UNIT 12

GEOMETRICAL OPTICS

After studying this unit, the students will be able to:

a. Describe the terms used in reflection and state laws of reflection. Including normal, angle of incidence, angle of
b. Solve problems of image location by spherical mirrors by using mirror formula.

c. Define the terminology for the angle of incidence i and angle of refraction r and describe the passage of light through parallel-sided transparent material.
d. Solve problems by using the equation sin i/ sin r= n (refractive index).
e. State the conditions for total internal reflection.
f. Describe the passage of light through a class prism.
g. Describe how total internal reflection is used in light propagation through optical fibres.
h. Describe how light is refracted through lenses.
i. Define power of a lens and its unit.
j. Solve problems of image location by lenses using lens formula.
k. Define the terms resolving power and magnifying power.
l. Draw ray diagram of simple microscope and mention its magnifying power.
m. Draw ray diagram of compound microscope and mention its magnifying power.
n. Draw ray diagram of a telescope and mention its magnifying power.
o. Dray ray diagrams to show the formation of images in the normal eye, a short-sighted eye and a long-sighted eye.
p. Describe the correction of short-sightedness and long-sightedness.

Q.1 What do you mean by reflection of light? Describe the laws and types of motion?

Answer

Reflection of light: (Definition)

When light travelling in a certain medium falls on the surface of another medium, a part of it turns back in the turns back in the same medium. This is called reflection of light.

shown in fig. (12.1).

Fig 12.1

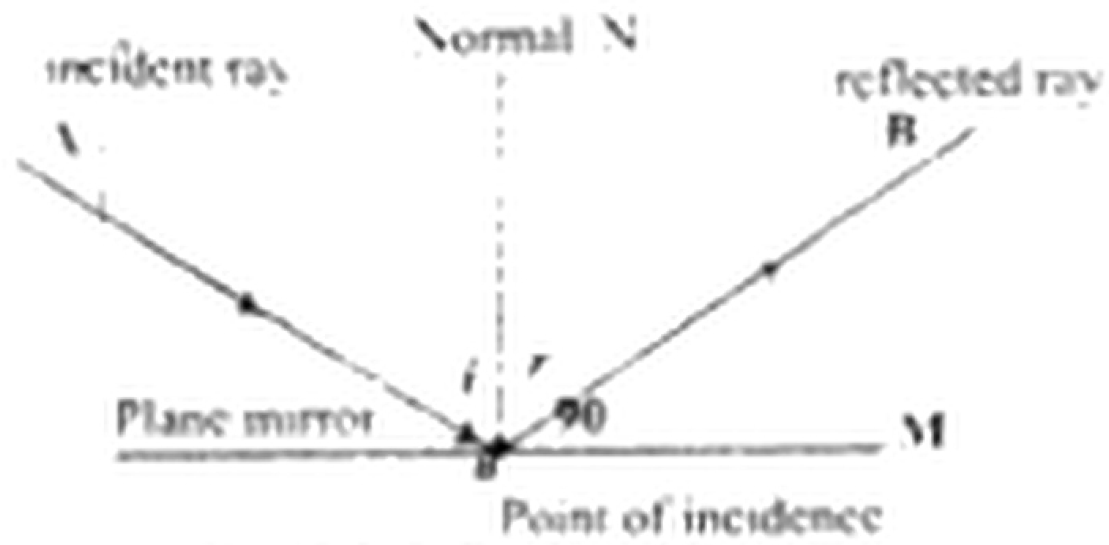


Fig. 12.2: Reflection of light

Activity

Spread a dark colored sheet of paper between the mirror and the comb as

Keep this apparatus in sunlight or send a beam of light from a torch through the comb.

The pattern formed in this activity gives us an idea of a process in which light gets deflected from a mirror. This' process is called reflection of light.

Laws of reflection

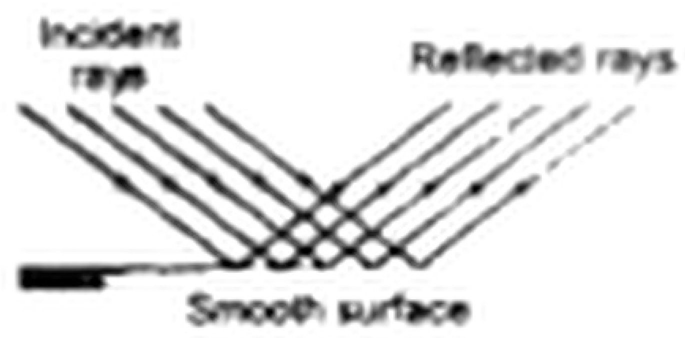


Fig. 12.3: Regular reflection

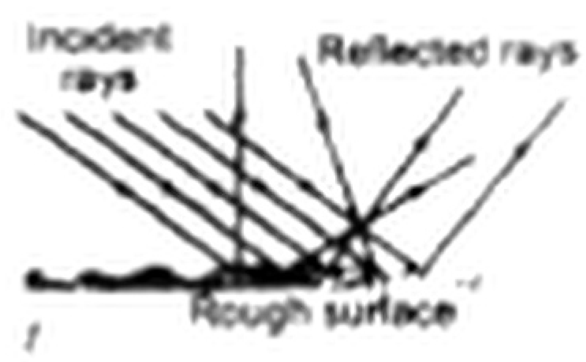


Fig. 12.4: Irregular reflection

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

ii) The angle of incidence is equal to be angle of reflection i.e. $i = r$

Types of reflection

a) Regular reflection

The reflection of light rays from the smooth surfaces (silver, mirror etc.) is called regular reflection.

b) Irregular reflection

Most of the objects in everyday world are not smooth on the microscopic level. The rough surfaces of these objects reflect the rays of light in many directions. Such a type of reflection is called irregular reflection.

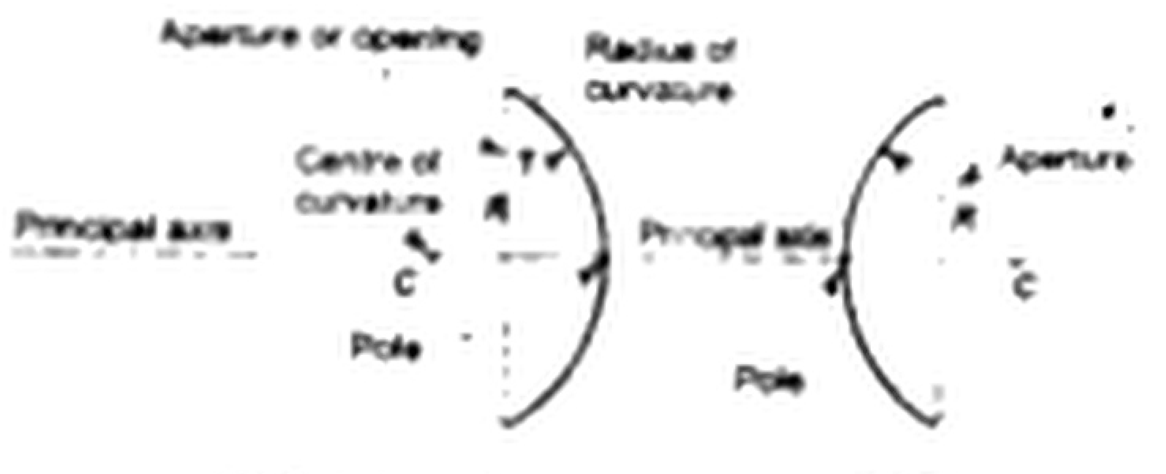
Q.2. What are the spherical mirrors? Write its types and different terms related to spherical mirrors?

Answer

Spherical mirror

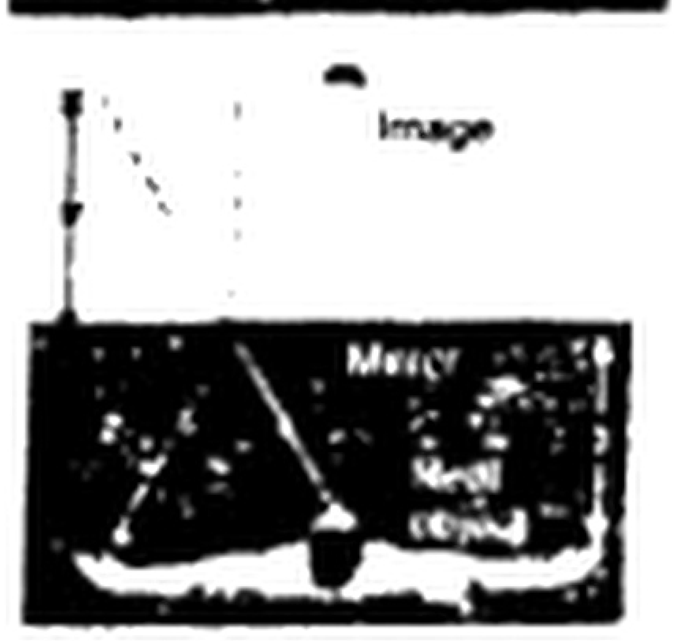
A mirror who's polished, reflecting surface is a part of a hollow sphere of glass or plastic is called a spherical mirror.

In a spherical mirror one of the two curved surfaces is called with a thin, layer of silver followed by a coating of red lead oxide paint. Thus, one side of the spherical mirror is opaque and the other side is a highly polished reflecting



(a) Concave mirror (b) Convex mirror
Fig. 12.5. Types of spherical mirrors

Do you know?



The image you see in a flat mirror is at the same distance behind the mirror as you are in front of it

surface. There are two types of spherical mirrors.

In this picture you can see clearly the image of a lion formed inside the pond water. Can you tell which phenomenon of physics is involved here?

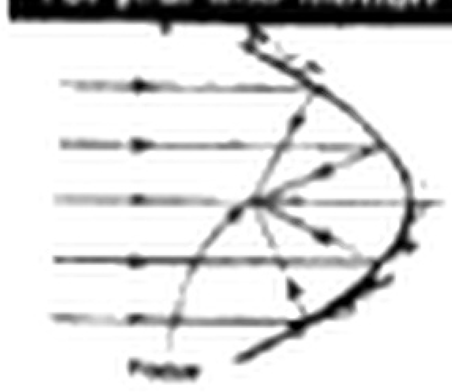
Concave mirror

"A spherical mirror whose inner curved surface is reflecting is called concave mirror."

1) In concave mirror the size of the image depends upon the position of the object.

2) Both virtual and real images can be formed by concave mirror.

For your information



Parabolic mirror used in head lights.

Convex mirror

"A spherical mirror whose outer curved Surface is reflecting is called convex mirror."

I) In convex mirror the size of the image is always smaller than the object.

2) Only virtual and erect image is formed by a convex mirror.

Different terms related to spherical mirrors

1) Pole

It is the midpoint of the curved surface of spherical mirror.

It is also called vertex.

2) Centre of curvature (c)

A spherical mirror is a part of a sphere. The centre of this sphere is called centre of curvature.

3) Radius of curvature (R)

It is the radius of the sphere of which spherical mirror is a part.

4) Principal axis

It is the line joining centre of curvature and pole of the spherical mirror.

5) The principal focus (F)

After reflection from a concave mirror, rays of light parallel to the principal Axis" converge to a point 'F'. This point is called 'the principal focus", of the mirror.

1) In case of convex mirror, parallel rays are converged at the principal focus.

2) In case of concave mirror, parallel rays appear to diverge from the principal focus.

6) Focal length (f)

It is the distance from the pole to the principal focus. The focal length is related to the radius of curvature by, f= R/2.

