LIGHT

WHAT IS LIGHT?

If we enter a dark room, the objects present in the room are not visible. However, if we switch on a bulb, everything in the room becomes visible. Why?

The bulb gives out an invisible energy called light. When this energy falls on the objects in the room, it bounces off from the surface of objects. When this energy enters our eyes, the eyes sense it and send a message to the brain. It is finally, the brain which really sees the objects. Eyes are only an aid in seeing the objects around us.

Why do we say that light is invisible ? Well, when light energy falls on the objects, we really do not see it. When energy bounces off from the surface of objects and enters our eyes, the sensation produced by this energy, helps our brain to see. Thus, to sum up we can say :

Light is an invisible energy, which causes in us the sensation of vision. When the light falls on any object, it bounces off from the surface of the object in all directions. This is called scattering of light.

DEFINITION

Light is form of energy which enables us to see objects which emit or reflect light.

Light is a type of (form of) energy which can produce sensation in our eyes. So we can experience the sensation of vision.

It is travel in straight line in form of particles and waves. With the help of light we see all colours of nature.

Our eyes are mostly sensitive for yellow colour and least sensative for violet and red colour. Due to this reason commercial vehicle's are painted with yellow colour, sodium lamps are used in road lights.

PROPERTIES OF LIGHT

Light energy propagates (travels) via two processes.

(i) The particles of the medium carry energy from one point of the medium to another.

(ii) The particles transmit energy to the neighbouring particles and in this way energy propagates in the form of a wave.

(iii) It propagates in straight line.

(iv) It's velocity in vacuum is maximum whose value is 3×10^8 m/sec. (297489978 m/s)

(v) Light does not need a material medium to travel that is it can travel through a vacuum.

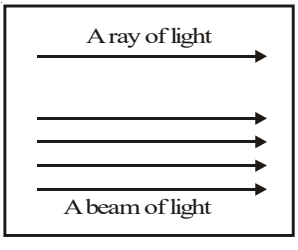
(vi) It exhibits the phenomena of reflection, refraction, interference, difraction, polarisation and double refraction.

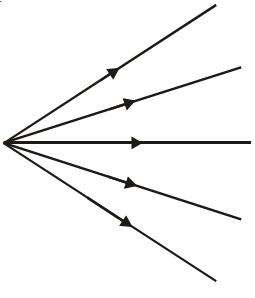
RAY OF LIGHT

A straight line which shows, the direction of light is called ray of light.

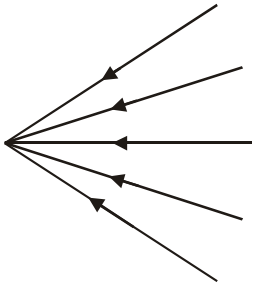
BEAM OF LIGHT

A bunch of light rays or bundale of rays at a point is called beam of light.





A divergent beam of light



A convergent beam of light

HOW WE SEE ?

When a light ray is falling (strike) on the surface of any object which reflect and reached to our eyes. Due to this our eyes feel a sensation then we see the object.

REFLECTION OF LIGHT

When rays of light falls on any object it return back in the same medium from the surface this phenomenon is called reflection of light. Due to reflection of light we can see all the nature.

INCIDENT RAY

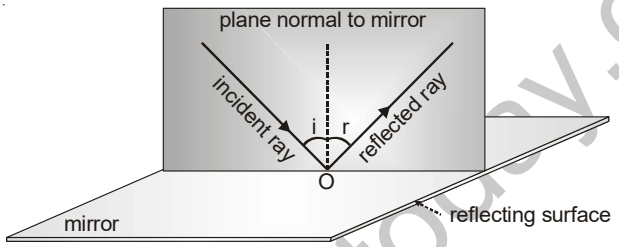
The ray of light which falls on a polished surface (or a mirror) is called the incident ray of light.

REFLECTED RAY

The ray of light which gets reflected from a polished surface (or a mirror) is called the reflected ray of light.

NORMAL

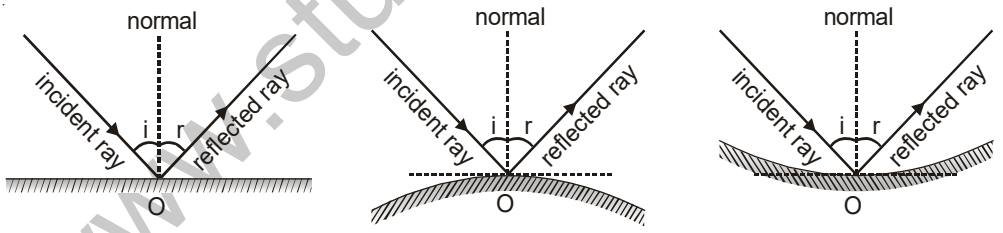
The normal is a line at right angle to the reflecting surface.



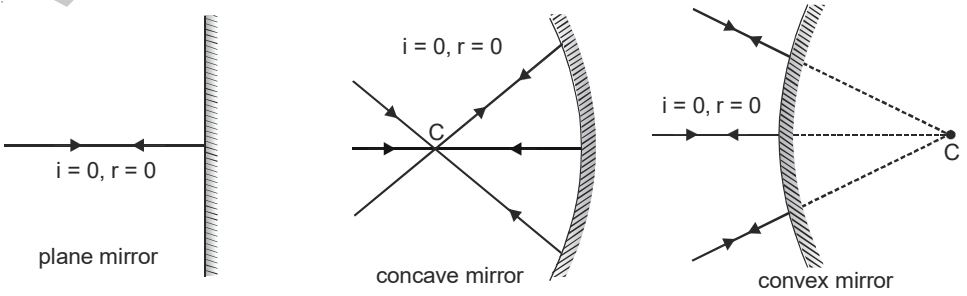
LAWS OF REFLECTION

I. The incident ray, the reflected ray and the normal to the surface at the point of incidence all lie in the same plane.

II. The angle of incidence ($\angle i$) is always equal to the angle of reflection ($\angle r$) i.e. $\angle i = \angle r$



- When a ray of light falls on a mirror normally or at right angle it gets reflected back along the same path.

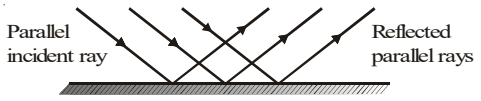


Depending on the nature of the reflecting surface there are two types of reflection :-

I. Regular (specular) reflection II. Irregular (diffused) reflection

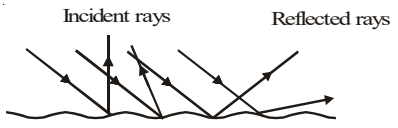
REGULAR REFLECTION

When parallel light rays fall on smooth plane surface like mirror, if all rays of light are reflected parallely along a difinite direction. Then this kind of reflection is called regular reflection.



IRREGULAR REFLECTION (DIFFUSED REFLECTION)

When paraller light rays fall on a rough surface all the rays of light are reflected in all possible (Different) direction this is called diffused or irregular reflection.



REFLECTING MATERIAL

The material or matter which reflect the light rays is called reflecting material. There are two types of reflecting material.

(i) Good reflector

(ii) Deem reflector

(i) **Good reflector :** The material which reflect all the incident light rays is called good reflector.

O R

This types of reflectors are reflected maximum incident light rays these type of reflector makes regular reflection like mirror.

(ii) **Deem (Midium) Reflector :** In this type of reflector, mostly part of incident rays are reflected. But some part is observed or transmitted by them irregular or diffused reflection are made by them like rough surface.

For making a reflector, a glass plate is polished one side by silver or nickel type material.

PRACTICE PROBLEMS

FILL IN THE BLANKS

(i) Impression of an image persists for ..... of the second on retina.

(ii) Angle of reflection is always ..... to the angle of incidence.

(iii) ..... is a small opening in the corner.

(iv) Cones are sensitive to ..... light.

(v) Muscles attached to the eye lens ..... and the lens becomes ..... when distant objects are to be seen.

(vi) To keep our eyes fit our diet should include vitamin ..... rich eatables.

(vii) Impression of an image is formed on .....

(viii) Braille system has ..... dot patterns.

MATCH THE FOLLOWING

Column A		Column B	
(i)	Cornea	(a)	transparent front part of eye
(ii)	Pupil	(b)	layer on which impression of images is formed
(iii)	Iris	(c)	point on retina where there are no nerve endings
(iv)	Retina	(d)	sensitive for bright light
(v)	Blind spot	(e)	is a small opening in the cornea
(vi)	Rods	(f)	sensitive for dim light
(vii)	Cones	(g)	controls the size of the pupil

TRUE OR FALSE

(i) Both incident ray and reflected ray lie in the same plane. [ ]

(ii) Diffused reflection is due to the failure of the laws of reflection. [ ]

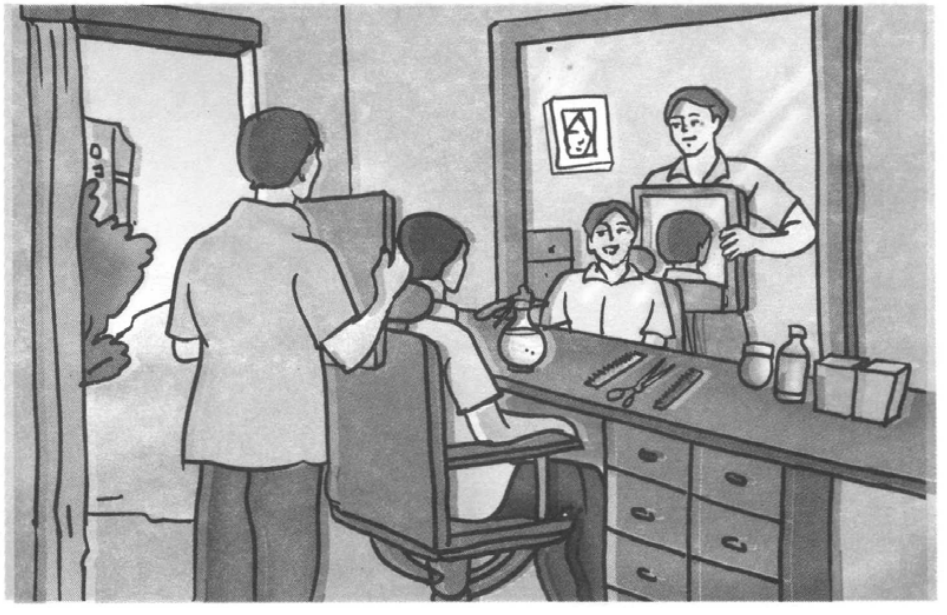
(iii) The image formed by plane mirror is laterally inverted. [ ]

(iv) The iris is the coloured part of the eye. [ ]

(v) Rods are sensitive to bright light. [ ]

(vi) Changing of the thickness of the eye lens is called accommodation. [ ]

MIRROR



Mirror at the hair dresser shop

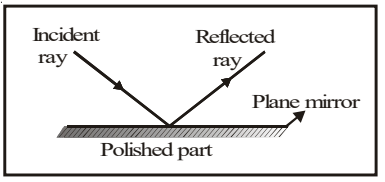
A smooth, highly polished reflecting surface is called a mirror.

When a glass plate is polished on one sided with reflecting material such silver or nickel then is becomes a mirror.

From the reflecting surface of mirror there are two types of mirror.

(i) Plane mirror (ii) Spherical or curved mirror

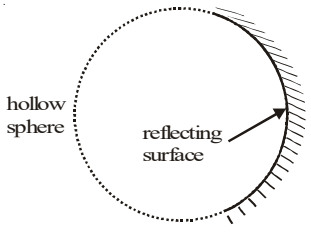
(i) **Plane mirror :** A highly polished plane surface is called a plane mirror or if a flat (totally plane) surface of a glass plate is polished one side of reflecting material is called plane mirror.



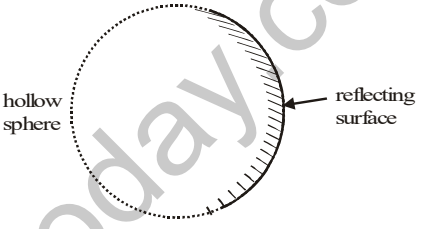
(ii) **Spherical mirror :** A mirror whose polished, reflecting surface is a part of hollow sphere of glass is called a spherical mirror. For a spherical mirror, one of the two curved surfaces is coated with a thin layer of silver followed by a coating of red lead oxide paint. Thus one side of the spherical mirror is made opaque and the other side acts as a reflecting surface.

For the polishing side there are two type of spherical mirror.

(A) Convex mirror (B) Concave mirror



Concave mirror



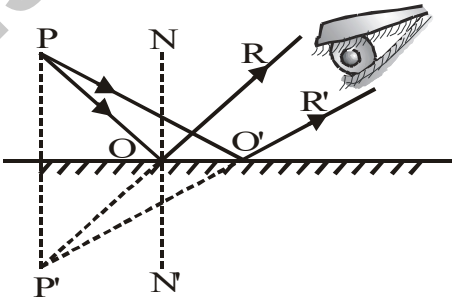
Convex mirror

(A) **Concave (Converging) mirror :** A spherical mirror whose inner hollow surface is the reflecting surface.

(B) **Convex (diverging) mirror :** A spherical mirror whose outer bulging out surface is the reflecting surface.

FORMATION OF IMAGE IN A PLANE MIRROR

P is an object which is placed in front of a plane mirror AB as shown in fig. Rays PO and PO' starting from P falls on mirror then these rays are reflected in OR and O'R' directions respectively. When the reflected rays enter the eye then they appear to diverge from P'. P' is called the image of object P.

