HOPE SERIES

CLASS 10TH COMPLETE BACKLOG

LIGHT : REFLECTION & REFRACTION
HUMAN EYE & COLOURFUL WORLD

PHYSICS

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TOPICS to be covered

5-7 Hours

1. LIGHT : REFLECTION & REFRACTION
2. HUMAN EYE & COLOURFUL WORLD
3. QUESTIONS
4.

LIGHT

Light is form of energy which enables up to see objects which emit or reflect light. Light is a type of energy which can **produce sensation in our eyes**. So we can experience the sensation of vision.

LIGHT

(Photon)

- It 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 sensitive 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

(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.

PROPERTIES OF LIGHT

(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.

Class 10 Class 12

(vi) It exhibits the phenomena of reflection, refraction, interference, diffraction, and polarization.

PROPERTIES OF LIGHT

(vii) Light is an electromagnetic wave.

(viii) The velocity of light changes when it travels from one medium to another.

(ix) The wavelength of light changes when it goes from one medium to another.

Light in air $\longrightarrow \lambda$

Light in medium $\longrightarrow \boxed{\lambda' = \frac{\lambda}{\mu}}$

$\mu \longrightarrow$ Refractive Index

PROPERTIES OF LIGHT

(x) The frequency (f) of the light wave remains the same in all media.

→ Property of Source

(xi) According to current scientific theories, no material particle can travel at a speed greater than that of light in vacuum.

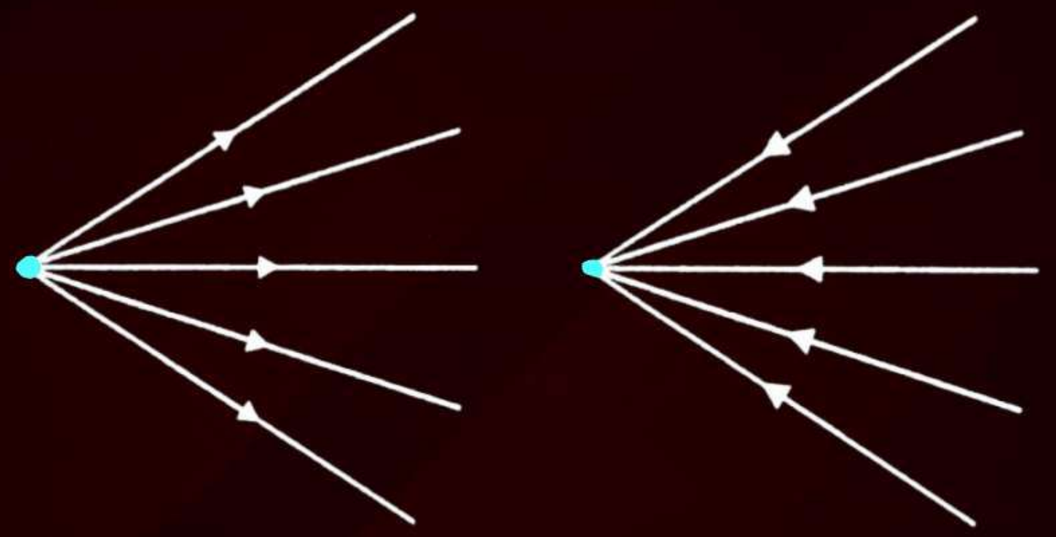
RAY OF LIGHT

A straight line showing the direction of light is called ray of light.

BEAM OF LIGHT

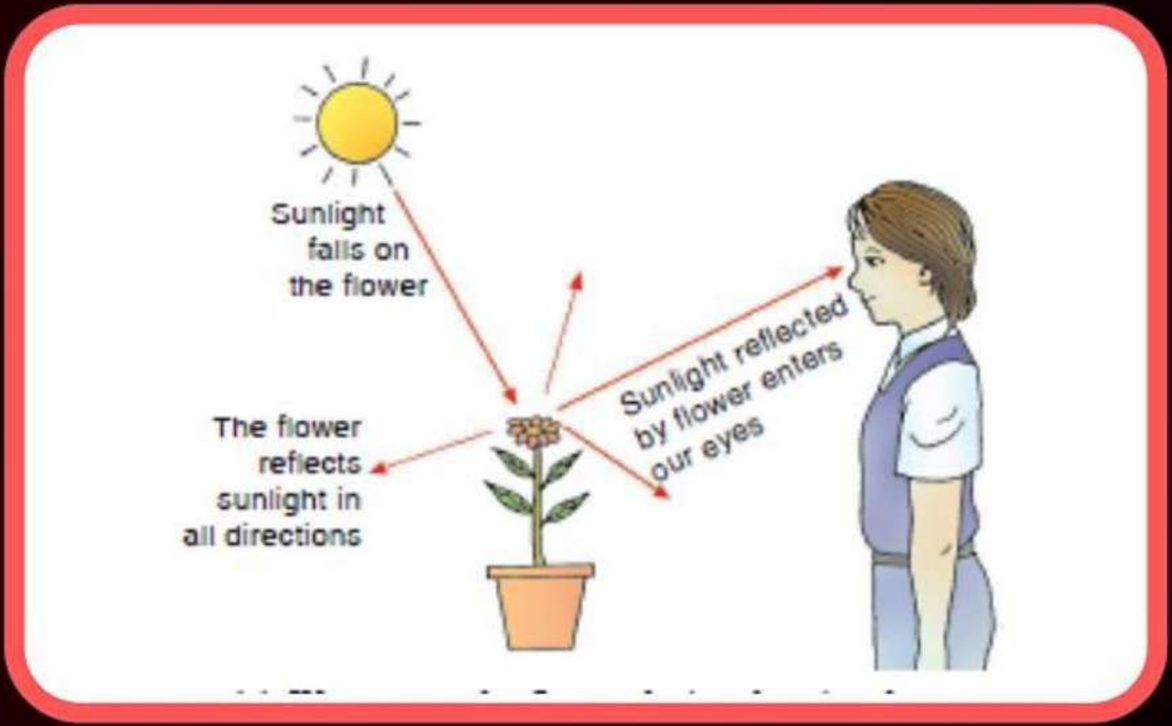
$\lambda \rightarrow$ wavelength

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



luminous objects

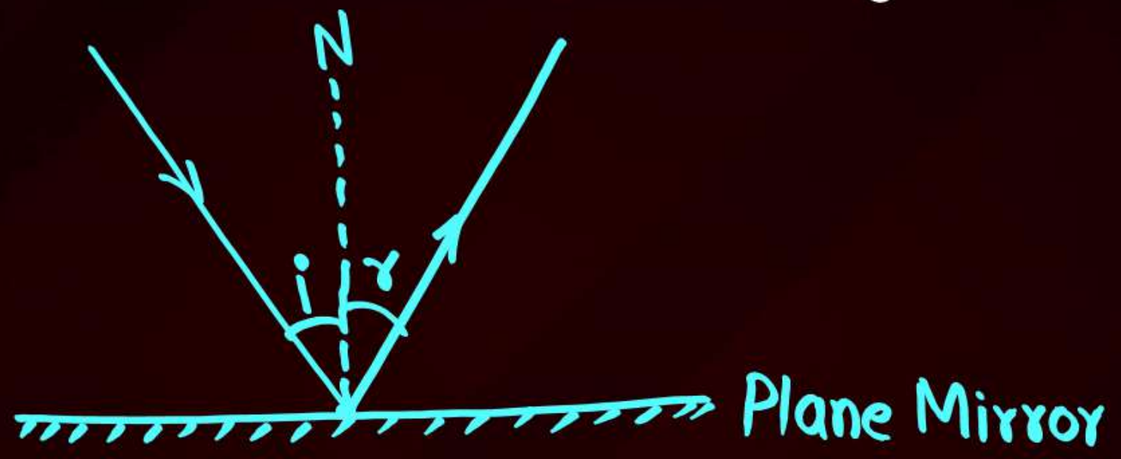
The objects which emit (give) light are called luminous objects. It may be natural or manmade. Sun is a natural source of light and electric lamp, and oil lamp, etc. are manmade source of light.

Non-luminous objects

The Non-luminous objects do not emit light. However, such objects become visible due to the reflection of the light falling on them. Moon does not emit light. It becomes visible due to the reflection of the sunlight falling on it.

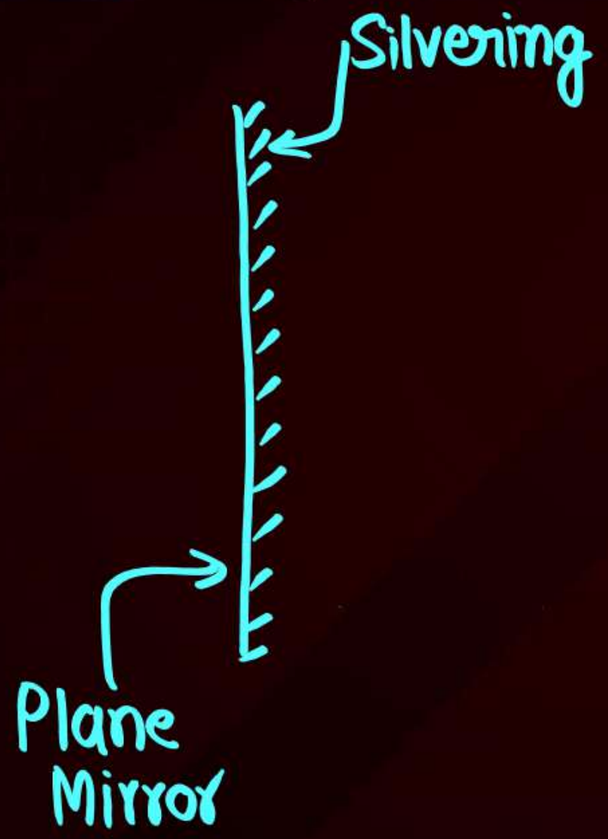
REFLECTION OF LIGHT

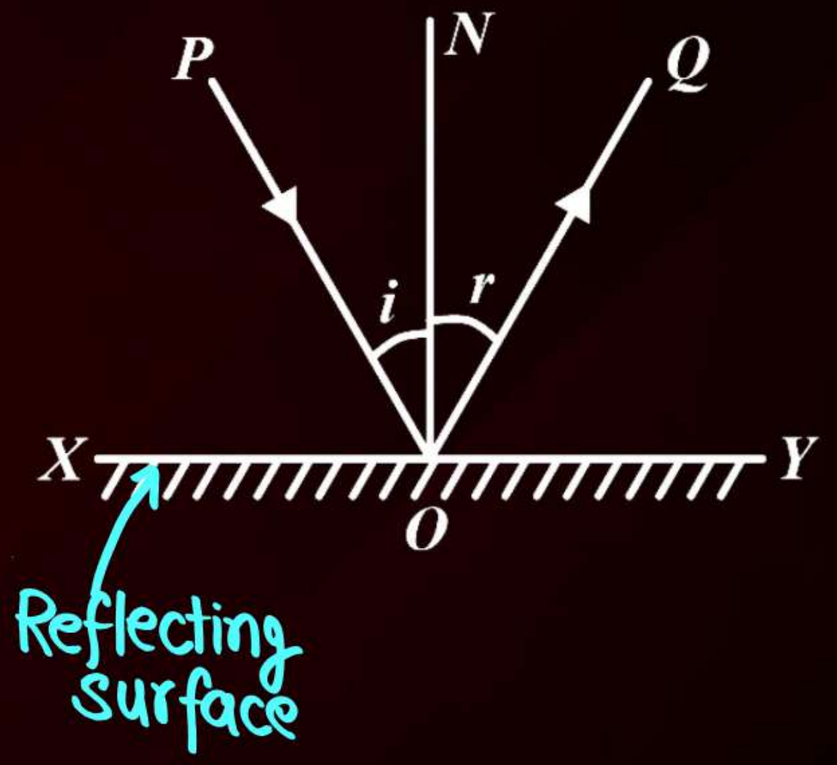
When rays of light falls on any object it return back in the same medium from the surface this phenomenon is called reflection of light. Due to reflection of light we can see all the nature.



Definition of some associated terms

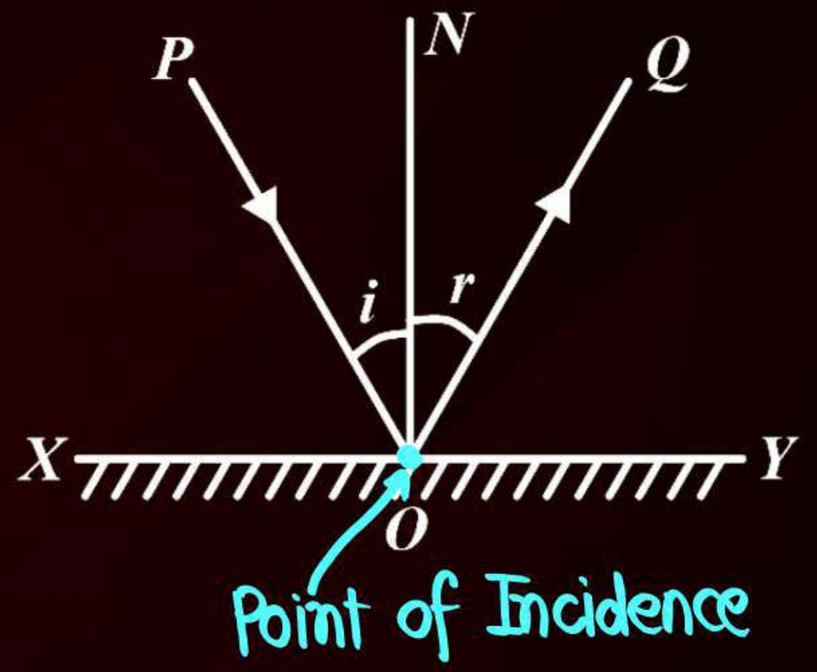
Reflecting surface: The surface from which the light is reflected, is called the reflecting surface. In diagram, XY is the reflecting surface.





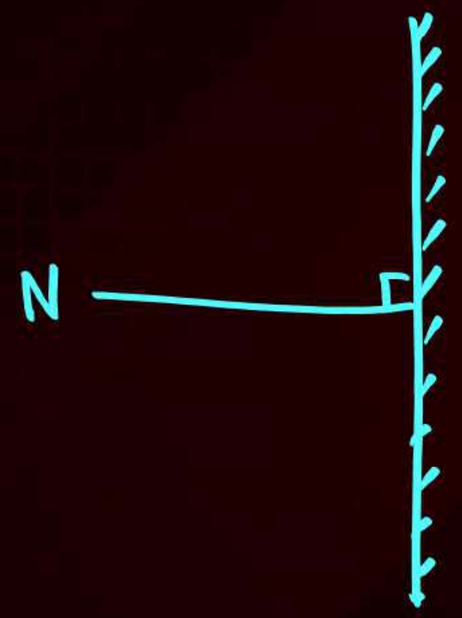
Definition of some associated terms

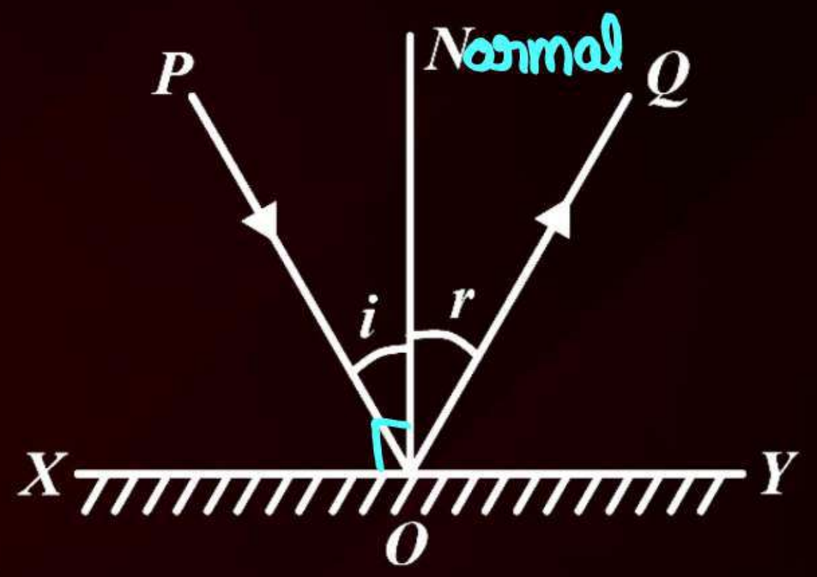
Point of incidence: The point on the reflecting surface at which a ray of light strikes, is called the point of incidence. In diagram, O is the point of incidence.



Definition of some associated terms

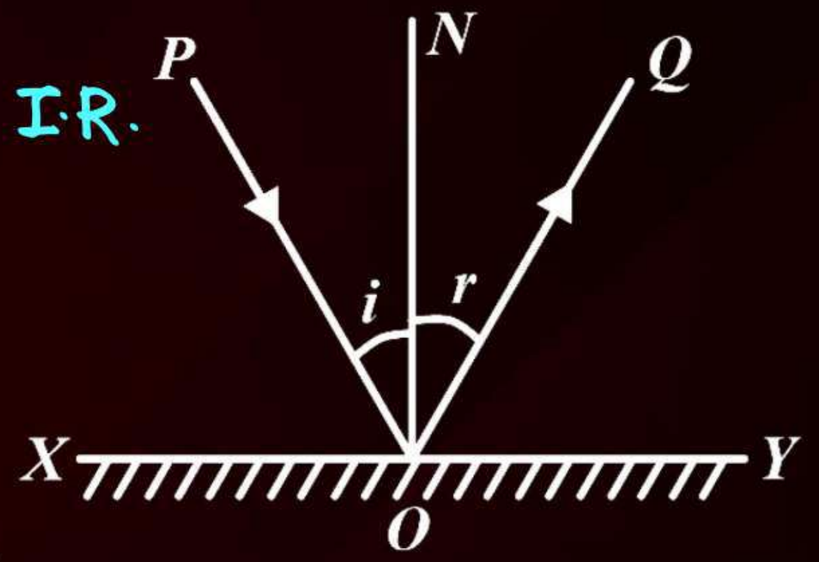
Normal: A perpendicular drawn on the reflecting surface at the point of incidence, is called the normal. In diagram, ON is the normal.





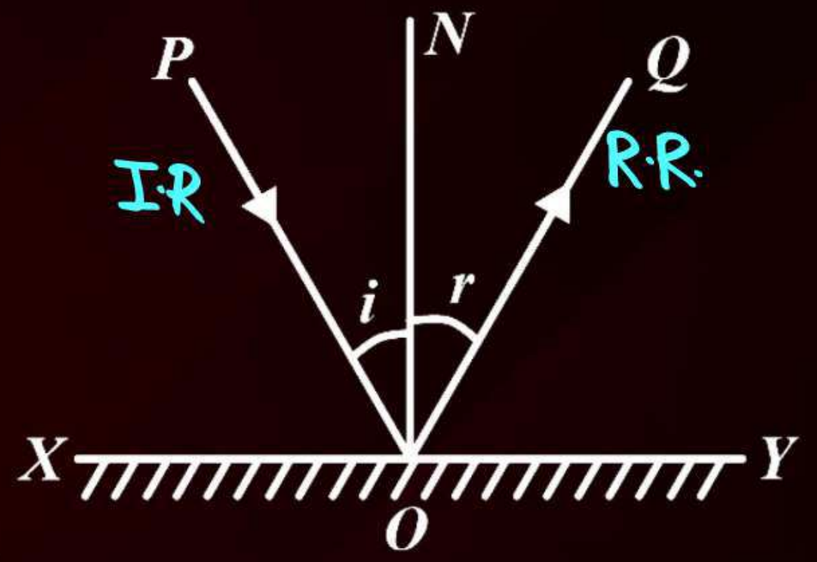
Definition of some associated terms

Incident Ray: The ray of light which strikes the reflecting surface at the point of incidence is called the incident ray. In diagram, PO is the incident ray.



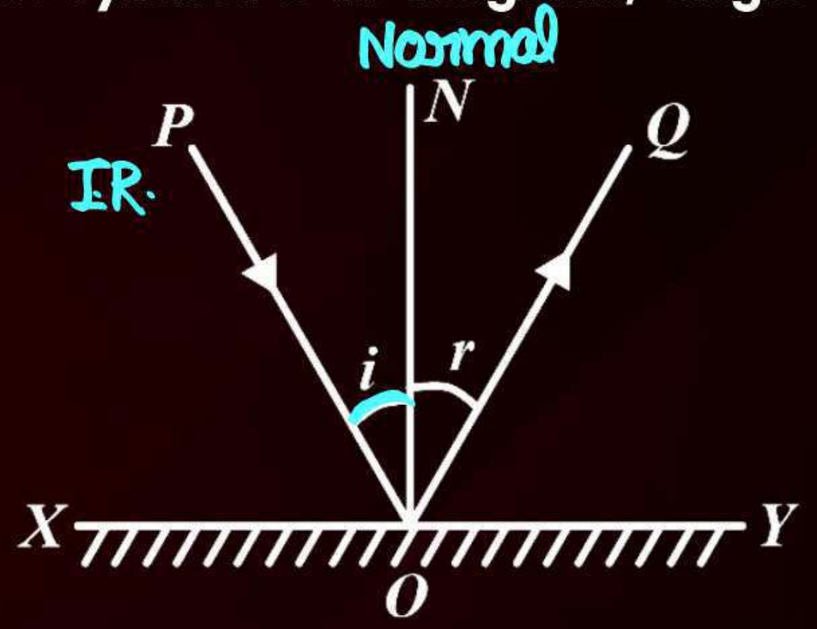
Definition of some associated terms

Reflected Ray: The ray of light reflected from the reflecting surface from the point of incidence, is called the reflected ray. In diagram, *OQ* is the reflected ray.