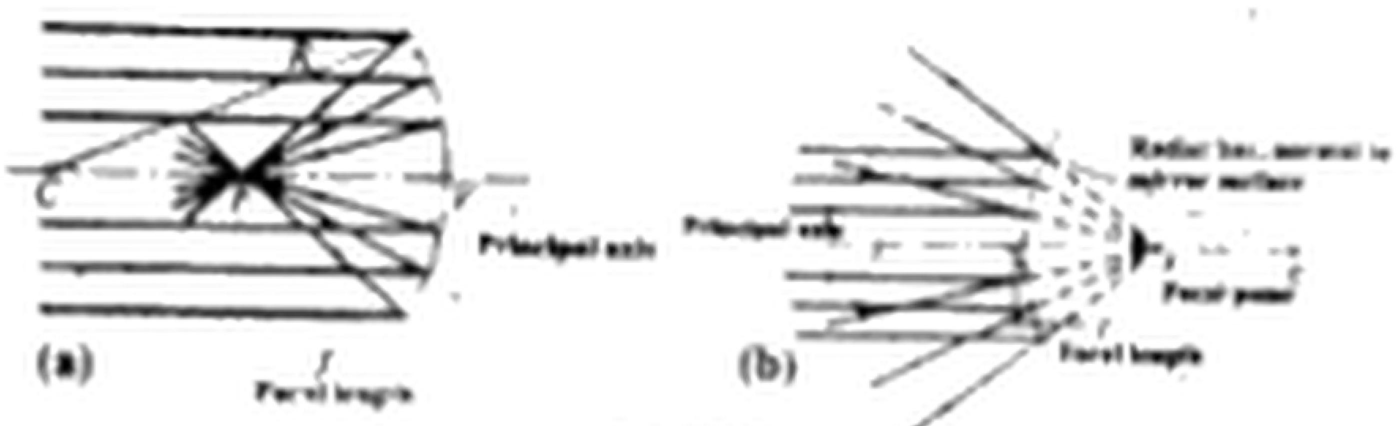


Fig. 12.6

Q.3. Describe the characteristics of focus of a concave and convex mirror.

How reflection of light takes place in spherical mirrors?

Answer

Characteristics of focus of spherical mirror

A well polished spoon acts as convex (right) and concave (left) mirrors

For convex mirror focus and centre of curvature are behind the mirror

a) Convex mirror

1) The focus lies behind the mirror.

2) The focus is virtual as the rays of light after reflection appear to come from the focus.

b) Concave mirror

1) The focus is in front of the mirror.

2) The focus is real as the rays of light after reflection converge at the focus.

Reflection of light by spherical mirrors

Like plane surface spherical surfaces also reflect light following the two laws of reflection.

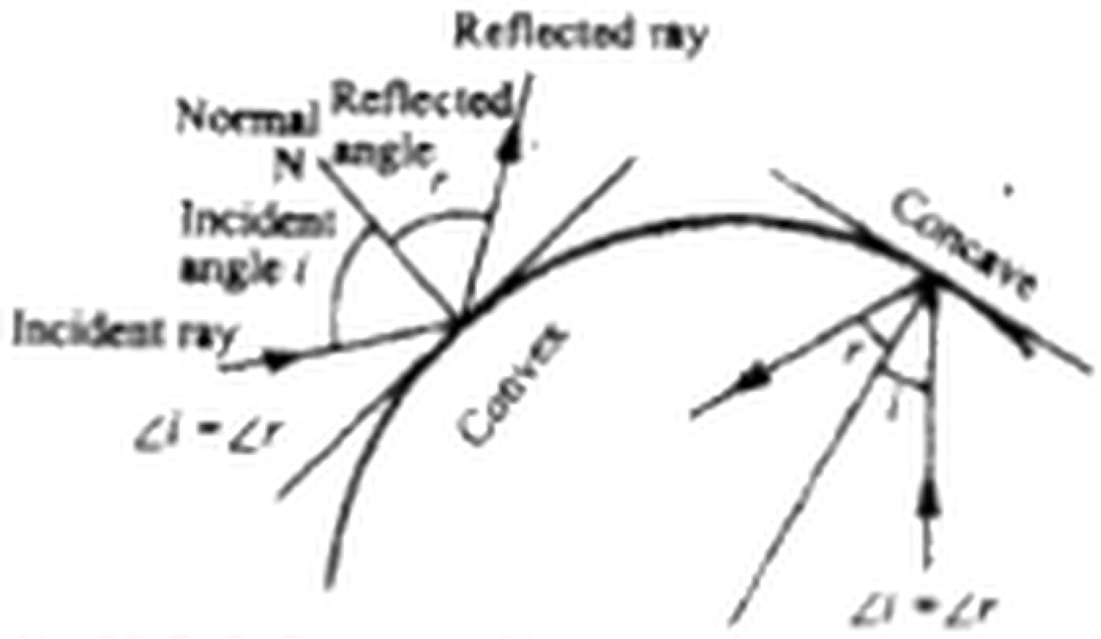


Fig 12.7: Reflection of light by spherical mirror

Activity

Take a convex mirror or a well-polished spoon (using the outside of the spoon, with the convex surface bulging outward), and hold it in one hand, Hold a pencil with its tip in the upright position in the other hand. When we look at its image in the mirror, it seems to be erect, virtual and smaller.

Q.4. What is spherical mirror formula? How can we fine the location of an image by using sign conventions?

Answer

Spherical mirror formula

Mirror formula is the relationship between object distance 'p', image distance 'q' from the mirror and focal length 'F of the mirror.

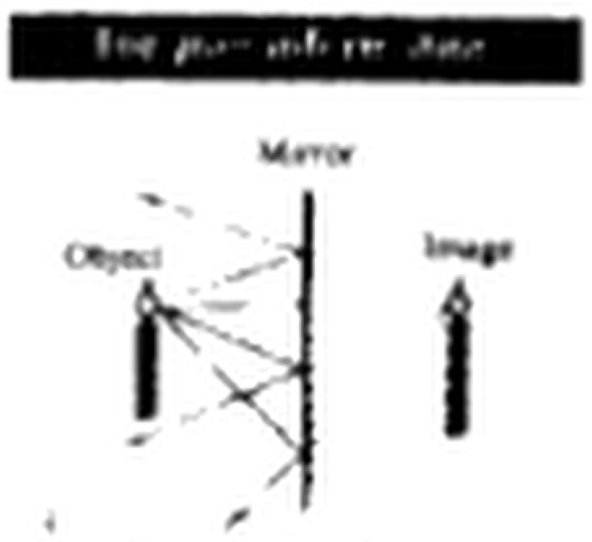
Thus we can write mirror formula as:

1/f = 1/p 1/q

> **For your information**
> The focal length of a spherical mirror is one-half of the radius of curvature i.e. f = R/2. However, we take the focal length of a convex mirror as negative. It is because the rays appear to come from the focal point behind the mirror. Therefore, for convex mirror f = - R/2 .

The above equation is true for both concave and convex mirrors. However, following sign conventions should be followed to apply this equation for solving problems related to mirrors.

Ray diagram for the virtual image formation In a plane mirror



Ray diagram for the virtual image formation in a plane mirror

Quantity	When positive (+)	When negative(-)
Object distance 'p'	Real object	Virtual object
Image distance 'q'	Real image	Virtual image
Facal length 'f'	Concave mirror	Convex mirror

Activity

Take a concave mirror or a well-polished spoon (using inside of the spoon with concave surface bulging inward). Hold it in hand towards a distant object, such as the sun, a building, a tree or a pole. Try to get a sharp, well focused image of the distant object on the wall or a screen. Measure the distance of the screen from the mirror using a meter scale. By applying the spherical mirror formula and by putting distance of object and distance of image from 'the mirror, we can find length of the concave mirror.

Q.5. Explain the phenomenon of refraction of light? What is the effect of medium on speed of light? Write the formula of refractive index?

Answer

Refraction of light (definition)

The process of bending of light as it passes from air into glass and vice versa is called refraction of light.

Point to ponder

Explanation

If we dip one end of a pencil or some other object into water at an angle to the surface, the submerged part looks bent as shown in fig. 12.8. Its image is 'displaced because the light coming from the underwater portion of the object changes direction as it leaves the water. This bending of light as it passes from one transparent medium into another is called refraction.

Fig 12.8 Bending of pencil in water due to refraction

Refraction of light can be explained with the help of figure 12.9.

A ray of light I_0' travelling from air falls on the surface of a glass block.

At the air glass interference, the ray of light 'i_0' changes direction and bends towards the normal and travels along the path 'OR' inside the glass block.

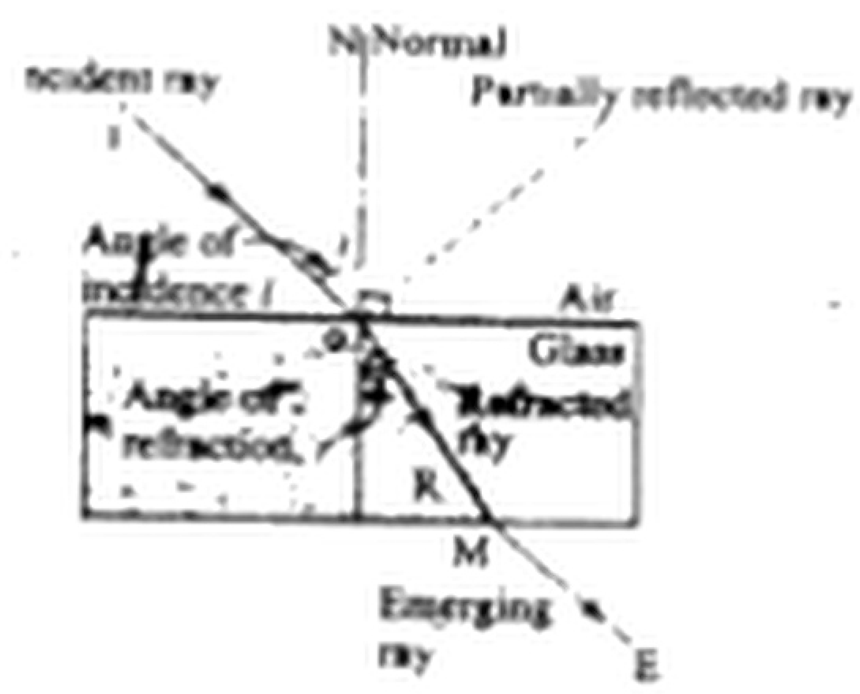
1) The rays 'i_0' and 'OR' are called the incident ray and the refracted ray respectively

2) The angle made by the incident ray with the normal is called angle of incidence.

3) The angle r made by the refracted ray with the normal is called angle of refraction.

Laws of refraction

1) The incident ray, the normal at the point of same plane.



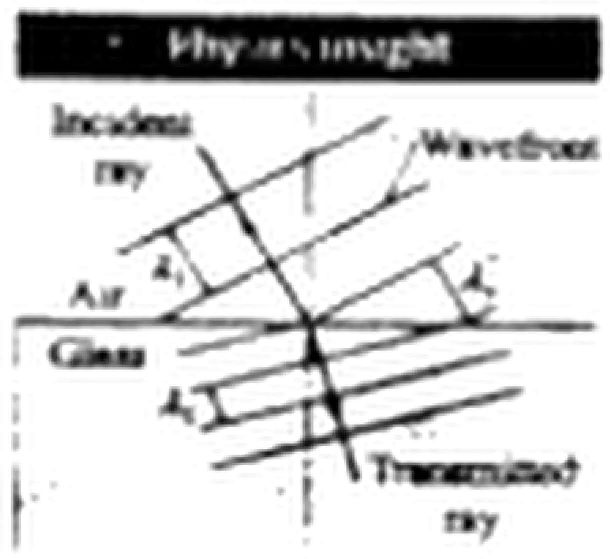
2) The ratio of the sine of the angle of incidence I to the sine of angle of refraction r is always equal to the constant. i.e. sin i / sin r = constant.