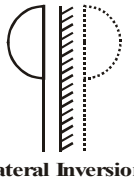


Reflection by plane mirror

Following are the properties of the image formed by a plane mirror

(i) Image is always virtual

(ii) Image lies as far behind the mirror as the object is infront of it.



Lateral Inversion

(iii) The size of image is the same as the object. The only difference is that the right side of an object appears to be left in the image and vice versa. This effect is known as lateral inversion. Lateral inversion is shown infig.

USES OF PLANE MIRRORS

(i) They are used as looking glass.

(ii) They are used by barbers to show the customer the back side of his head.

(iii) They are used for signalling by the scouts and the army personnel.

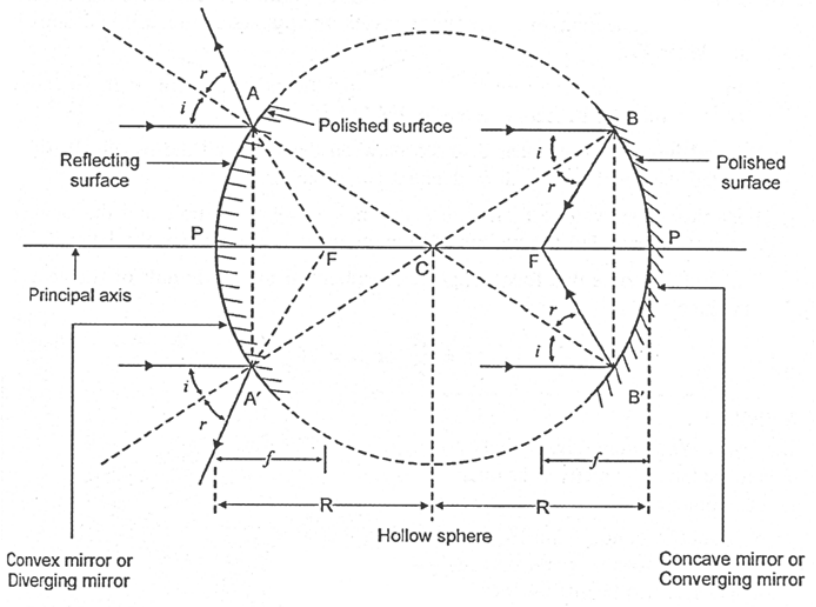
(iv) They are used by the opticians to provide false dimension, when their place of work is very small.

(v) They are used for providing false dimensions in show cases, displaying jewellery, wrist watches, etc. Two plane mirrors are fixed to the opposite sides of the show case, such that their reflecting surfaces face each other. This leads to the formation of multiple images.

(vi) They are used for reflecting the rays of the sun inside the solar cooker.

(vii) They are used for making toys like ***kaleidoscope***. In this toy, three plain mirrors are inclined at an angle of 60°, and fixed in a tube. Some broken bangles are placed inside the tube. When the tube is turned, the image of bangles form beautiful hexagonal patterns.

TERMINOLOGY FOR SPHERICAL MIRRORS



(a) **Aperture :** The effective width of a spherical mirror from which reflection can take place is called its aperture.

(b) **Pole (Vertex) :** The centre of a spherical mirror is called its pole it is denoted by letter P.

(c) **Centre of curvatue :** The centre of the hollow sphere of which the spherical mirror is a part is called centre of curvature. It is denoted by letter C.

(d) **Radius of curvature :** The radius of the hollow sphere of which the spherical mirror is a part called the radius of curvature (R).

(e) **Principal axis :** The straight line passing through the centre of curvature C and the pole P of the spherical mirror.

(f) **Normal :** The normal at any point of the spherical mirror is the straight line obtained by joining that point with the centre of curvature C of the mirror.

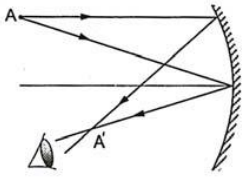
(g) **Principal focus or focus :** The point on the principal axis where all the rays coming from infinity (parallel rays) after reflection either actually meets or appears to meet is called the focus (or focal point) of the mirror. It is denoted by letter F.

(h) **Focal length :** The distance between the pole (P) and the focus (F) is called focal length (f) and $f = \frac{R}{2}$

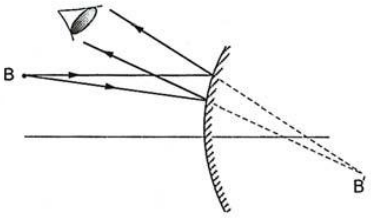
(i) **Focal plane :** An imaginary plane passing through the focus and at right angles to the principal axis.

(j) **Real image :** When the rays of light after getting reflected from a mirror (or after getting refracted from a lens) – actually meet at a point, a real image is formed. A real image can be obtained on a screen.

(k) **Virtual image :** When the rays of light after getting reflected from a mirror (or after getting refracted from a lens) appear to meet at a point, a virtual image is formed. Such an image can only be seen through a mirror (or a lens) but cannot be obtained on a screen.



(a) Real image



(b) Virtual image

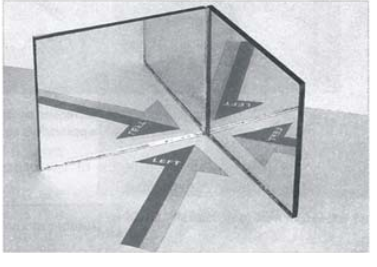
Differences between Real and Virtual Images

Real Image	Virtual Image
It can be taken on the screen.	It cannot be taken on the screen.
The rays of light after reflection or refraction meet at a point.	The rays of light after reflection or refraction appear to meet at a point.
It is always inverted.	It is always erect but laterally inverted.

MULTIPLE REFLECTIONS

A plane mirror forms an image of an object placed before it. This is the result of a single reflection of light. What happens if the object is placed between two mirrors that are at an angle to each other ? Let us find out.

Each of the mirrors will form an image due to reflection. Each of these images is formed by a single reflection. These images are laterally inverted. In addition, an image is formed at the edge where the mirrors meet. This image is formed by rays that get reflected twice. As a result, this image is not laterally inverted. So, the left and right sides of the arrow and the word 'left' appear the correct way round in this image.



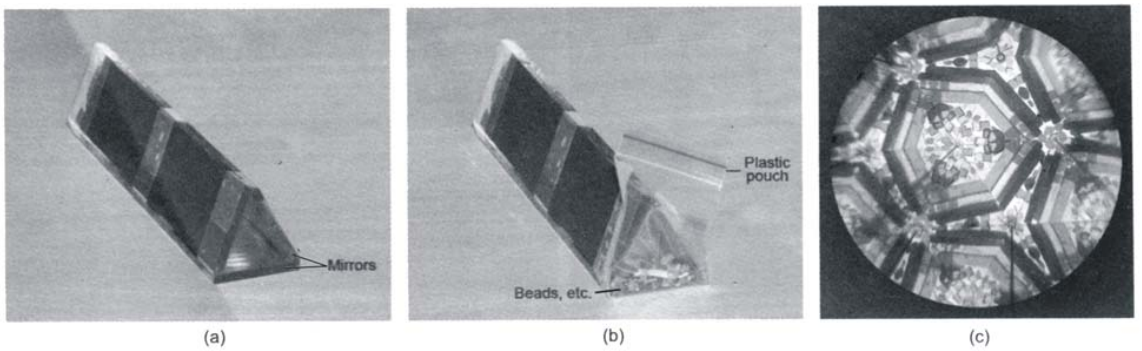
NOTE : The number of images of an object placed between two mirrors can be found from the following formula.

$$\text{Number of images} = \frac{360°}{\text{angle between mirrors}} - 1$$

When the angle between the mirrors is 90°, the number of images is (360°/90°) – 1 = 4 – 1 = 3. Similarly, when the angle is 60°, the number of images is (360°/60°) – 1 = 6 – 1 = 5.

KALEIDOSCOPE

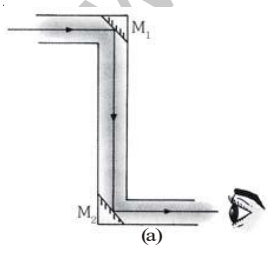
The keleidoscope is a device that uses reflections to produce patterns. It consists of mirrors inclined to each other. The mirrors form multiple images of objects in front of them. This creates beautiful patterns, which change when the keleidoscope is rotated or shaken.



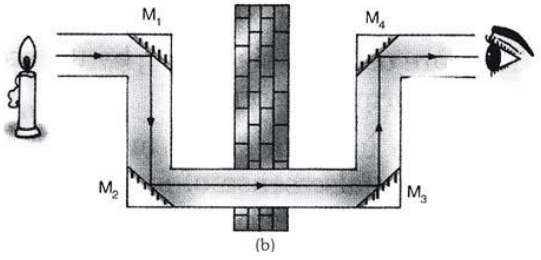
(a)-(b) Making a kaleidoscope (c) A pattern formed by a kaleidoscope

PERISCOPE

The working of a periscope is based on the principle of successive reflections from two plane mirrors. It consists of two plane mirrors M_1 and M_2 facing each other fixed at 45° to the framework of a tube which is bent twice at right angle (fig a). A beam of light from some object is turned through one right angle by the mirror M_1. In the same way the light is deviated through another right angle by the mirror M_2. Therefore, the object is seen by the eye in spite of the obstacle. This arrangement can be used by a person to see a match over the heads of a few people while standing at the back of the crowd.



Successive reflection from two plane mirrors in a periscope



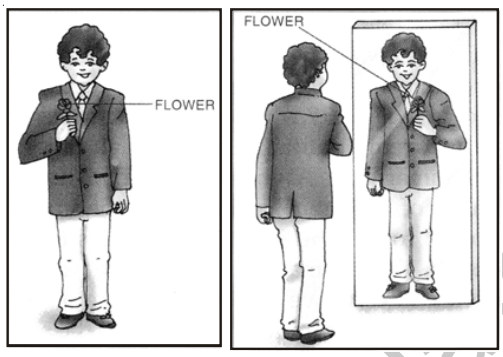
Successive reflection through four plane mirrors in a periscope

Even an object can be seen through a wall as well by an arrangement as shown in fig. (b) In this case, light from the candle is reflected by four mirrors M_1, M_2, M_3 and M_4 before reaching the eye. Therefore, the candle is seen through the wall.

LATERAL INVERSION IN A PLANE MIRROR

When we place any object in front of a plane mirror, its image is such that its left hand side is seen on the right hand side and the right side is seen on the left.

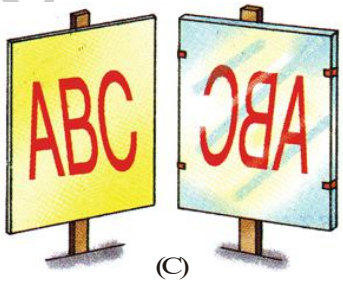
Fig (a) shows a boy as you will see him when he stands before you. Now, make him stand in front of a mirror and see his image fig (b). Note that the flower on the coat now appears to be on the right side, and when you see him directly the flower on the coat is on the left side. Similarly, if you write with your right hand, the image in the mirror shows as if you are writing with your left hand.



(a) A boy **(b) Mirror image of the boy**

This phenomenon of left appearing right and right appearing left on reflection in a plane mirror is called the **lateral inversion**

Fig. (c) illustrates another example of a lateral inversion. If you write letters 'ABC' on a piece of paper, they will look like 'ƆBA'. When see in the mirror. You can see that the letter A has gone from the left side to the right side in the mirror. Not only this, but each letter has gone through a lateral inversion. Letter 'B' becomes 'ᗺ' and 'C' has become 'Ɔ'. Can you now tell why 'A' remains as 'A', when seen in the mirror?



(C)
Lateral inversion in a plane mirror

Characteristics of an image formed by a plane mirror :

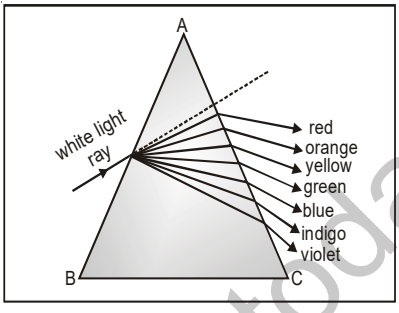
Thus, we summarise that the image formed in a plane mirror has the following characteristics :

- The image is virtual and erect.
- The image is laterally inverted.
- The image is formed behind the mirror and has the same size as that of the object.
- The image is as far behind the mirror as the object is in front of it.

DISPERSION OF WHITE LIGHT

Sir Issac Newton, while working with an astronomical telescope, observed that the images of stars as seen through the telescope were coloured near the fringes. He got the lenses of the telescope polished, but found that the colour still persisted. From the above observation, he concluded that the fault may not be with the lenses, but it had something to do with the nature of light itself. To investigate this conclusion, he performed the following experiment.

Experiment: Newton allowed sunlight to enter through a small hole in a window of a darkened room. He placed an equilateral prism in the path of the narrow beam of light. The light emerging from the prism was allowed to fall on the white screen. It was found that light received on the white screen was a band of seven colours. The order of colours from the base of prism is violet, indigo, blue, green, yellow, orange and red. This order of colours can be easily remembered by remembering the word VIBGYOR.



DEFINITIONS

(a) **Dispersion :** The phenomenon due to which white light splits into seven colours (VIBGYOR), when passed through an equilateral prism is called **dispersion**.

(b) **Spectrum:** The band of seven colours obtained on the screen, when white light splits into seven colours is called **spectrum**.