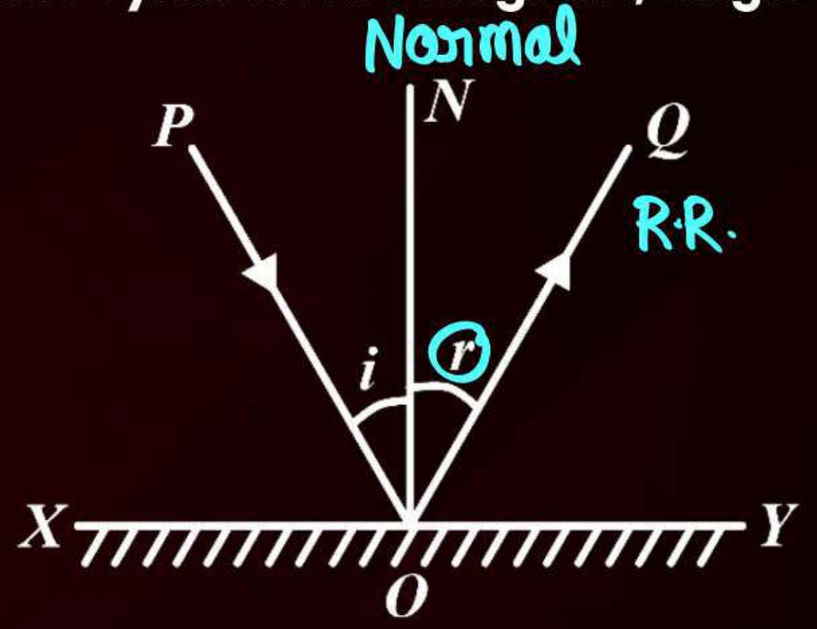
Definition of some associated terms

Angle of Incidence: The angle that the incident ray makes with the normal, is called the angle of incidence. It is represented by the symbol i. In diagram, angle PON is the angle of incidence.



Definition of some associated terms

Angle of Reflection: The angle that the reflected ray makes with the normal, is called the angle of reflection. It is represented by the symbol r. In diagram, angle QON is the angle of reflection.

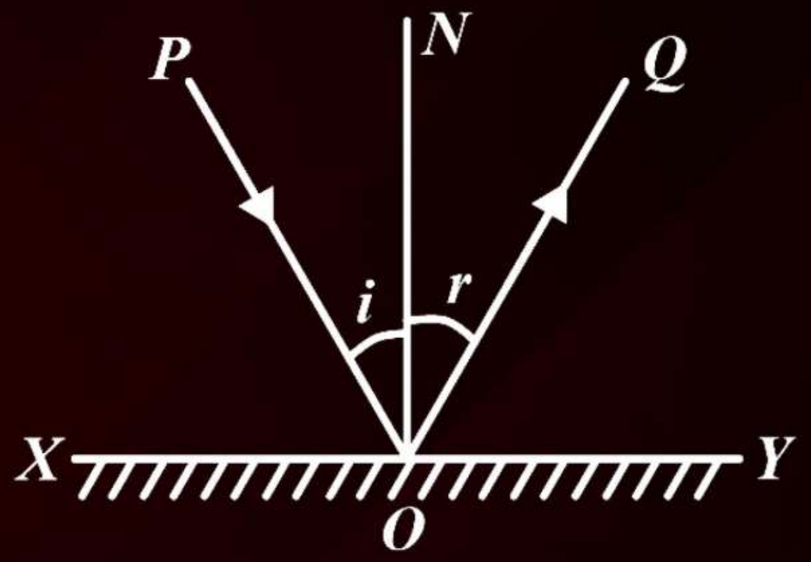


LAWS OF REFLECTION OF LIGHT

1) Incident Ray, Normal at the point of incidence and reflected ray, all lies in same plane.

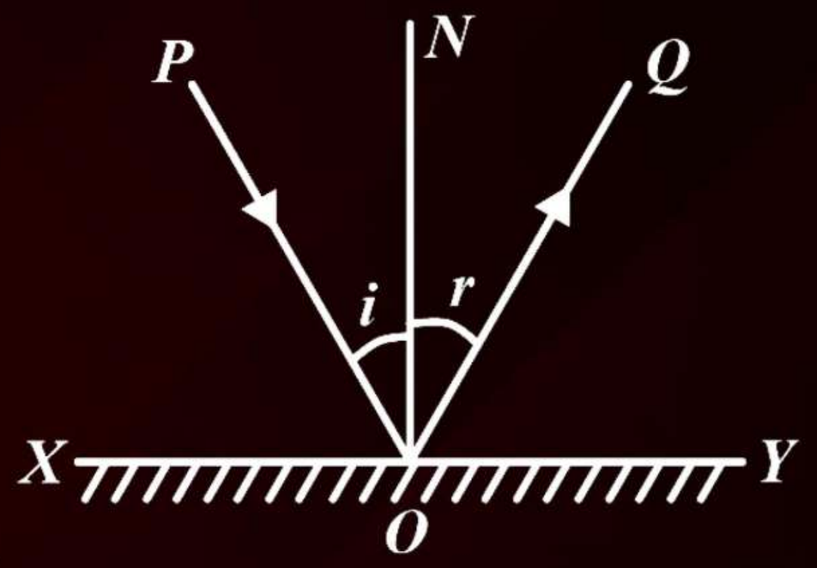
2) Angle of incidence is equal to angle of reflection.

$$\boxed{\angle i = \angle r}$$



LAWS OF REFLECTION OF LIGHT

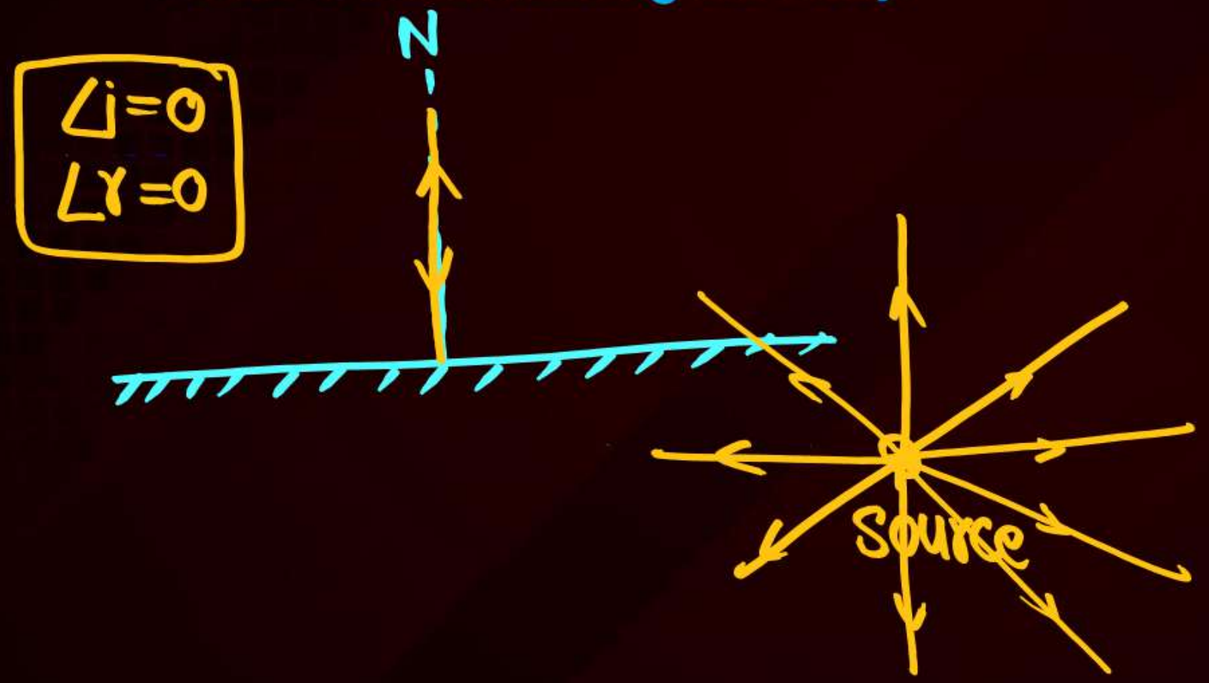
First law: The incident ray, the reflected ray and the normal at the point of incidence, all lie in the same plane.

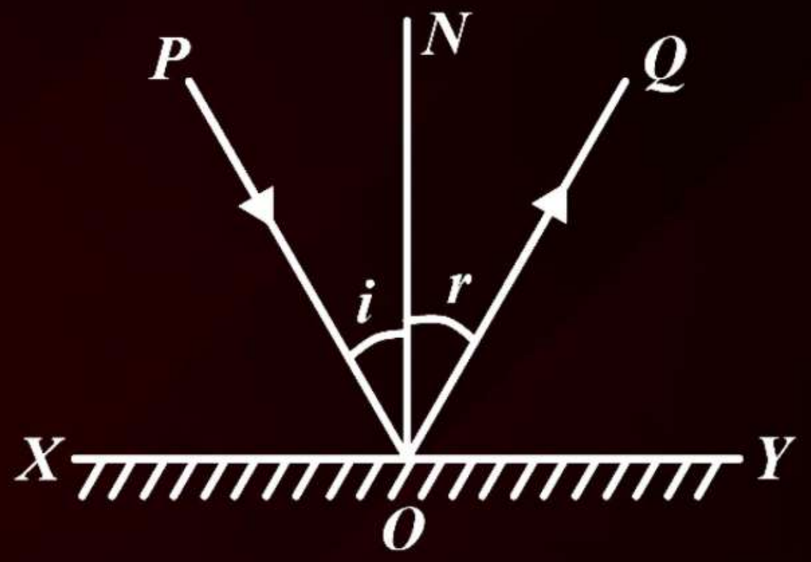


LAWS OF REFLECTION OF LIGHT

Second law: The angle of reflection (r) is always equal to the angle of incidence (i).

(For normal incidence, $i = 0$, $r = 0$. The ray is reflected back along normal).

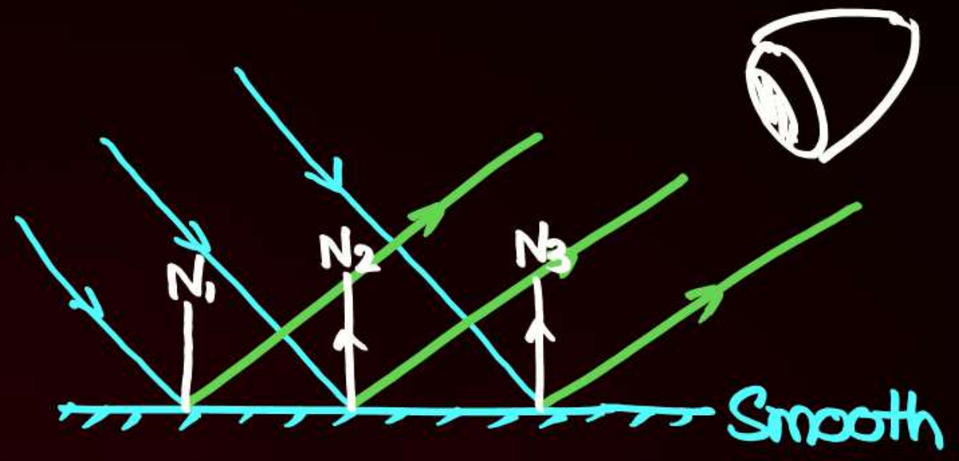


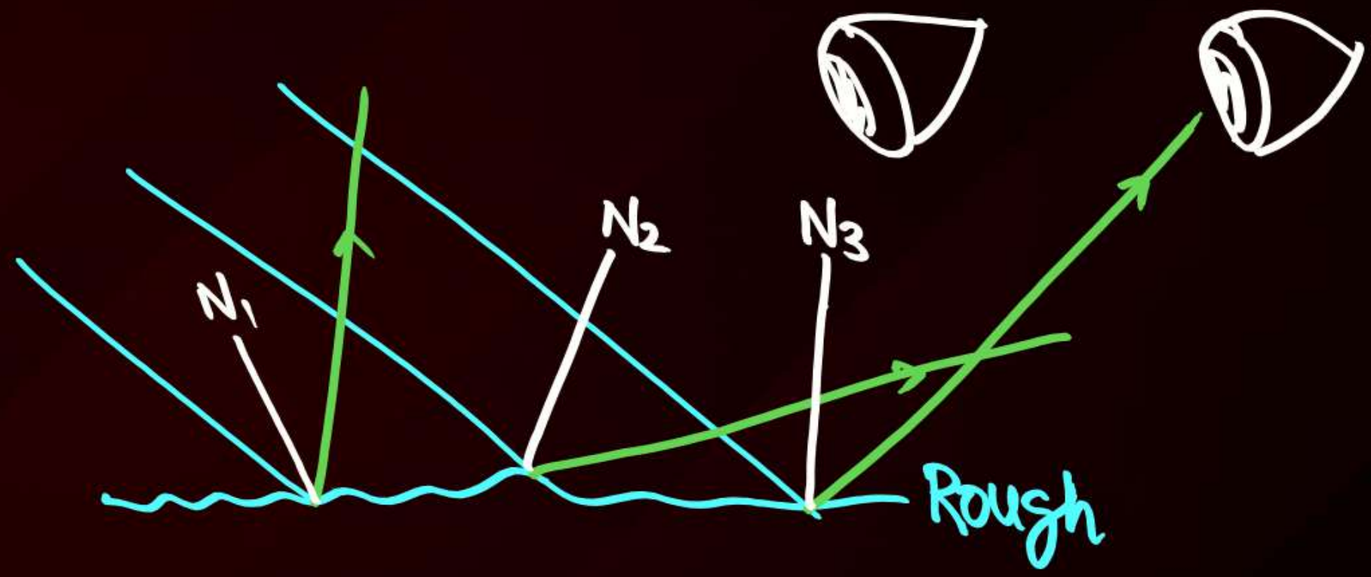


TYPES OF REFLECTION

a → 1) Regular

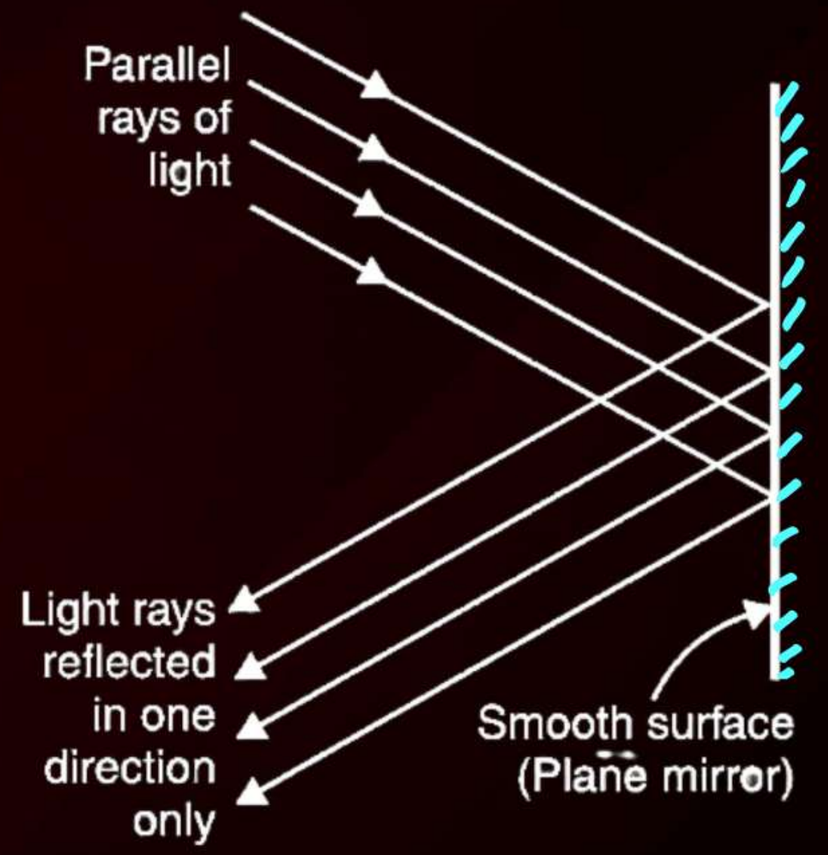
b → 2) Irregular or Diffused





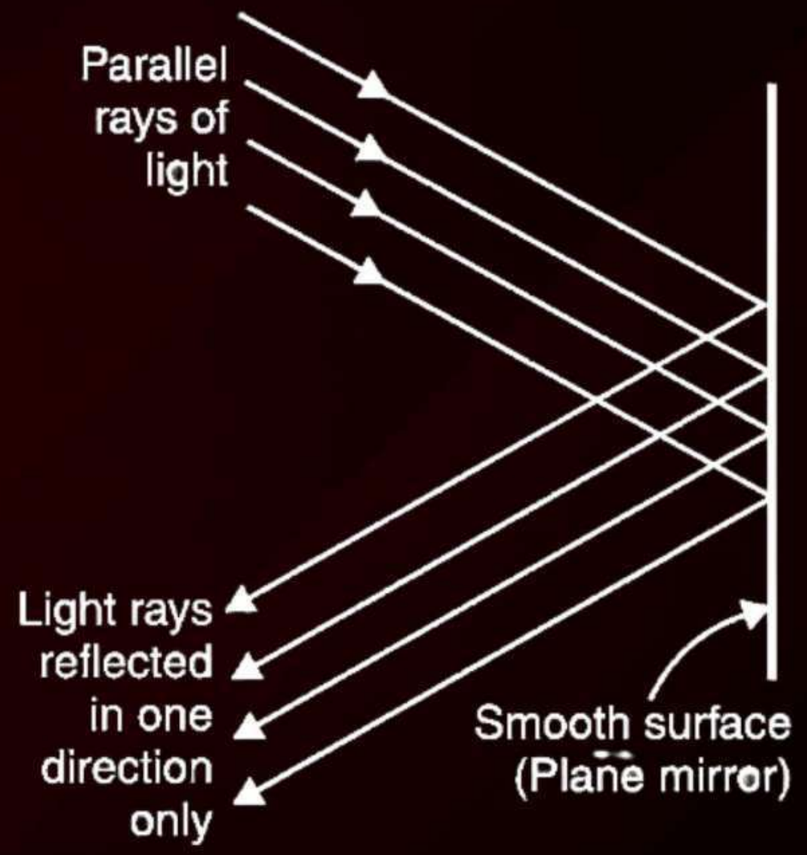
REGULAR REFLECTION

In regular reflection, a parallel beam of incident light is reflected as a parallel beam in one direction. In this case, parallel incident rays remain parallel even after reflection and go only in one direction



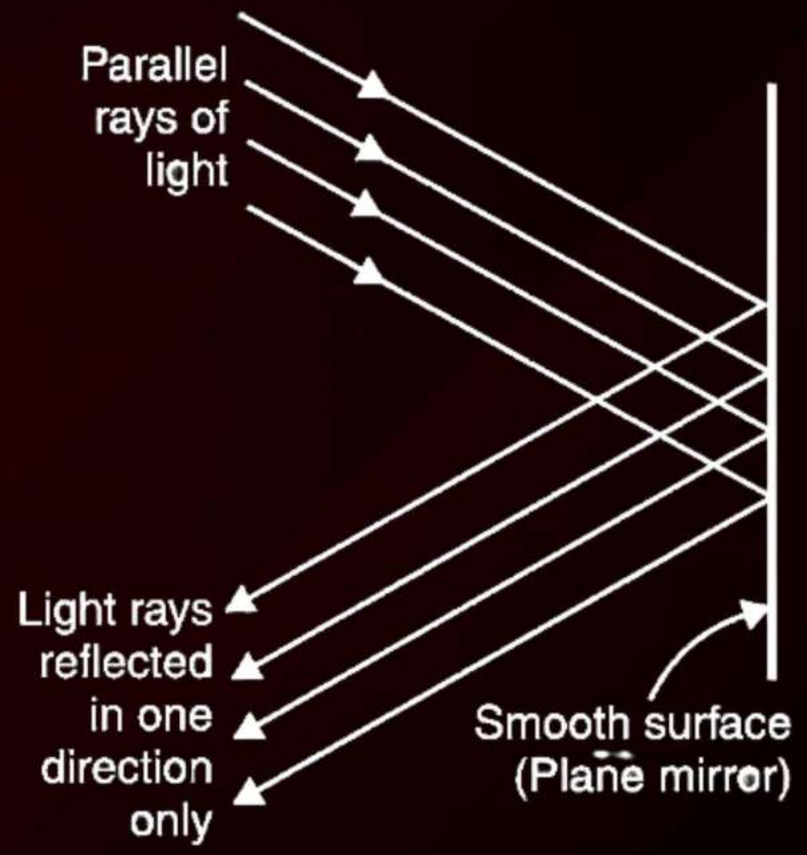
REGULAR REFLECTION

Regular reflection takes place from the objects like looking glass, still water, oil, highly polished metals, etc.