This constant is called the refractive index of the second medium, with respect to the first medium, so we have,

Refractive index 'n' of a medium is also the ratio of speed 'c' of light in a vacuum to the speed 'v' of light in the medium i.e..

Effect on speed of light in a medium

The speed of light in space is 3×10^{8}' ms^{-1}, when it passes through glass (medium) its speed decreases, i.e. 2×10^{8} ms^{-1}. The speed of light in water i's approximately 2.3 $\times 10^{8}$ ms^{-1}.



In refraction, the speed of light changes due to change in the wavelength. But, frequency and hence the colour of light does not change.

Dispersion of light is due to the variation in refractive index with the colour. Dispersion in drops of water separates the colors of sunlight into a rainbow.

Q.6. What is total internal reflection? Define the critical angle?

Answer

Total internal reflection

When a wave enters from denser medium to rare medium it bends at some certain angle in the rare medium. But if the angle pf incidence in the denser medium is such that the wave instead of bending into the rare medium,

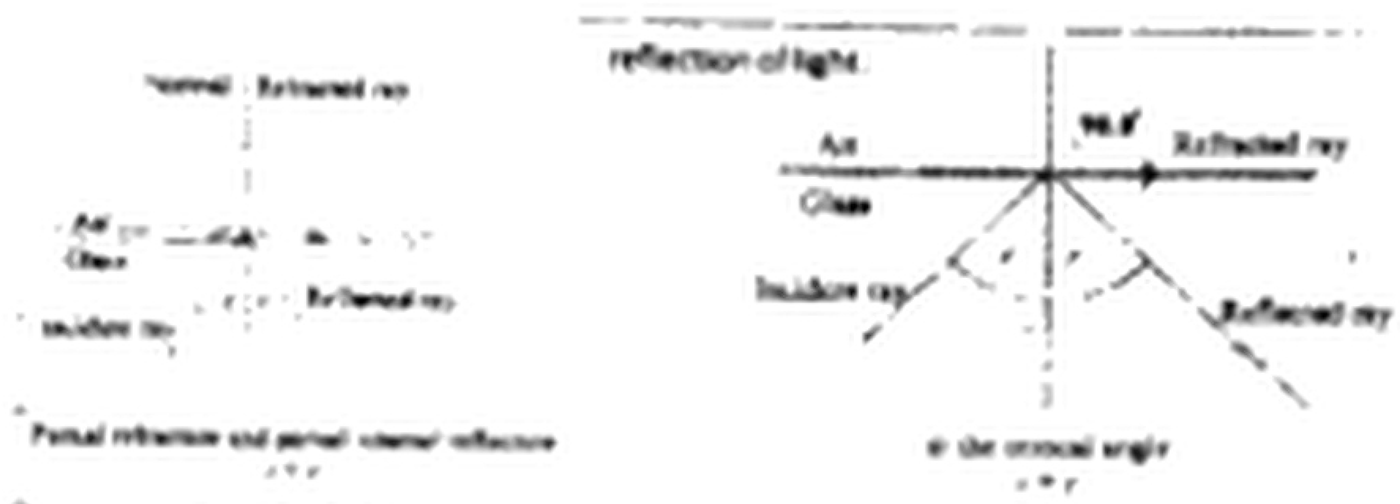


Fig. 12.10 (a)

Fig. 12.10 (b) Condition for total internal reflection

bounces back (reflected) in the same 'denser medium, then this phenomenon is called total internal reflection."

Critical angle

"The angle of incidence in the denser medium by which the angle of refraction in the rare medium becomes 90° is called critical angle."

If the incident angle become greater than the critical angle, the wave (ray) will reflect back in the same denser medium showing total internal reflection.

Q.7 Write about the refraction through prism?

Answer

Prism in a transparent body (made of optical glass) with at least two polished plane faces inclined towards each other from which light is refracted.

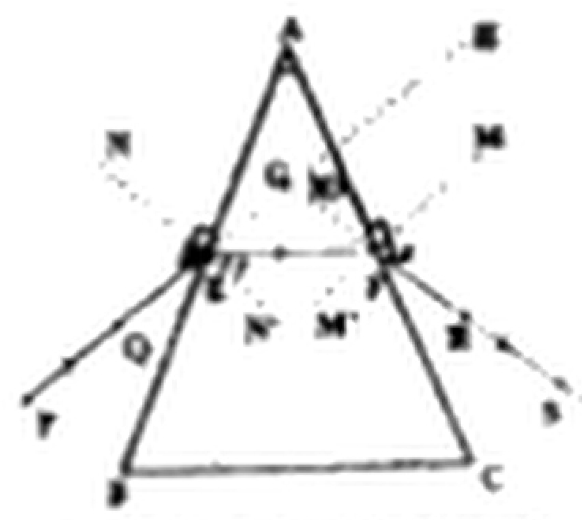
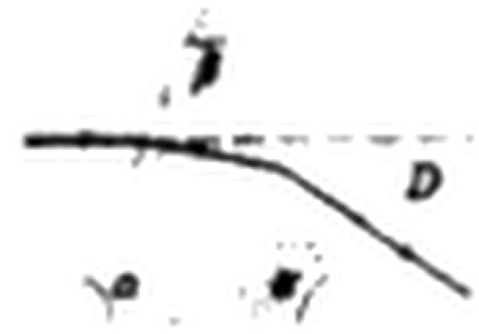


Fig.12.11 Refraction through a triangular glass prism

Refraction through prism

In case of triangular prism, the emergent ray is net parallel to the incident ray. It is deviated from the prism from its original path.



When light passes through prism it deviates from its original path due to refraction

The incident ray PE makes an angle of incidence i at point E and is refracted towards the normal 'N' as EF. According to the law of refraction.

The refracted ray EF makes an angle r inside the prism and travels to the other end of the prism. This ray emerges out from prism at point F making an angle S '.

Hence the emerging ray FS is not parallel to the incident ray EF but is deviated by an angle D' which is called "angle of deviation".

Q8. What are lenses? Write their types and terminology used?

Answer

Lenses

"A lens is any transparent material having two surfaces of which at least one is curved."

Lenses refract light in such a way that an image of the objects is formed.

Lenses of many different types are used in optical devices cameras, eye glasses, microscopes, telescopes and projectors.

Types of lenses

1) Convex lens

The lens which causes incident parallel rays to converge (focus) at a point is known as "Convex of converging lens."

This lens is thick at the centre but thin at the edges.

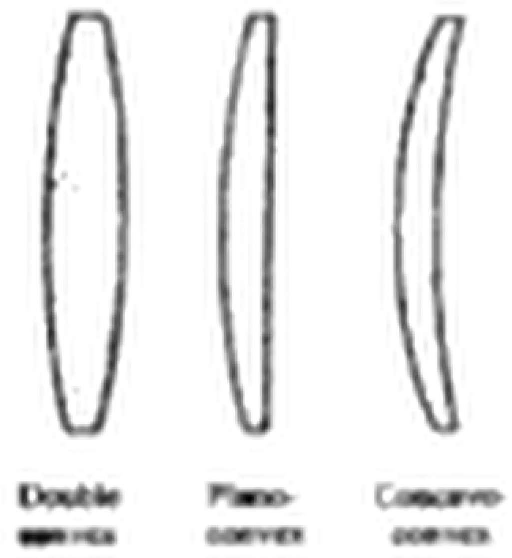


Fig 12.12 Convex lenses

2) Concave lens

The lens which causes diverge from a point is lens." incident parallel rays of light to known as concave or diverging

This lens is thin at the cent and thick at the edges.

Lens Terminology

1) Principal axis

Each of the two surfaces of a spherical lenses is a section of a sphere. The line passing through the two centres of curvature of the lens in called "principal axis."

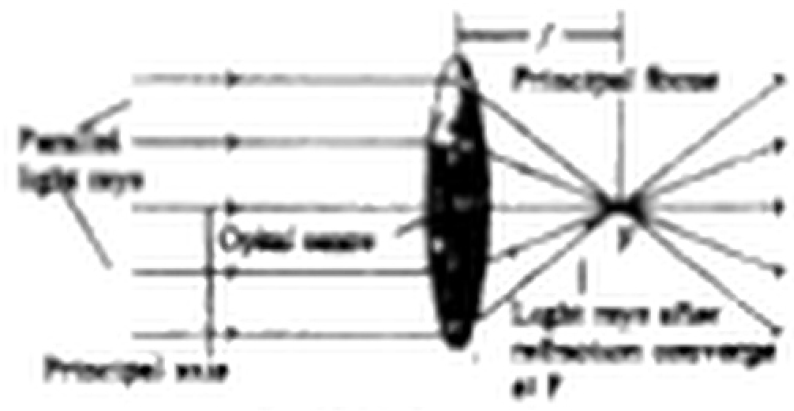


Fig. 12.14 Convex lens

2) Optical centre (c)

A point on the principal axis at the centre of lens is called optical centre.

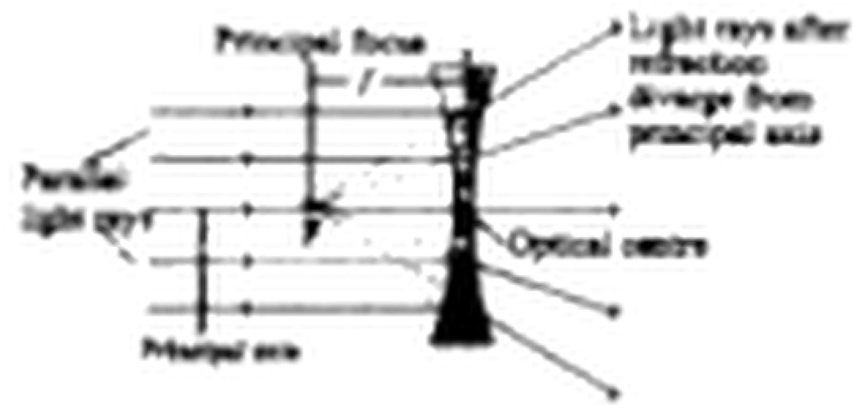


Fig. 12.15 Concave lens

3) Principal focus (F)

The light rays travelling parallel to. The principal axis of a convex lens after refraction meet at a paint on the principal axis called principal focus, or focal point (F).

For concave lens, the parallel rays appear to come from a point behind the lens called principal focus (F).

4) Focal length (f)

This is the distance between the optical centre and the principal focus.

5) Power of a lens (P)

Power of a lens is defined as the reciprocal of its focal length in meters.

Thus:

Power of a lens = p = 1/focal length in meters.

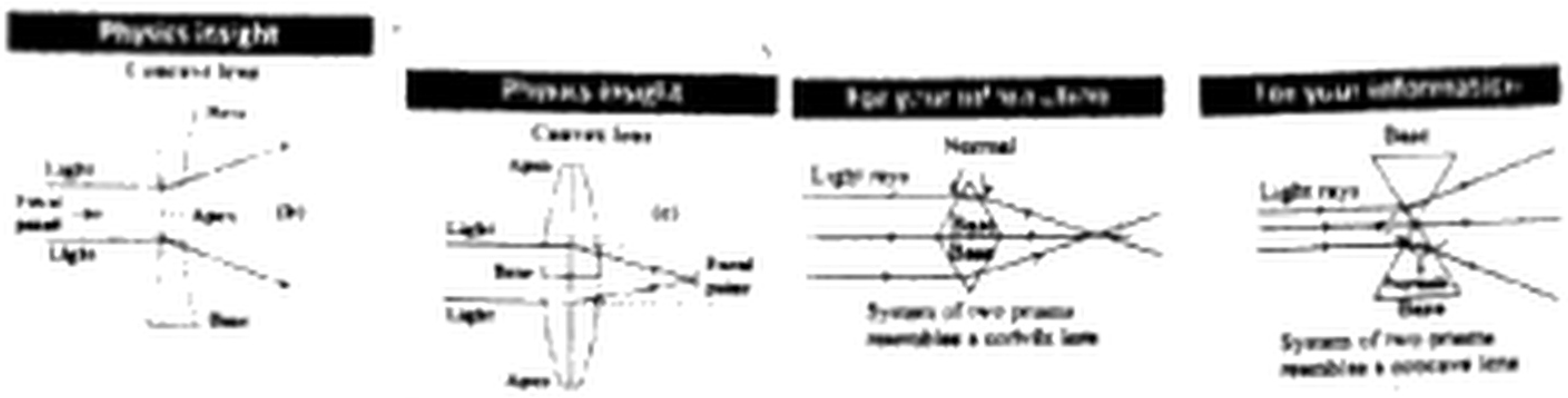
The unit of power of lens is "Diopter", denoted by symbol "D".