PRACTICE PROBLEMS

I State whether the following statements are true or false

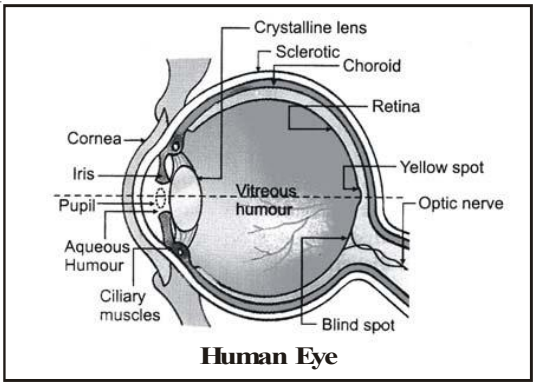
1. All surfaces act like mirrors.
2. Reflected images from an old stainless steel plate and a new plate are the same.
3. Two plane mirrors can give any number of images.
4. Splitting of white light is called spectrum.

II. Fill in the blanks

1. Reflection from a smooth surface is called ..... reflection. (regular/diffused)
2. Two plane mirrors kept at 90° give ..... images. (three/infinite)
3. Objects that emit light are called ..... (luminous/non-luminous)
4. The band of colours produced when white light is split is called ..... (dispersion/spectrum)

THE HUMAN EYE

The construction and working of the human eye is similar to photographic camera in many respects. Human eye is almost a spherical ball, with a light bulge in the front. The structure and function of each part of the eye is given below :



Human Eye

- **Sclerotic :** It is the outermost covering of the eye ball. It is made of white tough fibrous tissues.

  Its function is to house and protect the vital internal parts of the eye.

- **Cornea :** It is the front bulging part of the eye. It is made of transparent tissues.

  Its function is to act as a window to the world, i.e., to allow the light to enter in the eye ball.

- **Choroid :** It is a grey membrane attached to the sclerotic from the inner side.

  Its function is to darken the eye from inside and, hence, prevent any internal reflection.

- **Optic Nerve :** It is a bundle of approximately 70,000 nerves originating from the brain and entering the eye ball from behind.

  Its function is to carry optical messages (visual messages) to the brain.

- **Retina :** The optic nerve on entering the ball, spreads like a canopy, such that each nerve end attaches itself to the choroid. The nerve endings from a hemi-spherical screen called retina. These nerve endings on the retina are sensitive to visible light. On the retina are two important areas which we will discuss separately.

  The function of retina is to receive the optical image of the object and then convert it to optical pulses. These pulses are then sent to the brain through optic nerve.

- **Yellow spot :** It is a small area, facing the eye lens. It has high concentration of nerve endings and is slightly raised as well as slightly yellow in colour.

  Its function is to form a very clear image by sending a large number of optical pulses to brain.

- **Blind Spot :** It is a region on the retina, where the optic nerve enters the eye ball. It has no nerve ending and hence, is insensitive to light.

  It does not seem to have any function. Any image formed on this spot is not visible.

- **Crystalline lens :** It is a double convex lens made of transparent tissues. It is held in position by a ring of muscles, commonly called ciliary muscles.

  Its function is to focus the images of different objects clearly on the retina.

- **Ciliary Muscles :** It is a ring of muscles which holds the crystalline lens in position . When these muscles relax, they increase the focal length of the crystalline lens and vice versa. *Its function is to alter the focal length of crystalline lens so that the images of the objects, situated at different distances, are clearly focussed on the retina.*

- **Iris :** It is a circular diaphragm suspended in front of the crystalline lens. It has a tiny hole in the middle and is commonly called **pupil.** It has tiny muscles arranged radially around the pupil. These muscles can increase or decrease the diameter of the pupil. The iris is heavily. pigmented. The colour of eyes depends upon colour of pigment.

  The function of iris is to control the amount of light entering the eye. This is done by increasing or decreasing the diameter of pupil

- **Vitreous Humour :** It is a dense jelly-like fluid, slightly grey in colour, filling the part of eye between crystalline lens and retina.

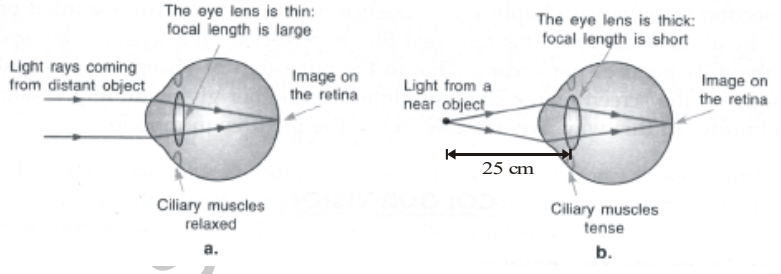
  Its function is (i) to prevent the eye ball from collapsing due to change in atmospheric pressure, (ii) in focussing the rays clearly on the retina.

- **Aqueous Humour :** It is a watery, saline fluid, filling the part of the eye between the cornea and the crystalline lens.

  Its function is (i) to prevent front part of the eyeball from collapsing with the change in atmospheric pressure, (ii) to keep the cornea moist.

POWER OF ACCOMMODATION OF THE EYE

When the object is infront of eye then light rays coming from the object are refracted and after passing through the vitreous humour they are focused on the retina. The sensation from retina is conveyed to the brain through the optic nerves and the object becomes visible.



When eye is in normal condition i.e. the muscles are not strained then a clear image of the objects situated at infinity is formed on the retina. This is possible only when the distance between lens and retina is equal to the focal length of the lens (fig) . When the object is close to the eye then its image should be formed behind the retina and it should by blurred, but it is not so in reality. Because when the object is close to eye then muscles are strained automatically. Muscles get contrated to make lens thicker at the centre which reduces the focal length of the lens and image is again formed on the retina. **The ability of self adjustment of focal length of the eye lens is called accommodation power.**

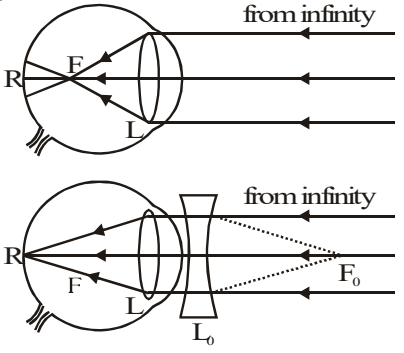
RANGE OF VISION

The most distant point from the eye where the object can be seen clearly is called the **far point.** For normal eye far point is infinity. The point at the shortest distance from the eye where the object can be seen clearly is called **near point**. It is 25 cm for a normal eye. The distance between far and near points is called range of vision.

DEFECTS OF VISION AND THEIR CORRECTIONS

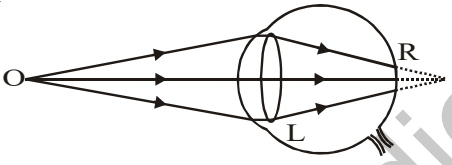
When the range of vision or accommodation of an eye does not lie between 25 cm and infinity then that eye is called defective eye. The defects in the vision of eye are as given below :

1. **Myopia or short sightedness :** Myopia or short-sighted eye is able to see near objects clearly but can not see distant objects clearly. For such an eye image of a distant object is formed in front of retina. This defect is corrected by the use of a concave lens (fig). This lens is chosen such that parallel rays comming from the object at infinity appear, after suffering divergence from the lens, to come from the point which is the far point of the defective eye.

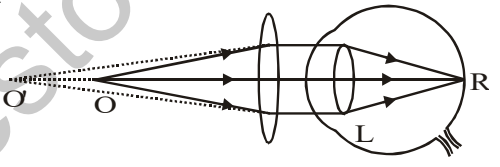


Myopia and its corection

2. **Hypermetropia or long-sightedness :** An eye with this defect is able to see distant objects clearly, but can not see near objects distintly. For such an eye the image of a nearby object will be formed behind the retina. A long sighted eye is corrected by the use of a convergent (convex) lens of suitable focal length (fig). This results in the increase in virtual distance of the object so that a sharp image is formed at the retina.



Least distance of distinct vision of the normal eye



Hyper metropia and its correction

CARE OF THE EYES

It is necessary that you take proper care of your eyes. If there is any problem you should go to an eye specialist. Have

(i) If advised, use suitable spectacles.

(ii) Too little or too much light is bad for eyes. Insufficient light causes eyestrain and headaches. Too much light, like that of the sun, a powerful lamp or a laser torch can injure the retina.

(iii) Do not look at the sun or a powerful light directly.

(iv) Never rub your eyes. If particles of dust go into your eyes, wash your eyes with clean water. If there is no improvement go to a doctor.

(v) Wash your eyes frequently with clean water.

(vi) Always read at the normal distance for vision. Do not read by bringing the book too close to your eyes or keeping it too far.

(vii) If food is deficient in some components, eyes may also suffer. Lack of vitamin A in foodstuff is responsible for many eye troubles. Most common amongst them is night blindness.

One should, therefore, include in the diet components e.g., vitamin A.

(viii) Raw carrots, broccoli and green vegetables (such as spinach) and cod liver oil are rich in vitamin A. Eggs, milk, curd, cheese, butter and fruits such as papaya and mango are also rich in vitamin A.

VISUALLY CHALLENGED PERSONS CAN READ AND WRITE

Some persons, including children, can be visually handicapped. They have very limited vision to see things. Some persons cannot see at all since birth. Some persons may lose their eyesight because of a disease. Such persons try to identify things by touching and listening to voices more carefully. They develop their other senses more sharply. However, additional resources can enable them to develop their capabilities further.

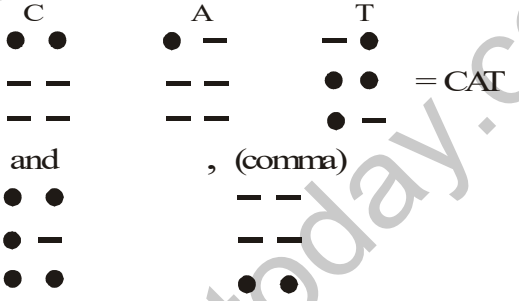
WHAT IS BRAILLE ?

The most popular resource for visually challenged persons is Braille.

`Louis Braille, himself a visually challenged person, developed a system for visually challenged persons and published it in 1821.

The present system was adopted in 1932. There is Braille code for common languages, mathematics and scientific notation. Many Indian languages can be read using the Braille system.

Braille system has 63 dot patterns or characters. Each character represents a letter, a combination of letters, a common word or a grammatical sign. Dots are arranged in cells of two vertical rows of three dots each.



Example of dot patterns used in Braille System

Patterns of dots to represent some English alphabets and some common words are shown below.

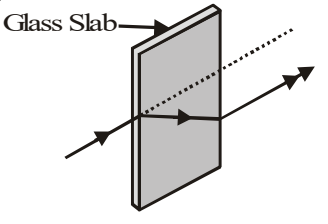
These patterns when embossed on Braille sheets help visually challenged persons to recognise words by touching. To make them easier to touch, the dots are raised slightly.

REFRACTION OF LIGHT

When a ray of light, travelling (in a straight line) in one transparent medium, enters in another transparent medium, it is observed to change its direction of travel or to bend its path. We call this phenomenon as **refraction** of light. Thus, **Refraction is the phenomenon in which a ray of light, travelling in one (transparent) medium, changes its direction of travel (or bends its path) when it goes into another (transparent) medium.** It is possible to observe refraction through a 'setup' of the type described below :

ACTIVITY

Go into a room which has thick curtains on its windows. Draw the window curtains and close the doors of the room. Let there be just one, very narrow (pin-hole) opening through which a fine pencil of light enters the room. This pencil of light would be visible through the smoke/dust particles coming in its way. Now, take a thick rectangular slab of glass and introduce it in the path of this (visible) pencil of light. We will observe that the path of the pencil of light, coming out the from the glass slab, **is displaced with respect to its original path**. This is because of the bending of light as it goes from air to glass and then from glass to air.



Optical Density : The speed of light, in a given medium, decides its **optical density.** We say that, the more is the speed of light in a given medium, the **less** is its optical density and vice-versa. Vacuum (or free space) has the least optical density because the speed of light is maximum in vaccum.

Of any two given media, the one having a higher speed of light in it, is referred to as the **rarer** of the two media. The other, having a lower speed of light in it, is referred to as the **denser** of the two media. Thus :

Denser medium ⟶ Higher optical density ; lower speed of light

Rarer medium ⟶ Lower optical density ; higher speed of light

Representative Values of speed of light in some media

We first note that light travels very very fast indeed! Its speed is much more than that of any other object we know of. Also, it is in vacuum that it travels, the fastest. The speed of light in vacuum has been measured to be (nearly) **3 lakh kilometres per second** (i.e., 3,00,000 km/s or 3×10^5 km/s or 3×10^8 m/s).

Unimagineably fast isn't it! Its speed in other media is smaller than its speed in vacuum but it is still very very high indeed. Given below are the representative values of the speed of light in some media.

S.No.	1	2	3	4	5
Medium	Vacuum	Air	Water	Glass (ordinary)	Diamond
Speed of light (nearly) in lakhs of kilometre per second	3	~3	2.25	2	1.25

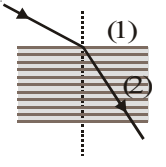
REFRACTIVE INDEX

The ratio of the speeds of light, in a given pair of media, gives us a measure of the extent of refraction (or bending) of a ray of light as it goes from one medium to another.

We call this ratio (or the speeds of light) as the **relative refractive index** for the given pair of media. We therefore, define **refractive index** (for a given pair of media) as follows :

The refractive index, of medium 2 with respect to medium 1, equals the ratio of the speed of light in medium 1 to its speed in medium 2. Thus,

$$\text{Refractive index (or medium 2 w.r.t. medium 1)} = \frac{\text{Speed of light in medium 1}}{\text{Speed of light in medium 2}}$$



Medium 1 is usually air. When we say that the refractive index of water is 1.33 (or 4/3), it means that the speed of light, in water, is 3/4th of its value in air.