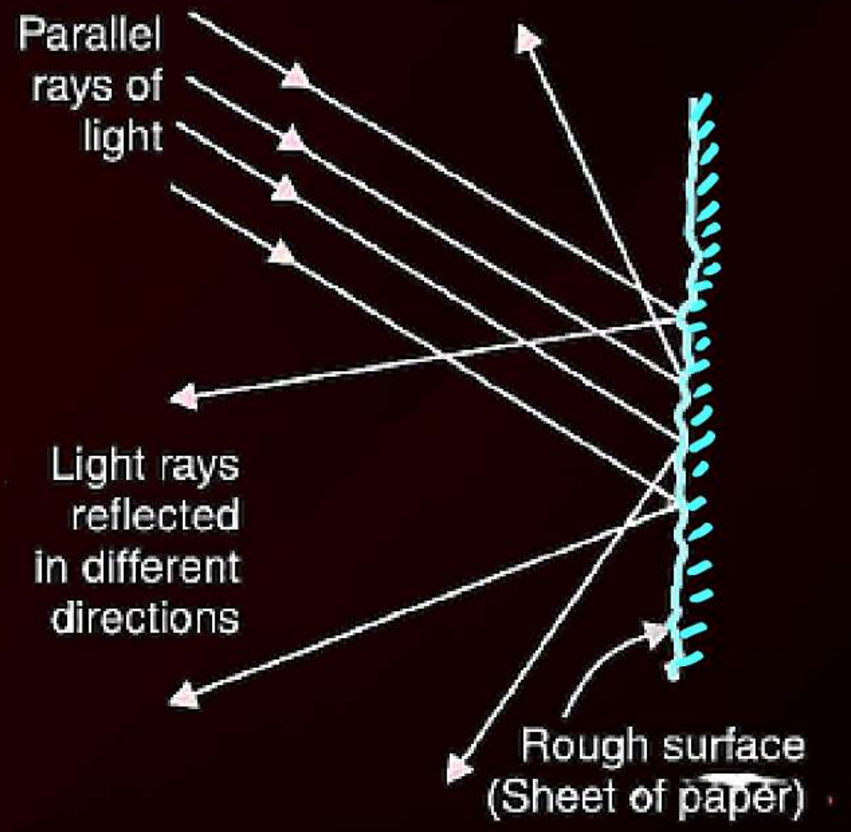
REGULAR REFLECTION

Regular reflection is useful in the formation of images, e.g., we can see our face in a mirror only on account of regular reflection. However, it causes a very strong glare in our eyes.



DIFFUSED REFLECTION

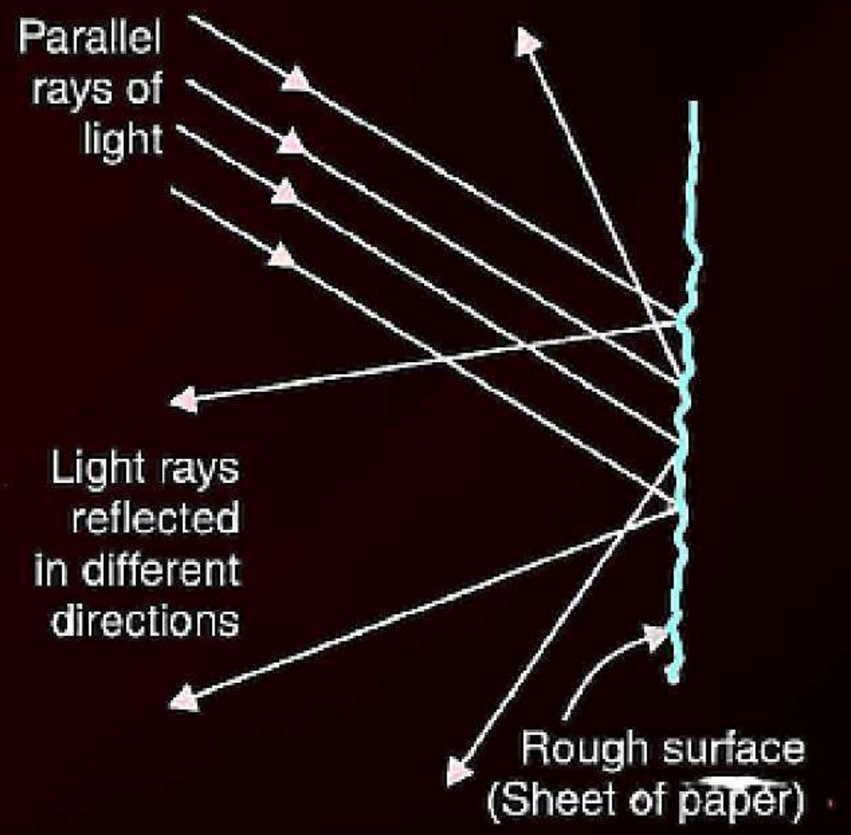
In diffuse reflection, a parallel beam of incident light is reflected in different directions. In this case, the parallel incident rays do not remain parallel after reflection, they are scattered in different directions



TYPES OF REFLECTION

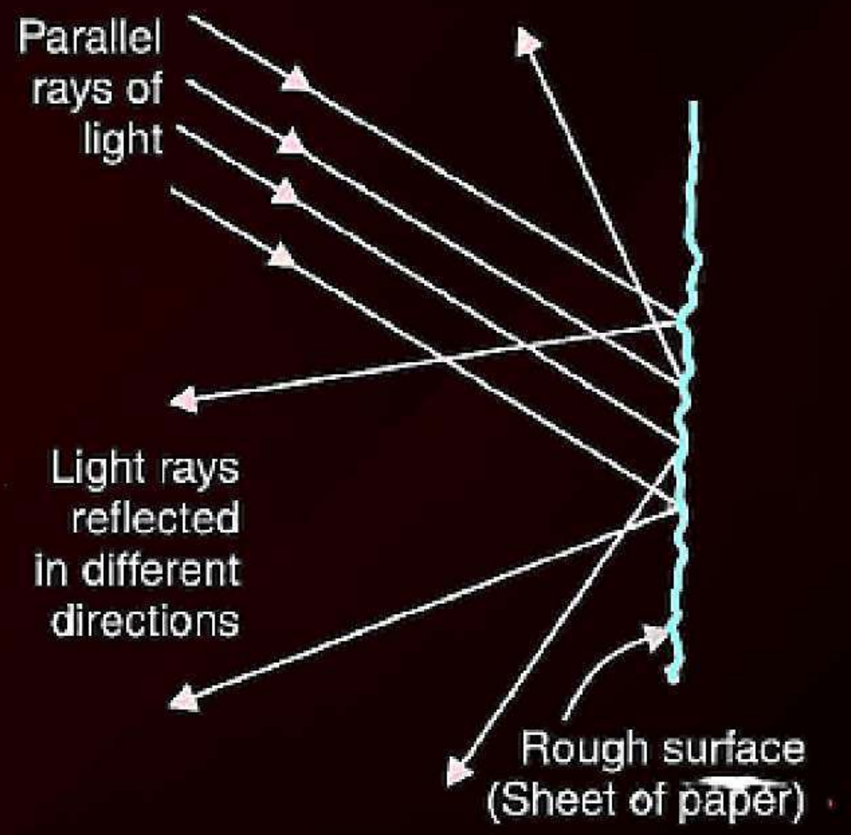
Imp

The reflection which takes places from ground, walls, trees, suspended particles in air, and a variety of other objects, which are not very smooth, is irregular reflection.



TYPES OF REFLECTION

Irregular reflection helps in spreading light energy over a vast region and also decreases its intensity. Thus, it helps in the general illumination of places and helps us to see things around us.



Laws of reflection are always valid no matter whether reflection is regular or irregular.

$\angle i = \angle r$

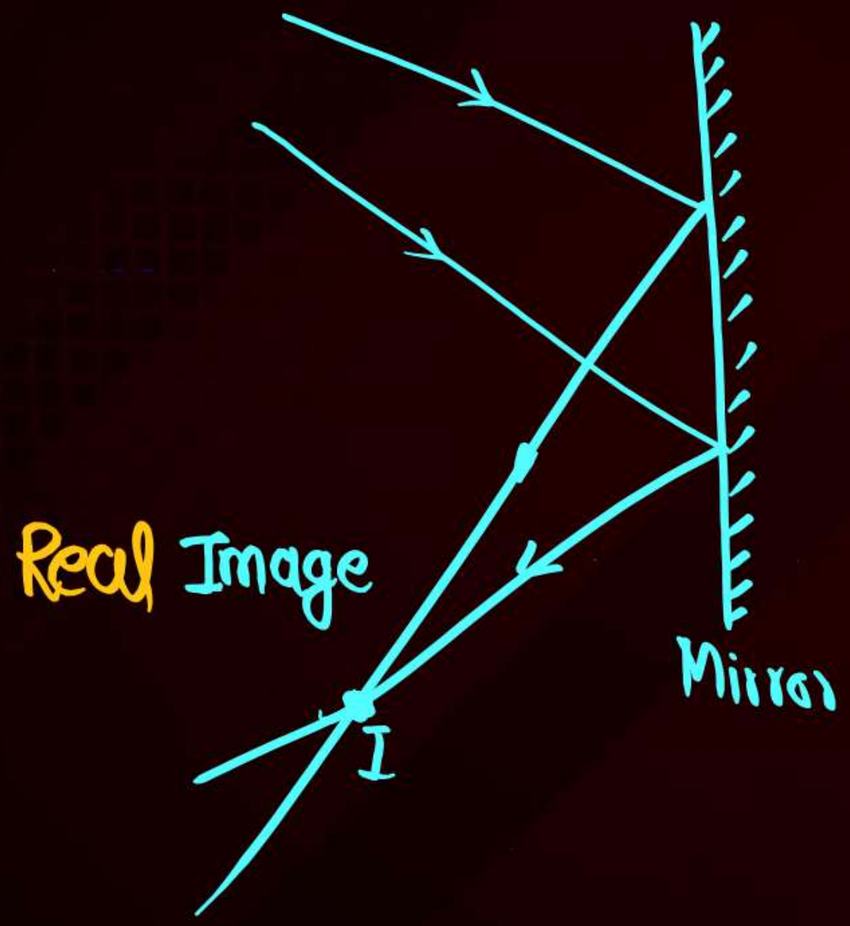
Objects

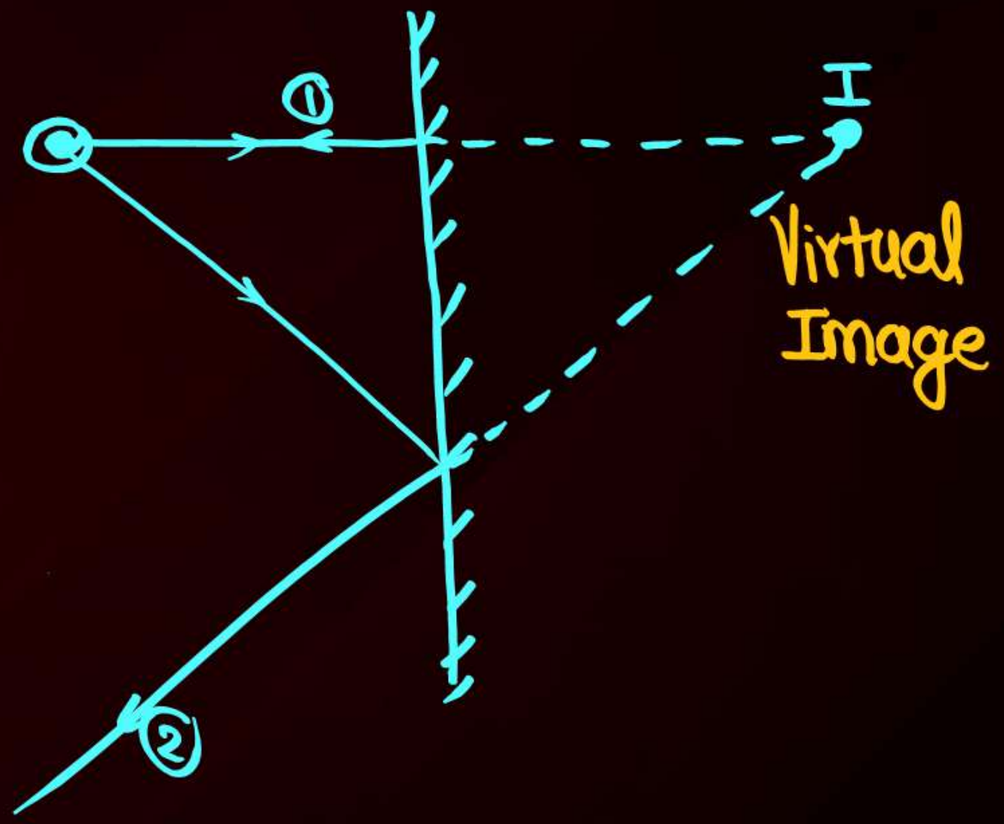
Anything which gives out light rays (either its own or reflected by it) is called an object.

Images

Imp

In physics, image is an optical appearance produced when light rays coming from an object are reflected from a mirror (or refracted through a lens).





Real Images and Virtual Images

The image which can be obtained on a screen is called a real image. In a cinema hall, we see the images of actors and actresses on the screen. So, the images formed on a cinema screen is an example of real images

Real → Inverted ✓

Virtual → Erect ✓

Imp HW

Real Image	Virtual Image
1. A real image is formed when two or more reflected rays meet at a point in front of the mirror.	1. A virtual image is formed when two or more rays appear to be coming from a point behind the mirror.
2. A real image can be obtained on a screen.	2. A virtual image cannot be obtained on a screen.
3. A real image is inverted with respect to the object.	3. A virtual image is erect with respect to the object.

