has a short focal length

Q.18 The resolving power of a telescope is increased if.

(A) the objective of a bigger diameter is used

(B) the objective of a smaller diameter is used
(C) the objective of a higher focal length is used
(D) the eyepiece of a shorter focal lengths is used

Q.19 If the aperture of the objective of a telescope is increased,
(A) its resolving power will increase
(B) its magnifying power will decrease
(C) the intensity of the final image will increase
(D) the intensity of the final image will decrease

C. COLUMN MATCHING

Q.20 Match Column-I with Column-II :

Column-I	**Column-II**
(A) Final image in astronomical telescope	(P) Virtual
(B) Final image in compound focal	(Q) Objective lens microscope of large length
(C) Magnifying power of astronomical telescope can be made large by using	(R) Eye lens of short focal length
(D) Magnifying power of compound microscope can be made large by using.	(S) Inverted relative to the object

Q.21 Match optical devices given in Column I with their applications given in Column II.

Column-I	**Column-II**	
(A) Optical fibre	(P) To examine bacteria	
(B) Spectrometer	(Q) To obtain spectrum of	composite light
(C) Telescope	(R) To send images to	distant places
(D) Microscope	(S) To see craters on moon	

ANSWER KEY

EXERCISE-1

D. MULTIPLE CHOICE QUESTIONS :

1. C	**2.** A	**3.** D	**4.** B
5. C	**6.** A	**7.** C	**8.** C
9. D	**10.** D	**11.** A	**12.** C
13. A	**14.** B	**15.** C	**16.** D
17. D	**18.** A	**19.** B	**20.** C
21. B	**22.** B	**23.** A	**24.** C
25. B	**26.** D	**27.** B	**28.** D

E. FILL IN THE BLANKS :

1. 25 cm	**2.** 25 cm, infinity
3. ciliary muscles	**4.** pupil, iris
5. retina	**6.** optic nerves
7. cones	**8.** rods
9. myopia, concave	**10.** hypermetropia, convex
11. cylindrical	**12.** smaller
13. larger	**14.** $M = \frac{f_0}{f_e}$

F. NUMERICAL PROBLEMS :

1. Concave lens of power –0.4D

2. Convex lens power +3D

3. 2 cm **4.** 37.5 **5.** 19, 95 cm

6. 60 cm, 3 cm **7.** 50 **8.** Eyepiece is 4 cm and object lens is 32 cm

9. –2.5D, convex lens

10. 19.2 cm

G. TRUE OR FALSE :

1. True	**2.** True	**3.** True	**4.** False
5. False	**6.** True	**7.** True	**8.** False
9. False	**10.** False	**11.** True	**12.** True
13. True	**14.** False	**15.** False	**16.** False
17. True	**18.** False	**19.** False	**20.** True