Chapter = 13

Geometric Optics

Q 1. Define the following: Reflected ray, Refracted ray, Incident ray, Normal

INCIDENT RAY

It is the ray that falls on the surface

REFRACTED RAY

The ray which is refracted from the surface

REFLECTED RAY

The ray which is reflected from the surface

NORMAL

Perpendicular on the polished surface

Q 2. Differentiate between reflection and refraction

REFLECTION	REFRACTION
Reflection is the bouncing back of light when it strikes a smooth surface.	Refraction is the bending of light rays when it travels from one medium to another.
Generally occurs on shinny surfaces that only allow rebounding of light	This occurs in transparent surfaces that allow bending of the ray to a different medium.
When a light ray strikes the boundary of a shiny surface the speed of light ray does not vary.	The speed of light varies with the medium in which the ray undergoes bending.
The medium in which light propagates remains the same.	The medium of propagation gets changed.
The angle of reflection and angle of incidence is the same in the case of reflection.	In refraction, the angle of reflection and angle of incidence are not the same.

Q 3. Give laws of refraction

LAWS OF REFRACTION

FIRST LAW:

The angle of incidence in equal to the angle of reflection $\angle i = \angle r$

SECOND LAW:

The incident ray, reflected ray and the normal to the reflecting surface all lie in the same plane

Q 4. Give law of reflection

FIRST LAW:

Ratio of Sin of angle of incidence to sin or angle of reflection is constant know as refractive index.

SECOND LAW:

The incident ray refracted ray, and the normal to the reflecting surface all lie in the same plane.

Q 5. List some examples of reflection in your daily life

EXAMPLES OF REFLECTION

1. Reflection of light in mirror.
2. Reflection of light in spherical mirror.

3. Reflection of light in water pool.
4. Reflection of light on polished surface.
5. Object seen due to reflection of light.
6. Glowing of stars.
7. Lighting of moon at night.
8. Reflection from luminous object.
9. Reflection from non-luminous objects.

Q 6. Give uses of convex mirror

USES OF CONVEX MIRROR

(i) A concave mirror is used in a microscope to illuminate the object.
(ii) In a telescope it is used to concentrate the parallel beams of light coming from distant stars.
(iii) Concave mirrors are used by the doctors in ophthalmoscopes, for the medical examination of car, nose, throat, and eyes.
(iv) Concave mirrors are used in searchlights and spotlights.
(v) They are also used in the headlights of automobiles.

Q 7. State Snell's law

SNELL'S LAW

The law of refraction of light which state that ratio of Sin of angle of incidence to sin or angle of reflection is constant refractive index is also known as Snell's law

$$\eta = \frac{sin\angle i}{sin\angle r}$$

Q 8. What is total internal reflection and critical angle. Also show them by figure

CRITICAL ANGLE

When a ray of light passing through in a dense medium enters into a rare medium, it bends away from the normal. If the angle of incidence "∠I" increases, the angle of refraction '∠r also increases. For a particular value of the angle of incidence, the angle of refraction becomes 90^0, The angle of incidence that causes the refracted ray in the rarer medium to bend through 90^o is called the critical angle

TOTAL INTERNAL REFLECTION

If a ray passes from a dense medium to a rare medium and its angle of incidence is greater than the critical angle, the incident ray is reflected into the dense medium. This phenomenon is called total internal reflection.

Q 9. Write short note on fiber optics

OPTICAL FIBERS

Optical fiber consists of hair-size threads made of flexible plastic er glass fitters that transmit light over long distance. An optical fitter comprises of two parts an inner part "core" with a high refractive index, coated with another material cladding. When a light ray enters the fiber and hits the cladding, it is reflected internally in the core as the incidence angle is larger than the critical angle. even if the fiber is

bent Light rays entering the fiber ae continuously reflected a the interface between two refractive materials and cover long distances without energy loss

Q 10. What is lens. Discus its types

LENS

A lens is a piece of transparent material, such as glass or plastic, that refracts light in a regular way. These are bounded by one or two spherical Surfaces.

Two main types of spherical lenses are generally used. These are

Convex lens

Concave lens.

CONVEX LENSES

A convex lens is thick at the center and thin at the edges. It converges parallel beam of light at a point and hence is called a converging lens.

CONCAVE LENSES

A concave lens is thinner at the center and thicker at-the edges. It diverges a parallel beam of light. The rays after refraction through a concave lens appears to diverge from a point. The concave lens is thus called a diverging lens.

Q 11. Define power of lens. Give its formula and unit

POWER OF LENS

The power of a lens is defined as the reciprocal of its focal length, measured in meters inverse (m).

FORMULA

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

UNIT

The unit use for power id diopter D.

Q 12. What is projector. Discus it in brief

THE PROJECTOR

A projector uses a convex lens as a projection lens and pair of condenser lenses to produce a large, inverted, and real image on a screen. In the projector, an object or a film is positioned between f and 2f from the projection lens. A concave mirror is used to reflect the light from the lamp onto a pair of condenser lenses so that the light from the lamp is concentrated on the film or slide, illuminating it evenly and directing it through the film(object) to the projection lens. The image formed on the screen is inverted, real, and magnified.

As the image formed is inverted, must turn the film must upside down to maintain an upright picture on the screen. Move the lens from the screen to obtain a large image. The lens is moved forward or backward to get a sharp picture on the screen.

Q 13. What is photographic enlarger

THE PHOTOGRAPHIC ENLARGER

The photographic enlarger uses a convex lens to produce an inverted, real, and magnified image of the film on photograph paper.
An enlarger is a specialized transparency projector used to produce photographic prints from glass negatives or transparencies or microfilm. The photographic enlarger works on the same principle as a projector. In the case of the enlarger, object is placed at a distance greater than F but less than 2F. In this way, we get an inverted, real, and enlarged image.