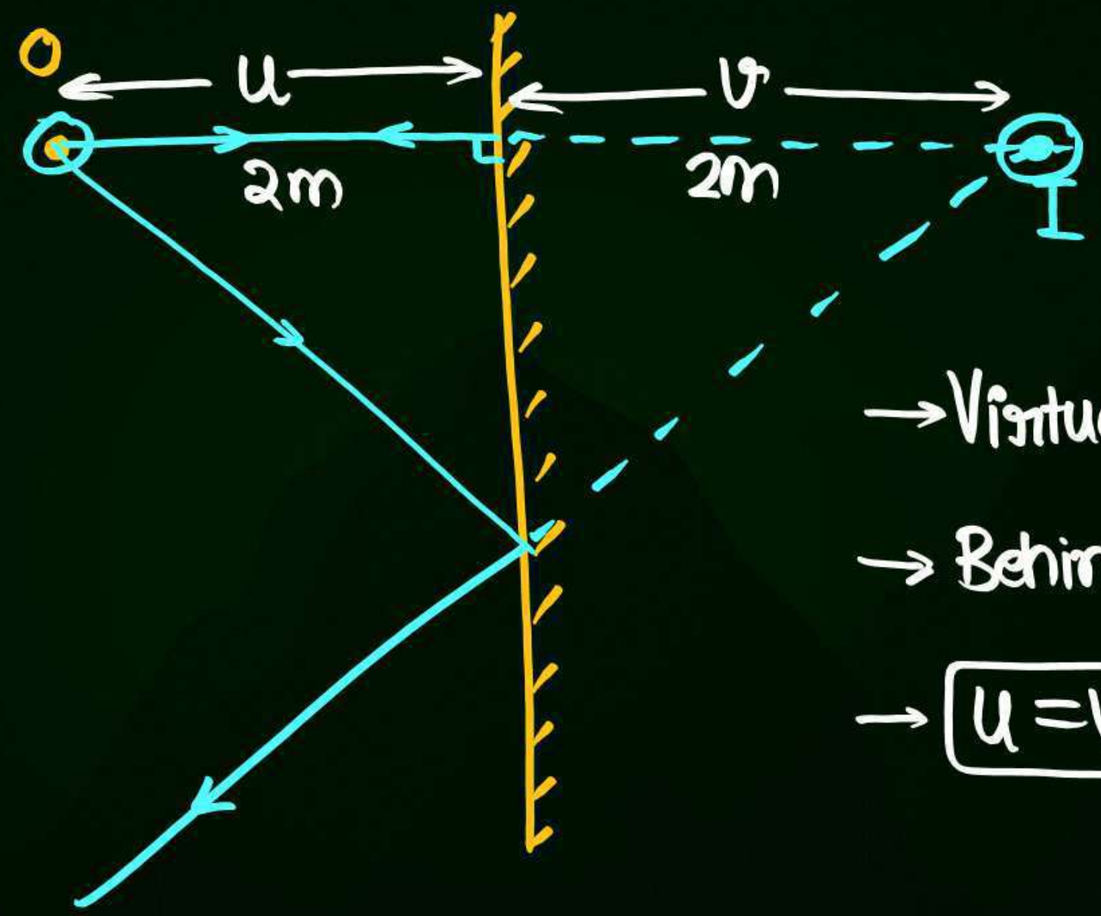
$O \longrightarrow I$

(a) 1m

(b) 2m

(c) 3m

(d) 4m ✓

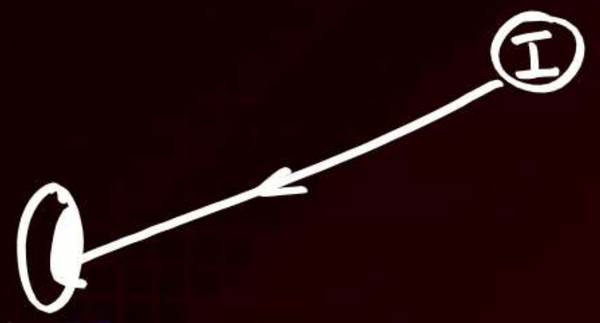


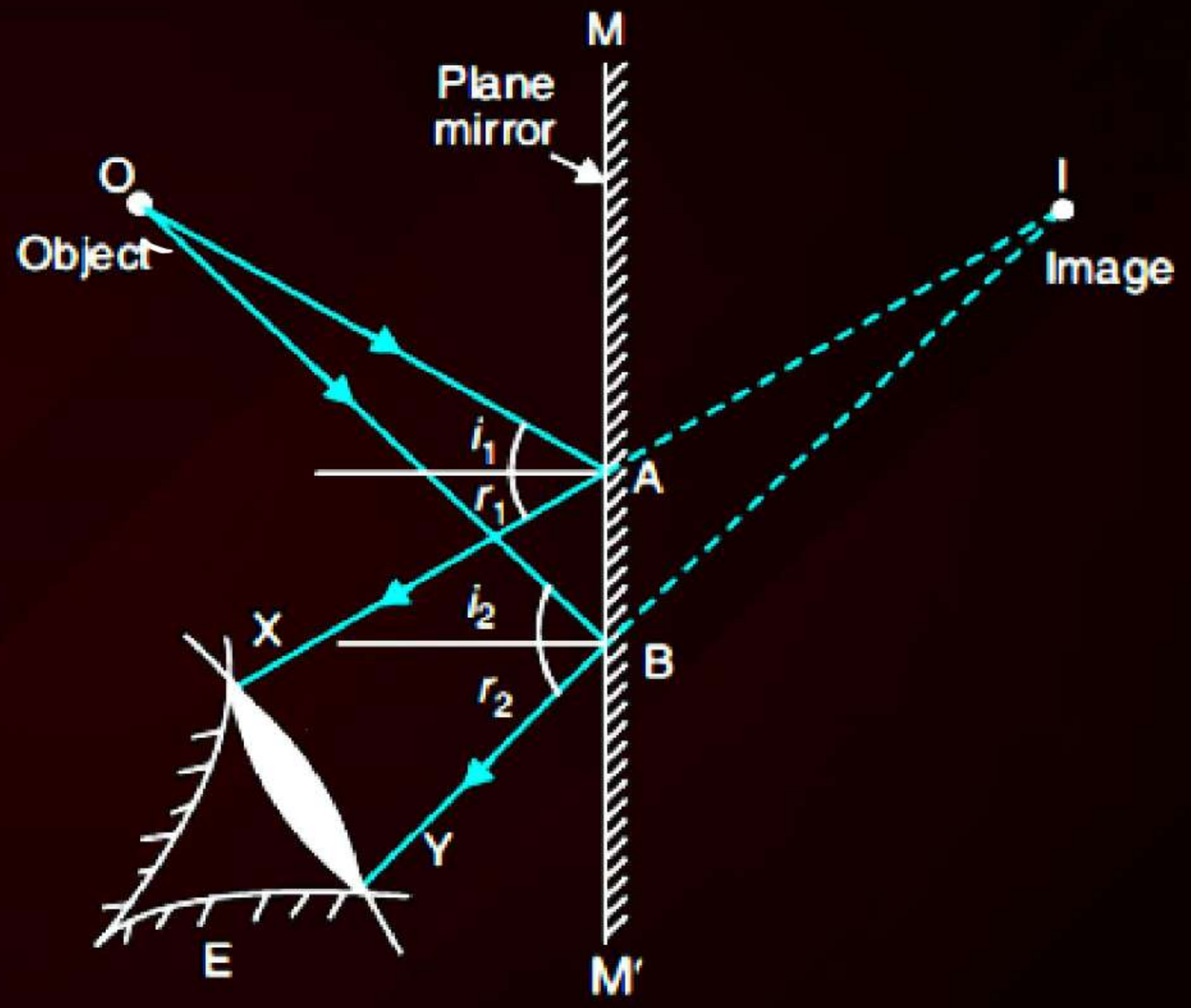
→ Virtual Image

→ Behind mirror

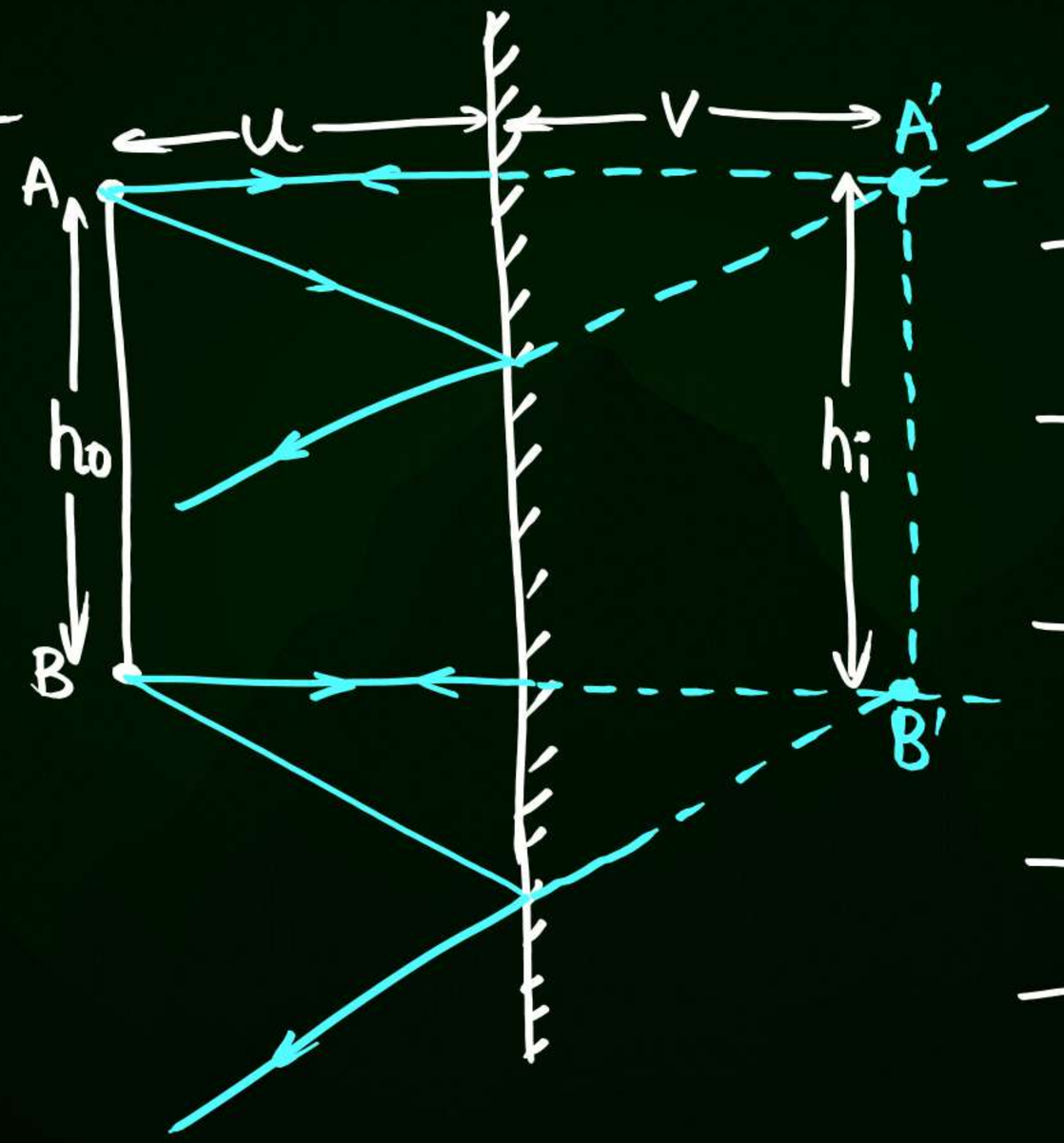
→ $\boxed{u = v}$

Formation of Image in a Plane Mirror





Imp



Virtual Image

→ Same distance

$u = v$

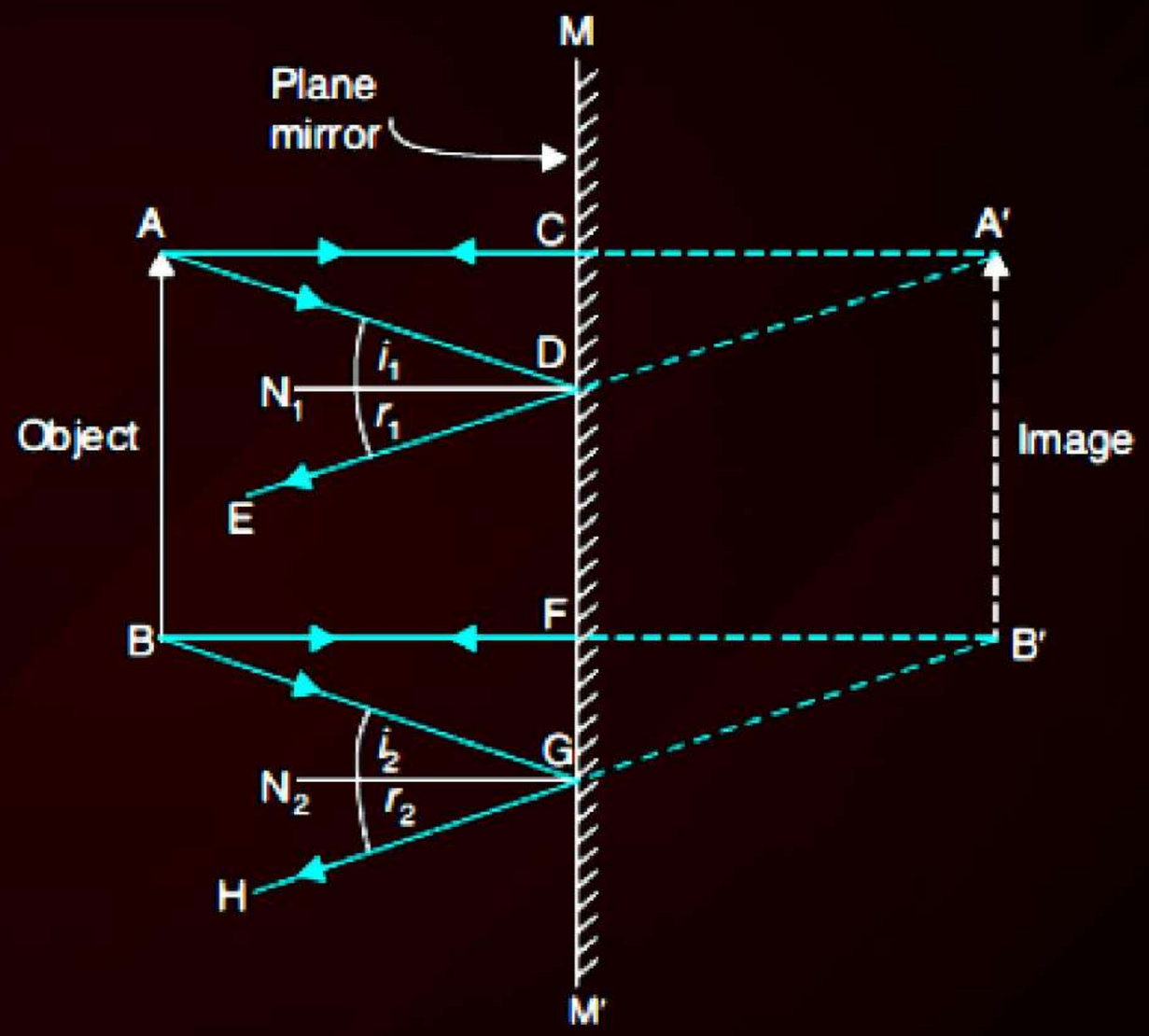
→ $h_o = h_i$

Same size

→ Erect Image

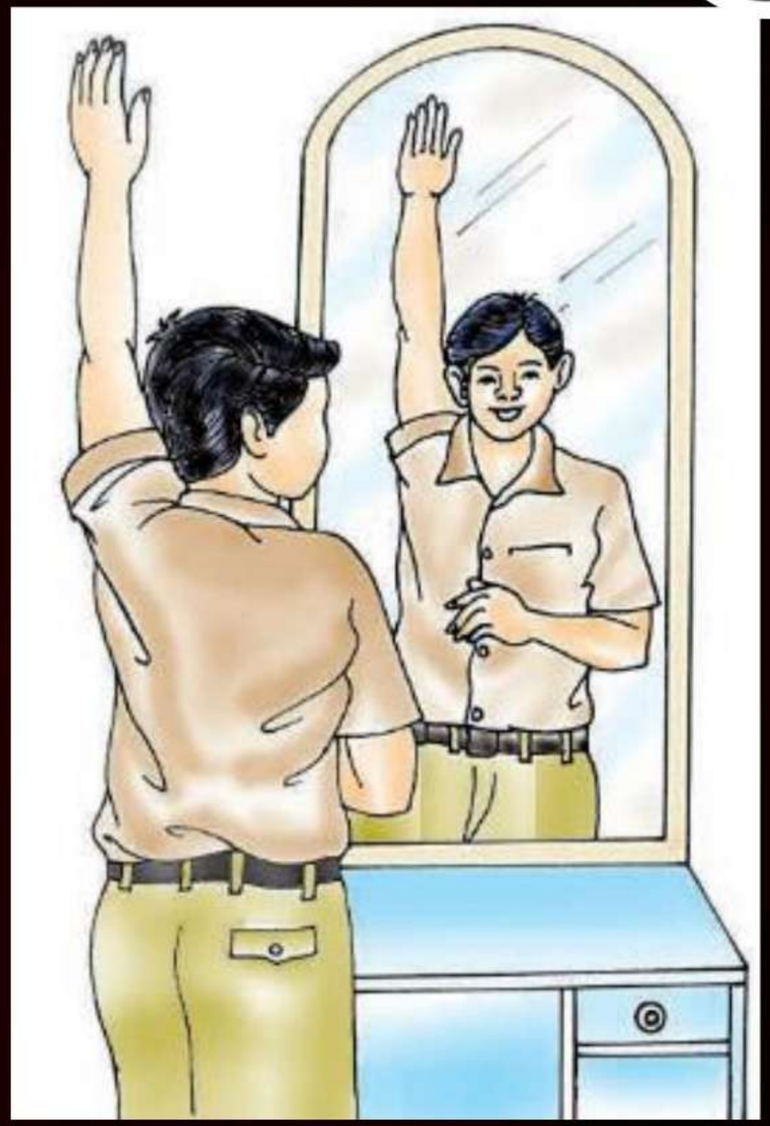
→ Laterally Inverted

Image of an Extended Object (or Finite Object)



Lateral Inversion

When an object is placed in front of a plane mirror, then the right side of object appears to become the left side of image; and the left side of object appears to become the right side of image. This change of sides of an 'object' and its 'mirror image' is called lateral inversion.



Lateral Inversion

The phenomenon of lateral inversion is due to the reflection of light.

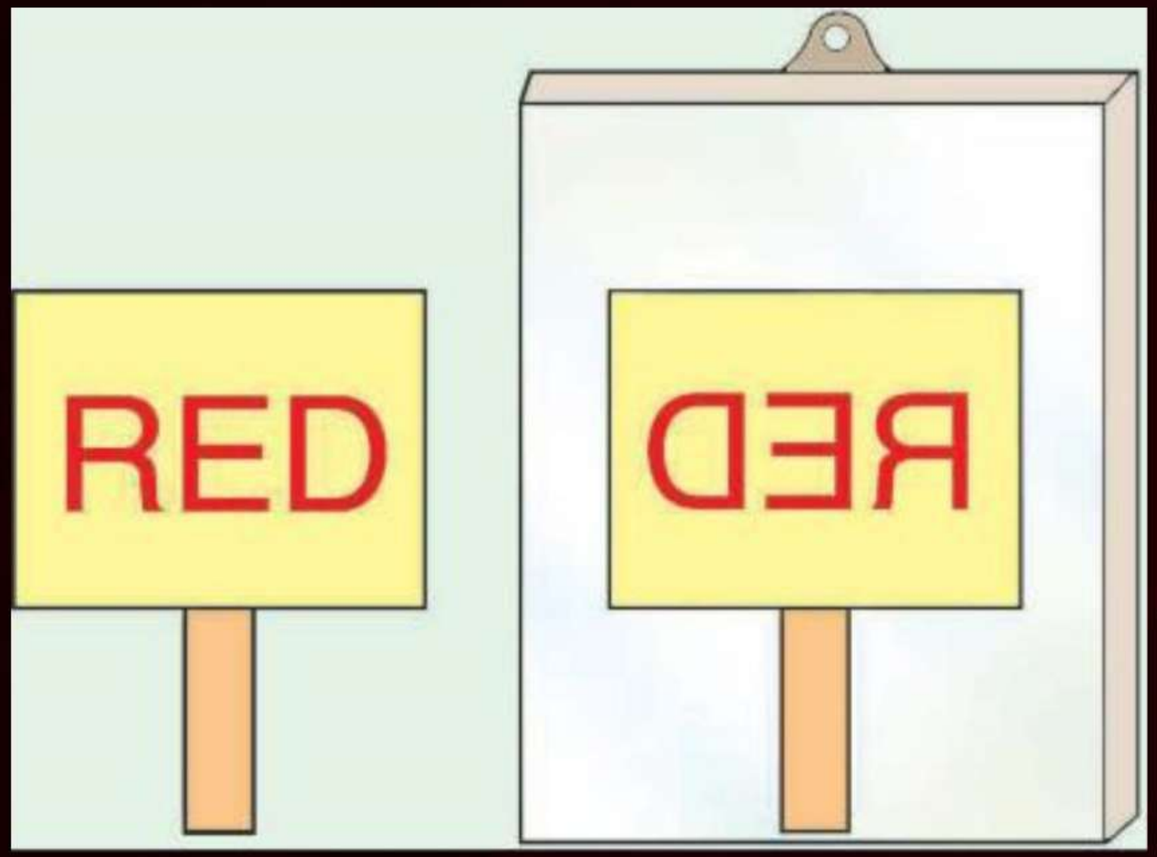


Image formed by a plane mirror

1. The image formed in a plane mirror is virtual. It cannot be received on a screen.
2. The image formed in a plane mirror is erect. It is the same side up as the object.
3. The image in a plane mirror is of the same size as the object.
4. The image formed by a plane mirror is at the same distance behind the mirror as the object is in front of the mirror.
5. The image formed in a plane mirror is laterally inverted (or sideways reversed).

Uses of Plane Mirrors

(i) Plane mirrors are used to see ourselves. The mirrors on our dressing table and in bathrooms are plane mirrors.

(ii) Plane mirrors are fixed on the inside walls of certain shops (like jewellery shops) to make them look bigger.

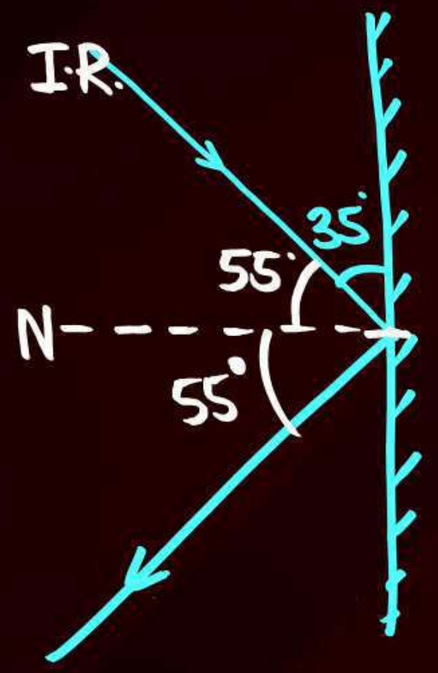
(iii) Plane mirrors are fitted at blind turns of some busy roads so that drivers can see the vehicles coming from the other side and prevent accidents.

(iv) Plane mirrors are used in making telescopes.

Question

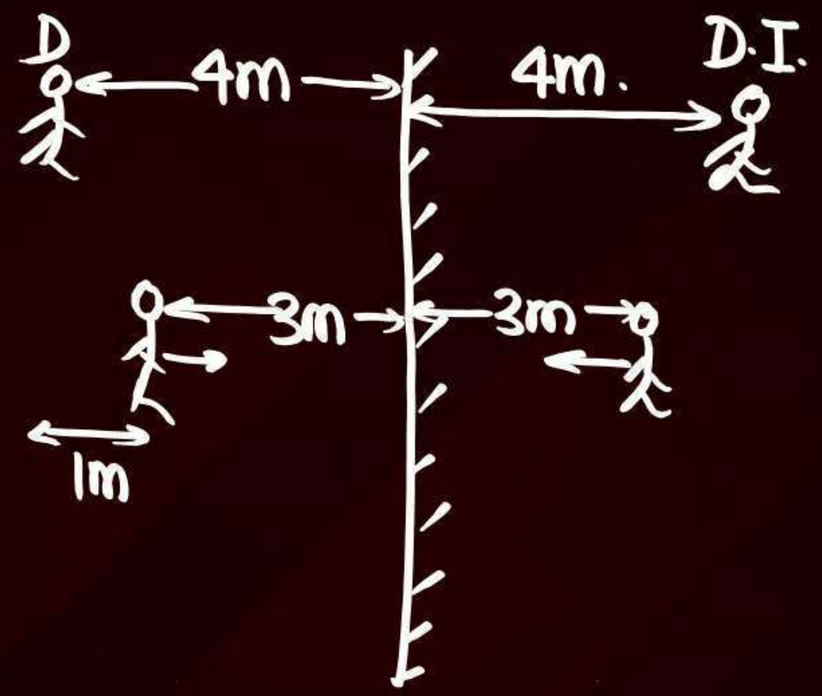
An incident ray makes an angle of 35° with the surface of a plane mirror. What is the angle of reflection?