If P is expressed in meters so that 1 D = $1\ m^{-1}$

Thus, Diopter is the power of a lens whose focal length is 1 meter.

1) Power of convex lens is positive because its focal length is positive.

2) Power of concave lens is negative because its focal length is negative.



Concave lens spreads light away from the principal axis of the lens after refraction.

Convex lens bends the light towards the principal axis i.e. the thickest part of the lens after refraction

Q.9. How images are formed in lenses through refraction? Explain with the help of ray diagrams of lenses?

Answer

Lenses form images through refraction. This is explained with the help of ray diagrams as follows:

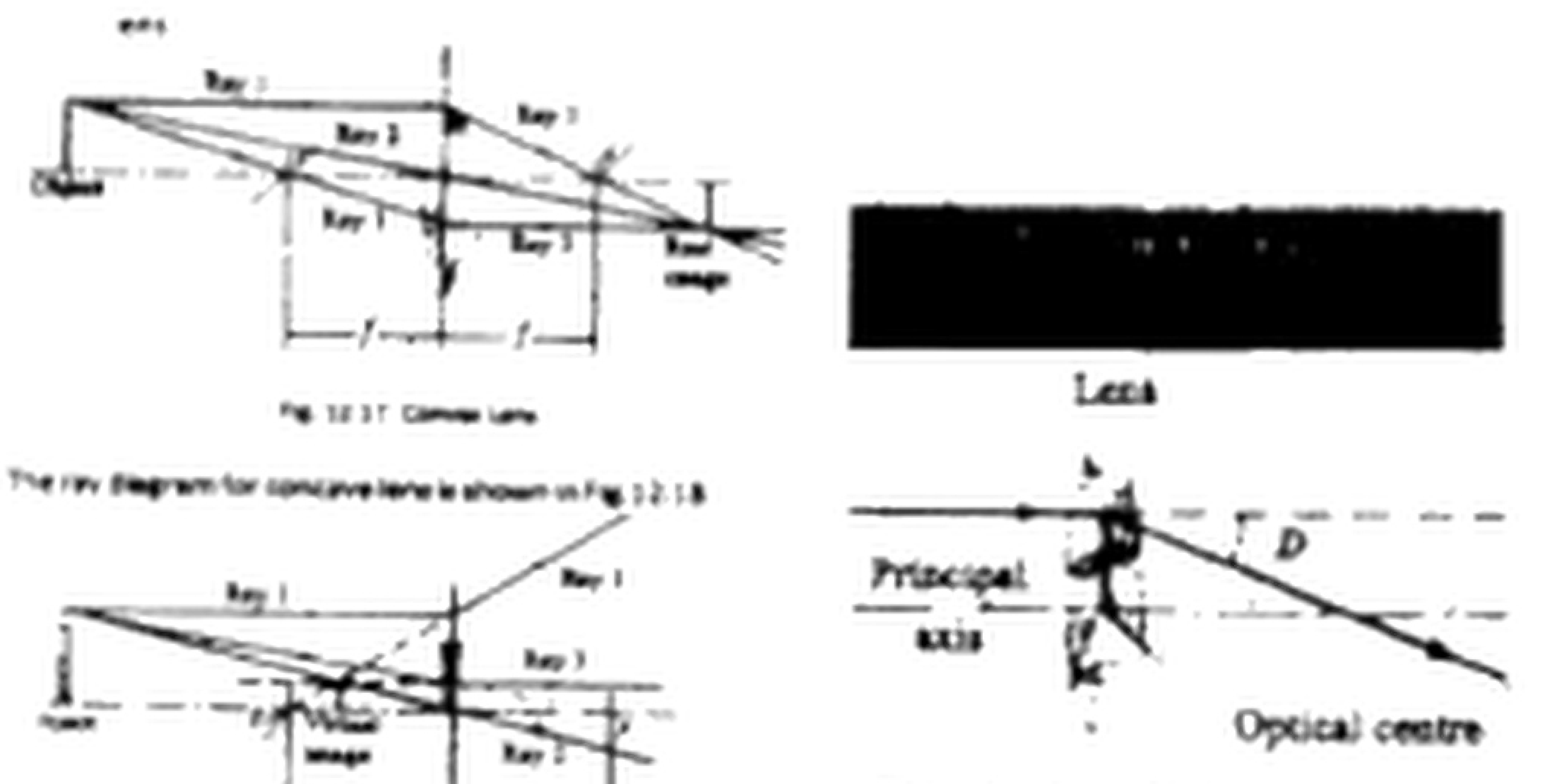
Ray diagram of lenses

Image formation in convex lens can be explained with the help of three principal rays shown in fig. 12.17.

1) The rays parallel to the principal axis passes through the focal point after refraction by the lens.

2) The ray passing through the optical centre passes straight through the lens and passes underrated.

3) The ray passing through the focal point becomes parallel to the principal axis after refraction by the lens.



The refraction of light by the convex lens causes the ray to deviate from its original pat like in prism

Image formation in convex lens

To explain image formation with ray diagrams for objects placed at different

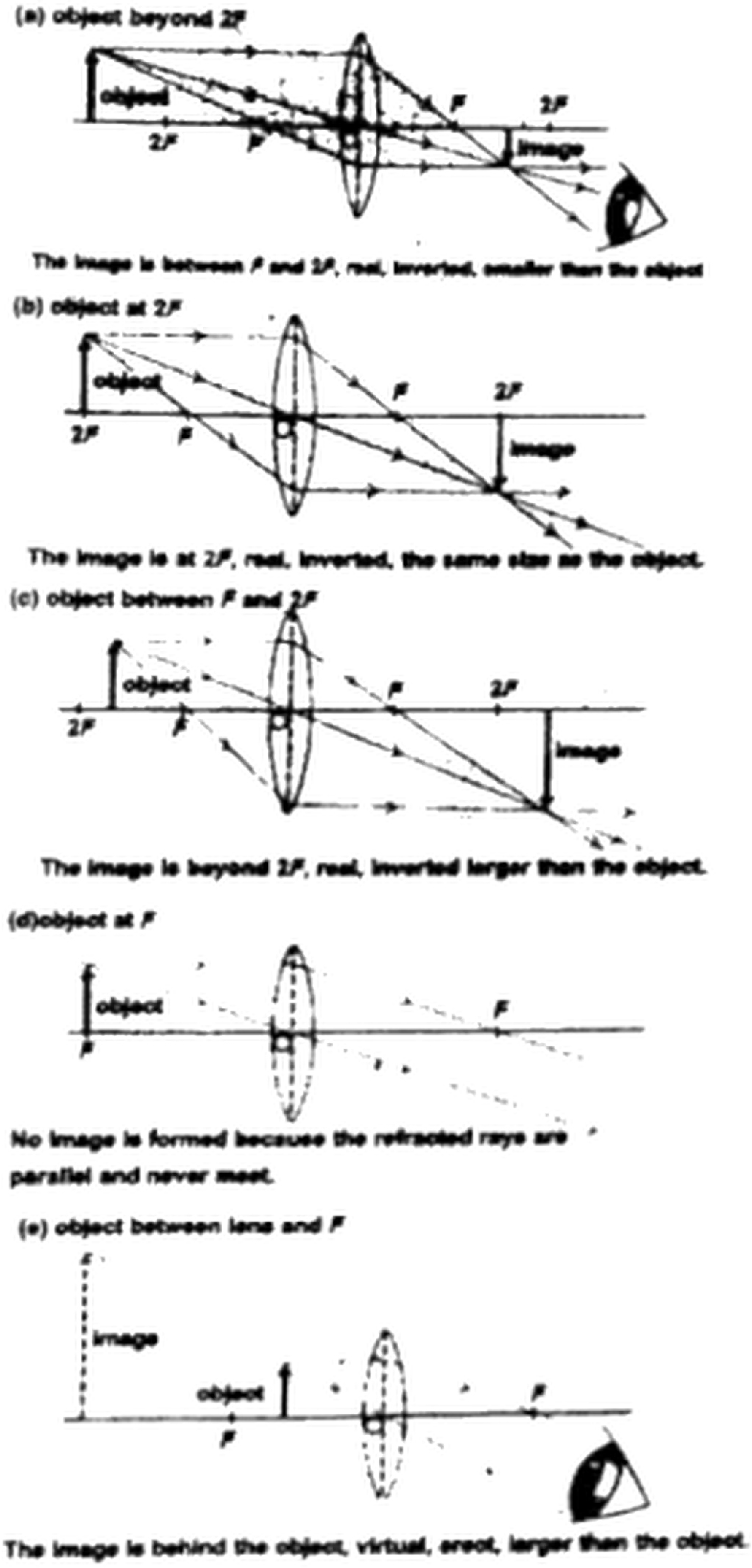


Fig. 12.19

positions from a convex lens, we have the following figures.

Physics insight

A converging lens becomes a magnifying glass when an object is located inside the lens's focal length.

Physics insight

A diverging lens always has the same ray diagram, which forms a smaller image.

Mirror Application

Concentrated solar power (CSP) systems use lenses or mirrors to focus a large area of sunlight into a small beam. This solar power can be used to heat water that can run turbine to produce electricity.

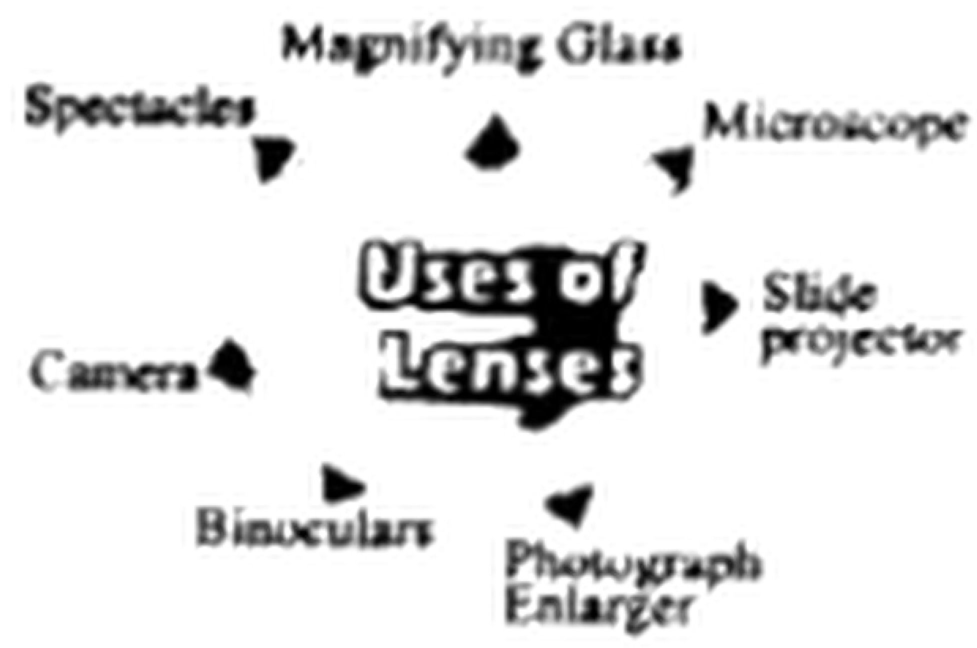
For your information

You can compare lenses simply by looking at them.