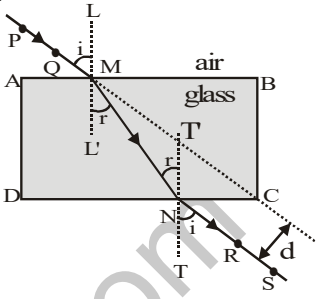
REFRACTION OF LIGHT BY A GLASS SLAB

A parallel faced glass slab can be easily used to study the basic features of the **phenomenon of refraction.** We can do a simple activity for this purpose.

ACTIVITY

To observe the details of the phenomenon of refraction through a glass slab.

Take a sheet of paper and fix it on a drawing board with the help of pins/cello-tape. Draw the outline (ABCD) of the available parallel faced glass slab on this sheet. Now draw a line PQ. inclined to the face AB, at an angle of say 30°. Fix two points P and Q vertically on the line PQ. Look at the image of these pins from the side CD of the glass slab. Now fix a pin R vertically so that its foot is in line with the images of the feet of the pins P and Q. Next, move a little backward and fix another pin S so that the foot of the pin S is in line with the feet of the images of the pins P and Q as well as the foot of the pin R. Draw small circles around the feet of the points P and Q as well as the pins R and S. Remove the glass slab as well as the pins P, Q, R and S. Join RS and let it meet the side CD at N. Similarly, produce PQ and let it meet the side AB at M. Draw the normals. LML' at M (to side AB) and T'NT at N (to side CD).



We observe that on refraction through the parallel faced glass slab ABCD,

- The final refracted ray RS is parallel to the incident ray PQ. However, it is displaced relative to the ray PQ by an amount, d, say.
- The incident ray PQ bends its path and travels along the direction MN within the glass slab.

Some definitions :

The initial ray PQ(M), falling on the glass slab, is known as the **incident ray**.

The path of the ray MN, within the glass slab, is known as the **refracted ray**.

The final ray (N)RS, coming out of the glass slab, is known as the **emergent ray**.

The angle, between the incident ray PQ(M) and the normal at the point of incidence (M), is known as the **angle of incidence (∠i).**

The angle, between the refracted ray MN and the normal, at the point of incidence, is known as the **angle of refraction (∠r).**

The angles, ∠MNT' (= ∠r) and ∠TNR (= ∠i) are similarly the angles of incidence and refraction respectively, at the face CD of the glass slab.

Some Results : We find that, at the face AB, the angle of incidence is more than the angle of refraction. We can express this by saying that the incident ray PQ has **bent towards the normal** while going from air (an optically rarer medium) to glass (an optically denser medium).

At the face CD, the (incident) ray MN is going from glass to air while getting refracted along the direction NRS. Here the angle of incidence (= ∠r) is less than the angle of refraction (= ∠i). We say that here the ray is getting **bent away from the normal**. Note that here it is travelling from glass (an optically denser medium) to air (an optically rarer medium).

Rules for Rerfraction

The above results are found to be general results that hold whenever a ray of light travels from one transparent medium to another (i.e., gets **refracted**). We can state them as follows :

(i) **A ray of light bends towards the normal when it goes (obliquely) from an optically rarer medium to an optically denser medium.**

(ii) **A ray of light bends away from the normal when it goes (obliquely) from an optically denser medium to an optically rarer medium.**

We call these results as the **rules for refraction.**

DO YOU KNOW?

A ray of light does not **always** bend its path when its goes from one medium to another. It keeps on travelling straight if it falls **normally** on the surface separating the two transparent media.

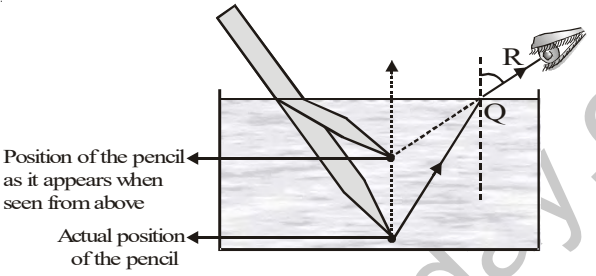
Common Phenomenon in terms of the Rules for Refraction :

We often observe the following phenomenon in our day-to-day life.

- A straight rod or a pencil appears bent when it is partially immersed in water.
- A pond or a swimming pool appears less deep (shallower) to us that it actually is.
- We find that a coin, put in an empty bowl or cup, that is not visible to us from a distance, becomes visible, if some one pours some water in what bowl or cup. This is often referred to as the **coin trick.**

All these (and many other similar phenomenon) can be easily understood in terms of the above stated rules for refraction.

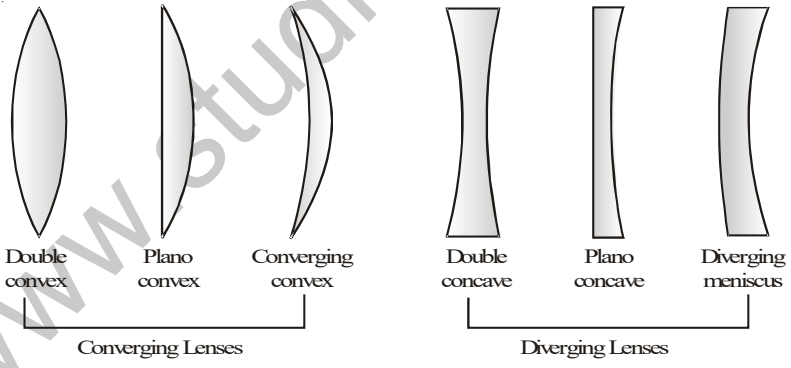
Consider, for example, a pencil partially immersed in water. The rays of light, starting from, say, the tip of the pencil, bend away from the normal as they travel from water (optically denser) to air (optically rarer). To us, therefore, these rays appear to be coming from a point, that lies above the actual position of the tip of the pencil. The same is true for all other points of the pencil under water. The part of the pencil, under water, thus, appears bent with respect to its part above water.



LENSES

Besides the glass slab and the prism, it is lenses that are used very often for studying and using the effects of refraction. A lens is a portion of a transparent refracting medium bounded by two surfaces. When both or one of these surfaces is spherical (with the other surface plain), the lens is known as a **spherical lens**.

Spherical lenses are of two types : (i) **Convex** or converging lenses and (ii) **concave** or diverging lenses. The common shapes of these two types of lenses are shown below.

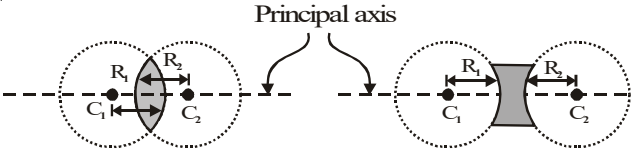


Some Definitions

Let us first understand the meanings of a few terms relevant to the lenses.

Centres of curvature : Each of the two surfaces of a spherical lens can be regarded as a part of a sphere. The centres of these two spheres are known as the centres of curvature or the two surfaces of the lens.

Radii of curvature : The radii of the two spheres, of which the lens surfaces are a part of, are known as the radii of curvature or the two surfaces of the lens.

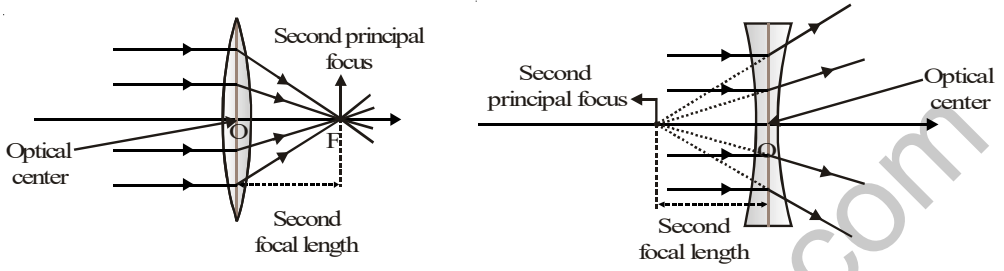


Principal axis : The line joining the centres of curvature of the two surfaces of a lens is known as its principal axis.

Optical centre : The **optical centre** of a lens is a special point on its principal axis. A ray of light passing through the optical centre of a lens, goes straight through it without undergoing any bending or deviation from its path.

Principal Focus/Focal length : It turns out that if a beam of rays, all parallel to the principal axis of a lens, falls on the lens, they either all converge to a point on its principal axis, or appear to diverge from a point on its principal axis. We call this point as the (second) principal focus of the lens.

The distance of the (second) principal focus from the optical centre of a lens, equals the focal length of the lens.

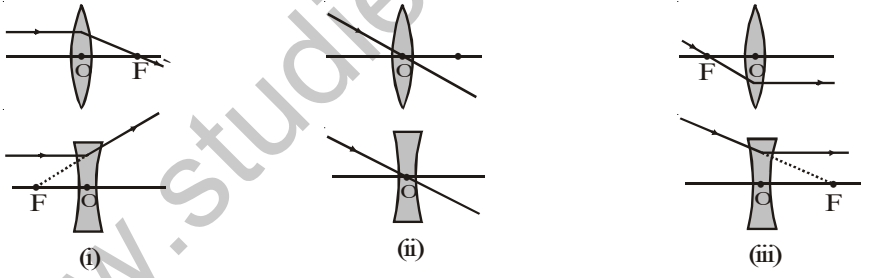


Three Special Rays for Lenses : We can use the ideas and definitions, outlined above, to draw **ray diagrams** for lenses. These ray diagrams help us to know the nature, size and position of the iamge formed when the object is kept at different distances from the lens. We prefer to use two of the three (special) incident rays given below, to draw these ray diagrams.

(i) An incident ray, parallel to the principal axis, passes through (or appears to come from, the (second) principal focus of the lens.

(ii) An incident ray, passing through the optical centre of the lens, goes undeviated from the lens.

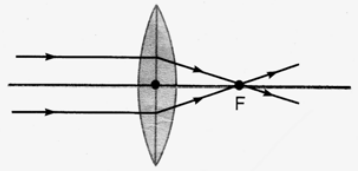
(iii) An incident ray, passing through the (first) principal focus of the lens, or directed towards it, becomes parallel to the principal axis after refraction from the lens.



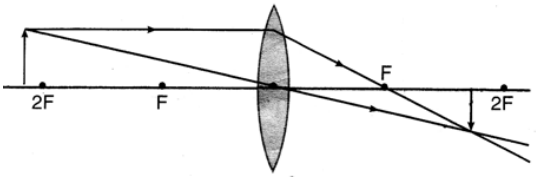
Let us now see how we can use any two of these three (special) incident rays to draw ray diagrams, for different object positions, for a convex lens and a concave lens.

Convex lens : A convex lens forms images of different sizes, nature, and at different positions, for objects kept at different distances from its optical centre. We consider the following five cases that cover all possible types of image formed by this lens. The ray diagrams have been drawn using (up to) two of the three (special) rays mentioned above. The characteristics, of the image formed, have been written along with the corresponding ray diagram.

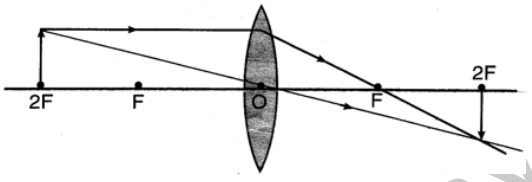
(i) **Object at infinity :** The image of a very far off object (object at infinity) is a real, diminished and almost point like image. It is formed at the focus of the lens.



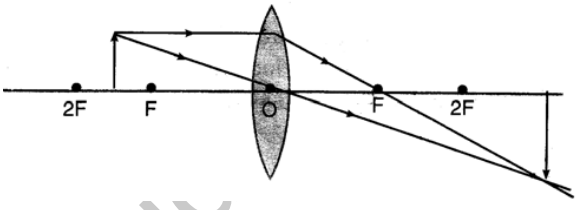
(ii) **Object beyond the '2F' point of the lens :** The image formed here is a real, diminished, inverted image. It is formed between the 'F' and '2F' point of the lens, on its other side (the side opposite to the side on which the object has been put).



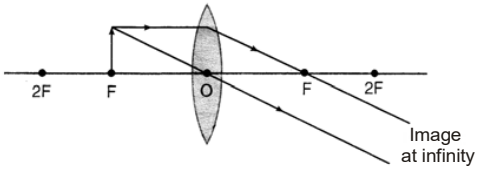
(iii) **Object at the '2F' point of the lens :** The image formed here is a real, inverted image that has the same size as the object. It is formed at the '2F' point, of the lens, on the other side of the lens.



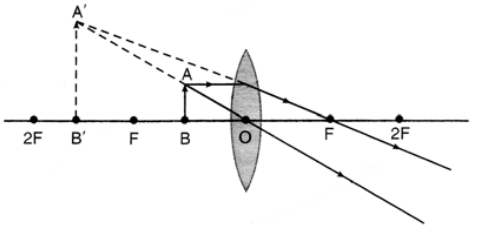
(iv) **Object between the '2F' and 'F' point of the lens :** The image formed here is a real, inverted and magnified image. It is formed beyond the **'2F'** point of the lens on its other side.