55°



Question

David is observing his image in a plane mirror. The distance between the mirror and his image is 4 m. If he moves 1 m towards the mirror, then the distance between David and his image will be:



(A) 3 m

(B) 5 m

(C) 6 m

(D) 8 m

Question

Imp

The rear view mirror of a car is a plane mirror. A driver is reversing his car at a speed of 2 m/s. The driver sees in his rear view mirror, the image of a truck parked behind his car. The speed at which the image of the truck appears to approach the driver will be:

Relative Motion

(A) 1 m/s

(B) 2 m/s

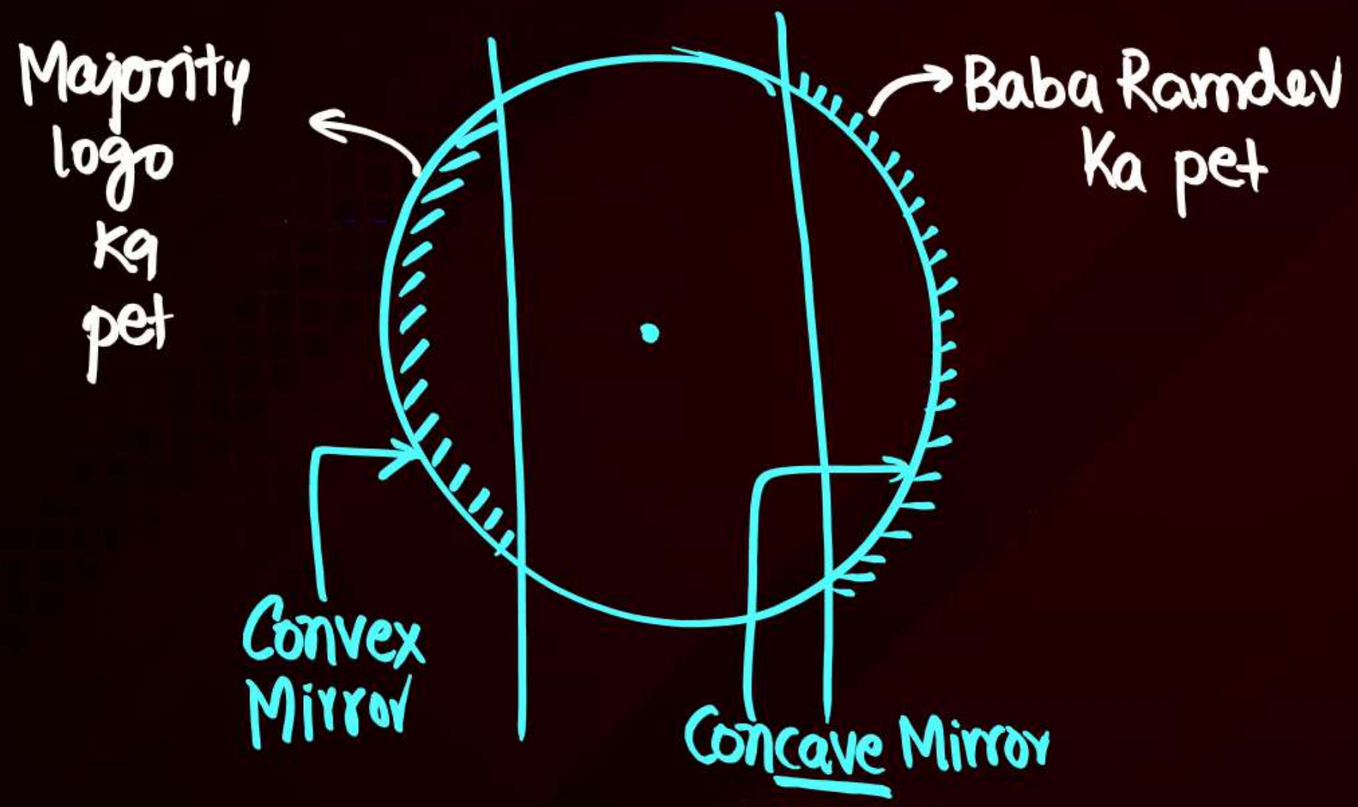
(C) 4 m/s

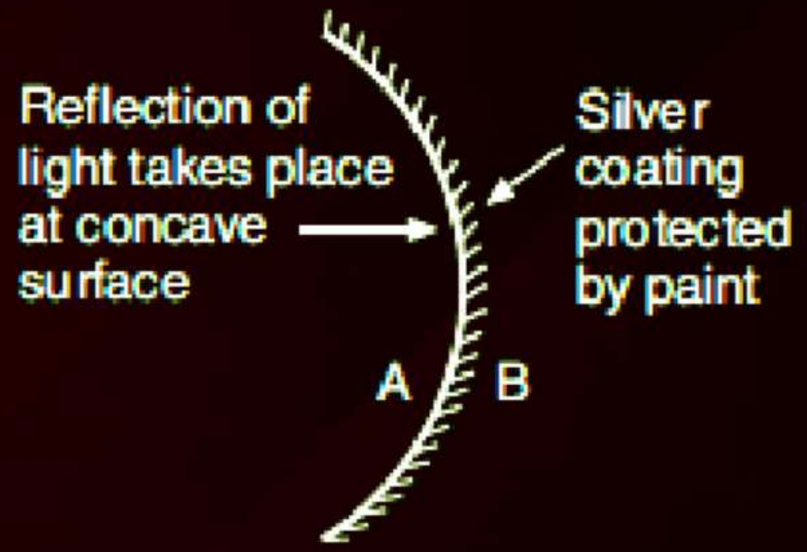
(D) 8 m/s

REFLECTION OF LIGHT FROM CURVED SURFACES

SPHERICAL MIRRORS:

(i) A concave mirror is that spherical mirror in which the reflection of light takes place at the concave surface (or bent-in surface).



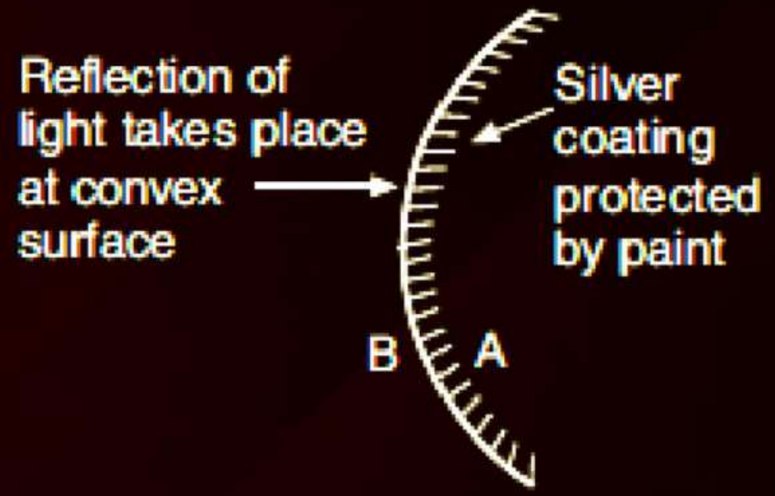


(a) A concave mirror

REFLECTION OF LIGHT FROM CURVED SURFACES

SPHERICAL MIRRORS:

(ii) A convex mirror is that spherical mirror in which the reflection of light takes place at the convex surface (or bulging-out surface).



(*b*) A convex mirror

The front side of a shining steel spoon is a concave mirror whereas its back side is a convex mirror.

NCERT WALLAH

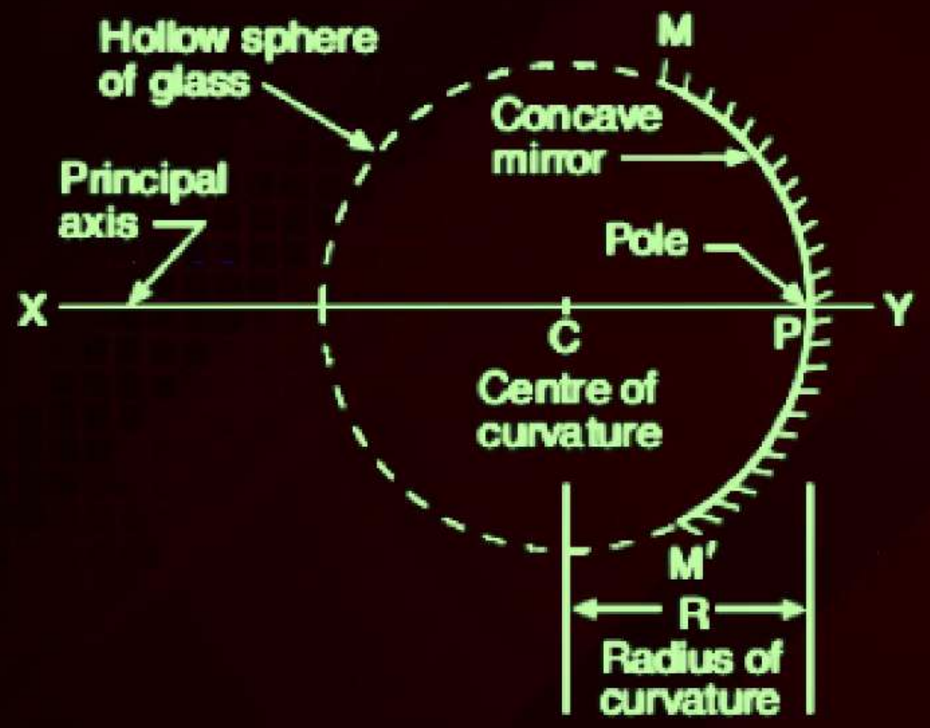
PACE SERIES

Concave

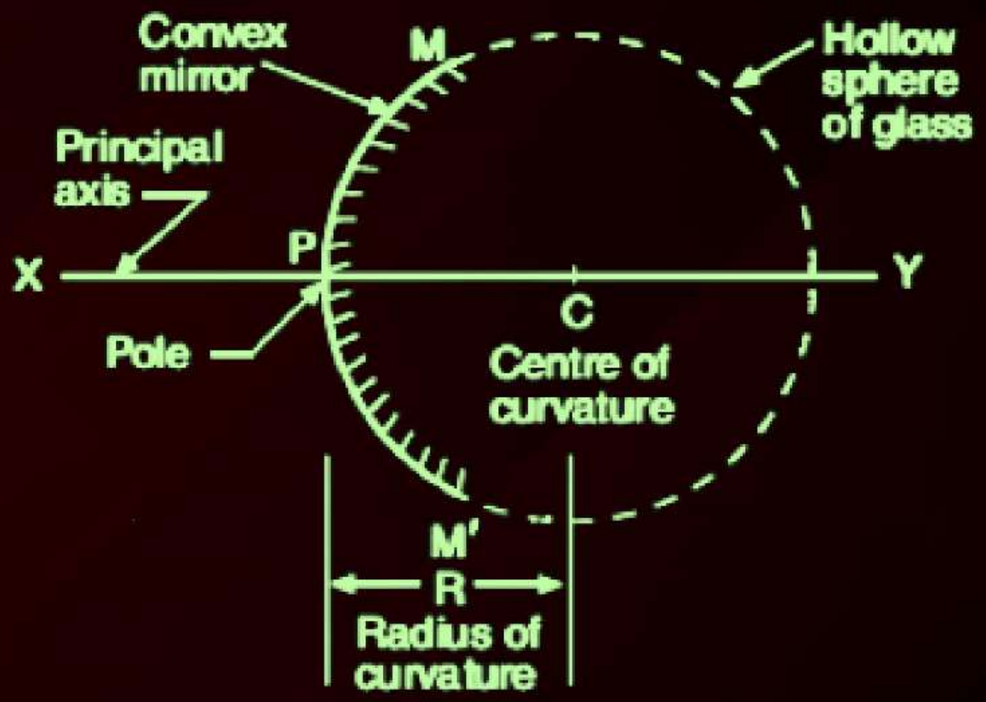
Convex

TERMINOLOGY FOR SPHERICAL MIRRORS

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



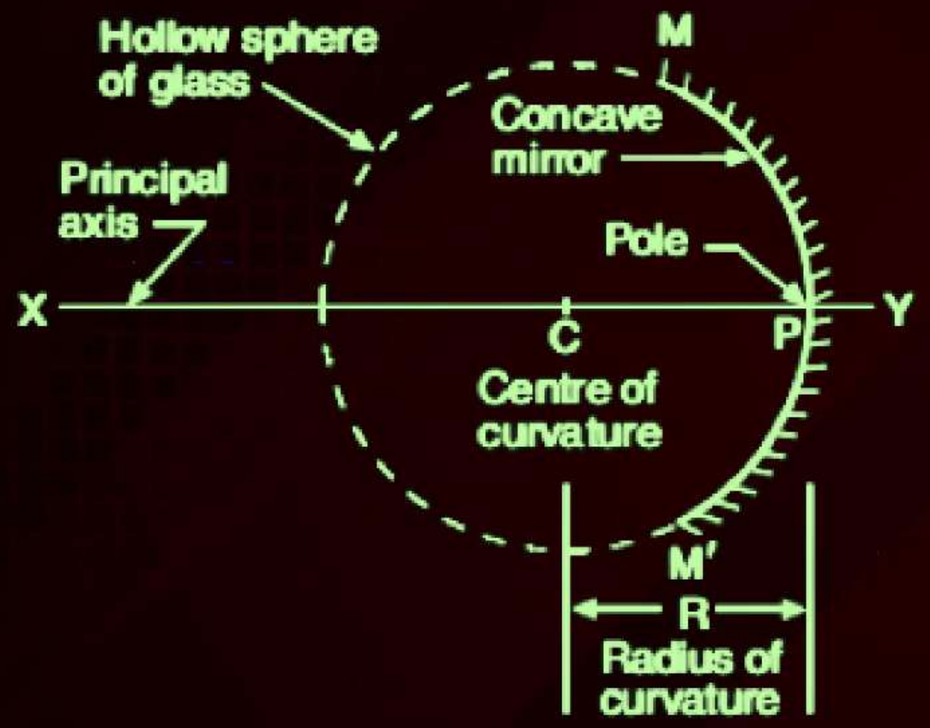
(a)



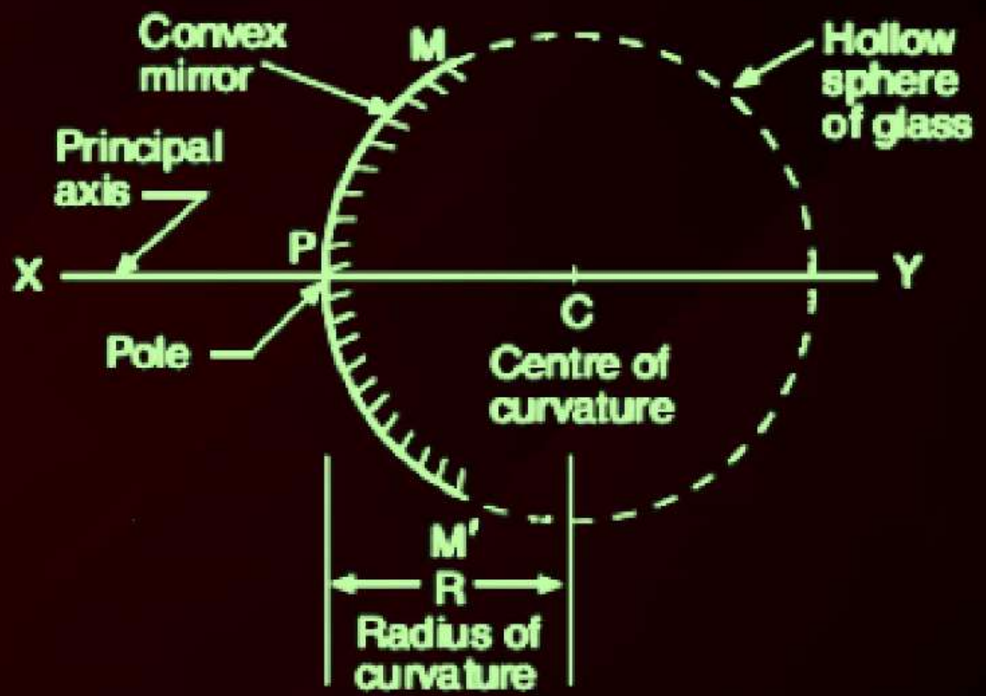
(b)

TERMINOLOGY FOR SPHERICAL MIRRORS

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



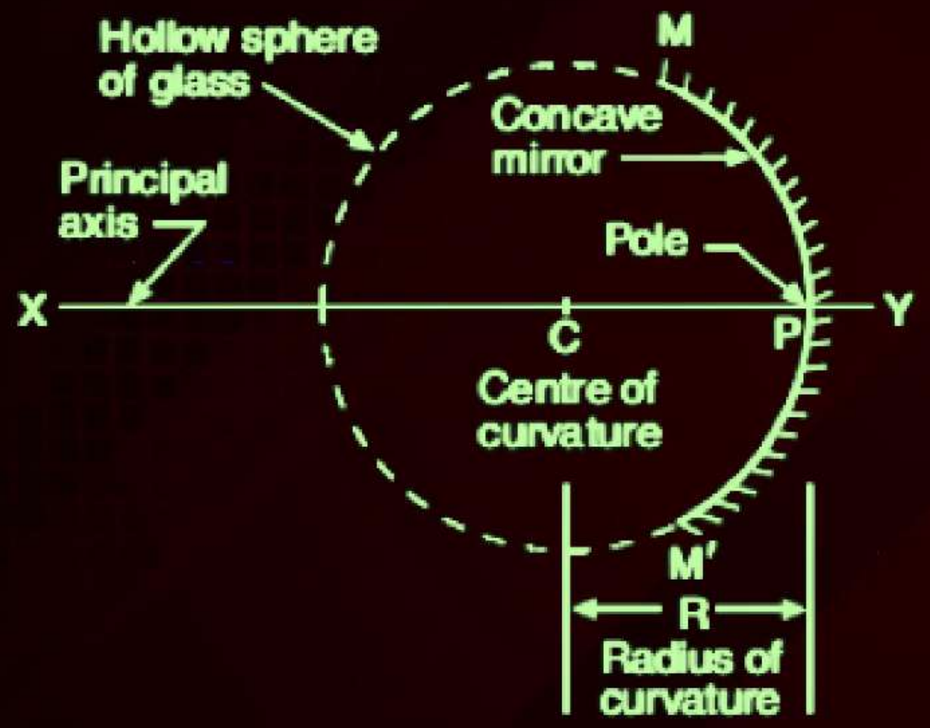
(a)



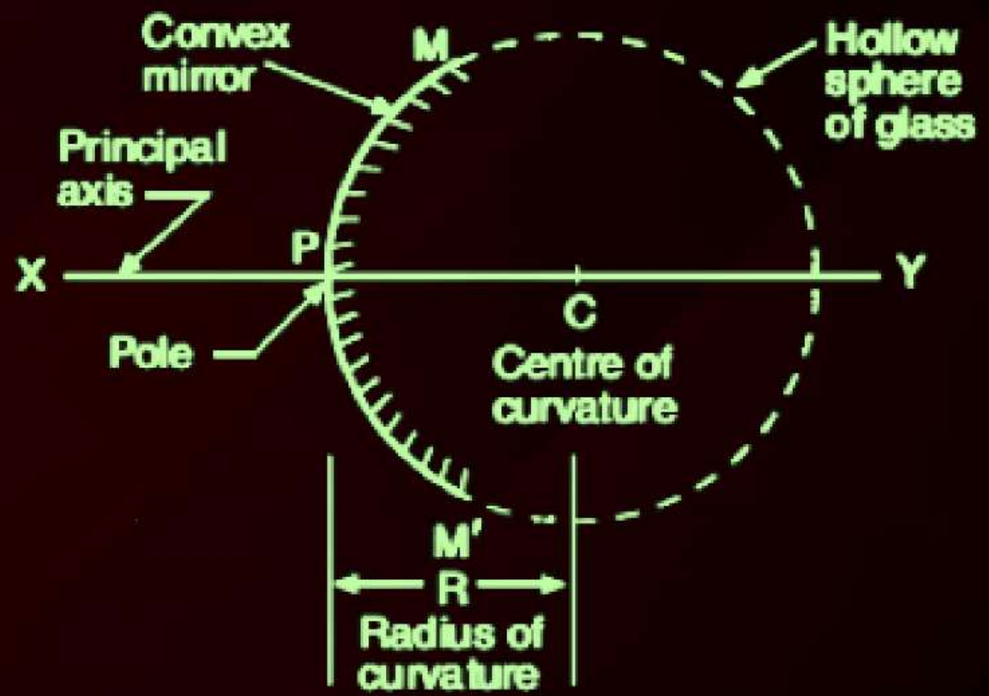
(b)

TERMINOLOGY FOR SPHERICAL MIRRORS

Centre of curvature: 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.