- A lens with a long focal length is thin, its surfaces are not very strongly curved.
- A lens with a short focal length is fatter, its surfaces are more strongly curved.

Q.10. How can the location of an image be found by using lens equations?

Answer



In fig. 12.20, let an object 'OP' is placed in front of a convex lens at a distance 'P'. A ray 'PR' parallel to the principal axis after refraction passes through focus F'. Another ray 'PC' meets the first ray at point 'P' after passing through the optical centre 'C'. If this process is repeated for the other points of the object, a real and inverted image 'OP' is formed at a distance 'q' from the lens. Size of image formed in a lens for particular distance, nature of image, whether the image is real or imaginary, erect or inverted all these can be found by using lens formula lens.

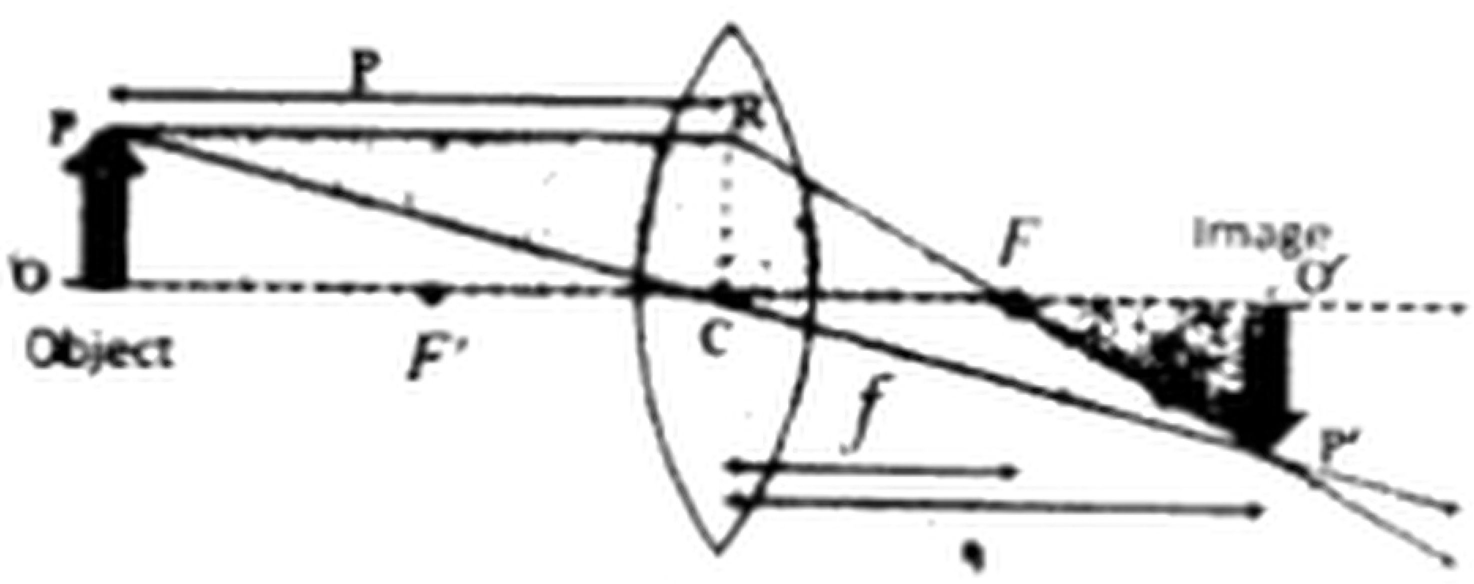


Fig.12.20

Lens formula

The relationship between the object and, image distance from the lens in terms of the focal length of the lens is called lens formula and is given by:

$1/f = 1/p \quad 1/q$

The above equation is valid for both concave and convex lenses.

Sign conventions for lenses

1) Focal lengths

a) 'f' is positive for a converging (convex) lens.

b) 'f' is negative for a diverging (concave) lens.

2) Object distance

a) 'P' is positive, if the object is towards the left side of the lens.

b) 'P' is negative, if the object is on the right side of the lens. It is called virtual object.

3) Image distance

a) 'q' is positive for a real image made on the right side of the lens by a real object.

b) 'q' is negative for a virtual image made on the left side of the lens by a real object.

Q.11 Write the use of lens in a camera and slide projector?

Answer

Camera

A simple camera consists of a light proof box with a converging lens in front and a light sensitive plate or film at the back.

The lens focuses images to be photographed onto the film. In simple lens camera, the distance between lens and film is fixed which is equal to the focal length of the lens. In camera, object is placed beyond '2F:

A real, inverted and diminished image iS formed in this way as shown in fig.

12.21.

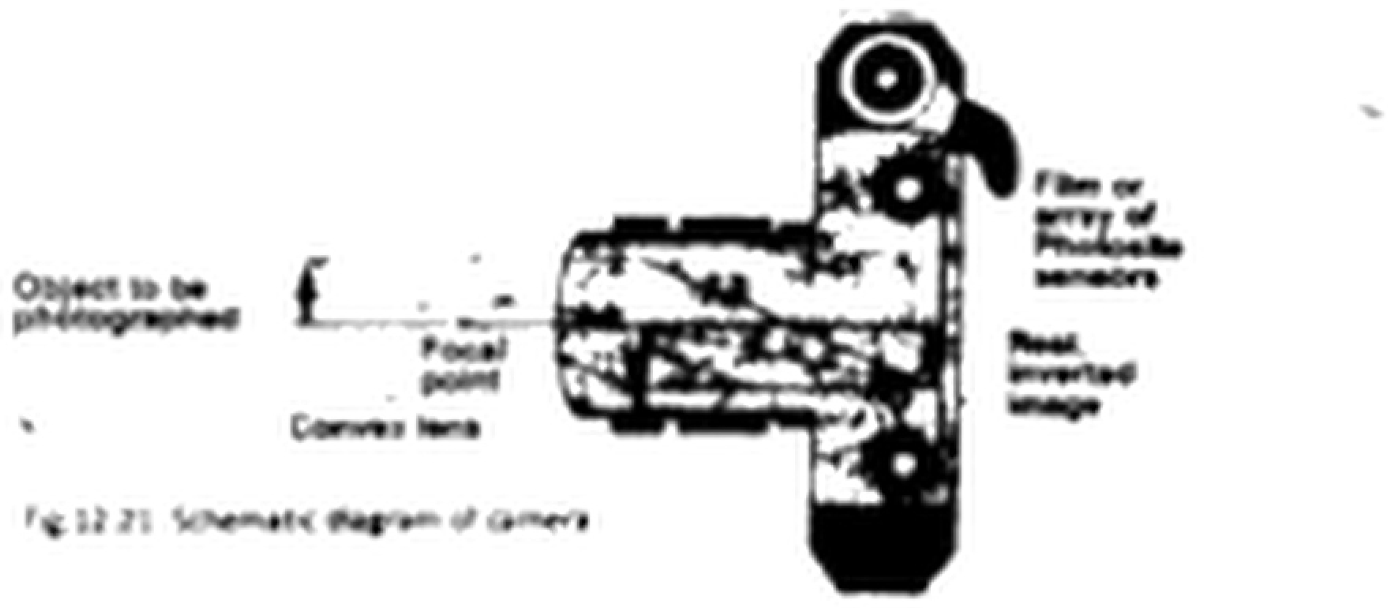


Fig 12.21 Schematic diagram of camera

Slide projector

Fig. 12.22 shows how a slide or movie projector works. The light source is placed at the centre of curvature of a concave mirror. The concave mirror is used to reflect light back in fairly parallel rays. The condenser is made up of 2 converging lenses, that refract light so all parts of the slide are illuminated with parallel rays.

The projection or converging lens provides a real, large and inverted image. It must be real to be projected on a screen. The slide (object) must be placed between Y and because 2F' of projection lens so as to produce the image is inverted, the slide must be a real, large, and inverted image, placed upside down and laterally inverted so we can see the image properly.

Q. How lenses are used in a photograph enlarger? What is reflecting?

Answer

Photograph Enlarger

In the case of photograph enlarges object is placed at distance more than 'F' but less than '2F': in this way we get a real, inverted and enlarged image as shown in fig.

12.23.

The working principal of photograph enlarger is basically the same as that of a slide projector. It uses a convex lens to produce a real, magnified and inverted

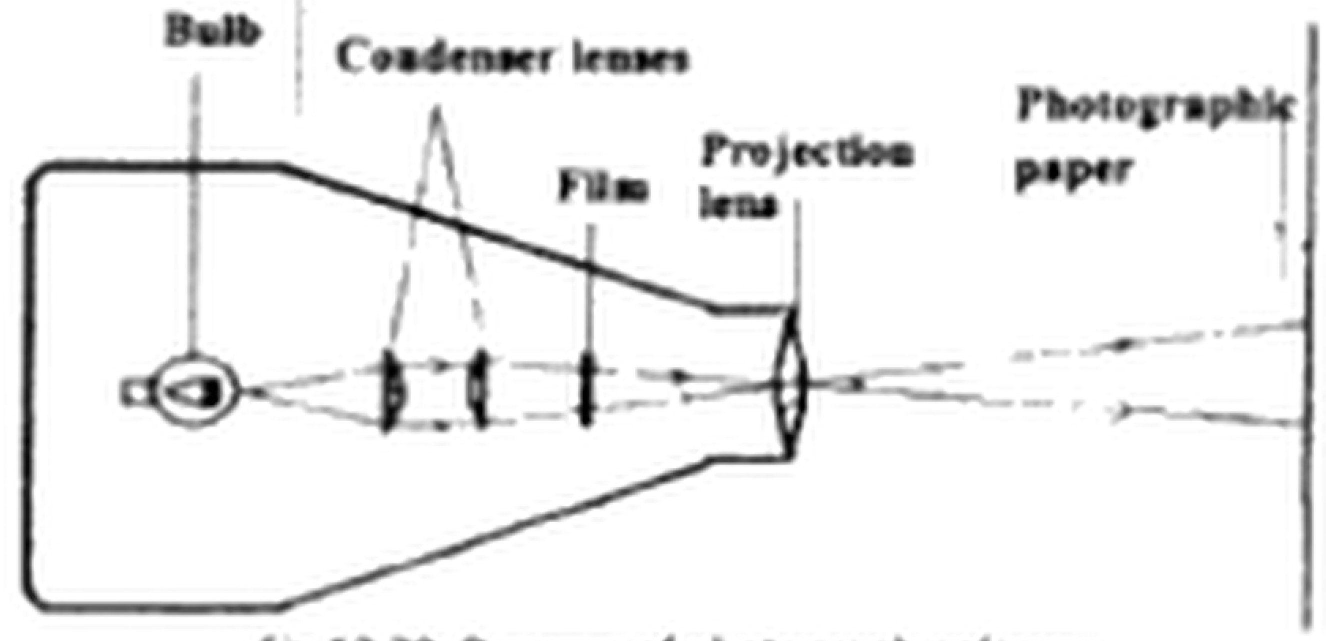


Fig 12.23: Diagram of photograph enlarger

image of the film on photographic paper.

Totally reflecting prism

Many optical instruments use right angled prisms to reflect a beam of light through 90° or 180° (by total internal reflection) such as cameras, binoculars, periscope and telescope.