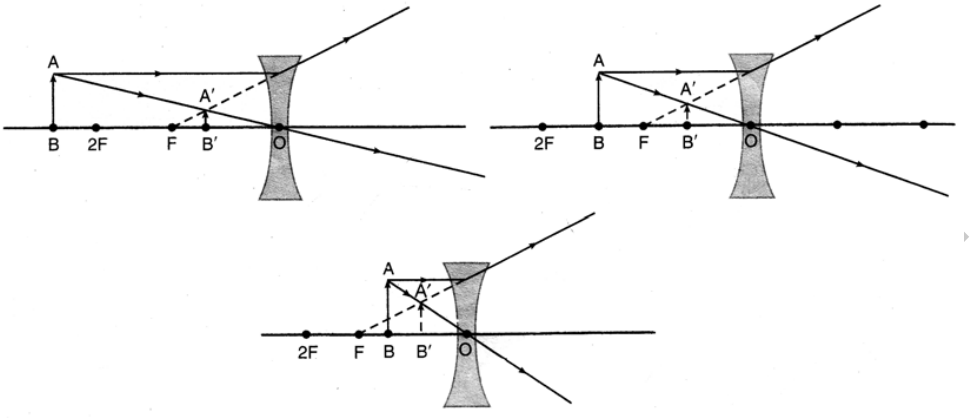
(v) **Object kept at the (first) principal focus or the 'F' point of the lens :** The image formed here is taken as a real, inverted and magnified image. It is regarded as formed very far off or at infinity.



(vi) **Object between the optical centre and the 'F' point of the lens :** The image formed here is a virtual erect and magnified image. It appears to be formed beyond the 'F' point of the lens on ther same side as the object is.



Concave lens : Unlike a convex lens, the nature and position of the image, formed by a concave lens, does not depend upon the distance of the object from the lens. A **concave lens always** forms of **virtual, erect** and **diminished image.** Also, the image always appears to be located between the optical centre and the 'F' point of the lens on the same side as the object is. We illustrate these features of the concave lens by drawing 'ray diagrams' for three different distances of the object from the lens.

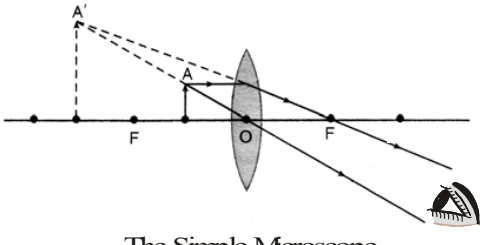


In all cases, the image formed is a **virtual, erect** and **diminished** one. Also, it always appears to be formed between the optical centre and the 'F' point of the lens.

APPLICATION OF LENSES

Lenses find a number of uses in our day- to-day life. The simplest of such applicatins include the **magnifying glass,** the **microscope**, the **telescope** and the **photographic camera**. And, of course, that wonderful gift of nature to mankind the eye also has a 'built-in' lens that plays a very important role in its functioning.

The Magnifying Glass (The simple Microscope) : The magnifying glass, or a **simple micrscope,** is simply a convex lens of short focal length. We have seen above that the convex lens produces a virtual, erect and magnified image of an object when the object is kept within the focal point of the lens. it turns out that the smaller the focal length of a lens, the more is the magnification produced by it. We often use a (small focal length) convex lens, provided with a frame and a handle, as a simple **magnifying glass** or as a **reading lens.** However, we can use such a lens for producing a magnification of 5 to 10 times only.



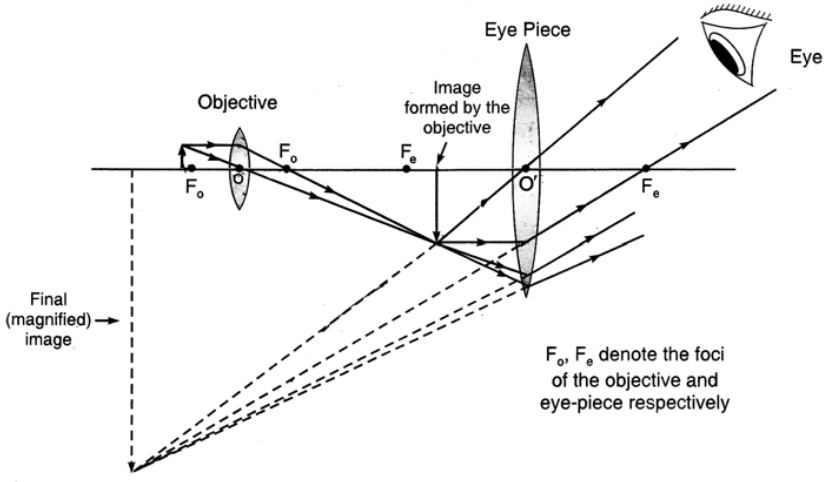
The Simple Microscope

THE COMPOUND MICROSCOPE

The compound microscope is made from two convex lenses - both of short focal length. It helps us to produce magnifications as large as a few hundred times.

The (small) object to be magnified, is kept just beyond the focus of the first (short focal length) lens. It then produces a real, inverted and magnified image of the object. The second (short focal length) lens is so adjusted that this (magnified) image falls just within its focus. It then further magnifies this image. We are thus, able to get a final image that is magnified 100 times or even more.

The compound microscope is very widely used to get clear magnified images of very small objects. It is an essential part of a Zoology or a Botany laboratory. The lens, kept near the object, is known as its **objective**. The other lens, from which the eye observes the final image, is known as the **eyepiece**.

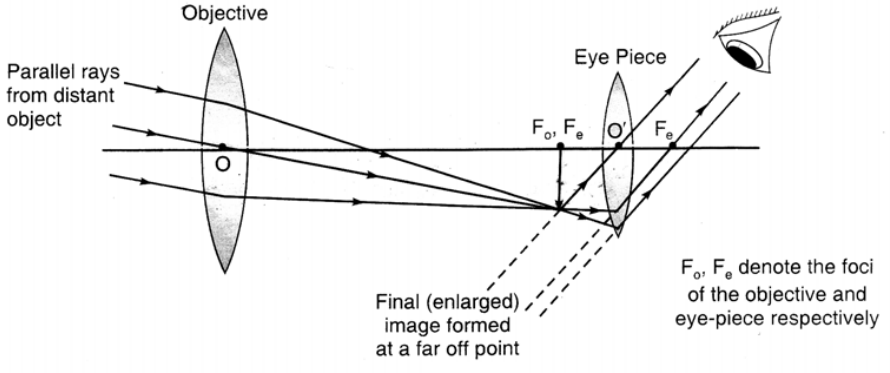


The Compound Miscroscope

TELESCOPE

We all know that it was the discovery of the telescope that helped the astronomers to know more about the different heavenly objects. The telescope is a device that is used for getting a magnified image of very far off distant objects like the moon, the planets and the stars. A telescope, used for viewing such heavenly objects, is known as an **astronomical telescope**.

Like the compound microscope, the astronomical telescope is also made by using two convex lenses. However, here, the lens facing towards the object - the **objective lens** is a convex lens of the large focal length and large aperture (diameter). The other lens, used as the eyepiece, is a convex lens of small focal length and small aperture. These lenses are fixed at one end each of two cylindrical tubes. The tube, containing the eyepiece, fits in, and can slide within, the longer tube containing the objective.



TELESCOPE

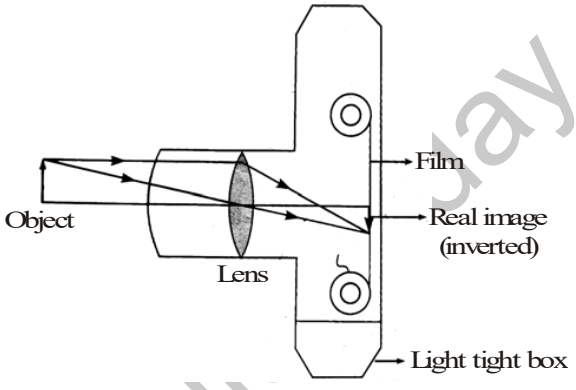
The objective, of an astronomical telescope, has a large diameter so that it can collect a greater amounmt of light from the (very) far off heavenly object. It forms a real, inverted and diminished image of this (heavenly) object near its focus. The eyepiece is so adjusted that this image lies at its focus also. It then forms a magnified image, of this image, formed by the objective. Hence the final image is quite enlarged and virtual with respect to the object. This helps us to see the details of far of heavenly objects.

THE PTOTOGRAPHIC CAMERA

'Smile please', says the ptotographer as she/he 'clicks' on the camera. This helps us to store yet another memorable moment/occasion/memory in our 'photo-file'.

The ptotographic camera is a simple application of the 'images' formed by a convex lens. The (good quality) convex lens of a camera forms a real, inverted (sharp) image of the object on the light sensitive screen or film of the camera. This image can then be stored as a 'photograph' by making use of the light dependent chemical properties of the materials deposited or coated on the film.

Besides the (convex) lens and its light sensitive screen, the camera also has a light tight (and blackened from inside) box. This has an (adjustable) aperture (or opening) in front through which the correct amount of light enters the box. This light falls on the 'light sensitive' screen kept near the 'back' of the box. It is possible to adjust the distance between this 'screen' and the lens of the camera. This (possibility) enables us to get sharp images of objects at different distances from the camera.



The Photographic Camera

KEY WORDS

1. **Angle of incidence:** The angle which the incident ray makes with normal at the point of incidence.
2. **Angle of reflection:** The angle which the reflected ray makes with normal at the point of incidence.
3. **Braille:** A special script developed for visually challenged people for reading.
4. **Ciliary muscles:** A ring of muscles which alter the focal length of the eye lens by expanding or contracting.
5. **Cornea :** A transparent tissue in front of the eye, which allows the light to pass through.
6. **Diffused reflection :** When a parallel beam of light on striking some rough surface gets reflected in different directions.
7. **Dispersion :** The phenomenon due to which white light splits into seven colours.
8. **Incident ray :** A ray of light which travels towards a mirror or some other medium.
9. **Iris :** A circular diaphragm which controls the amount of light entering the eye .
10. **Kaleidoscope :** A toy made by joining three plane mirror strips at an angle of 60°, such that coloured objects placed in it form beautiful hexagonal patterns .
11. **Mirror :** A highly polished surface from which reflection takes place.

12. **Normal :** A perpendicular drawn on the surface of mirror, at the point of incidence.

13. **Point object :** An object of the size of a point or a pin head .

14. **Point source of light :** A source of light of the size of a pin head.

15. **Ray diagram :** A diagram showing reflection in form of line diagram.

16. **Real image :** An inverted image which can be projected on screen .

17. **Regular reflection :** The phenomenon due to which a parallel beam of light, is reflected as parallel beam in some other direction.

18. **Retina :** A hemispherical light sensitive screen at the back of the eye on which image is formed.

19. **Spectrum :** A band of seven colours formed on the screen, when white light splits into seven colours.

20. **Virtual image :** An erect image which can not be taken on screen.

21. Light has both wave and quantum nature, this is known as dual nature of the light.

22. **Lasw of reflection :**

    (i) Incident ray, reflected ray and normal, all the three lie in the same plane.

    (ii) Angle of incidence is equal to angle of reflection $\angle i = \angle r$.

23. When a glass plate is polished with reflecting material then it becomes a mirror. Mirrors are of three types :

    (i) **Plane mirror**

    (ii) **Concave Mirror**

    (iii) **Convex mirror.**

24. Tha angle of incidence in a denser medium for which the angle of refraction in rarer medium is 90° is called **critical angle**.

25. When a ray travelling from denser to rarer medium gets incident at the interface of the two media at an angle greater than the critical angle, then the ray is totally reflected in the denser medium. This phenomenon is called total internal reflection.

26. When white light is incident on a prism then it splits up into seven colours. This phenomenon of splitting up of white light into its constituent colours is called dispersion.

27. Refractive medium bounded by two curved or one curved and one plane surface is called lens. Lenses are of two types :

    (i) **Convex or convergent lens**

    (ii) **concave or divergent lens.**

28. The image of an object formed by concave lens is always **virtual erect** and **smaller** than the object.

29. Microscope : It is an optical instrument which is used to view the magnified image of small objects. These are of two types :

    (i) **Simple microscope**

    (ii) **Compound microscope.**

TICK THE CORRECT OPTION

1. Angle of incidence is always equal to the angle of ___
(A) reflection (B) refraction (C) normal (D) emergence

2. Laws of reflection are true in case of ___
(A) plane mirrors only (B) spherical mirrors only (C) plane glass only (D) All types of mirrors

3. Which of the following types of mirror is used in the solar cooker ___
(A) plane mirror (B) simple glass (C) convex mirror (D) concave mirror

4. An incident ray makes an angle of 30° with a plane mirror. Then the angle of reflection is ___
(A) 30° (B) 60° (C) 90° (D) 45°

5. The device used for seeing over the heads of crowds is ___
(A) periscope (B) kaleidoscope (C) prism (D) telescope

6. The reflection taking place from the walls of building is called ___
(A) regular reflection (B) diffused reflection (C) multiple reflection (D) deam reflection

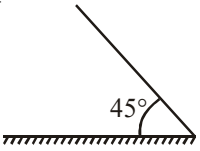
7. The reflection in which reflected rays travel as parallel beam is called ___
(A) regular reflection (B) scattering (C) irregular reflection (D) multiple reflection

8. A ray of light which bounces off the surface of a mirror is called ___
(A) normal (B) incident ray (C) reflected ray (D) emergent ray

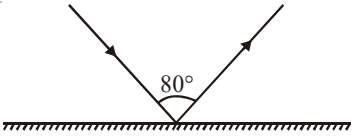
9. Still water or oil have a smooth surface and hence act like a ___
(A) mirror (B) lens (C) glass (D) prism

10. A real image ___
(A) is always verctual (B) can't be taken on the screen
(C) is always erect (D) is always inverted

11. A ray of light is incident on a plane mirror as shown in the figure.
What is the angle of reflection ___
(A) 45° (B) 120° (C) 60° (D) 90°