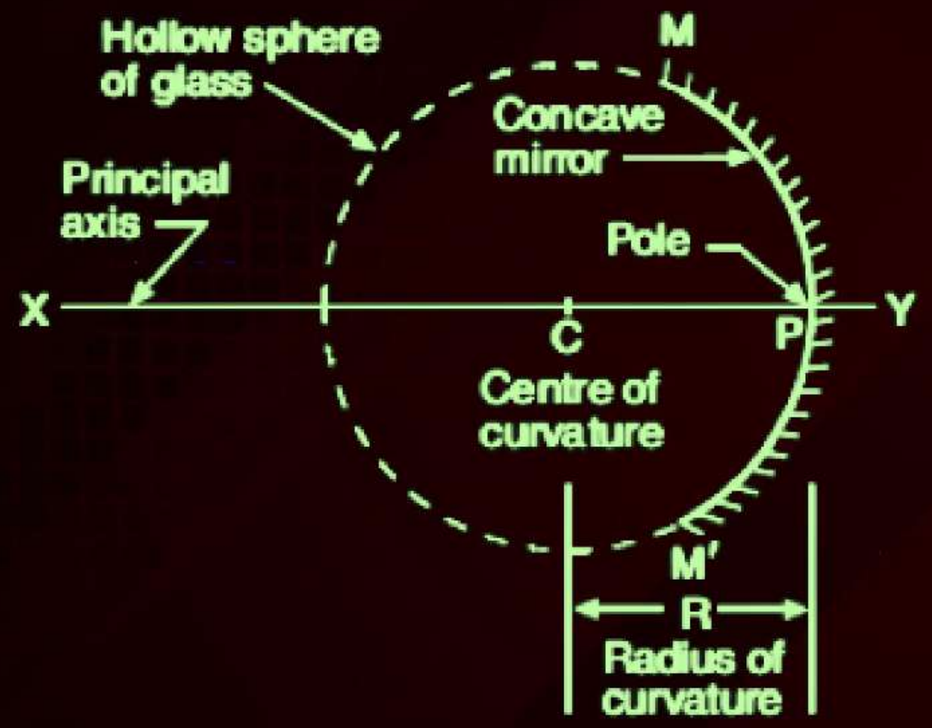
(a)



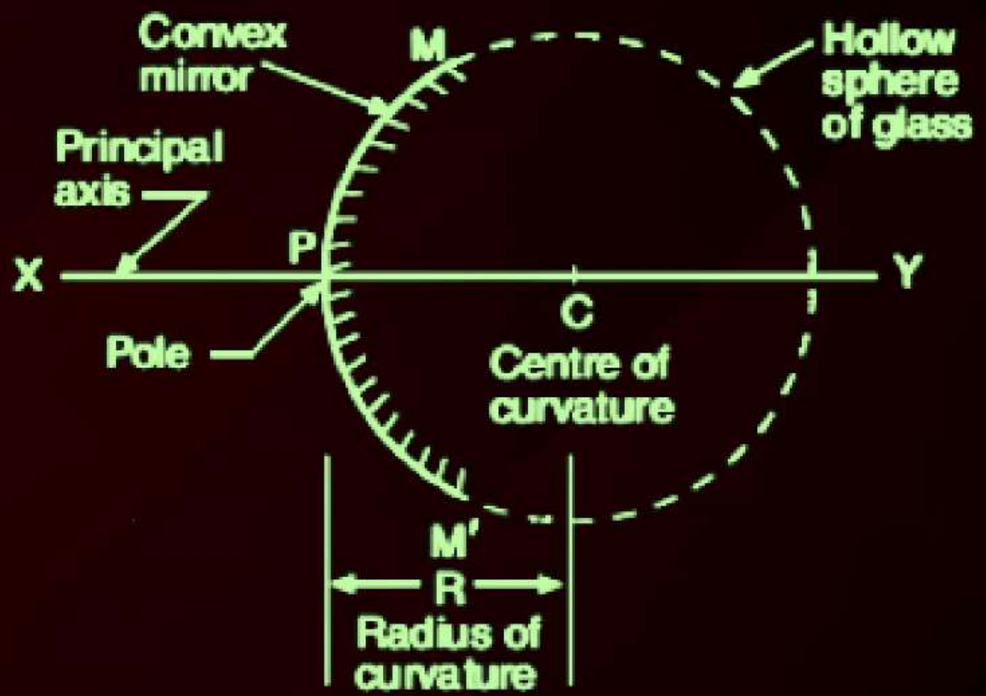
(b)

TERMINOLOGY FOR SPHERICAL MIRRORS

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



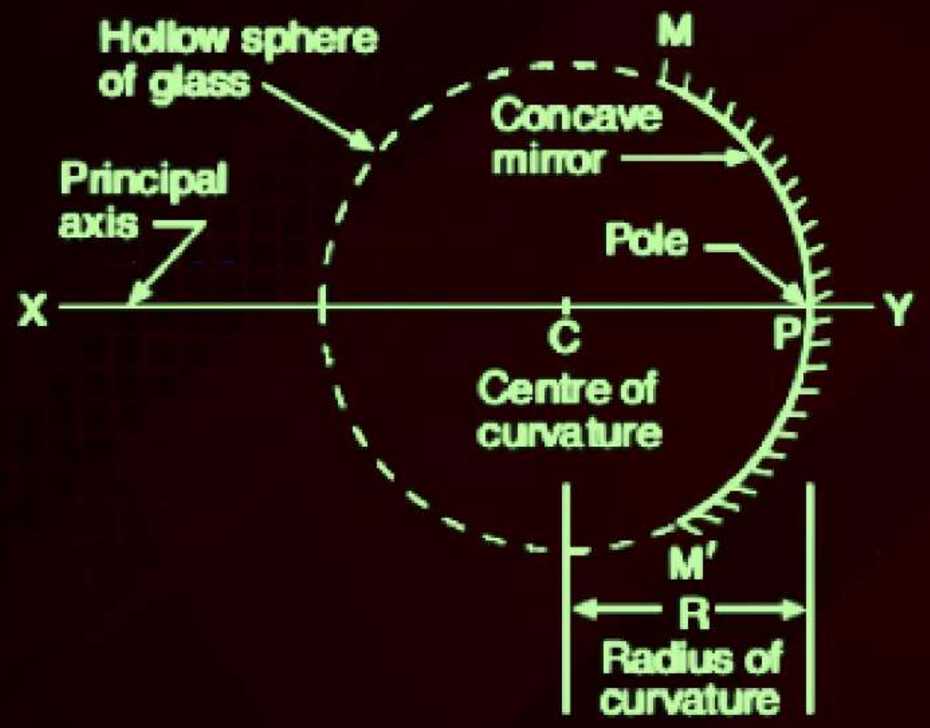
(a)



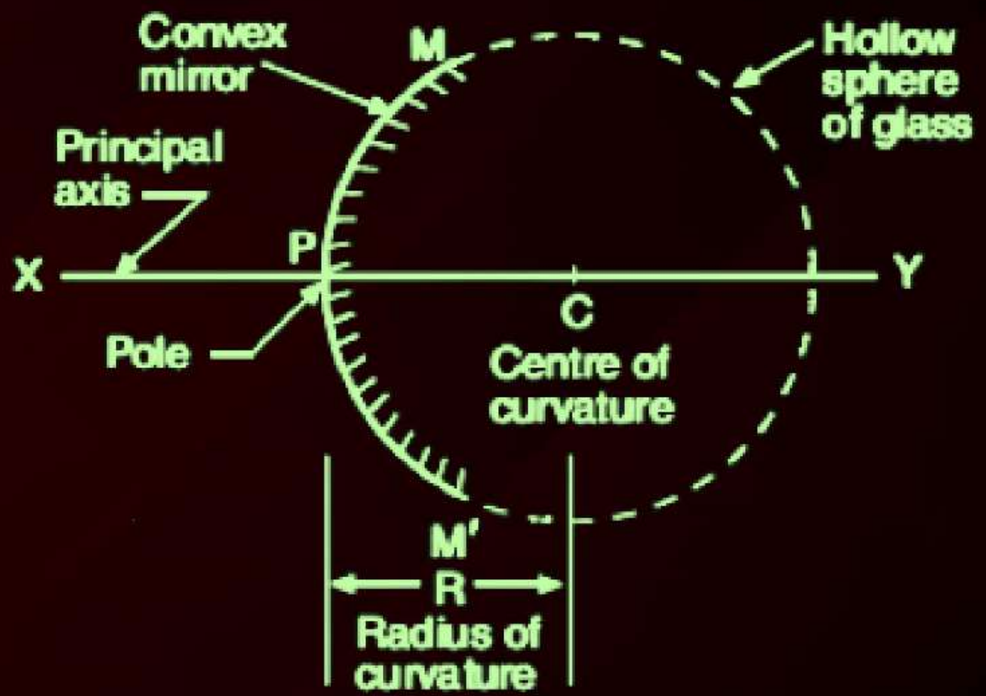
(b)

TERMINOLOGY FOR SPHERICAL MIRRORS

Principal Axis : The straight line passing through the centre of curvature C and the pole P of the spherical mirror.



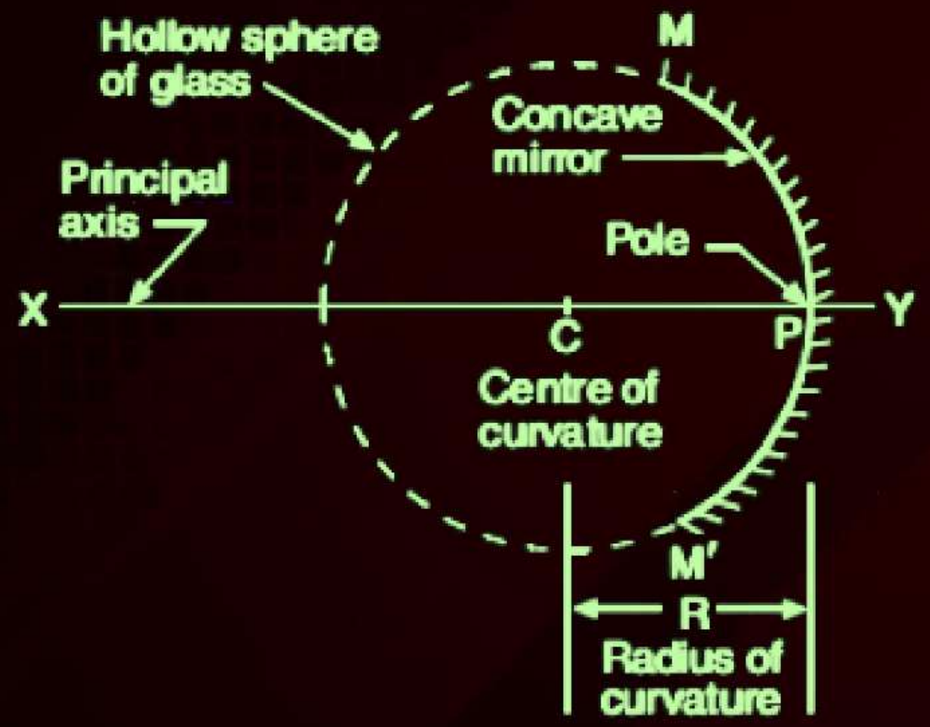
(a)



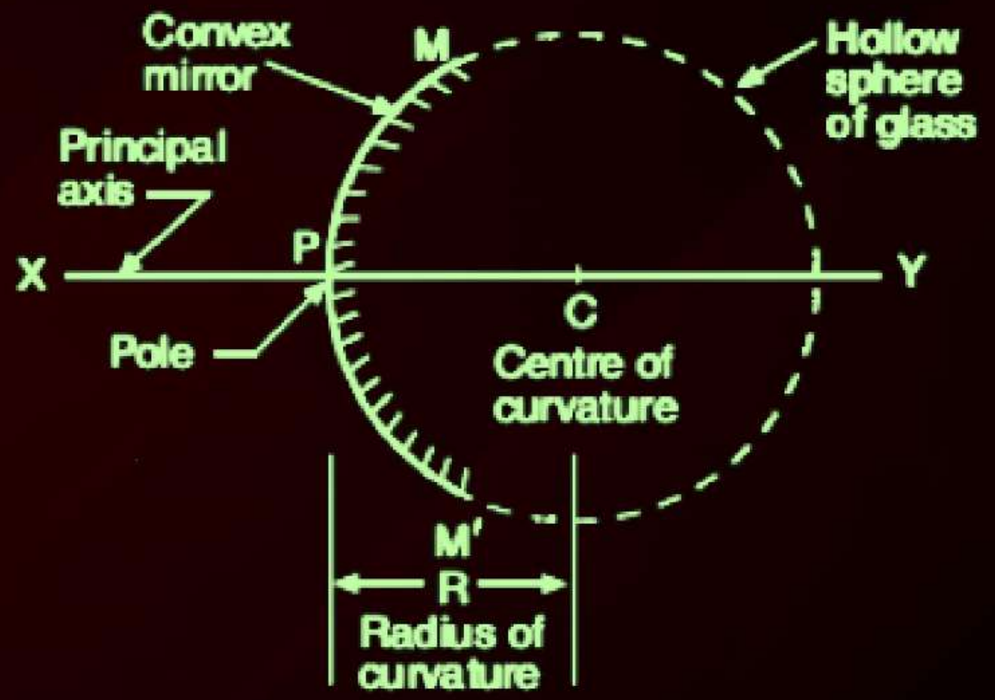
(b)

TERMINOLOGY FOR SPHERICAL MIRRORS

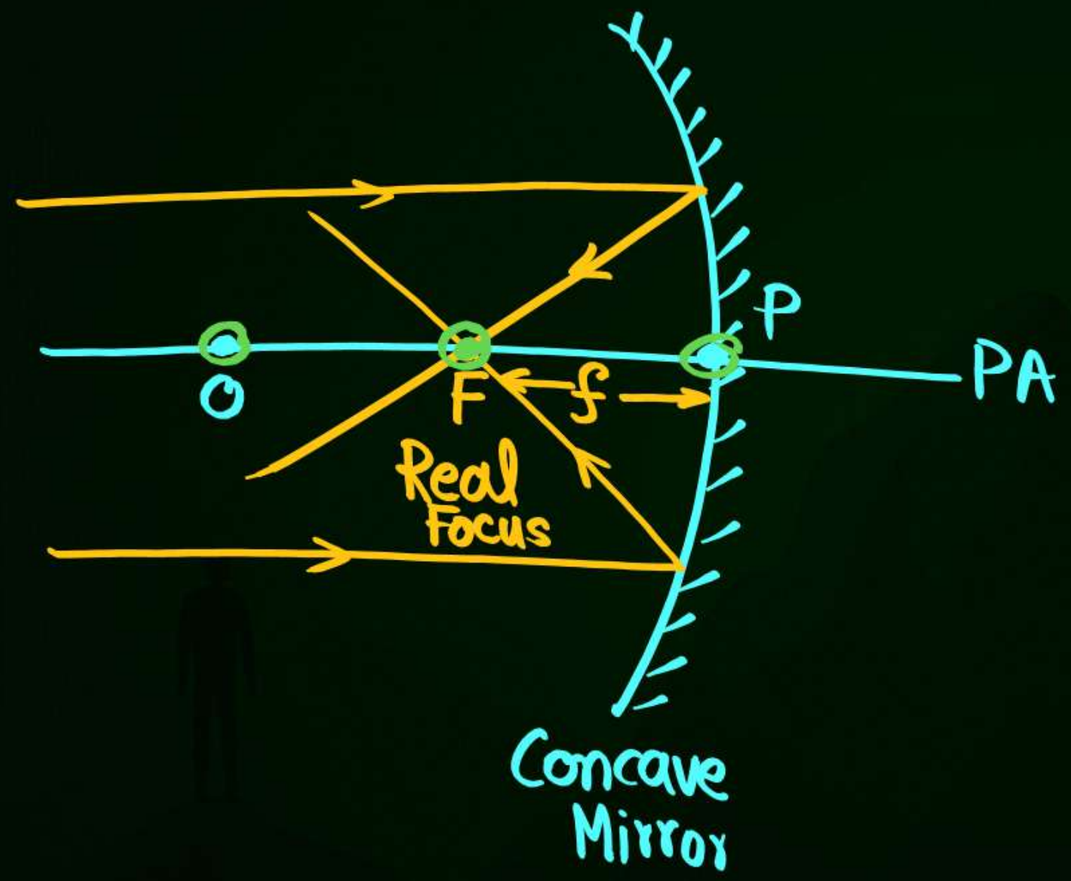
Principal focus or focus: The point on the principal axis where all the rays coming from infinity (parallel rays) after reflection either actually meets or appears to meet is called the focus (or focal point) of the mirror. It is denoted by letter F.

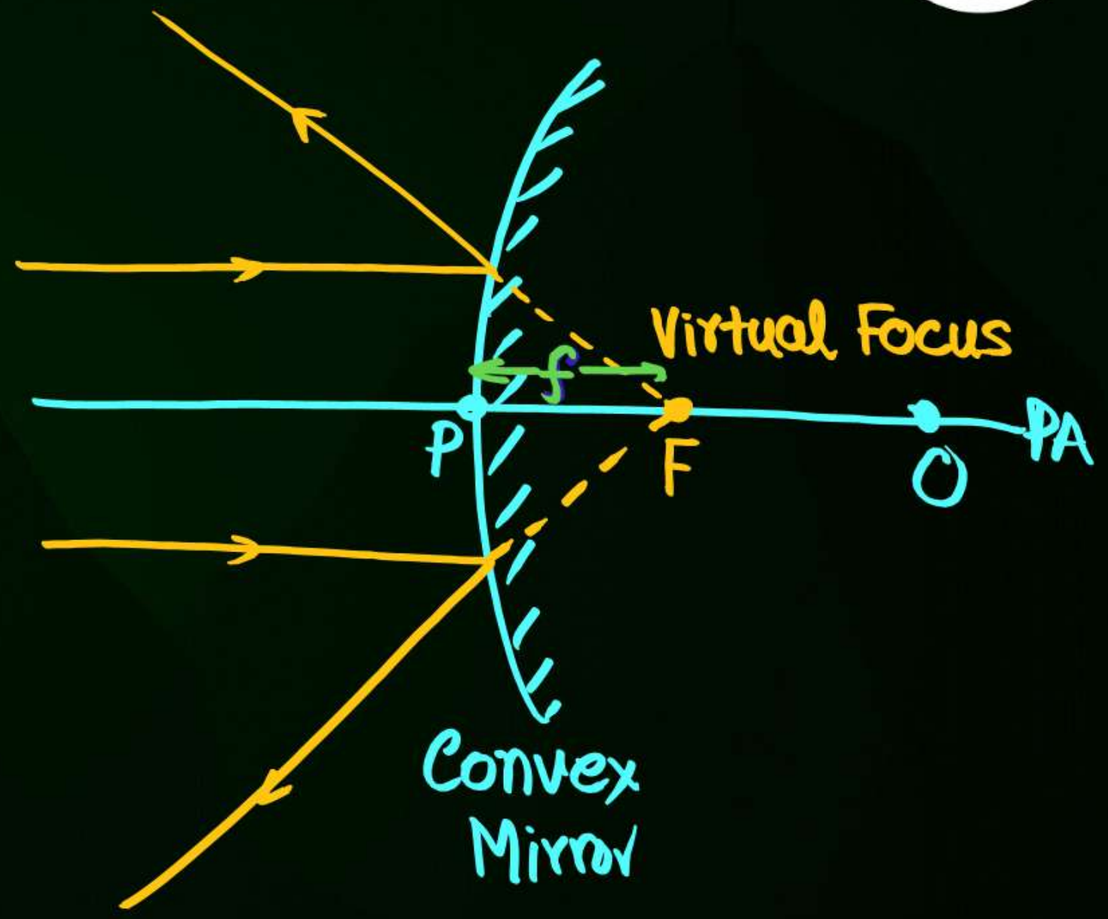


(a)



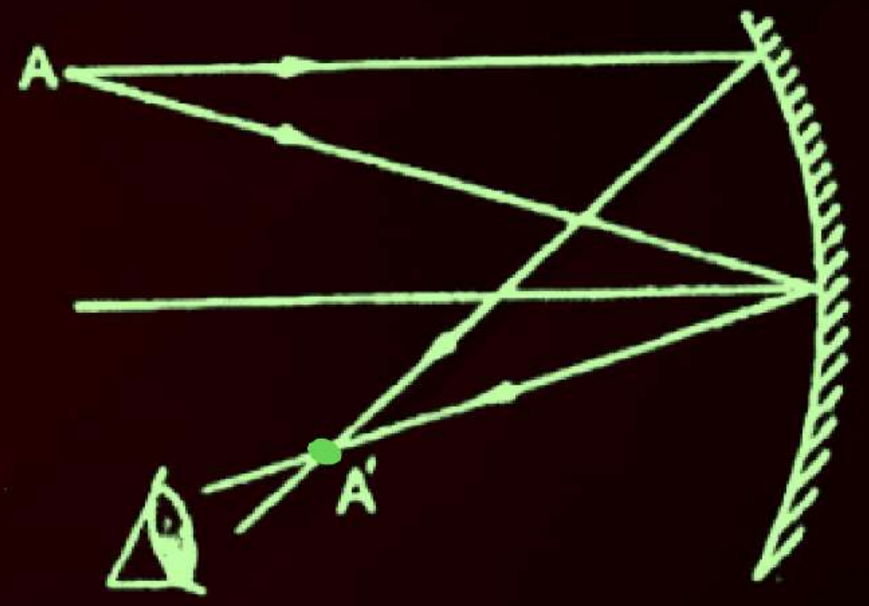
(b)


P
PA
O
F
f
Real Focus
Concave Mirror


Virtual Focus
f
P
F
O
PA
Convex Mirror

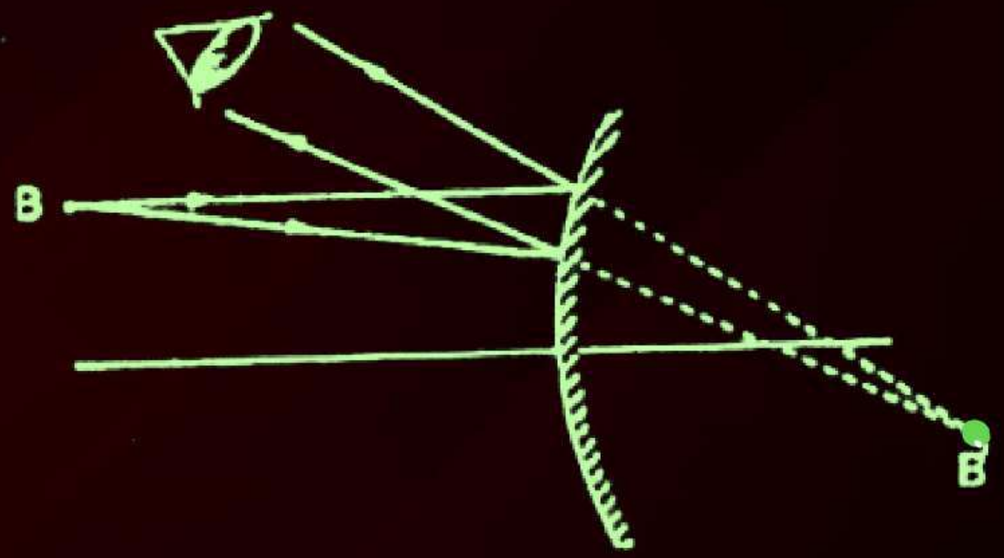
TERMINOLOGY FOR SPHERICAL MIRRORS

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.