Fig. 12.24 Total internal reflection through right angled prism

One of the angles of a right-angled prism is 90°, when a ray of light strikes a face of prism perpendicularly, it enters the prism without deviation and strikes the hypotenuses at an angle of 45°. Since the angle of incidence 45° is greater than critical angle 45° the light is totally reflected by the prism through an angle of 90°.


Fig. 12.25 Prism periscope

Two such prisms are used in periscope as shown in fig. 12.25. In fig. 12.26, the light is totally reflected by the prism by an angle of 180°. Two such prisms are used in binoculars.

Q13. Write in detail about optical fibres and its uses?

Answers

Optical fibres

Total internal reflection is used in fibre optics which has number of advantages in telecommunicate ion field.

Fibre optics consists of hair size threads of glass or plastic through which light can travel as shown in figure. 12.28

The inner part of the fibre optics is called core that carries the light and an outer concentric shell is called cladding. The core is made from glass or plastic of

Fig.12.28 Passage of light through optical fibre

relatively large (high) index of refraction.

The cladding is made of glass or plastic of relatively low refractive index.' Light entering from one end of the core strikes the core/cladding boundary at an angle of incidence greater than critical angle and is reflected back into the core.

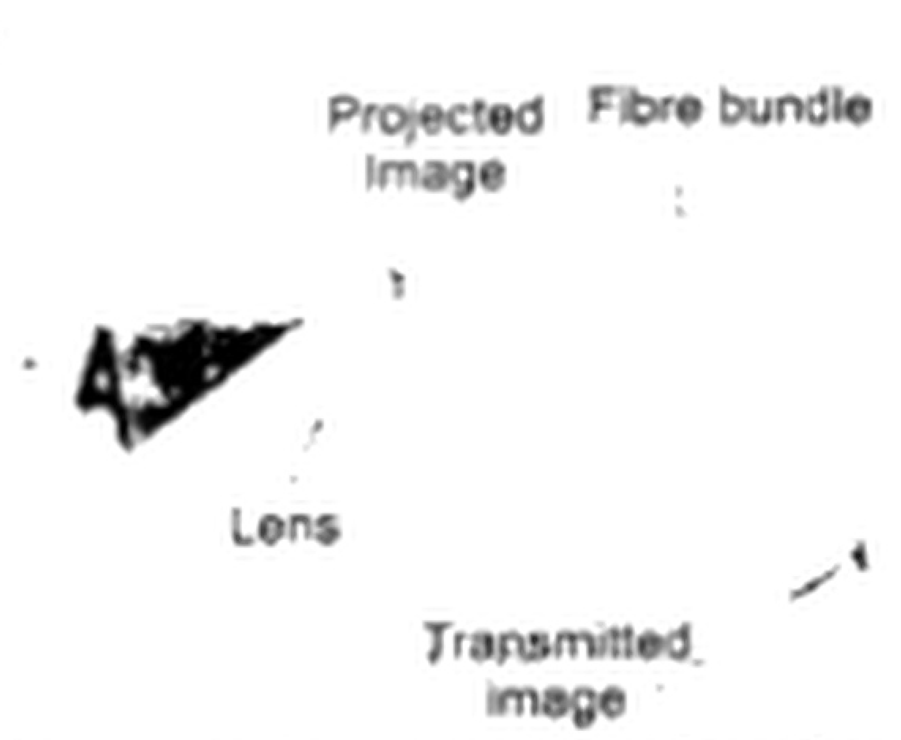
In this way, light travels many kilometers with small loss of energy.

In Pakistan, optical fibre is being used in telephone and advanced telecommunication systems. Now. We can listen thousands of phone calls without any disturbance.

Light pipe

Light pipe is a bundle of thousands of optical fibres bounded together. They are used to illuminate the inaccessible places by-the doctors or engineers.

For example, doctors view inside the human body. They can also be used to transmit images from one place to another.



. .2 19: A lens and light pipe can be used together to produce a

Endoscope

An endoscope is a medical instrument used of exploratory diagnostics, and surgical purposes. An endoscope is used to explore the interior organs of the body. Due to its small size. It can be inserted through the mouth and thus eliminates the invasive surgery.

The endoscope to diagnose the stomach, bladder and throat are called "Gastroscope, cystoscope and Bronchoscope respectively.

An endoscope uses two fibre-optic tubes through a pipe. A medical procedure using any type of endoscope is called "endoscopy".

The light shines on the organ of patient to be diagnosed entering through one of the fibre tubes of the endoscope. Then light is transmitted back to the physician's viewing lens through the other fibre tube by total internal reflection.

Fig. 12.30: Doctors are investigating a patient with endoscope.

Flexible endoscopes have a tiny camera attached to the end. Doctor can see the view recorded by the camera is displayed on a computer screen.

Q14. Write the construction and working of simple microscope.

Answer

Simple microscope (construction)

A magnifying glass is a convex lens which is used to produce magnified images of small objects. Hence it is also called simple microscope.

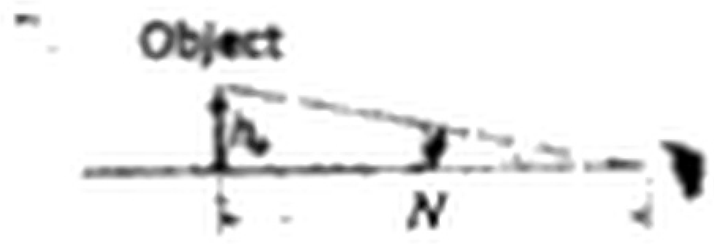


Fig. 12.31 (a)

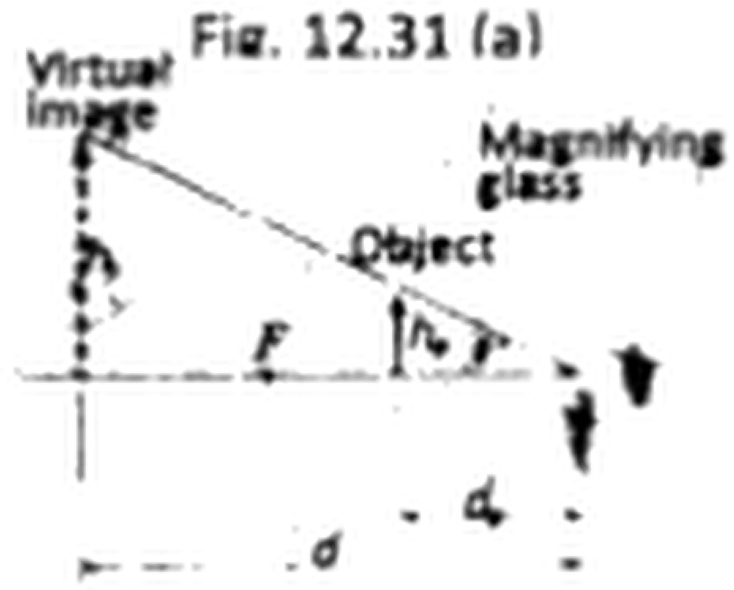


Fig. 12.31 (b) Image formation in magnifying glass

The object is placed nearer to the lens then the principal focus such that an upright, virtual and magnified image is seen clearly at 25 cm from the normal eye.

Working

1. Magnifying power

Let '8' is the angle subtended at the eye by the object when it is placed at the near distance from eye as shown is fig. 12.31.

Let 'θ' is the angle subtended by the final image at the eye when the object is placed close to the eye at a distance less than 'F. The angular magnification (or magnifying power) M is the angular sixe 'θ' of the final image produced by the magnifying glass divided by an angular size 'B' of the object seen without the magnifying glass.

Image in a magnifying glass

Ray diagram

Magnifying glass is a lens that forms a virtual image that is larger than object and appears behind the lens.

$$M = \frac{\text{Angular size of final image produced by magnifying glass}}{\text{Angular size of object seen without magnifying glass}}$$

i.e., $M = \theta'/\theta$

Fig. 12.31 (b) indicates that the lens produces virtual image which is enlarged and upright with respect to the object. If 'd' is the near distance of the object from eye which is usually equal to 25 cm, then magnifying power becomes,

$$M = (\frac{d}{f} + 1)$$

2) Resolving Power

The resolving power of an instrument is its ability to distinguish between to closely spaced objects or point sources.

In order to see objects that are close together, we use an instrument of high resolving power.

For example, we use high resolving power microscope to see tiny organisms and telescope to view distant stars.

Q9. What is 'the construction of compound microscope? Write about its magnification and uses?

Answer

Compound microscope (construction)

Compound microscope has two converging sets of lenses, the objective and the eye-piece and is used to investigate structure of small objects as shown in the fig. 12.22.

Following are some features of compound microscope:

1) It gives greater magnification than a single lens.

2) The objective lens has a short focal length, $f_0 < 1$ cm.

3) The eye-piece has a focal length, f_0 of a few cm.

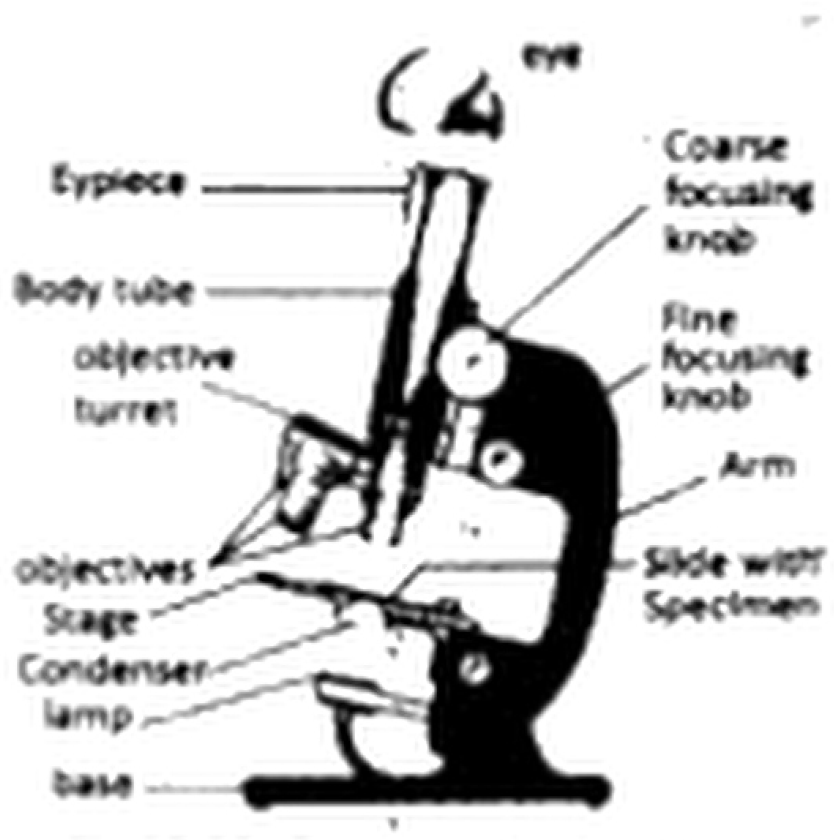


Fig.12.32. Compound microscope

Magnification of the compound microscope

Magnification can be determined through the ray diagram as shown in fig. 12.33. Objective forms a small image Ii ', inside the focal point of eye-piece.

This image acts as an object for the eye-piece and the final larger image I,', is from outside the focal point of the objective.

The magnification of compound microscope is given by:

$M = L/f_0 (l + d/f_e)$

Where 'L' is the length of compound microscope which is equal to the distance between objective and eye-piece, d is near distance of object from eye, f_0 and f_e are the focal length of object and eye-piece respectively.