12. The sum of angles of incidence and reflection is 80°.
What is the angle between the reflected ray and the mirror?
(A) 45° (B) 30°
(C) 60° (D) 50°



13. The far point for a normal eye is ___
(A) 25 cm (B) 1 m (C) 2.5 cm (D) at infinity

14. The area on the retina which does not have light sensitive nerve fibres is called ___
(A) Iris (B) Sclera (C) pupil (D) blind spot

15. Blindness can be ___
(A) blindness only (B) congenital (C) acquired only (D) congenital or acquired

16. How many dots does Braille system involve ___
(A) 2 (B) 10 (C) 4 (D) 6

17. When the eye lens becomes opaque before birth, the person is born blind. this is known as ___
(A) cataract (B) congenital blindness (C) night blindness (D) none of these

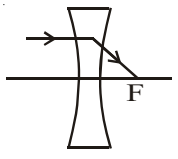
18. Who established that white light consists of light of seven colours ___
(A) Newton (B) Joule (C) Pascal (D) Huygen

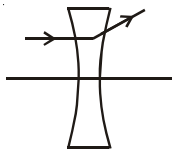
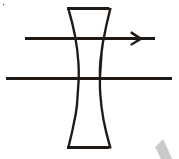
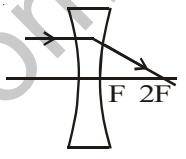
19. Louis Braille was born in ___
(A) Paris (B) London (C) New York (D) Japan

20. In the middle of the iris is a hole called the ___
(A) pupil (B) blind spot (C) sclera (D) yellow spot

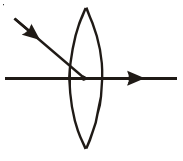
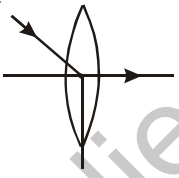
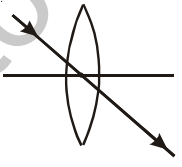
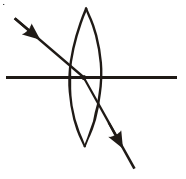
21. What happens, when a ray of light travels from air to glass medium ?
(A) It bends towards the normal at the separation of two media
(B) It bends away from the normal at the separation of two media
(C) It does not deviate from its path
(D) None of these

22. When a ray of light strikes the surface of separation of two media at an angle of 90°, then ___
(A) It deviates from its path at an angle of 30° (B) It does not deviates from its path
(C) It deviates from its path at an angle of 45° (D) None of these

23. Which of the following diagrams correctly represent the passage of a ray of light through a concave lens ?
(A) 

(B) 
(C) 
(D) 

24. When light travels from water to glass, angle of incidence ___
(A) Is less than the angle of refraction (B) Is greater than the angle of refraction
(C) Is equal to the angle of refraction (D) None of these

25. Which of the following diagrams correctly represents the ray of light passing through the optical centre?
(A) 
(B) 
(C) 
(D) 

26. Where should an object be placed so that a real and inverted image of very large size is obtained, using a convex lens ?
(A) At the focus (B) At 2F (C) At infinity (D) Beyond 2F

27. Refractive index of a glass is maximum for ..... colour of visible light.
(A) violet (B) yellow (C) blue (D) red

28. Which instrument is used to study distant starts, comets etc. ?
(A) compound microscope (B) simple microscope
(C) Telescope (D) Both (A) and (B)

29. The eye lens is held in position by —
(A) rods and cones (B) iris and pupil (C) ciliary muscles (D) none of these

30. Which of the following lens is used to minimize myopia —
(A) Convex lens (B) Concave lens (C) Cylindrical lens (D) None of these

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	D	A	A	A	B	A	C	A	D	A	D	D	D	D
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	D	B	A	A	A	A	B	B	B	C	A	A	C	C	B

FILL IN THE BLANKS

1. A real image can be taken on the .....
2. A virtual image is always ..... but laterally .....
3. The angle of incidence is equal to angle of .....
4. The plane containing the incident ray and the ..... is called the plane of .....
5. Any smooth polished surface which can return back the rays of light into the same medium is called .....
6. The phenomenon of left appearing right and right appearing left on reflection in a plane mirror is called .....
7. Periscope is based on the principle of successive ..... from two plane mirrors.
8. Beautiful patterns are formed in a kaleidoscope because of multiple .....
9. Splitting of light into its constituent colours is known as .....
10. Visually challenged persons can read and write using the ..... system.
11. The coloured part of the eye in front of the lens is called .....
12. The thickness of the eye lens is altered by .....
13. A ray of light, passing from one medium to another, does not bend is path if its angle of incidence equals .....
14. The more is the optical density of a given medium, the ..... is the speed of light through it.
15. The phenomenon, of the splitting of white light into seven colours, is known as the phenomenon of .....
16. The objective lens of a telescope is a ..... lens of ..... focal length .
17. A person 1.5 m in front of a mirror seems to be ..... m behind the mirror.
18. The angle between the incident ray and the normal is called angle of .....
19. The angle between the reflected ray and the normal is called angle of .....
20. A kaleidoscope is based on ..... reflections.
21. Sunlight consists of ..... colours.
22. The ..... muslces attached to the eye lens make it thicker to see objects.
23. Cones are sensitive to ..... light.
24. Rods are sensitive to ..... light.
25. Night birds have ..... cones than rods in their eyes.
26. In a kaleidoscope, three plane mirror are inclined at an of .....
27. The point where the optic nerve leaves the retina is called ..... spot.
28. Lateral inversion is also called ..... inversion.
29. ..... or ..... reflection occurs when light falls on an uneven surface.
30. The ..... is a luminous object.

WRITE TRUE OR FALSE THE FOLLOWING STATEMENTS

1. Angle of incidence is sometime equal to angle of reflection in case of mirror.
2. Laws of reflection are true for a plane mirror only.
3. Night blindness is caused due to the deficiency of vitamin A.
4. For a normal eye, the near point is at a distance of 25 cm from eye.
5. A virtual image cannot be taken on the screen.
6. A real image is always inverted.
7. In a plane mirror, the image is as far behind the mirror as the object is in front of it.
8. The image formed by a plane mirror is virtual and erect.
9. The most popular resource for visually challenged persons is Braille.
10. Two mirrors inclined to each other do not give multiple images.
11. Braille is a system of writing using six raised dots and helps the visually challenged to read.
12. The spectrum of white light has seven colours.
13. Droplets of water split sunlight to form a spectrum known as rainbow.
14. A diet rich in vitamin D is useful for the eyes.
15. The basic cause of refraction is the change in the speed of light as it goes from one medium to another.

16. The final refracted ray (the emergent ray), coming out of a parallel faced glass slab, is bent with respect to the incident ray.
17. An incident ray always bends away from the normal when it passes from one transparent medium into another.
18. A coin, kept at the bottom of an empty dry cup, appears to 'rise up' when some water is poured into the cup.
19. If the yellow light alone, coming out of a glass prism, is made to fall on to another glass prism, it will again get split into orange and green colours.
20. All reflection produce image .

MATCH THE ITEMS IN COLUMN-A WITH THE ITEMS IN COLUMN-B

1.

Column-A		Column-B	
(A)	Image in a plane mirror	(i)	Angle of reflection
(B)	Left appearing right in a plane mirror	(ii)	Formation of images by inclined mirros
(C)	Angle of incidence equals	(iii)	used as looking glass
(D)	Kaleidoscope	(iv)	Lateral inversion
(E)	Plane mirror	(v)	Virtual and erect
		(vi)	Angle of refraction

2.

Column-A		Column-B	
(A)	The line joining the centres of curvature of the two surfaces of a lens.	(i)	Object at the '2F' point
(B)	A ray of light, passing through it, does not	(ii)	Concave lens
(C)	Real, inverted image of the same size as the object	(iii)	Principal Axis
(D)	A virtual, erect and diminished image for all position of the object	(iv)	Compound Microscope
(E)	An optical instrument using two convex lenses of short focal length	(v)	Optical centre

SELECT THE ODD ONE OUT GIVING REASON

1. Diffused reflection, Regular reflection formation of image.
2. Kaleidoscope, periscope, Mirror.
3. Cones, retina, Iris.
4. Iris, Cornea, retina
5. Sun, moon, glowworm, tubelight.
6. Spectrum, prism, reflection, dispersion.
7. Focus, cornea, iris, pupil.
8. Real, virtual, plane mirror, laterally, inverted.
9. Plane mirror, kaliedoscope, periscope, prism.
10. Concave mirror, convex mirror, plane mirror.

ANSWER KEY

- **Fill In The Blanks :**
  1. Screen **2.** erect, incidence **3.** reflection **4.** normal, incidence **5.** mirror **6.** lateral inversion **7.** reflection **8.** reflection **9.** disperson **10.** Braille **11.** Iris **12.** Ciliary muscles **13.** 90° **14.** less **15.** dispersion of light **16.** convex, small **17.** 1.5 **18.** incidence **19.** reflection **20.** multiple **21.** seven **22.** ciliary **23.** bright **24.** dim **25.** less **26.** 60° **27.** blind **28.** lateral **29.** irregular, diffused **30.** sun
- **Write True Or False For the Following :**

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

- **Match the following :**
  (A) (A) → v ; (B) → iv ; (C) → i ; (D) → ii ; (E) → iii;
  (B) (A) → iii ; (B) → iv ; (C) → i ; (D) → v ; (E) → ii;

SUBJECTIVE ANSWER TYPE QUESTIONS

Short Answer Type Questions

1. What is a luminous object?
2. Define angle of incidence.
3. Define angle of reflection.
4. What is meant by normal to the surface?
5. Can a real image be obtained on a screen?
6. Is a virtual image inverted?
7. An incident ray makes an angle of 30° with the miror. What is the angle of incidence?
8. An incident ray makes an angle of 20° with the normal. What is the angle of reflection?
9. Who had invented Braille system for visually impaired people?
10. Who controls the amount of light entering the eye?
11. What is the blind spot? Where is the located?
12. Which mirror is used in solar cookers?
13. When is a person unable to see?
14. How is a rainbow formed?
15. Wher in the eye will you find nerve fibres sensitive to light?
16. Will red light passing through a prism result in a spectrum?
17. Why does eye lens become cloudy in case of old people?
18. What is reflection of light?
19. What are angle of incidence and angle of reflection?
20. What type of image is formed by a plane mirror?
21. What type of reflection forms an image?
22. What is a kaleiodscope?
23. What is persistence of vision?
24. What is cataract?
25. Who invented the braille system?

Answer The Following In Brief

1. What do you mean by reflection?
2. State the laws of reflection.
3. Write two uses of plane mirrors.

4. What is power of accommodation?

5. What is lateral inversion?

6. Define dispersion of light through a prism.

7. What will be the value of angle refraction if light ray is incident normally on the glass slab?

8. A light ray is incident at 45° on a plane mirror then what is the angle between incident ray and reflected ray?

9. What type of lens is used in a simple microscope?

10. Name the lens which diverges the light rays.

Answer The Following In Appropirate Detail

1. With the help of diagrams, explain the difference between regular and irregular reflection.

2. What do you mean by a spectrum? Why is a spectrum formed by a prism and not by a glass slab?

3. Draw a labelled diagram to show the working of a kaleidoscope. What are the uses of a kaleidoscope?

4. What do you mean by reflection of light? State the laws of reflection of light. With the help of an experiment prove the laws of reflection in case of a plane mirror.

5. What are the properties of the image formed by a plane mirror? Explain the phenomenon of lateral inversion with the help of a diagram.

6. With the help of a labelled diagram, show the essential parts of the human eye. How do we see objects? Briefly explain the common defect of eye.

7. What is a simple microscope? Write about its working by drawing ray diagram.

8. Describe the construction and working of a compound microscope by drawing ray diagram.

9. Draw a labeled diagram of the human eye and explain its various parts.

10. Draw the ray diagram for the formation of image of a distance object by a telescope.

Each Question 1 Marks

1. Define dispersion of light.

Ans. Splitting up of white into seven colours when it passes through a glass prism is known as dispersion of light.

2. Name the colours in the order they appear in the spectrum of light.

Ans. VIBGYOR - Violet, Indigo, Blue, Green, Yellow, Orange and Red.

3. What is the angle of incidence of a ray if the reflected ray is at an angle of 90° to the incident ray?

Ans. The angle of incidence = 45°.

4. What are the two factors reponsible for an object be seen?

Ans. To be seen an object, the sence of vision and light are required.

5. Why we cannot see an object in a dark room?

Ans. We cannot see an object in a dark room because no light is reflected from the object.

6. What is meant by normal?

Ans. The perpendicular drawn at the point of incidence is known as normal.

7. What name is given to the angle between the normal and the reflected ray?

Ans. Angle of reflection.

8. What are illuminated object?

Ans. Objects which reflect the light falling on them and can be seen are known as illuminated objects.

9. Give one example of natural dispersion.

Ans. Formation of rainbow.

10. What type of lens is pressent in the eye?

Ans. Convex lens.

Each Question 2 Marks

1. Which kind of spherical mirrors are used in vehicles? Why?

Ans. A convex mirror is used in vehicles because it gives the driver a lager field of view.

2. Why is it important to take care of our eyes? Mention any two activities that may cause damage to our eyes.

Ans. Eyes are the most wounderful gift of nature to us and they must serve us for whole life.

3. Suppose you are in a dark room. Can you see object in the room? Can you see objects outside the room? Expain.

Ans. The objects cannot be seen inside the room because their is no light. The objects outside the room can only be seen if there is light outside.