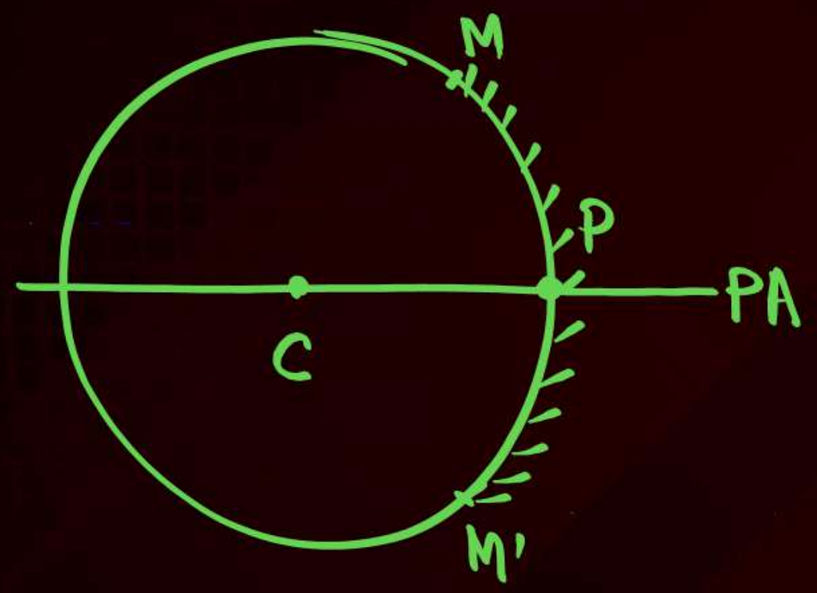
TERMINOLOGY FOR SPHERICAL MIRRORS

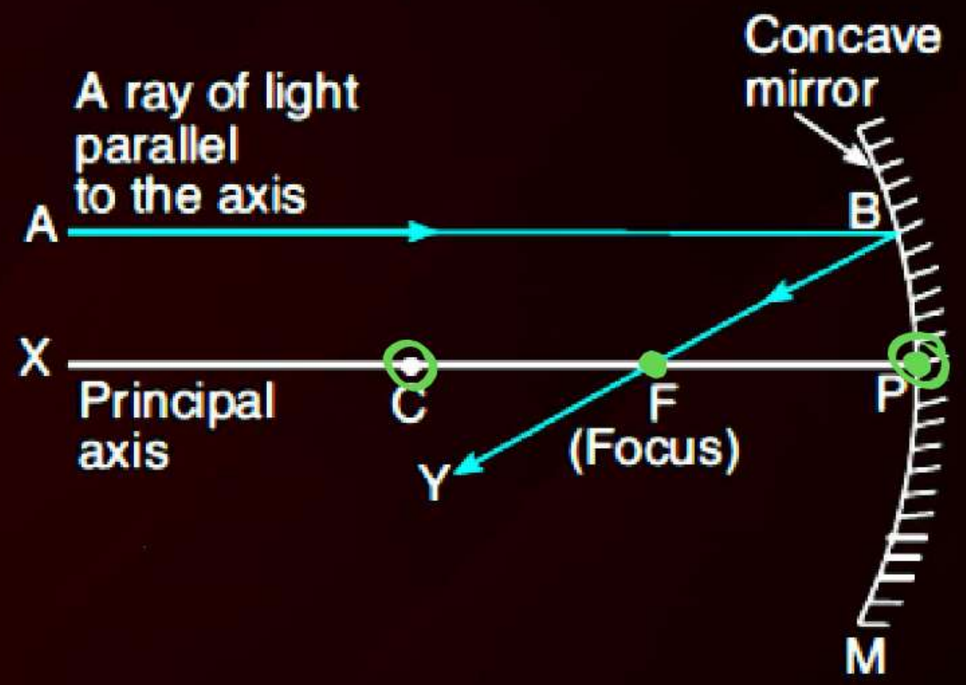
Virtual image : When the rays of light after getting reflected from a mirror (or after getting refracted from a lens) **appear to meet at a point**, a virtual image is formed. Such an image can only be been through a mirror (or a lens) but cannot be obtained on a screen.



❖ RULES FOR OBTAINING IMAGES FORMED BY CONCAVE MIRRORS

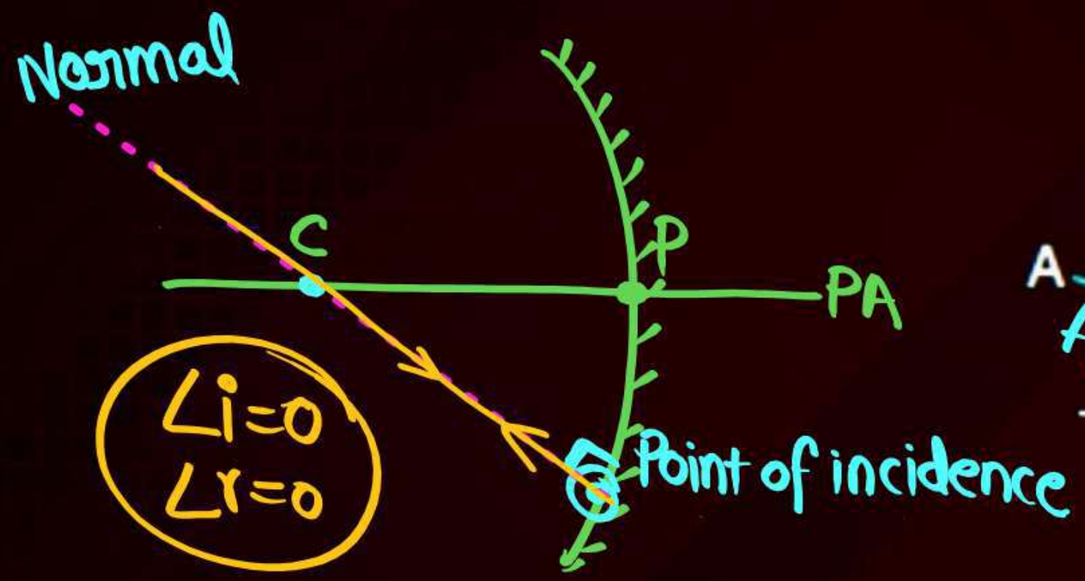
Rule-1: A ray of light which is parallel to the principal axis of a concave mirror, passes through its focus after reflection from the mirror.

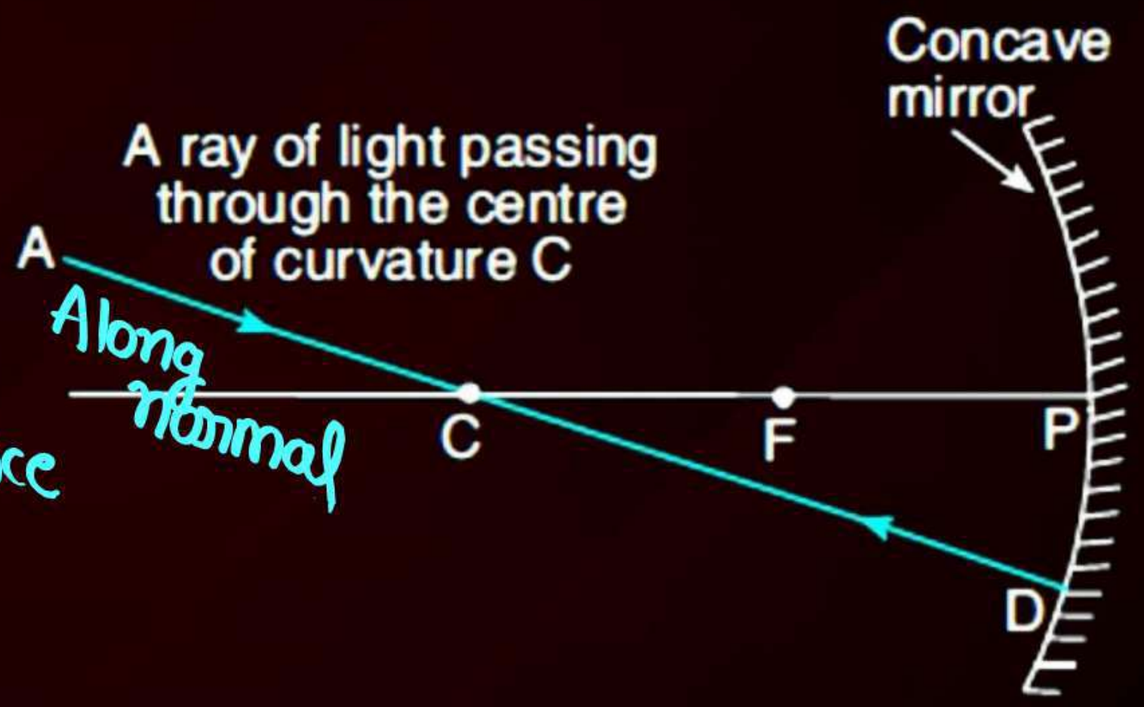




❖ RULES FOR OBTAINING IMAGES FORMED BY CONCAVE MIRRORS

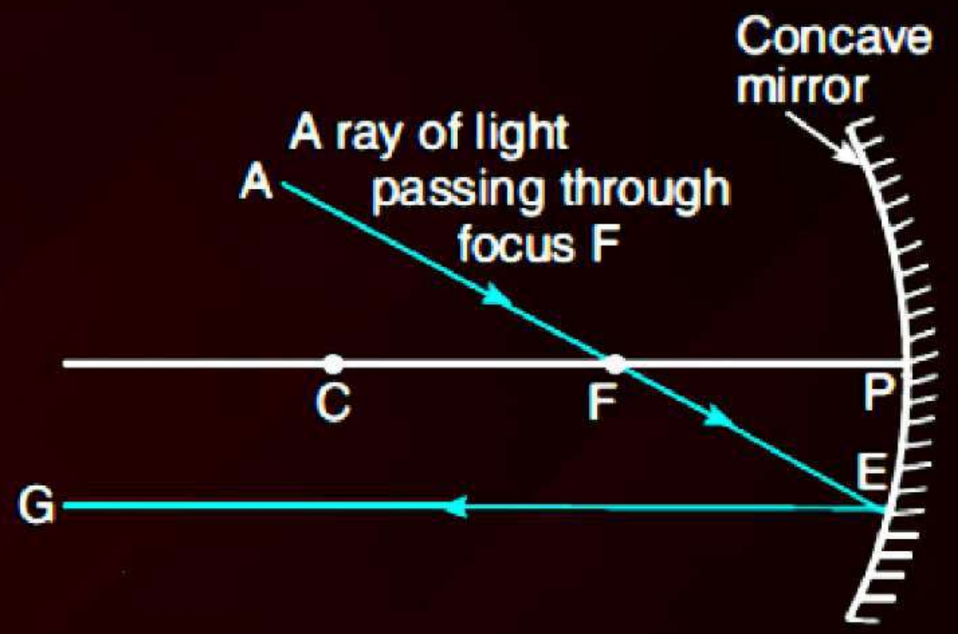
Rule-2: A ray of light passing through the centre of curvature of a concave mirror is reflected back along the same path (because it strikes the mirror normally or perpendicularly)





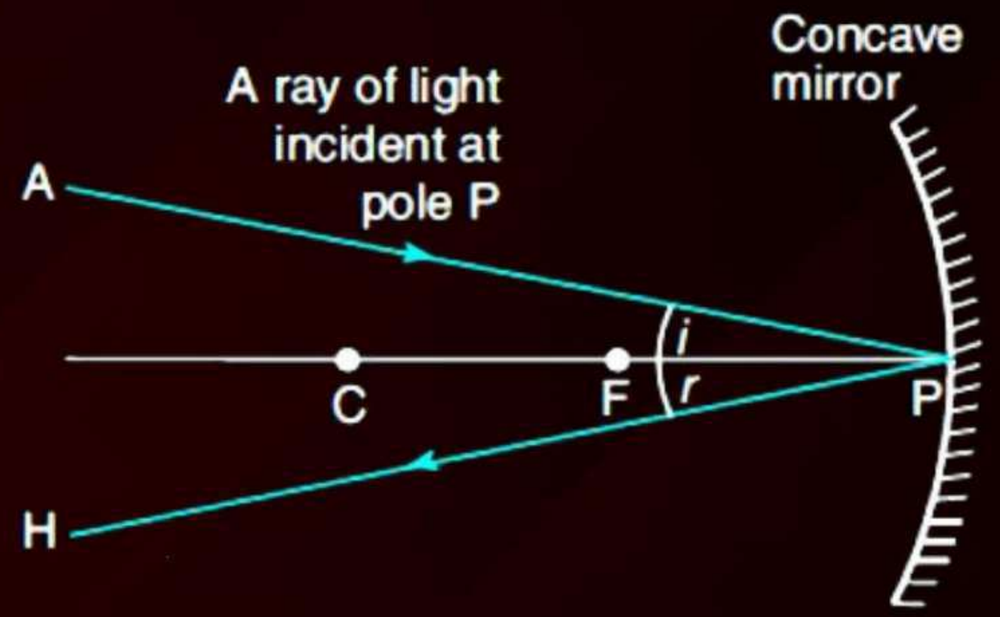
❖ RULES FOR OBTAINING IMAGES FORMED BY CONCAVE MIRRORS

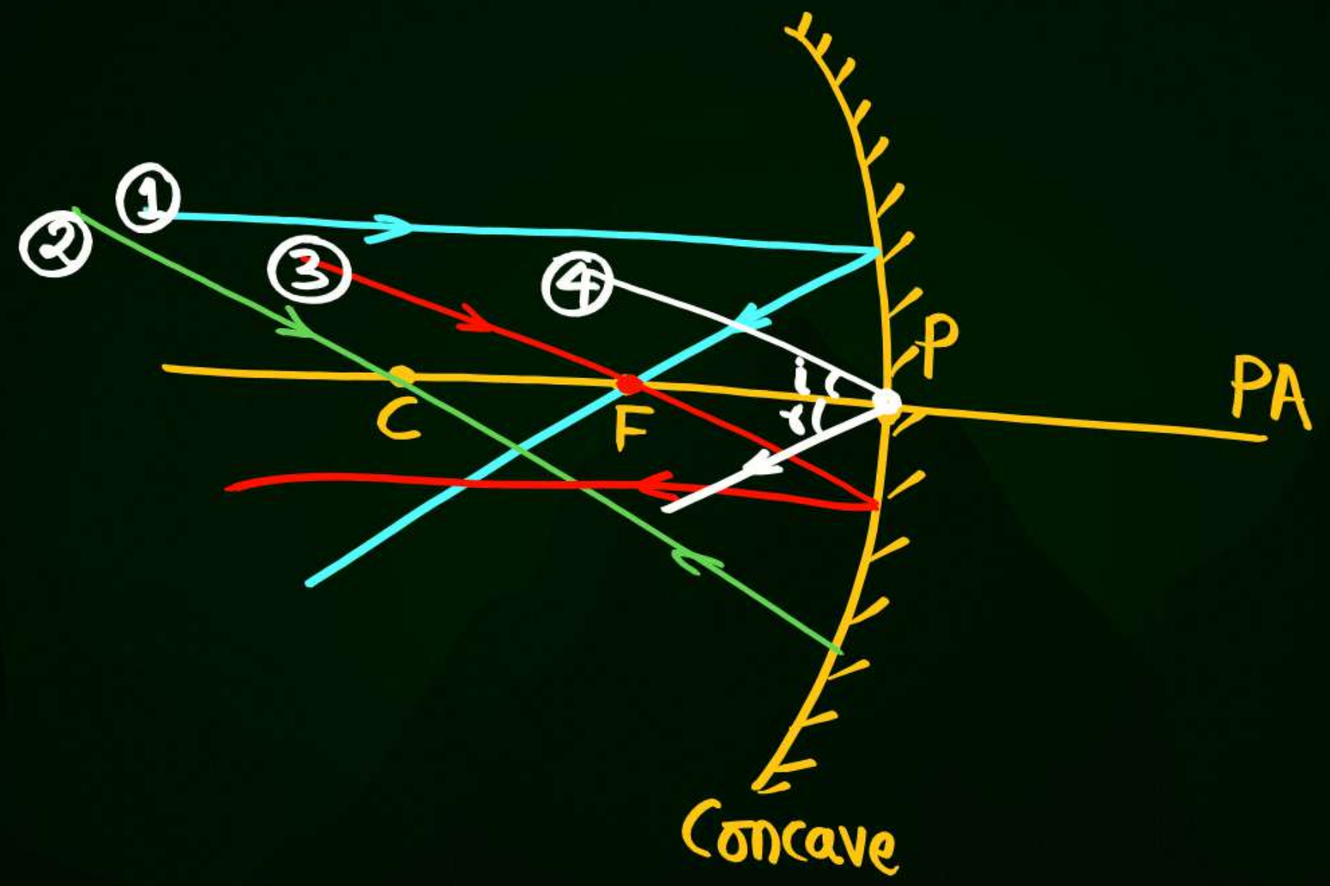
Rule-3: A ray of light passing through the focus of a concave mirror becomes parallel to the principal axis after reflection.



❖ RULES FOR OBTAINING IMAGES FORMED BY CONCAVE MIRRORS

Rule-4: A ray of light which is incident at the pole of a concave mirror is reflected back making the same angle with the principal axis.




1
2
3
4
P
PA
C
F
i
r
Concave

❖ FORMATION OF DIFFERENT TYPES OF IMAGES BY A CONCAVE MIRROR

The type of image formed by a concave mirror depends on the position of object in front of the mirror.