Q 14. Differentiate between real and virtual image?

REAL IMAGE	VIRTUAL IMAGE
1. Real image can be obtained on screen	1. virtual image cannot be obtained on screen
2. real image is formed by actual meeting of rays after refraction	2. virtual image is formed by just extending the refracted rays backward.
3. real image is always inverted	3. virtual image is always erect

Q 15. What is resolving power and magnifying power?

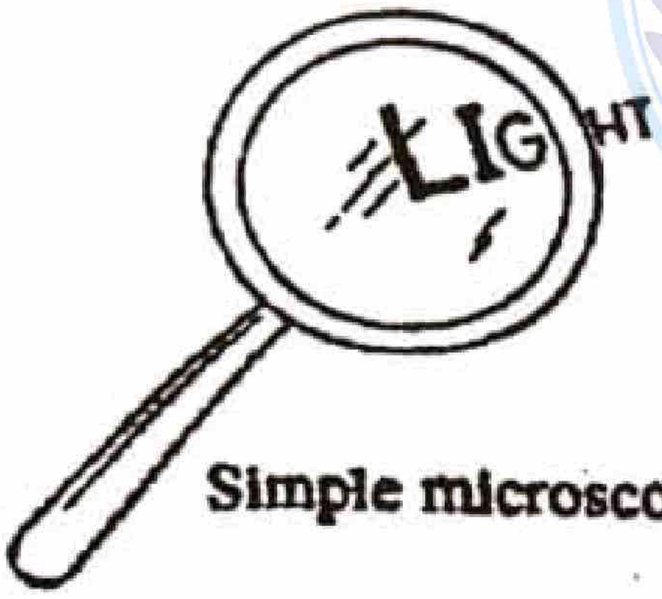
RESOLVING POWER:

The resolving power is usually taken as the smallest distance at which two points can be seen as distinctly when viewed through the optical instrument. The greater the resolving power, the smaller the minimum distance between points or lines that can still be distinguished.

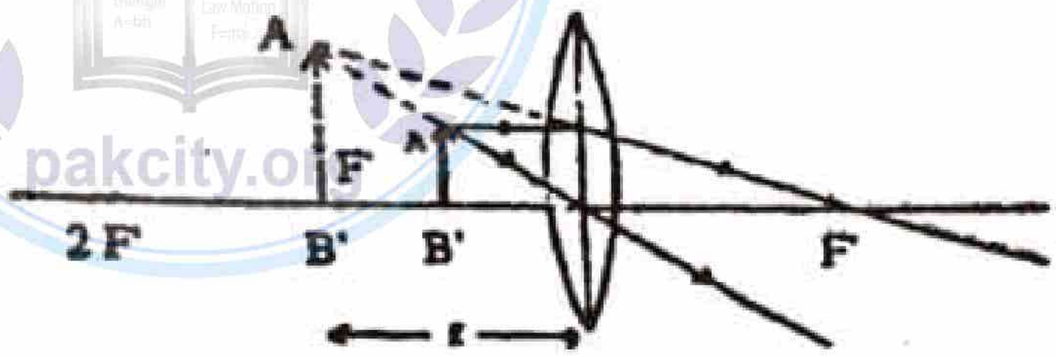
Q 16. What is magnification glass or simple microscope? Also give its formula for magnification. Draw a ray diagram for image formed by magnifying glass.

SIMPLE MICROSCOPE

A simple microscope uses a convex lens to produce magnified images of small objects. The object is placed nearer to the lens than the focal length produces an upright, virtual, and magnified image. It is also called magnifying glass.



Simple microscope



Formation of virtual image with a simple microscope.

MAGNIFICATION

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

Q 17. What is compound microscope. Give its construction and working. Also draw its ray diagram and give its formula for magnification.