4. State the laws of reflection.

Ans. Laws of reflection :

i. The incident ray, the reflected ray and the normal at the point of incidence lie in the same plane.

ii. The angle of incidence is equal to the angle of reflection.

5. Distinguish between real and virtual image.

Ans. Differences :

Real Image	Virtual image
(a) The rays actually meet at a point	(a) The rays donot meet at a point.
(b) The image can be obtained on a screen.	(b) The image cannot be obtained on a screen.

6. How many plane mirror strips do we use in a kaleidoscope. At what angle are they inclined with respect to each other?

Ans. The kaleiodscope uses a set of three equal size plane mirror strips. The three strips are inclined to each other at angles of 60° each.

7. What is short sightedness? How is it corrected?

Ans. A person with shorts sight can see nearly objects but not far away objects. It can be corrected by using a concave lens.

8. What is long sightedness? How is it corrected?

Ans. A person with long sight can see far away objects clearly but cannot see nearby object clearly. It can be corected by using a convex lens.

9. Why should children take milk and eat carrots?

Ans. Milk, carrots and yellow fruits are rich in vitamin A, which is very essential for the eyes to maintain good vision.

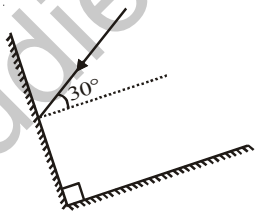
10. Is the moon a luminous body? How are we able to see the moon?

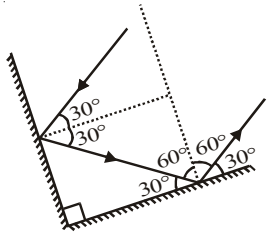
Ans. The moon is non-luminous. We are able to see the moon because it reflects the sunlight falling on it.

EACH QUESTION 3 MARKS

1. Two mirrors meet at right angles. A ray of light is incident on one at an angle of 30° as shown in fig. Draw the reflected ray from the second mirror.

Ans.





2. How are we able to see objects?

Ans. The lens focuses the light on the back of the eye on the retina. Retina contains several nerve cells which transmit the sensations to brain through the optic nerve. We are then able to see the objects.

3. What are cones and rods? What are their function?

Ans. Cones are the nerve endings which are sensitive to colour light. They help us to distinguish between colours.

Rods are the nerve ending which are sensitive to bright light.

4. (i) In a periscope two mirrors are arranged parallel to each other but they do not form multiple images. Why?

(ii) What is the use of periscope?

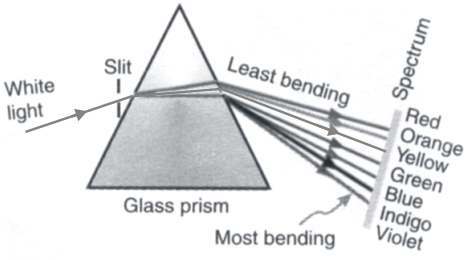
Ans. (i) In a periscope two mirrors are placed parallel and facing each other but are in an inclined position at an angle of 45°. So that do not form multiple images.

(ii) Uses of periscope – In submarines to view the happening on the surface of water.

– to view objects behind the wall.

5. Draw a diagram to show dispersion of light.

Ans.



6. (i) What is spectrum?

(ii) What is the meaning of VIBGYOR?

Ans. (i) Spectrum is the band of seven colours obtained on the screen when white light splits on passing through a prism.

(ii) VIBGYOR represents the seven colours of the spectrum, i.e. violet, indigo, blue, green, yellow, orange and red.

7. How is a rainbow formed?

Ans. The water droplets suspended in the air after the rain act as prisms. When the sun is towards the horizon the inclined rays pass through the water drops to disperse into the seven colours of the spectrum.

8. Why does white light disperse when it passes through a glass prism?

Ans. White light is a combination of seven colours of light. The speed of each colour is different. So, while passing through the glass prism each colour deviates by different amounts. Therefore, despersion of light into a spectrum takes place.

9. (i) Which part of the human eye makes a person 'blue eyed' ?

(ii) What role is played by ciliary muscles?

(iii) What is the importance of retina in the eye?

Ans. (i) Iris is responsible for making the person blue eyed.

(ii) Ciliary muscles help to adjust the focal length of the lens to view all objects clearly.

(iii) The image of the object is formed on the retinal of the eye.

10. What is the difference between the eye of the night birds and day birds?

Ans. The day birds can see clearly during the day but not at night. The day birds have more cones and less rods. The cones are sensitive to bright light and can sense colours. Night birds can see clearly at night but not during the day. Their eyes have a large cornea and pupil to allow more light to pass. Also their retinal has mostly rods and few cones. Rods are more sensitive to dim light.

Each Question 5 Marks

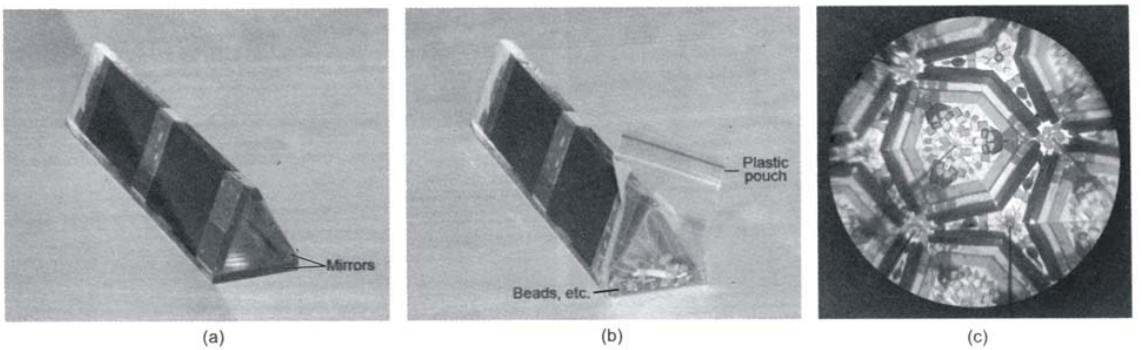
1. How can you compare human eye with a photographic camera?

Ans.

Human Eye	Photographic Camera
(a) Real, Inverted image is formed on retina.	(a) Real, inverted image is formed on a film.
(b) The image cannot be stored as a ptotograph	(b) The image can be stored as a photograph
(c) The focal length of convex lens can be adjusted by cliary muscles.	(c) The focal length of the lens cannot be adjusted.

2. Describe the construction of a kaleidoscope.

Ans. To make a kaleidoscope, get three rectangular strips of glass 15 cm long and 4 cm wide each. Join them together to form a prism. Fix them with a few thick chart papers in a slightly long circular tube. Close one end of the tube by a cardboard disc having a hole in centre. At the other end touching the mirrors fix a circular plane glass sheet. Invert the tube and place some broken small pieces of coloured bangles on the glass plate. Close this end of the tube by a ground glass plate.



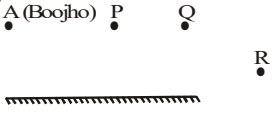
(a)-(b) Making a kaleidoscope (c) A pattern formed by a kaleidoscope

3. Explain how you can take care of your eyes.

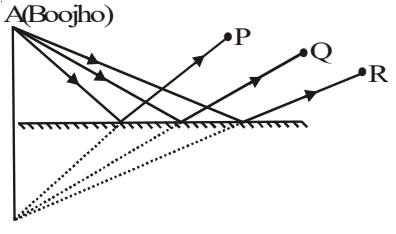
Ans. We can take care of our eyes in the following ways –

(a) have a regular check up.
(b) if advised, use suitable spectacles.
(c) avoid too much or too little sight.
(d) wash your eyes frequenctly with clean water.
(e) always read at the normal distance for vision.

4. Boojho stands at A just on the side of a plane mirror as shown in figure. Can he see himself in the mirror? Also can he see the image of objects situated at P, Q and R?



Ans. Yes, Boojho can see his image. Yes, he can see the objects situated at P, Q and R.



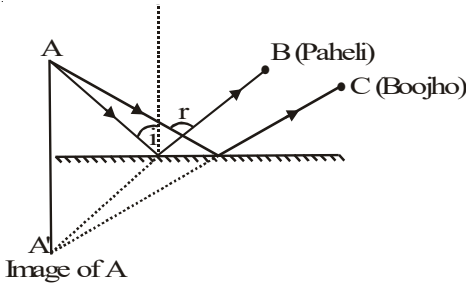
5. (i) Find out the position of the image of an object situated at A in the plane mirror (fig).

(ii) Can Paheli at B see this image?

(iii) Can Boojho at C see this image?

(iv) When Paheli moves from B to C, where does the image of A move?

Ans. (i)



(ii) Yes Paheli can see the image of A.

(iii) Yes, Boojho can see this image.

(iv) When Paheli moves from B to C, the image of A will move from B to C.

REFLECTION OF LIGHT

Tick (✓) the correct choice among the following :

1. An incident ray strikes a plane mirror at an angle of 15° with the mirror. The angle between the incident ray and reflected ray is
(A) 15° (B) 30° (C) 150° (D) none of these

2. In the question above, the angle between the reflected ray and the mirror is
(A) 15° (B) 30° (C) 75° (D) none of these

3. If a mirror has a focal length of + 15 cm, it is a
(A) convex mirror (B) concave mirror (C) plane mirror (D) none of these

4. The focal length of a plane mIrror is
(A) positive (B) negative (C) zero (D) infinity

5. The mirror used in automobiles to see the rear field of view is
(A) concave. (B) convex (C) plane (D) none of these

6. A mirror having a very wide field of view must be
(A) concave (B) convex (C) plane (D) none of these

7. The mirror used in search lights is
(A) concave (B) convex (C) plane (D) none of these

8. In order to have a very wide field of view, the mirror used in cars is
(A) convex (B) plane (C) concave (D) none of these

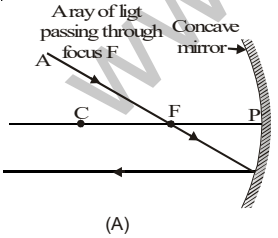
9. Shaving mirrors are
(A) convex mirrors (B) concave mirrors (C) plane mirrors (D) none of these

10. The laws of reflection are true for
(A) the plane mirror only (B) the concave mirror only
(C) the convex mirror only (D) all reflecting surfaces

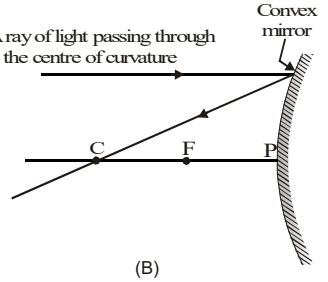
11. A virtual image is one which
(A) can be taken on a screen
(B) cannot be taken on a screen
(C) sometimes can be and sometimes cannot be taken on a screen
(D) is formed only by a concave mirror

12. When an object is at infinity from a concave mirror, the image formed is
(A) at the focus (B) virtual and erect (C) highly enlarged (D) none of these

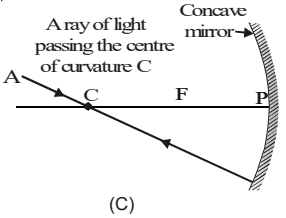
13. Which of the following ray diagrams is not correct?



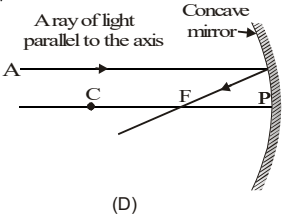
(A)



(B)



(C)



(D)

14. Which of the following is a non-luminous body?
(A) Fire (B) Sun (C) Stars (D) Earth

15. Which of the following is a luminous body?
(A) Fire (B) Earth (C) Moon (D) Tree

16. Choose the only correct option in case of a concave mirror:

	Object distance	Image distance	Image size	Nature of image
(A)	At C	At C	Equal to object	Real and inverted
(B)	Beyond C	Between F and C	Diminished	Virtual and erect
(C)	Between F and C	At infinity	Enlarged	Real and inverted
(D)	At F	At infinity	Highly diminished	Virtual and erect

17. When light falls on matter, it can produce
(A) mechanical effect (B) chemical effect (C) heating effect (D) all the above

18. Which of the following body allows only a part of the light to pass through it?
(A) Oiled paper (B) Brick (C) Wood (D) Air

19. The path along which light travels in a homogenous medium is called the
(A) beam of light (B) ray of light (C) pencil of light (D) none of these

20. The amount of light reflected depends upon
(A) the nature of material of the object (B) the nature of the surface
(C) the smoothness of the surface (D) all the above

21. Air is not visible because it
(A) is nearly a perfectly transparent substance (B) neither absorbs nor reflects light
(C) transmits whole of light (D) all the above are correct

22. A real image is formed when two or more
(A) reflected rays meet (B) refracted rays meet
(C) reflected rays appear to meet (D) none of these

23. The image of our face in a plane mirror is
(A) real (B) magnified (C) diminished (D) none of these

24. The sideways reversal of the image by plane mirror is called
(A) lateral inversion (B) parallex (C) optical illusion (D) none of these

25. Two points such that each focus for the rays proceeding from the other, are called
(A) centres of curvature (B) conjugate foci (C) converging foci (D) none of these

26. In case of a concave mirror, when the object lies between the pole and the principal focus, the image formed is
(A) virtual (B) erect (C) magnified (D) all the above

27. The rays parallel and close to the principal axis are called
(A) converging rays (B) divergent rays (C) coherent rays (D) paraxial rays