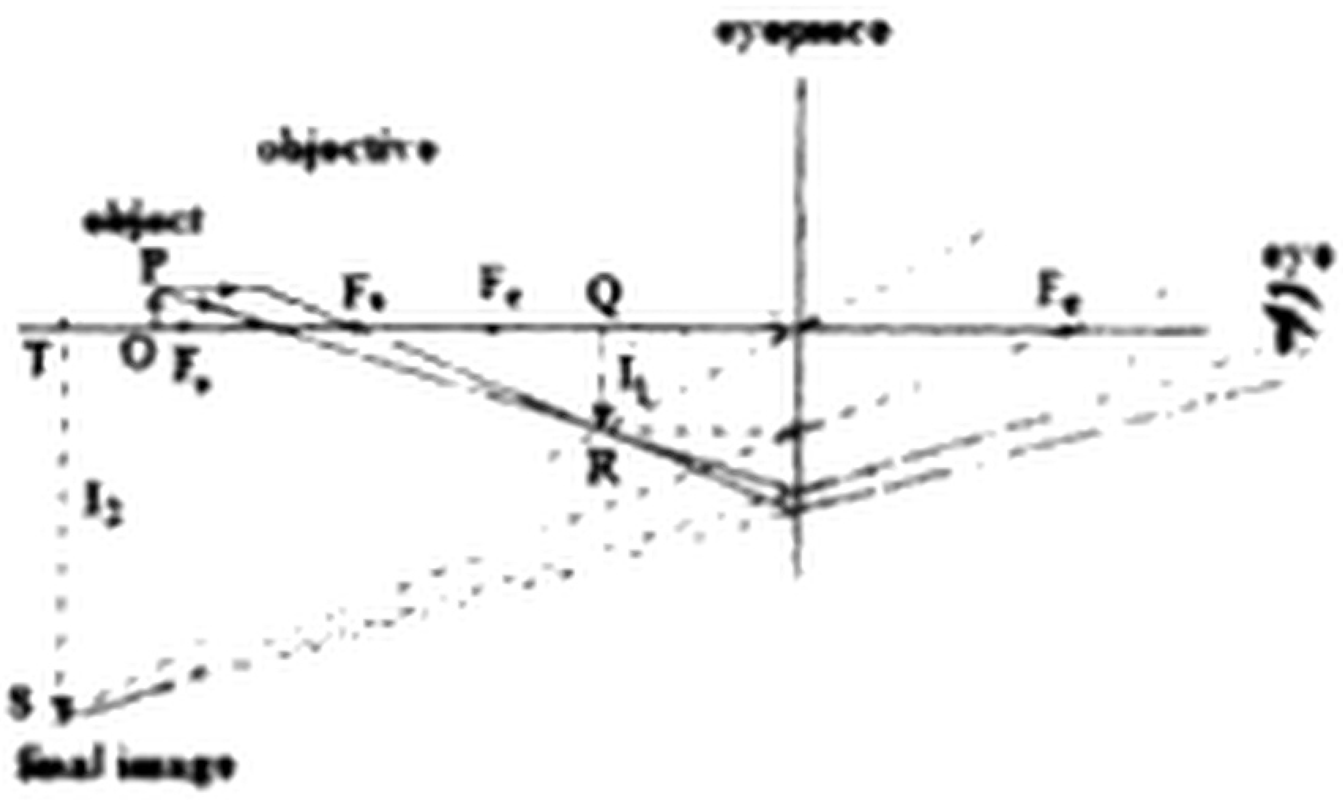


Fig. 12.33: Ray diagram for compound microscope

Uses of compound microscope

The compound microscope is used to study bacteria and other micro objects. It is also used for research in several fields of sciences like, Microbiology, Botany, Geology and

Genetics.

Q16 Write the construction and working Of telescope?

Answer

Telescope

Construction

Telescope is an optical instrument which is used to observe distant objects using lenses or mirrors. A telescope that uses two converging lenses is called "refracting telescope" as shown in figure 12.34. In refracting telescope an objective lens forms a real image of the distant object, while an eye piece forms a virtual image that is viewed by the eye.

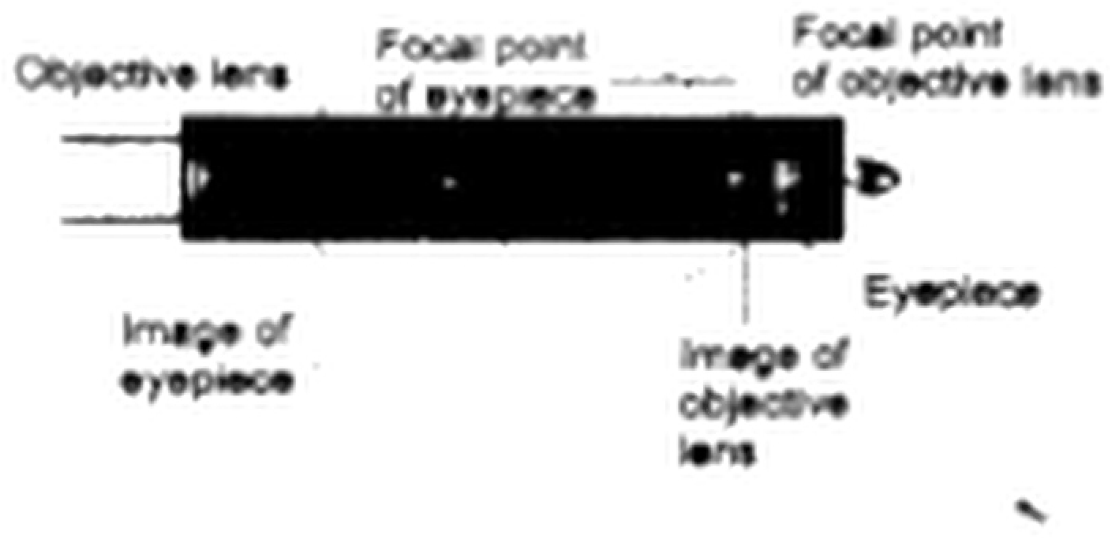


Fig. 12.34: An astronomical refracting telescope creates a

Working of refracting telescope

The ray diagram of refracting telescope' is shown in fig. 12.35. When parallel rays from a point on a distant object pass through objective lens, a real image I', is formed at the focus Ft' of the objective lens. This image acts as an object for the eye piece. A large virtual image I and I, is formed by the, eye piece at a large distance from the objective lens.

This virtual image makes an angle 'θ' at the eye-piece.

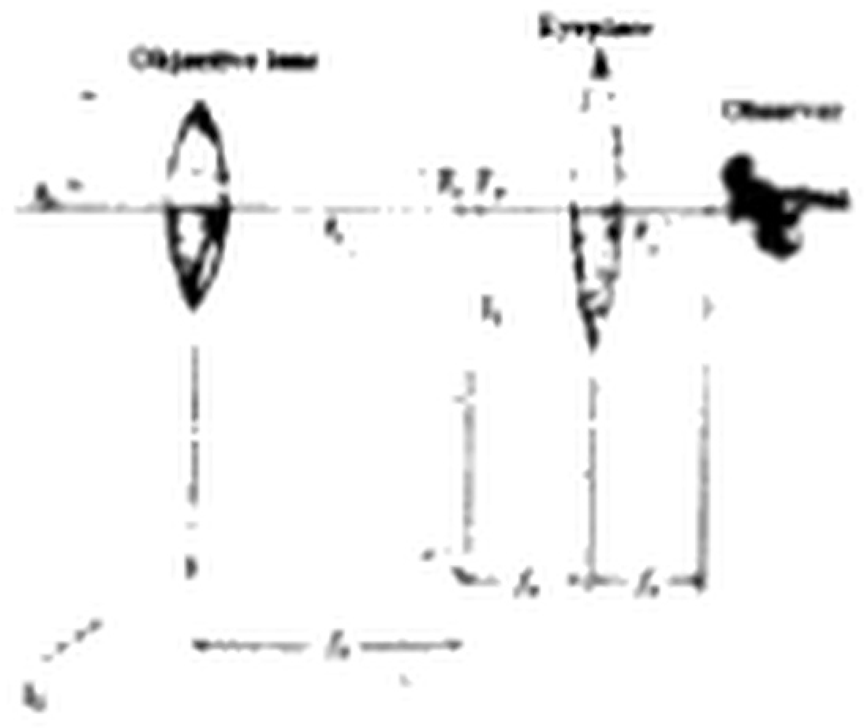


Fig 12.35 Ray diagram of refracting telescope

Magnification n of telescope

Magnification of a refracting telescope can figure 12.35 and is given by:

$M = f_0/f_e$

Q17. How image is formed in the' human eye? What is human eye accommodation?

Answer

The human eye

The image formation in human eye is shown in fig. 12.36. Human eye acts like a camera. In place of the film, the retina records the picture. The eye has a refracting system containing a converging lens. The lens forms an image on the retina which is a light sensitive layer at the back of the eye. In the camera. The distance of lens from films is adjusted for proper focus but in the eye, the lens changes focal length. Light enters the eye through a transparent membrane called the cornea.

We see because the eye forms images on the retina at the back of the eyeball

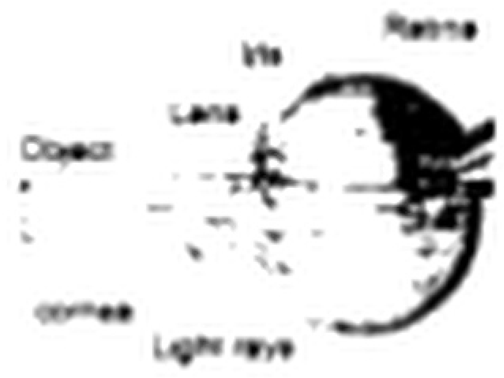


Image formation in human eye

This iris is the colored portion of the eye and controls the amount of light reaching the retina. It has an opening at its center called "pupil". The iris controls the size of the pupil.

In bright light, iris contracts the size of the pupil while in dim light pupil is enlarged. The lens of the eye is flexible and accommodates objects over a wide range of distance.

Accommodation

The camera focuses the image of an object at a given distance from it by moving the lens towards or away from the film.

The eye has different adjusting mechanism for focusing the image of an object onto the retina its ciliary muscles control the curvature and thus the focal length of the lens, and allow objects at various distances to be seen. If an object is far away from the eye. The deviation of light through the lens must be less. To do this, the ciliary muscles relax and decrease the curvature of the lens, thereby increasing the focal length. The rays are thus focused onto the retina producing a sharp image of the distant object. If an object is close to the eye, the cliary muscles increase curvature of the lens. Thereby shortening the local length.

The divergent rays Drum the nearer object are thus bent more so as to come to a focus on the retina as shown in fig. 12. 37 (b).

This variation of local length of eye lens is called accommodation.

It is large in young people while it goes on decreasing with age.