COMPOUND MICROSCOPE

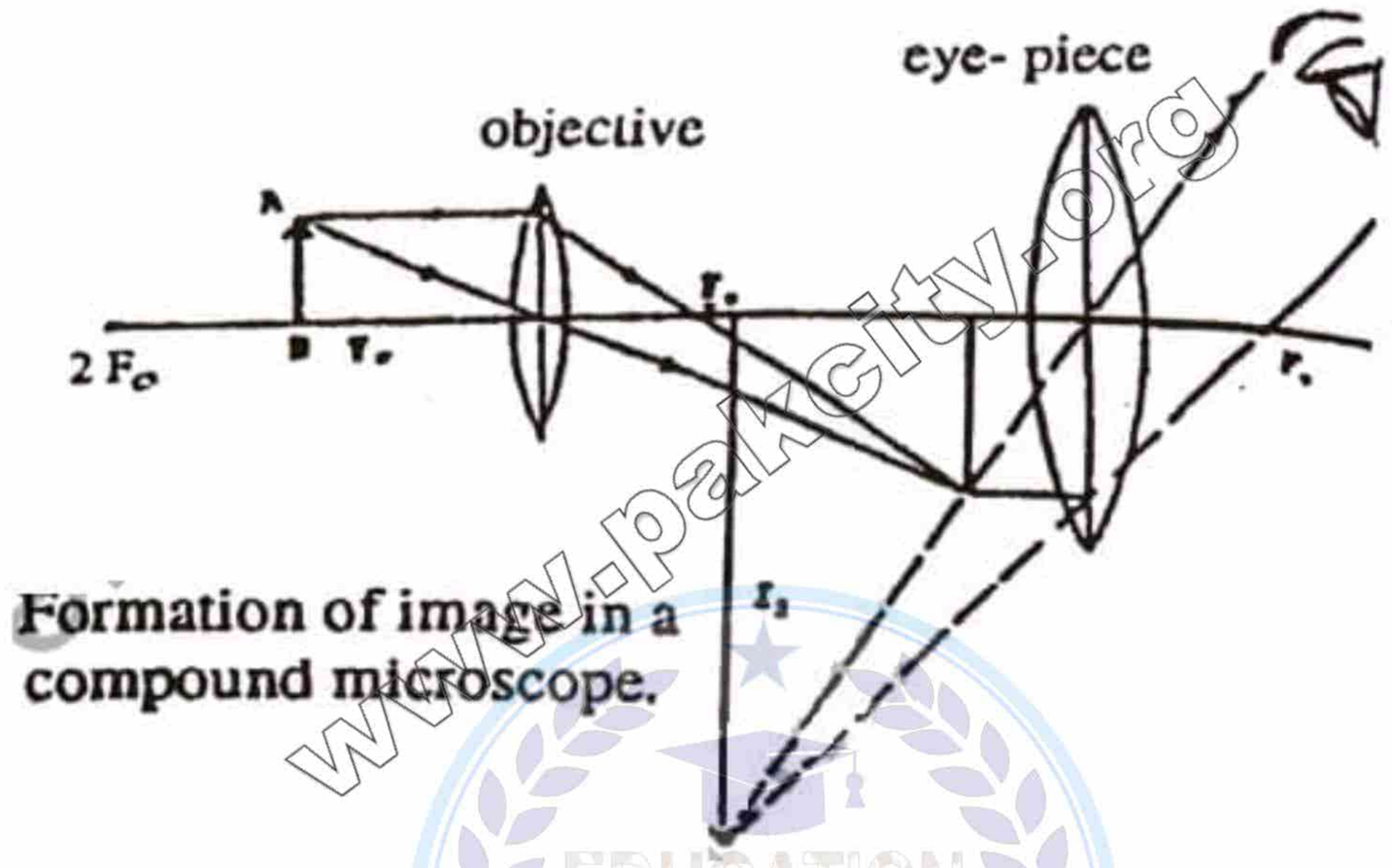
A compound microscope is an upright microscope that uses two sets of lenses (a compound lens system) to obtain higher magnification than a stereo microscope.

The objective lens has a shorter focal length "fo" than the focal length of eyepiece "fe".

It is used to study the structure of small objects.

MAGNIFICATION BY COMPOUND MICROSCOPE

When rays of light from a point on a nearby object pass through an objective lens. The objective forms a small image "I_1" on the inside focal point of the eyepiece. This image behaves as an object for the eyepiece, and the larger image "I_2" is formed at the near point of the normal human eye. This final magnified virtual image makes an angle " θI" at the eyepiece.



Formation of image in a compound microscope.

$$M = \frac{L}{f_o}\left(1 + \frac{d}{f_e}\right)$$

Here,

F_o = focal length of objective

F_e = focal length of eyepiece

d = least distance of distinct vision

L = length of tube

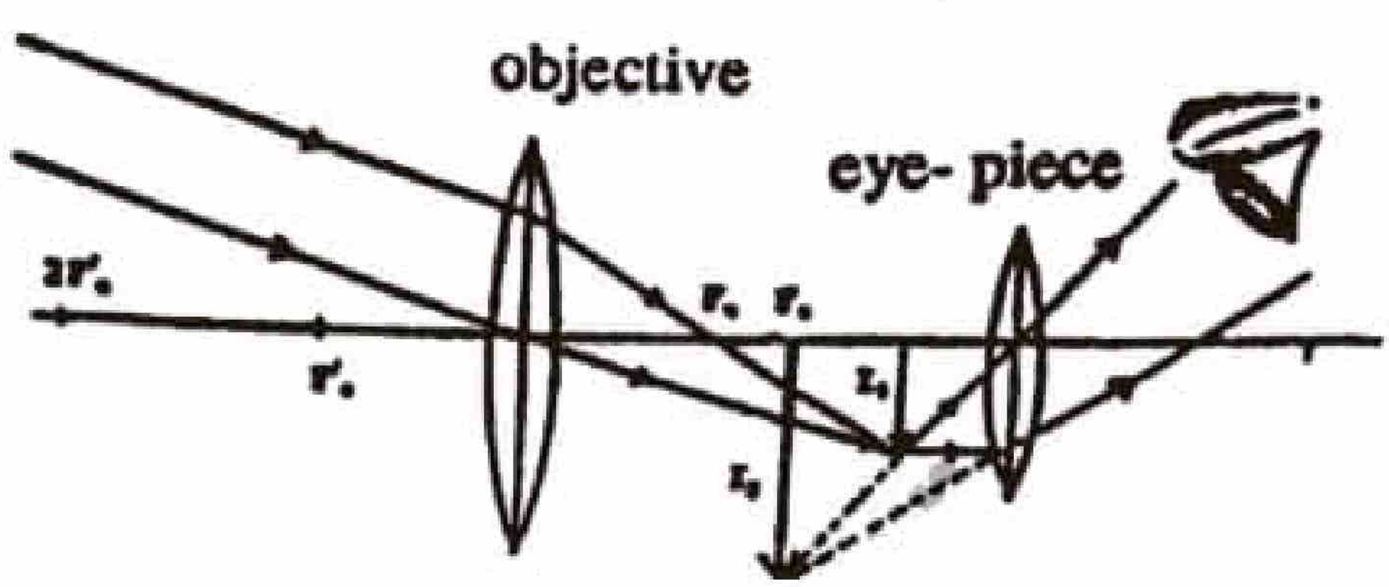
Q 18. What is telescope microscope. Give its construction and working. Also draw its ray diagram and give its formula for magnification.

TELESCOPE

The telescope is also an optical instrument that uses two convex lenses, the objective and the eyepiece. The objective lens has a larger focal length, "f_o" than the eyepiece, which has a focal length, "f_e". Telescopes are helpful because they can gather far morelight than the human eye. It is used to form magnified images of distant objects.