28. A mirror having a very wide field of view must be
(A) concave (B) convex (C) plane (D) paraboloid

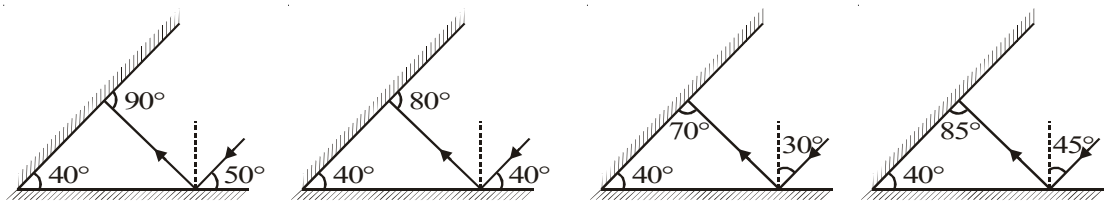
29. The laws of reflection are true
(A) for plane reflecting surfaces only (B) for all reflecting surfaces
(C) not for curved reflecting surfaces (D) none of these

30. As the object is brought nearer to the vertex of a mirror, it is found that the image also moves towards the vertex. The mirror must be
(A) convex (B) concave (C) concave or convex (D) paraboloid

31. The principle of successive reflections of light at inclined mirrors is used in
(A) periscope (B) telescope (C) microscope (D) kaleidoscope

32. Which of the following is employed to clearly view objects which cannot be seen directly due to obstruction?
(A) Laser (B) Periscope (C) Kaleidoscope (D) None of these

33. Which of the following correctly depicts reflections in case of plane mirrors inclined at 40°?

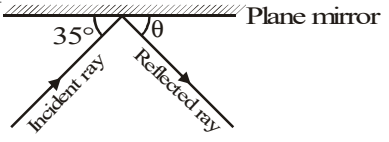


(A) (B) (C) (D)

34. A ray of light is incident on a plane mirror at an angle θ. If the angle between the incident and reflected rays is 80°, what is the value of e

(A) 40° (B) 50° (C) 45° (D) 55°

35. A ray of light is incident at an angle of 35° on a plane mirror. What is angle θ?



(A) 35° (B) 45° (C) 55° (D) none of these

36. If a ray of light incident on a plane mirror is such that it makes an angle of 30° with the mirror, then the angle of reflection is

(A) 30° (B) 45° (C) 55° (D) 60°

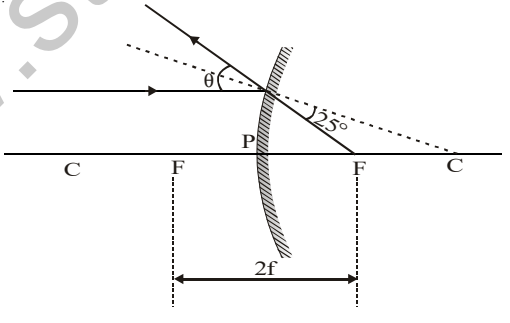
37. A boy is standing in front of a plane mirror at a distance of 3 m from it. What is the distance between the boy and his image?

(A) 3 m (B) 4.5 m (C) 6 m (D) none of these

38. The centre of curvature of a _____ mirror is in front of it.

(A) convex (B) concave (C) convex or concave (D) none of these

39. What is the value of θ in the following ray diagram?



(A) 25° (B) 35° (C) 50° (D) none of these

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	A	A	D	B	B	A	A	B	D	B	A	B	D	B
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	A	D	A	B	D	D	A	D	A	B	D	D	B	B	A
Que.	31	32	33	34	35	36	37	38	39						
Ans.	D	B	A	B	A	D	C	B	C						

REFRACTION OF LIGHT

Tick (✓) the correct choice among the following :

1. Who amongst the following used corpuscular theory to explain reflection and refraction of light?

(A) Newton (B) Maxwell (C) Young (D) Hertz

2. Albert Einstein used corpuscular theory to explain

(A) $E = mc^2$ (B) photoelectric effect (C) quantisation of charge (D) none of these

3. Who first proposed that light was wave-like in character?

(A) Huygens (B) Newton (C) Young (D) Maxwell

4. The unit of power of a lens is

(A) metre (B) dyne (C) dioptre (D) none of these

5. The least distance of distinct vision for a normal person is about

(A) 1 m (B) 0.5 m (C) 0.25 m (D) none of these

6. The focal length of a lens is 50 cm. Its power would be

(A) 50 dioptres (B) 2 dioptres (C) 20 dioptres (D) none of these

7. A simple magnifying glass consists of a

(A) concave lens (B) con vex lens of large focal length

(C) convex lens of small focal length (D) plane mirror only

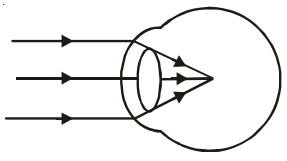
8. Fig. (1), (2), (3), and (4) respectively correspond to

(A) the short-sighted eye, the correction of long-sight, the long-sighted eye and the correction of short-sight

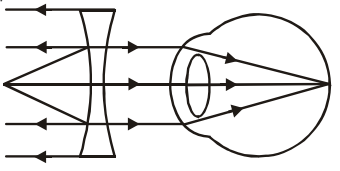
(B) the short-sighted eye, the correction of short-sight, the long-sighted eye and the correction of long-sight

(C) the long-sighted eye, correction of shortsight, the short-sighted eye and the correction of long-sight

(D) none of these



(1)



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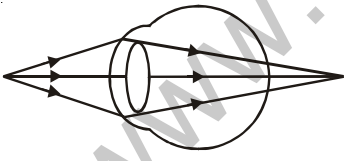

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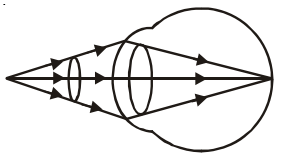


(4)

9. The screen behind the eye lens is called the

(A) iris (B) ciliary muscle (C) retina (D) pupil

10. The image on the retina remains for

(A) 20 s (B) 10 s (C) $\frac{1}{10}$ s (D) $\frac{1}{16}$ s

11. The middle vascular coat that darkens the eye chamber and prevents refraction by absorbing the light rays is

(A) choroid (B) sclera (C) retina (D) cornea

12. The amount of light entering the eye is controlled by the

(A) iris (B) cornea (C) pupil (D) crystalline lens

13. The eye lens is a

(A) transparent double-convex lens (B) transparent double-concave lens

(C) transparent concavo-convex lens (D) none of these

14. The eye lens contains a watery liqui.d called the

(A) aqueous humour (B) peroxide (C) vitreous humour (D) none of these

15. Long-sightedness is caused by the eyeball being too short. It can be corrected by the use of a

(A) convergent lens (B) plane mirror (C) divergent lens (D) none of these

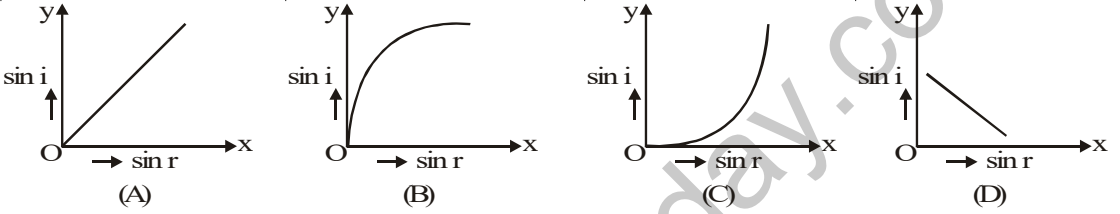
16. Astigmatism occurs when the cornea does not have a truly spherical shape. This defect can be cured by the use of a

(A) concave lens (B) cylindrical lens (C) convex lens (D) plano-convex lens

17. The amount of light entering in the eye is controlled by the

(A) pupil (B) iris (C) cornea (D) eye lens

18. Which of the following correctly represents graphical relation between sine of angle of incidence (i) and sine of angle of refraction (r)?



19. The bending of light as it passes from one medium into another is commonly known as

(A) reflection (B) refraction (C) scattering (D) dispersion

20. Which of the following quantity does not have any unit?

(A) Velocity of light (B) Light year (C) Magnification (D) Power of a lens

21. When light travels another, it suffers

(A) reflection (B) refraction (C) dispersion (D) none of these

22. The refraction of light is commonly known as

(A) bending (B) scattering (C) reflection (D) interference

23. When a ray of light passes from an optically less dense medium to a more dense medium, it

(A) goes undeviated (B) bends towards the normal

(C) bends away from the normal (D) none of these

24. Light year is the unit of

(A) time (D) distance (C) intensity of light (D) None of these

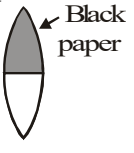
25. How will the image formed by a convex lens be affected if the upper half of the lens is wrapped with a black paper?

(A) The size of the image is reduced to one-half.

(B) The upper half of the image will be absent.

(C) The brightness of the image is reduced.

(D) There will be no effect



26. A green leaf placed in a dark room is illuminated by red light. The leaf will appear to be

(A) green (B) red (C) yellow (D) black

27. An object looks red when seen through a piece of red glass. What is the actual colour of the object?

(A) Red only (B) White only (C) Red or green (D) Black

28. The ratio of the sine of angle of incidence to the sine of angle of refraction is called

(A) Snell's law (B) optical density (C) relative density (D) none of these

29. The mirror formula is given by

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

where the symbols have their usual meanings. Then the lens formula is given by

(A) $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ (B) $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$ (C) $\frac{1}{v}+\frac{1}{u}=-\frac{1}{f}$ (D) none of these

30. A lens is called a thin lens if its overall thickness is

(A) small (B) large (C) infinitely large (D) none of these

31. In optical instruments, the lenses are used to form images by

(A) reflection (B) refraction (C) dispersion (D) scattering

32. 1 D is equal to

(A) 1 m (B) 1 cm (C) 1 m^{-1} (D) 1 cm^{-1}

33. The power of a lens is denoted by

(A) P (B) D (C) m^{-1} (D) W

34. If f is focal length of the lens, then the power of a lens is equal to

(A) $\frac{100}{f(cm)}$ (B) $\frac{10}{f(cm)}$ (C) $\frac{100}{f(m)}$ (D) $\frac{1}{100\ f(m)}$

35. A ray of light coming parallel to the principal axis after passing through a convex lens, passes through its

(A) optical centre (B) focus (C) centre of curvature (D) none of these

36. The focal length can be expressed in

(A) metre (B) Dioptre (C) watt (D) horse power

37. A concave lens always gives

(A) virtual image (B) erect image (C) diminished image (D) all the above

38. The power of a lens whose focal length is one metre is_____dioptre.

(A) one (B) ten (C) hundred (D) none of these

39. Our eye lens is a

(A) convex lens (B) concave lens (C) plano-convex lens (D) none of these

40. The camera lenses are marked with

(A) dioptres (B) metres (C) f-numbers (D) none of these

41. The eye lens is held in position by

(A) rods and cones (B) iris and pupil (C) ciliary muscles (D) none of these

42. The time of exposure in a camera is controlled by a

(A) shutter (B) convex lens (C) bellows (D) diaphragm

43. A simple microscope is also known as

(A) a simple glass (B) magnifying glass

(C) a converging lens (D) both (A) and (B)

44. In case of a compound microscope, the objective forms

(A) real image (B) inverted image (C) magnified image (D) all the above are correct

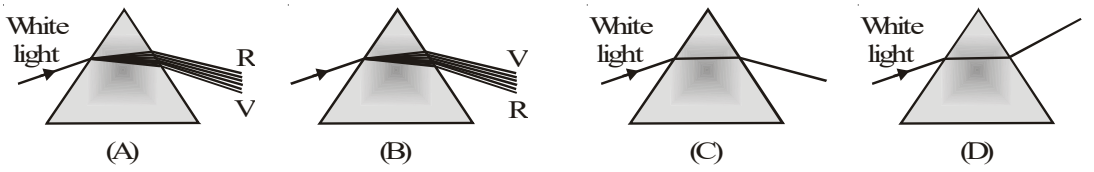
45. The effect of ' the glass prism is only to separate the seven colours of

(A) white light (B) sunlight (C) light from a bulb (D) all the above

46. Who discovered by his experiments with glass prisms that white light consists of seven colours?

(A) Newton (B) Faraday (C) Maxwell (D) Young

47. Which of the following figures correctly represents the passage of white light through a prism?



48. Colour blindness is due to

(A) the absence of cone cells (B) the absence of rod cells

(C) the presence of rod cells (D) none of these

49. The rod cells correspond to

(A) the colour of light (B) the source of light (C) the intensity of light (D) none of these

50. The colour complementary to yellow is

(A) blue (B) white (C) red (D) green

51. Choose the colour which is different from the others.

(A) red (B) green (C) blue (D) yellow

52. A red rose appears red in

(A) white light (B) green light (C) yellow light (D) none of these

53. Human beings cannot see

(A) red light (B) yellow light (C) green light (D) ultraviolet light

54. The colour of light corresponds to its

(A) speed (B) frequency (C) wave length (D) none of these

55. Under normal conditions, the colour of the sky at noon is

(A) blue (B) red (C) yellow (D) none of these

56. Light wavelength visible to the human eye is

(A) 1000 Å (B) 3000 Å (C) 6000 Å (D) 8000 Å.

57. The angle between two plane refracting surfaces of the prism is called the angle of

(A) prism (B) emergence (C) deviation (D) incidence

58. The ratio of real depth to apparent depth is called lhe

(A) refractive index (B) critical angle (C) lateral displacement (D) none of these

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	A	B	A	C	C	B	C	B	C	D	A	C	A	A	A
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	B	B	A	B	C	B	A	B	D	C	D	A	A	B	A
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	B	C	A	A	B	A	D	A	A	C	C	A	A	D	D
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58		
Ans.	A	A	A	C	A	D	A	D	C	A	C	A	A		