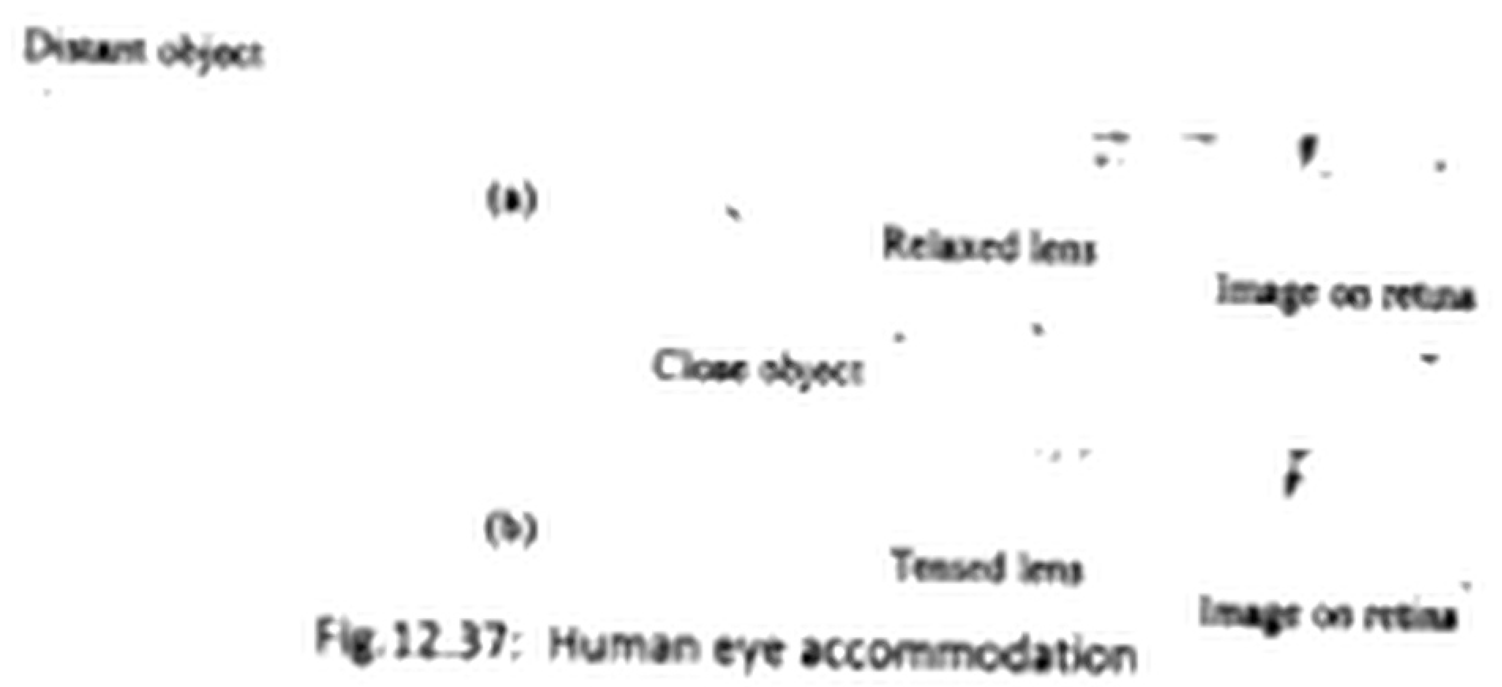


Fig.12.37: Human eye accommodation

Q18. Write about the defects of vision and their remedies?

Answer

Near point and far point

When we hold a book too close, the point is blurred because the lens cannot adjust enough to bring the book into focus. The near point of the eye is the minimum distance of an object from the eye at which it produces a sharp image on the retina as shown in the figure 12.38. This distance is also called "the least distance of distinct vision." An object closer to the eye than the near point appears blurred. For people in their early twenties with normal vision, the near point is located about 25 cm from the eye. It increases to about 50 cm at the age of 40 years and to roughly 300 cm at the age of 60 years.

The far point of the eye is the maximum distance of a distant object from the eye on which the fully relaxed eye can focus. A person with normal eye sight can see object very far away, such as the planets and stars, and thus has a far point located at infinity.

Majority of people do not have "normal eyes" in this sense.

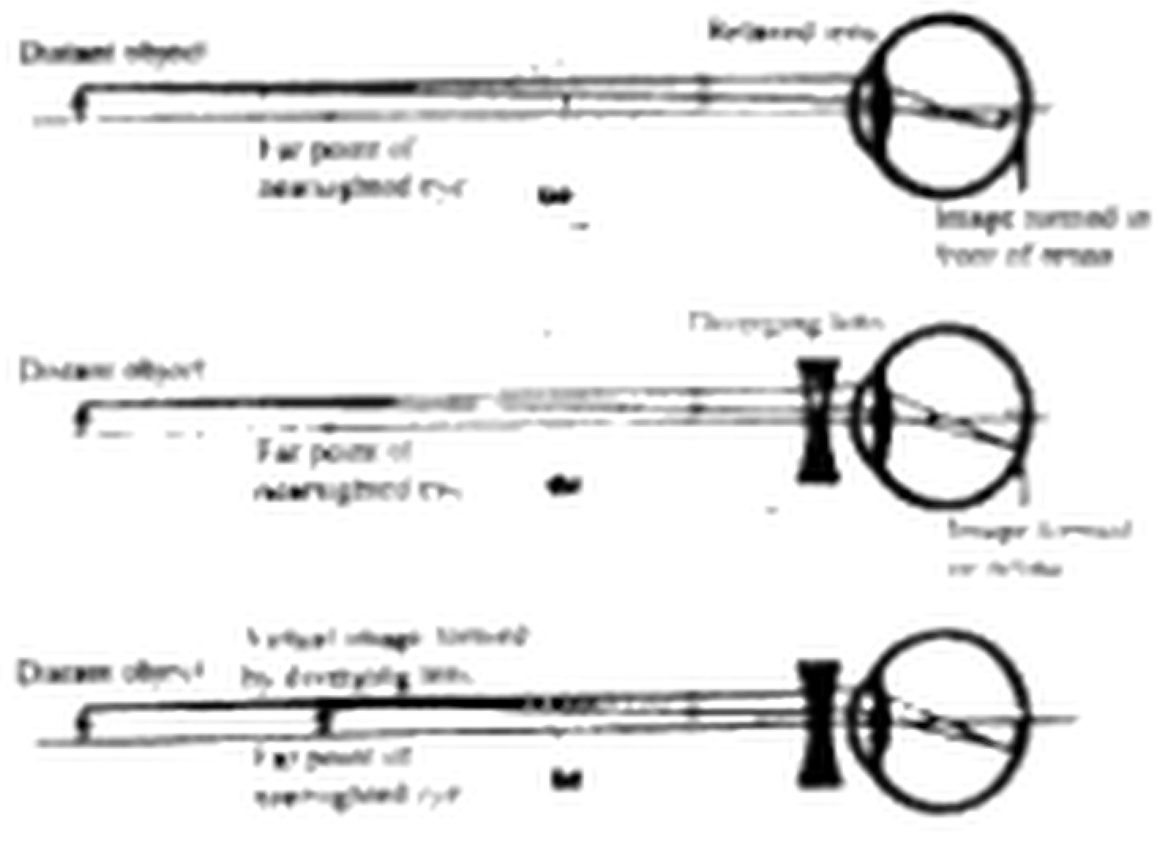


Fig. 12.39 Correction of near sightedness

Defects of vision

The inability of the eye to see the image of objects clearly is called defect of vision.

The defects of vision arise when the eye lens is unable to accommodate effectively.

The images formed are therefore blurred.

1) Near sightedness (myopia)

Some people cannot see distant objects clearly without the aid of spectacles. This defect of vision is called near-sightedness and it may due to the eye ball being too long.

Light rays from a distant object are focused in front of the retina and a blurred image is produced, as shown in the figure 12.39 (a).

The near sighted eye can be corrected with glass or contact lenses that use diverging lenses as shown in fig. 12.39 (b). Light rays from the distant object are now diverged by this lens before entering the eye.

To the observer, these light rays appear to come from far point and are therefore focused on the retina, thus forming a shape image as shown in fig. 12.39 (c).

Far sightedness (hypermetropia)

The disability of the eye to form distinct images of nearby objects on its retina is known as far sightedness. When a far sighted eye tries to focus on a book held closer than the near point, it shortens its focal length as much as it can.

However, even at its shortest, the focal length is longer than it should be. Therefore the light rays from the book would form a sharp image behind the retina as show in fig.12.40 (a).

The lens refracts the light rays and they converge to form an image on the retina.

To an observer, these rays appear to come from near point to form a sharp

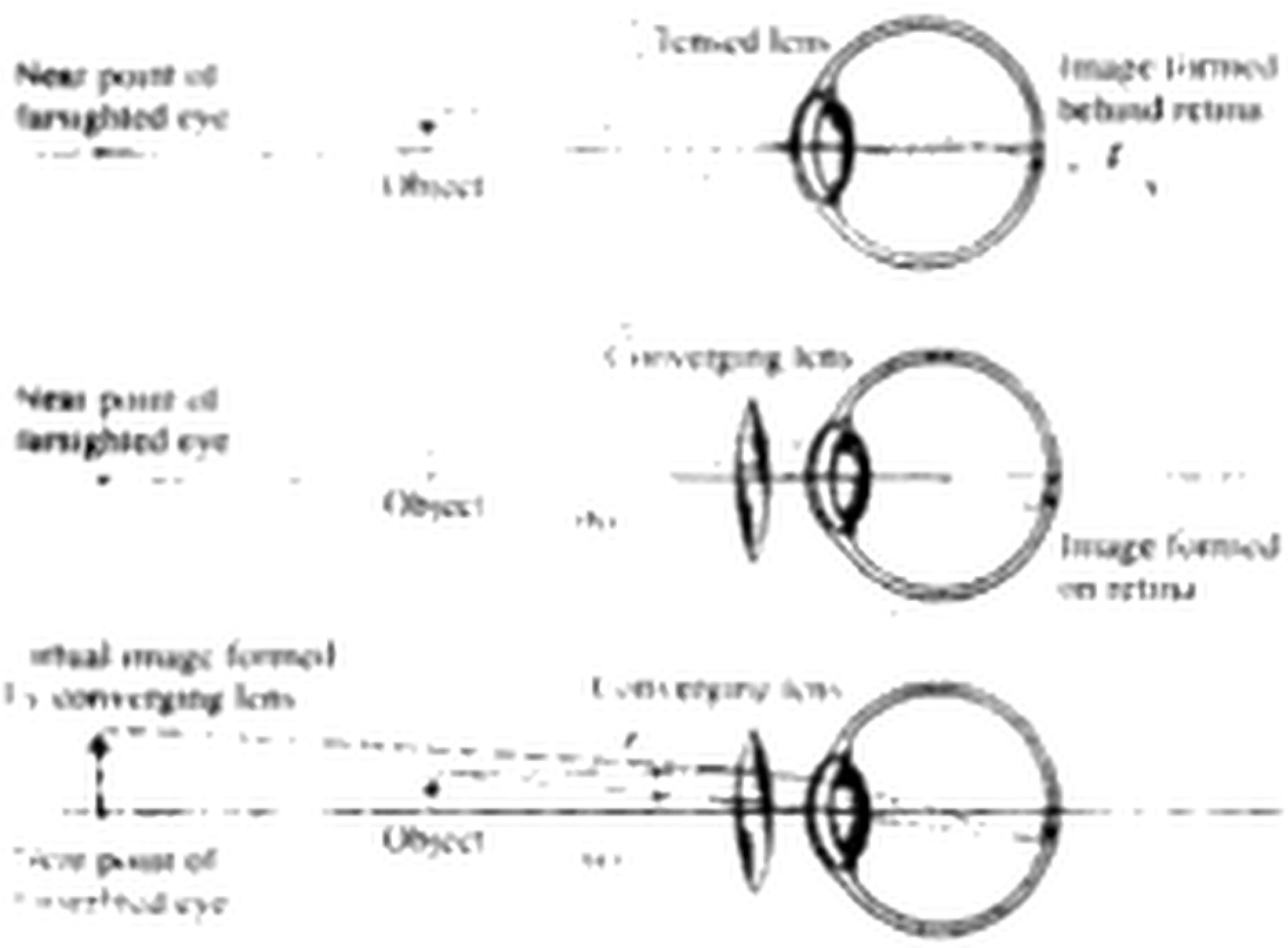


Fig. 12.40 Correction of farsightedness

virtual image on the retina as shown in the figure 12.40 (c).