MAGNIFICATION BY TELESCOPE

When parallel rays from a point on a distant object pass through the objective lens, a real image I1 is formed at the focal point for the objective lens. This image behaves as an object for the eyepiece. The eyepiece forms a magnified Virtual image l_2 a considerable distance from the objective lens. This enlarged virtual image makes an angle θi at the eyepiece.



The magnification of a telescope is given by the formula

$M = \frac{f_o}{f_e}$

Here,

F_o = focal length of objective

F_e = focal length of eyepiece

Q 19. List uses of telescope

USES OF TELESCOPES

1. Telescopes are used to collect and focus the light towards the eyepiece.
2. Telescopes have extended our sights to the universe.
3. They also showed mountains and carters on the moon.
4. Modem telescopes provide evidence of billions of galaxies each containing billions of stars.
5. Telescopes are now discovering planets around the stars and possible life over there.

Q 20. What do you know about myopia and hypermetropia? Give reason and state how they can be corrected.

SHORT SIGHTEDNESS(MYOPIA)

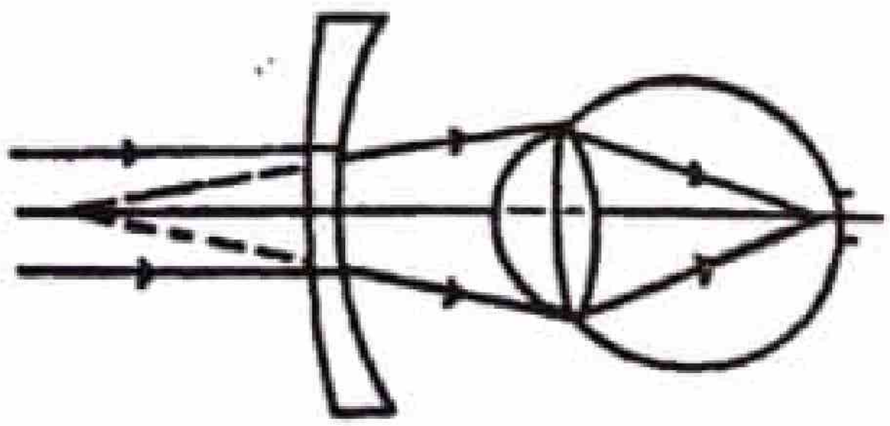
A short-sighted person can see near objects clearly but distant objects are not seen clearly.

REASON

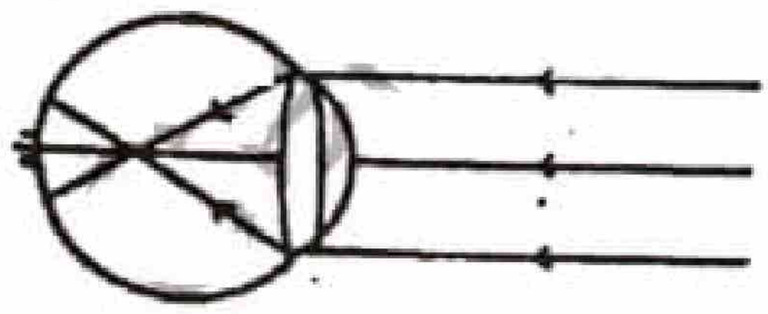
The reason for this defect is either the focal length of the eye lens is too short or the eye ball Is too elongated. This means that light rays from a distant object are focused in front of the retina.

CORRECTION

This defect can be corrected by wearing spectacles (or contact lenses) with concave lenses. These lenses diverge the rays of light so that the eye lens can focus the image clearly on the retina.



correction by a concave lens



short sightedness

LONG SIGHTEDNESS (HYPERMETROPIA):

A long sighted person can see distant objects clearly but cannot see near objects distinctly.

REASON

The reason for this defect is either the focal length of eye lens is too long or the eye ball is too short.

This means that light rays Tom near objects are focused behind the retina.

CORRECTION

This defect can be corrected by wearing spectacles (or contact lenses) with convex lenses as these lenses Converge rays so that the eye lens can focus the image on the retina clearly.

Long sightedness

Correction by convex lens

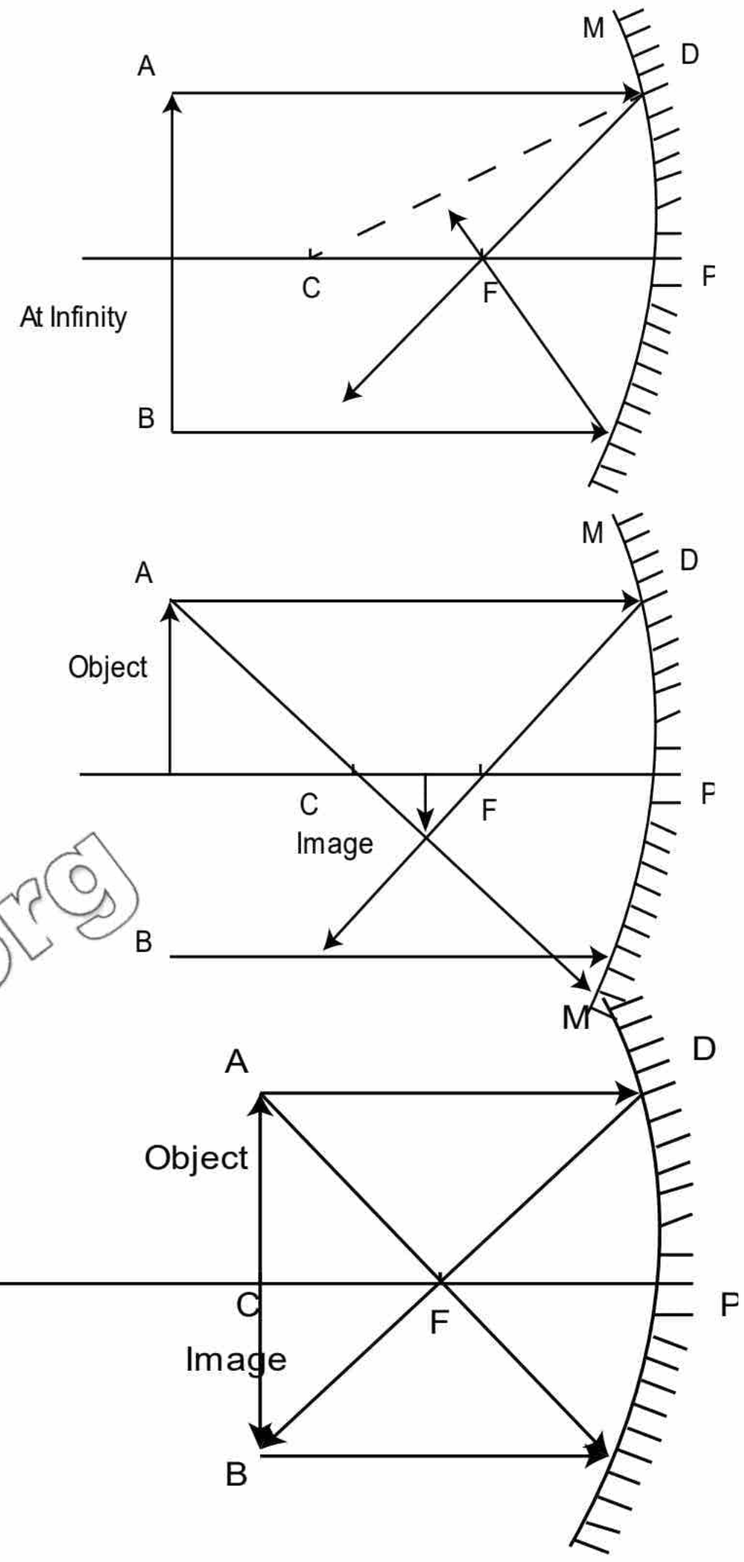
Q 21. Differentiate between simple microscope and compound microscope

SIMPLE MICROSCOPE	COMPOUND MICROSCOPE
Simple microscope is used at a basic level, where there is no rigorous requirement of research.	Due to an added lens to a compound one, professionals use this for research purposes
There is single lens in simple microscope.	There are 3 to 5 objective lenses in a compound which helps in magnifying algae, fungi and bacterium.
Has only one lens for magnifying objects.	Has two sets of lenses for magnifying objects: eyepiece lens and objective lenses
Can only be used in simple ways such as enlarging small letters while reading.	Has a wide range of use such as in studying the structure of different objects, e.g. details of cells in living organisms.

Q 22. Draw ray diagram for the image formation by a concave mirror. Also state their characteristics

1. CHARACTERISTICS

Position of object	At infinity
Position of image	At the focus F
Size of image	Highly diminished point sized
Nature	Real and inverted



2. CHARACTERISTICS

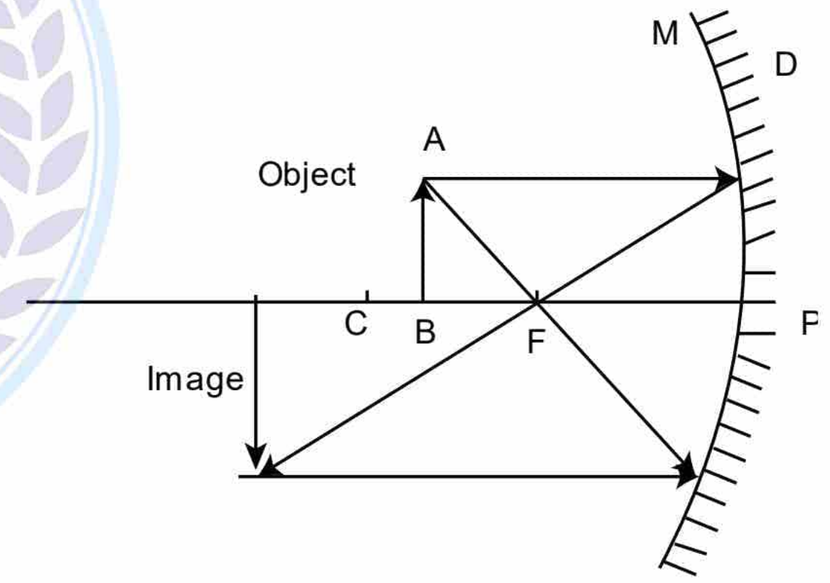
Position of object	Beyond C
Position of image	Between F and C
Size of image	Diminished
Nature	Real and inverted

3. CHARACTERISTICS

Position of object	At C
Position of image	At C
Size of image	same size
Nature	Real and inverted

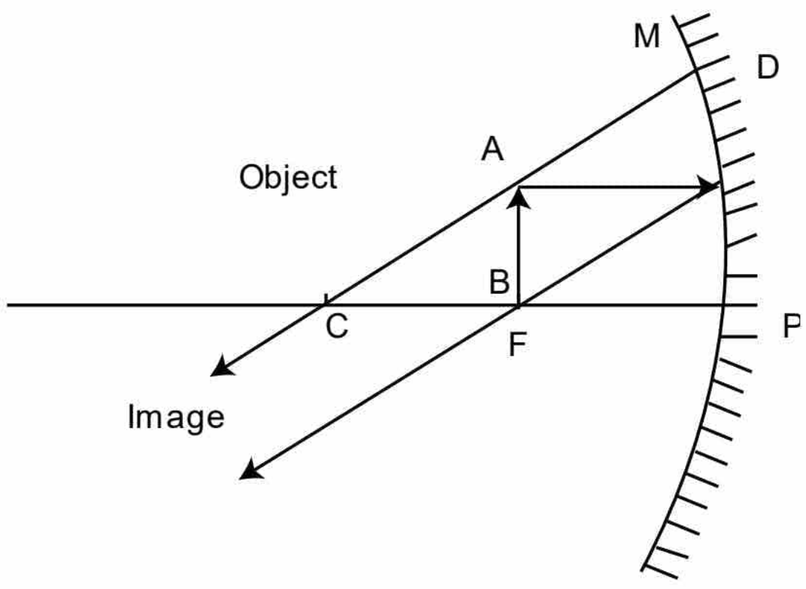
4. CHARACTERISTICS

Position of object	Between C and F
Position of image	Beyond C
Size of image	Enlarged
Nature	Real and inverted



5. CHARACTERISTICS

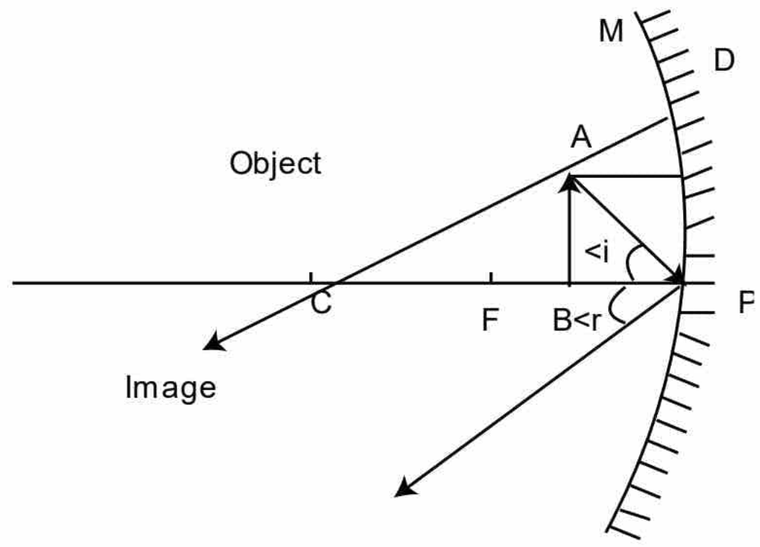
Position of object	At F
Position of image	At infinity
Size of image	Highly enlarged
Nature	Real and inverted



6. CHARACTERISTICS

Position of object	Between P and F
Position of image	behind the mirror
Size of image	Enlarged

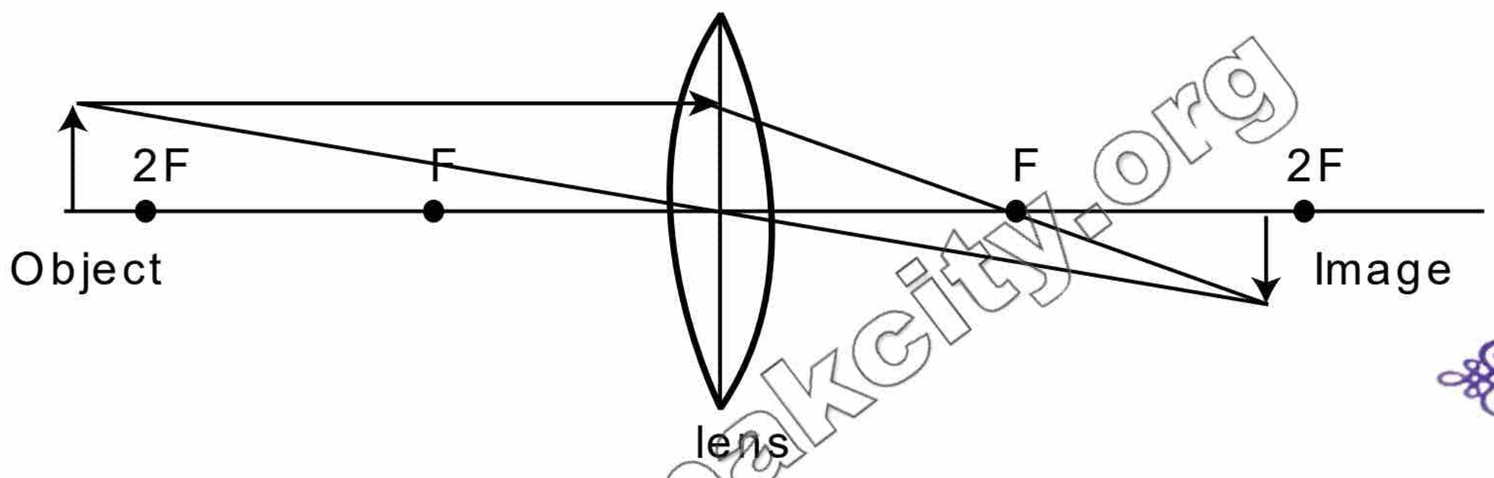
Nature virtual and erect



Q 23. Draw ray diagram when image form by convex lens also give its characteristics.

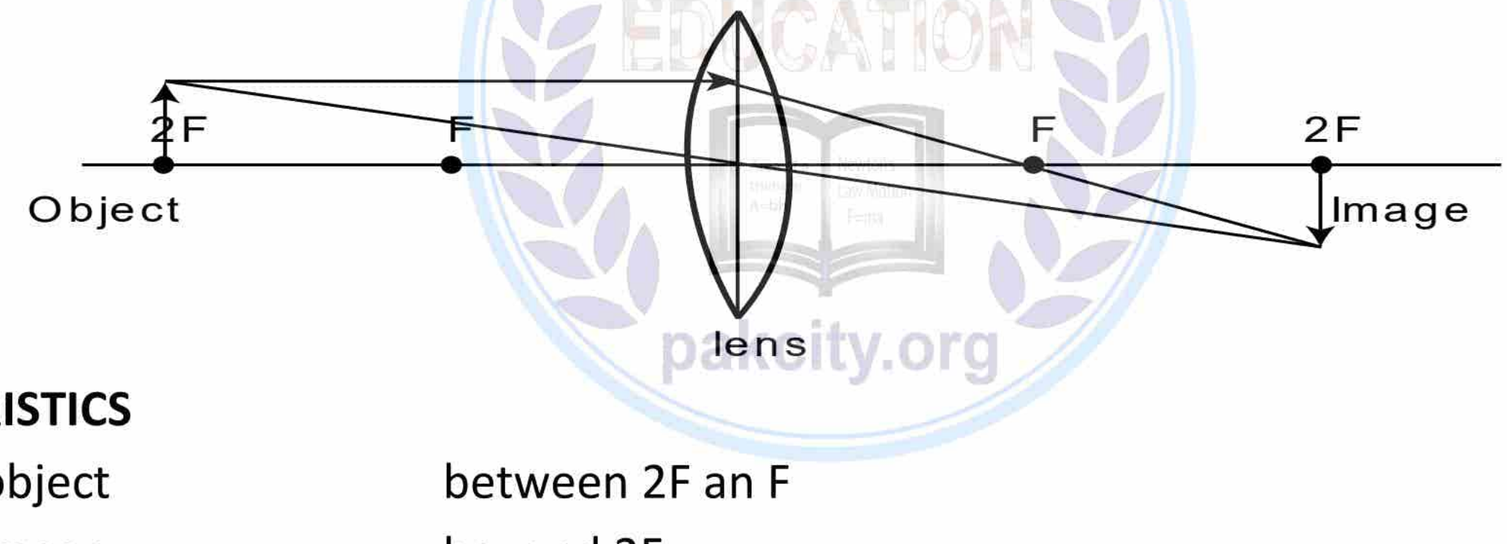
CHARACTERISTICS

Position of object beyond 2F
Position of image between F and 2F
Size of image small
Nature Real and inverted



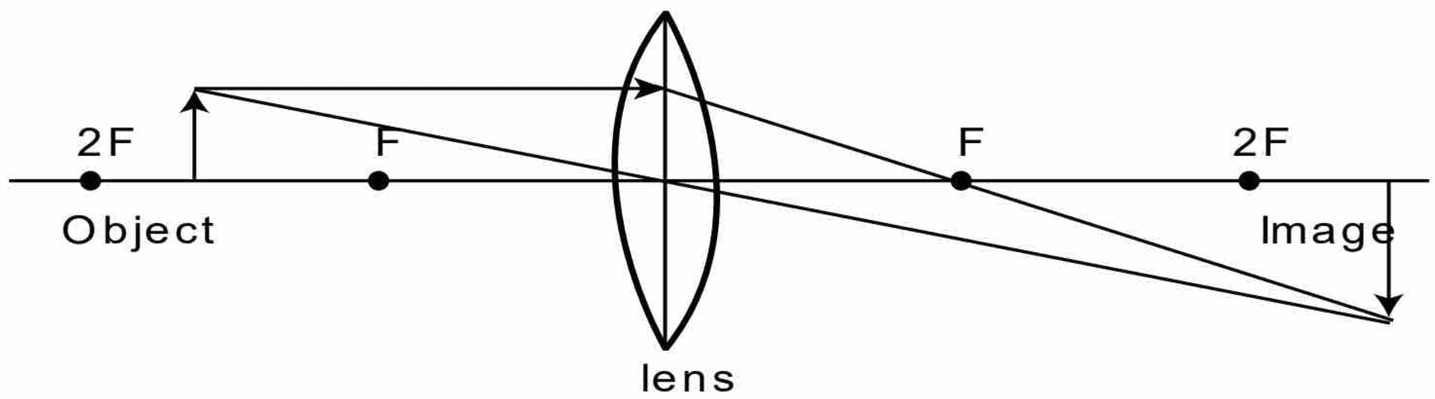
CHARACTERISTICS

Position of object At 2F
Position of image At 2F
Size of image same as that of size of the object
Nature Real and inverted



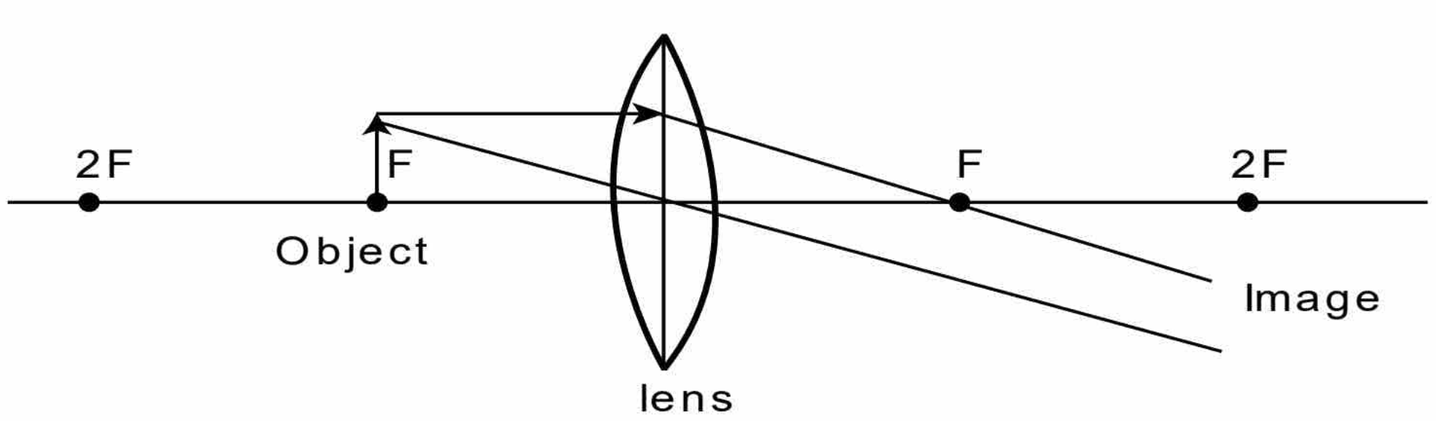
CHARACTERISTICS

Position of object between 2F an F
Position of image beyond 2F
Size of image enlarged
Nature Real and inverted



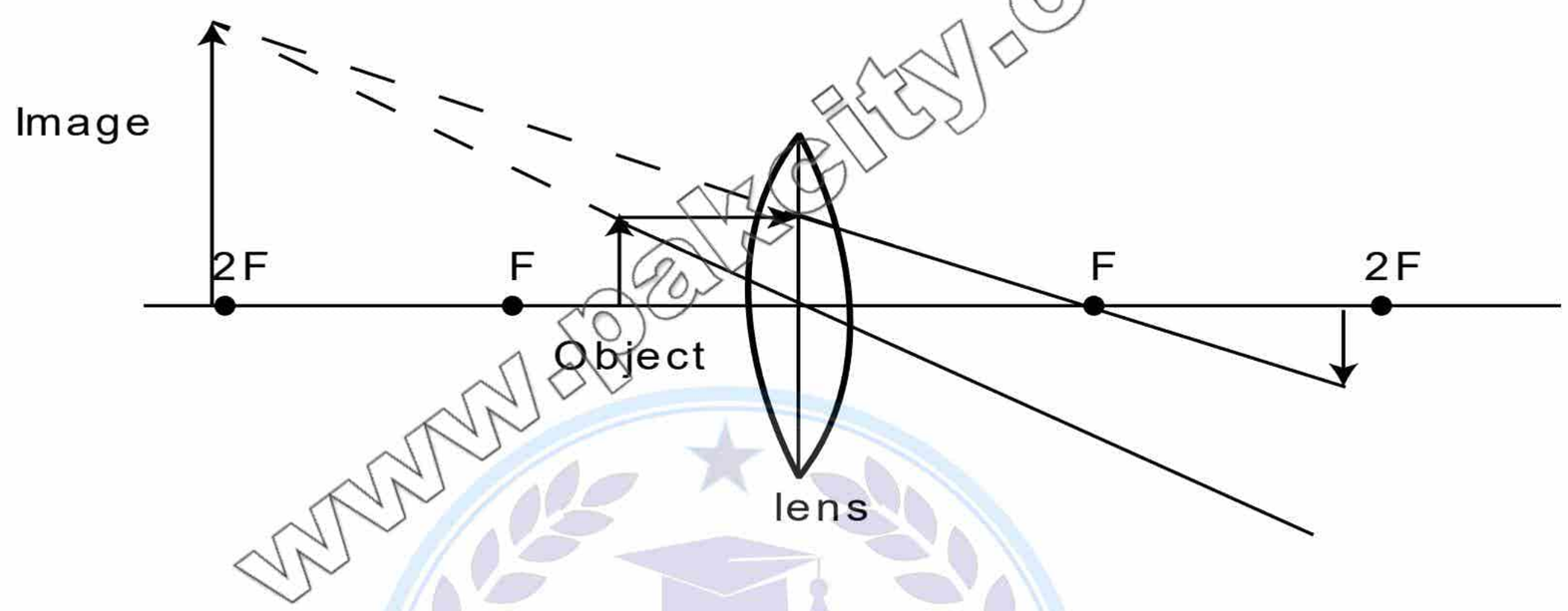
CHARACTERISTICS

Position of object	At F
Position of image	At infinity
Size of image	Highly enlarged
Nature	Real and inverted



CHARACTERISTICS

Position of object	between F anf 2F
Position of image	same side of the lens
Size of image	enlarged
Nature	virtual and erected



Worked Example 1

A concave mirror forms a real image at 25.0 cm from the mirror surface along the principal axis. If the corresponding object is at a 10.0 cm distance, what is the focal length of the mirror?

Worked Example 2

The refractive index of the diamond is 2.42. What is the speed of light in a diamond?

Worked Example 3

Calculate the value of critical angle for water refracted angle at The retractive index of water is 1.33.

Worked Example 4

A boy is standing 2.500 m in front of a camera. The camera uses a convex lens whose focal Length is 0.050 m. Find the image distance (the distance between the lens and the film and determine whether the image is real or virtual. Also, find the power of the lens.

Book Numerical

1. A thumb pin is positioned at a distance of 15 cm from a convex mirror of a focal length of 20 cm. Determine the position and nature of the image. (8.57cm)

2. An image of a specimen appears to be 11.5 cm behind a concave mirror with a focal length of 13.5 cm. Find the specimen's distance from the mirror. (6.21cm)

3. A convex mirror used for rear-view on an automobile has a radius of curvature of 4.00 m. If a bus is located at 5.00 m from this mirror, find the image's position, nature, and size. (1.428m)

4. An object is placed 15 cm away from a converging lens of a focal length of 10 cm. Determine the position, size, and nature of the image formed. (2cm)

5. A concave lens of focal length 20 cm forms an image 15 cm from the lens. Determine the power of a lens. Also, how far is the object positioned from the lens? (0.05cm)

6. The angle of incidence for a ray of light from air to water interface is 40. If the ray travels through the water with a refractive index of 1.33, calculate the angle of refraction. (28.8°)