(i) between the pole (P) and focus (F),

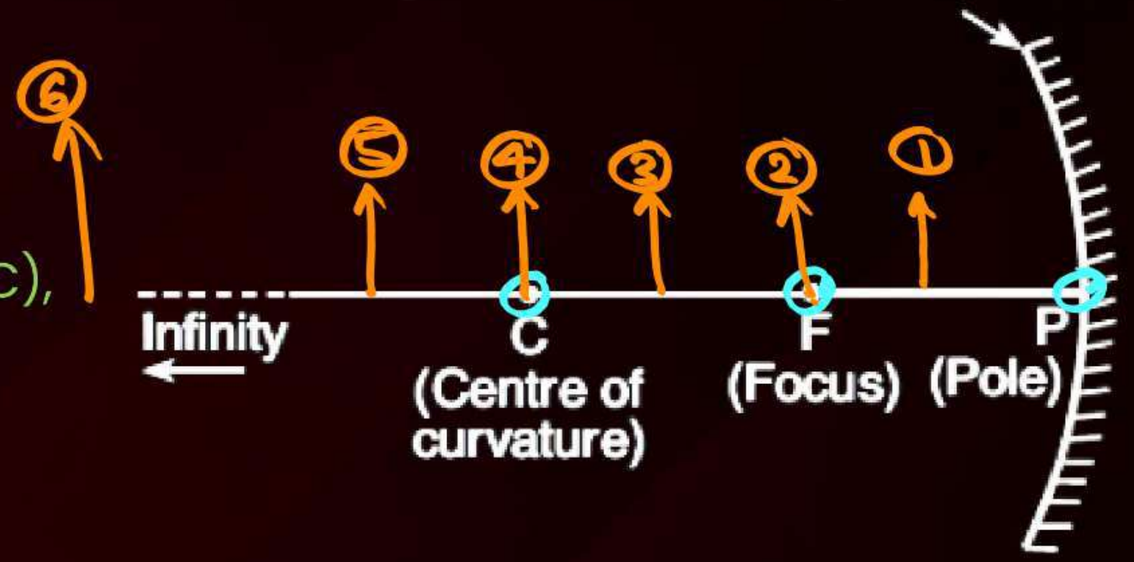
(ii) at the focus (F),

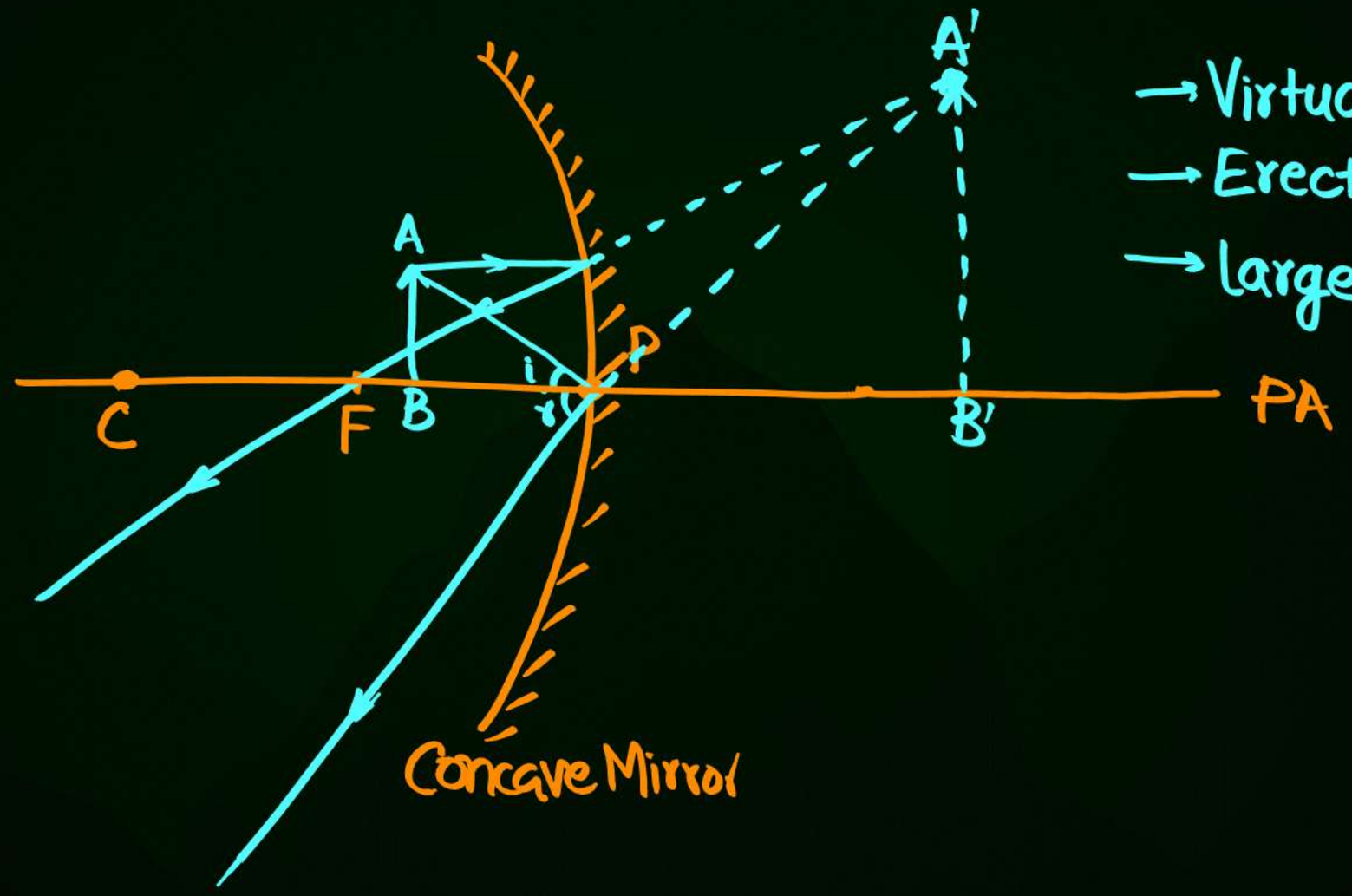
(iii) between focus (F) and centre of curvature (C),

(iv) at the centre of curvature (C),

(v) beyond the centre of curvature (C), and

(vi) at far-off distance called infinity





→ Virtual

→ Erect

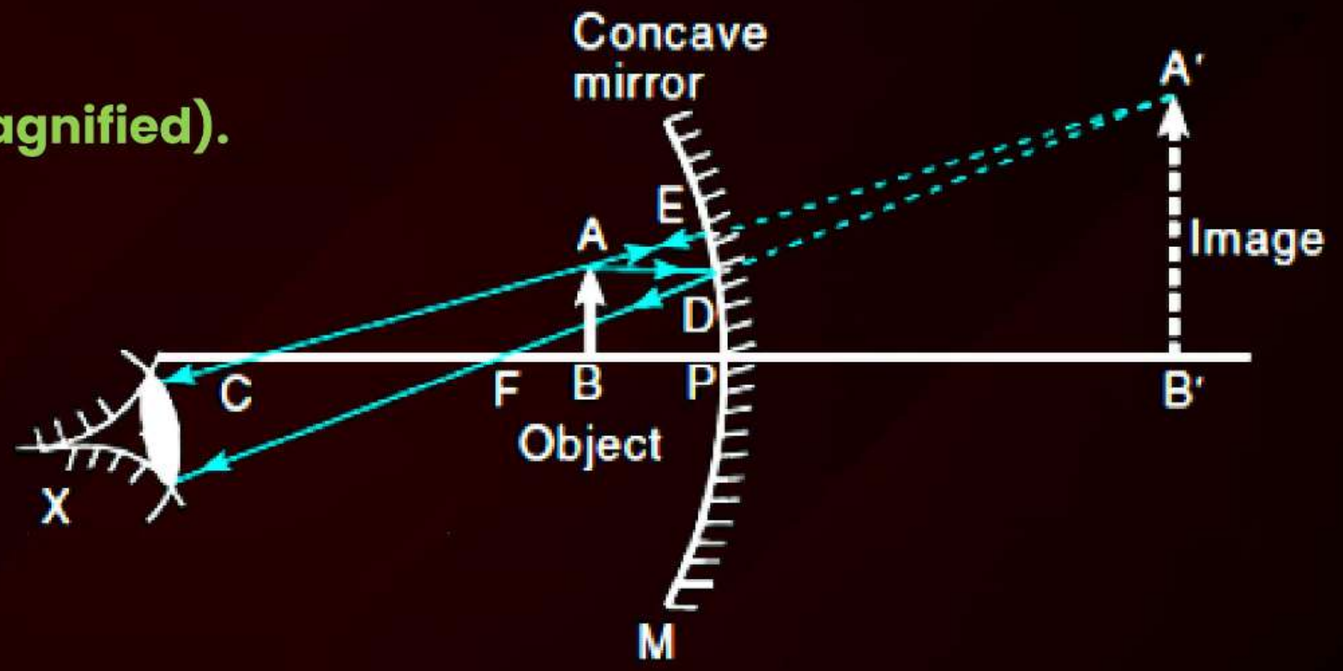
→ larger or magnified

Object between P and F

Sunlight → white Colour (all colours.)

When an object is placed between the pole (P) and focus (F) of a concave mirror, the image formed is :

(i) behind the mirror,
(ii) virtual and erect, and
(iii) larger than the object (or magnified).

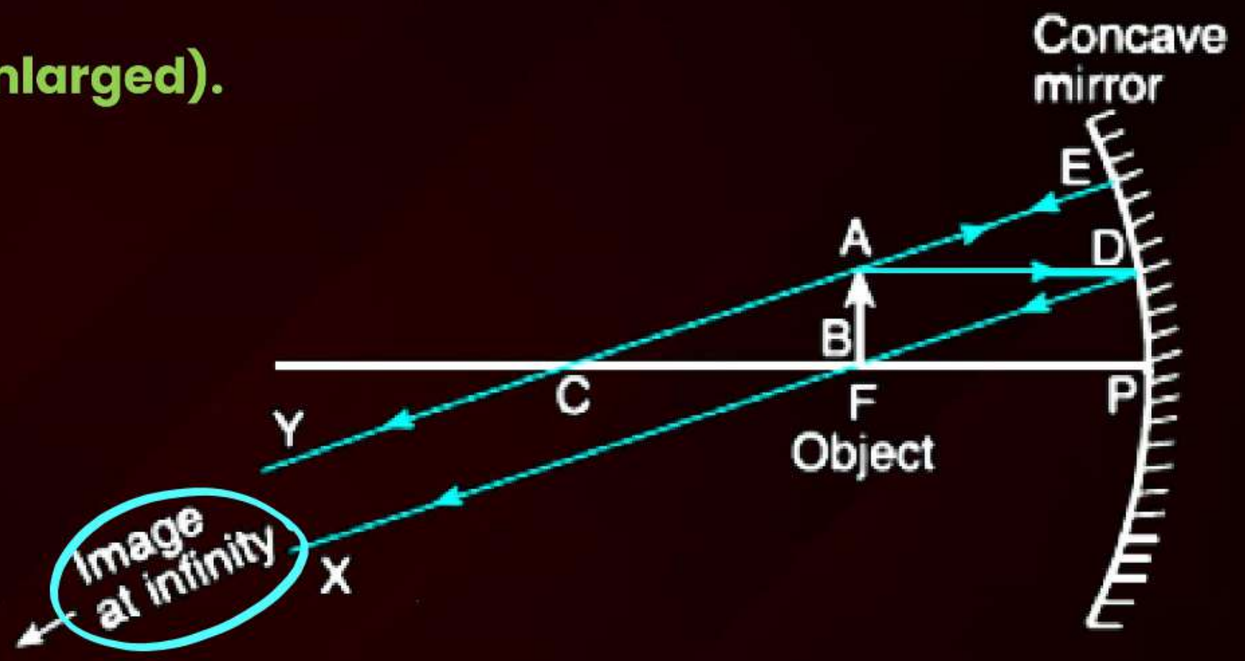


Object at F

$\angle i = \angle r$ → Wave Optics

When an object is placed at the focus of a concave mirror, the image formed is :

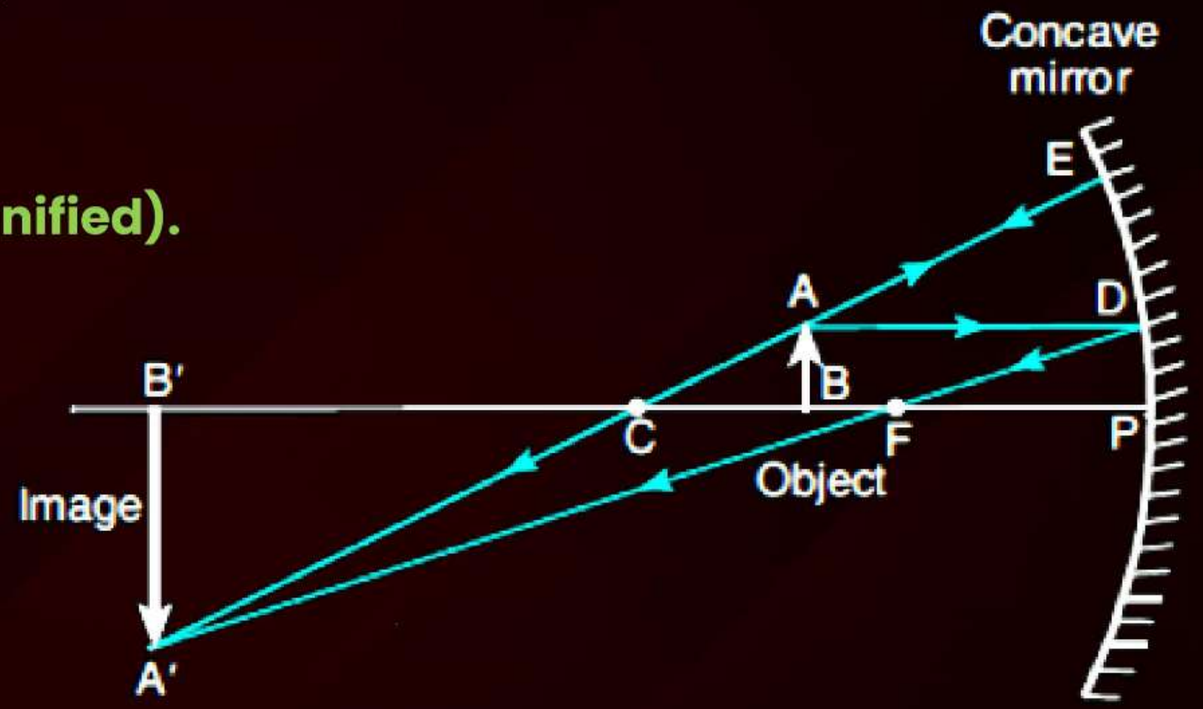
(i) at infinity,
(ii) real and inverted, and
(iii) highly magnified (or highly enlarged).



Object between F and C

When an object is placed between the focus (F) and centre of curvature (C) of a concave mirror, the image formed is :

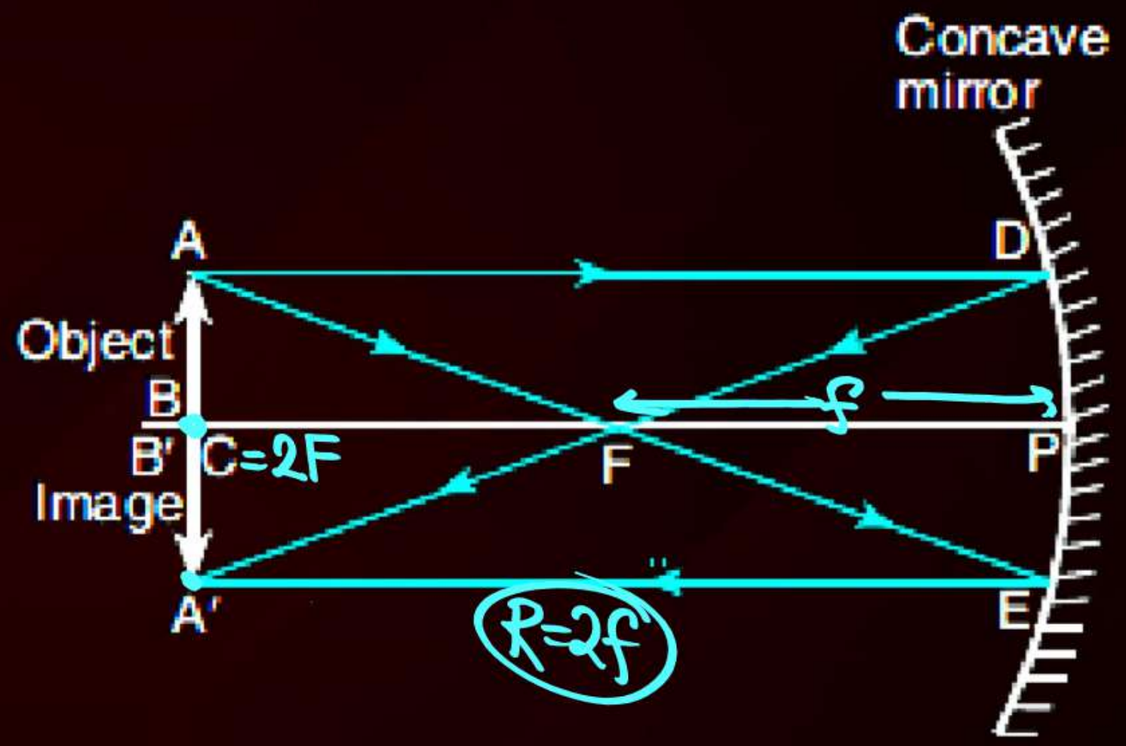
(i) beyond the centre of curvature,
(ii) real and inverted, and
(iii) larger than the object (or magnified).



Object at C

When an object is placed at the centre of curvature (C) of a concave mirror, the image formed is :

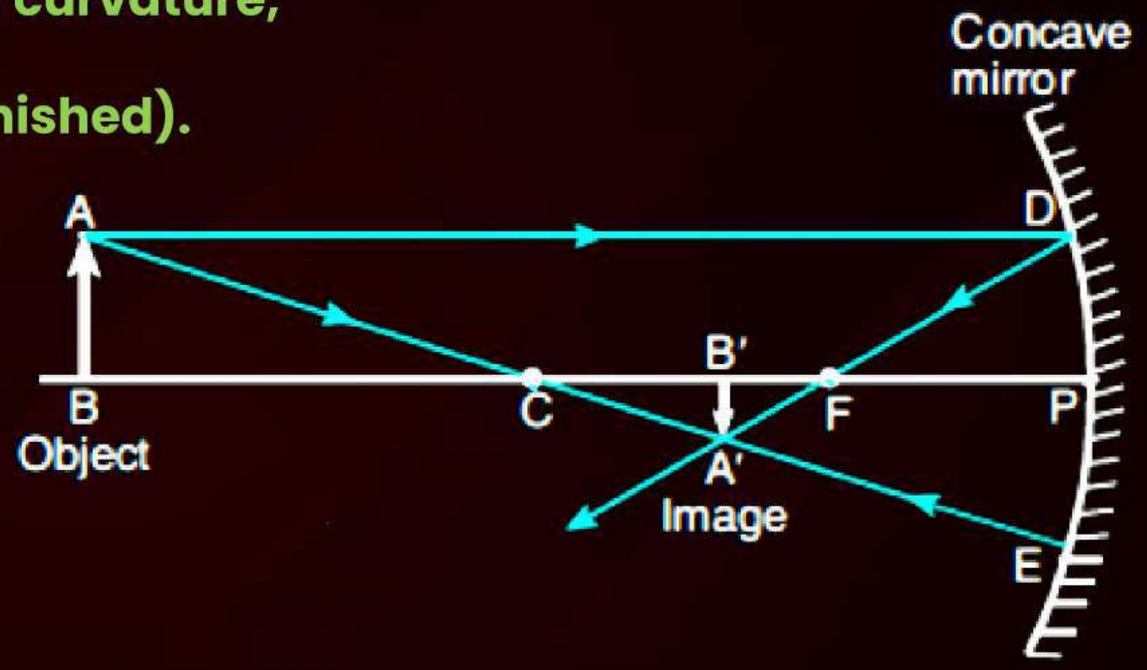
(i) at the centre of curvature (C),
(ii) real and inverted, and
(iii) same size as the object.



Object beyond C

When an object is placed beyond the centre of curvature (C) of a concave mirror, the image formed is :

(i) between the focus and centre of curvature,
(ii) real and inverted, and
(iii) smaller than the object (or diminished).

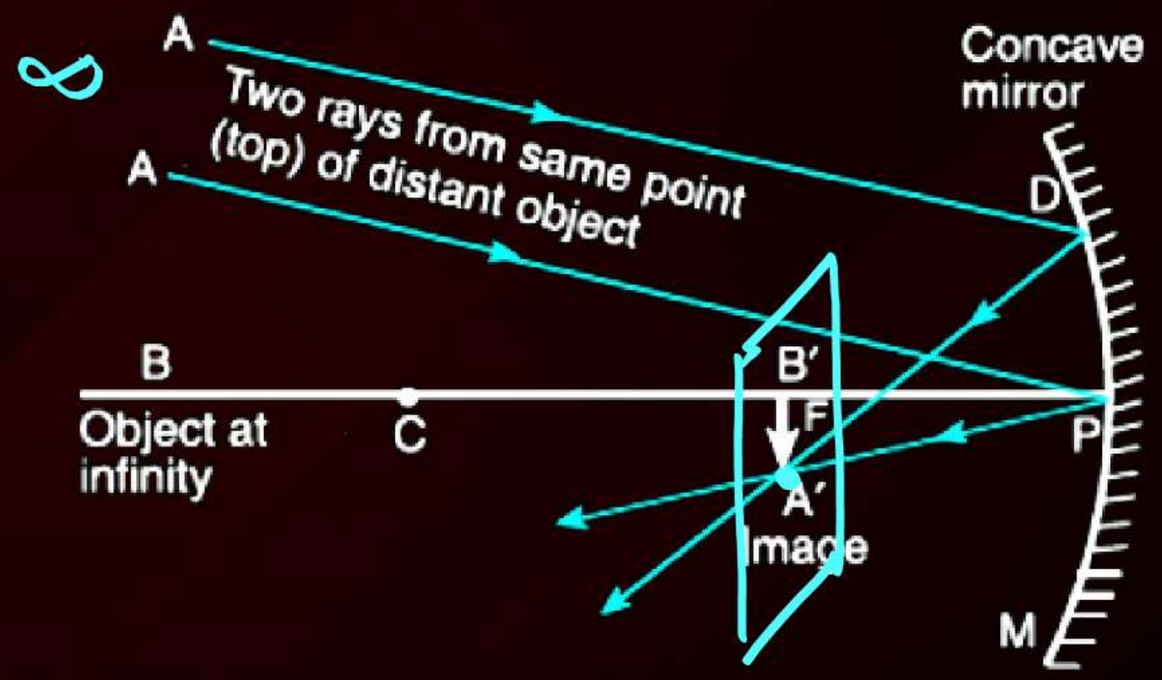


Object is at Infinity

When an object is at infinity from a concave mirror, the image formed is :

focal plane

(i) at the focus (F),
(ii) real and inverted, and
(iii) much smaller than the object (or highly diminished).

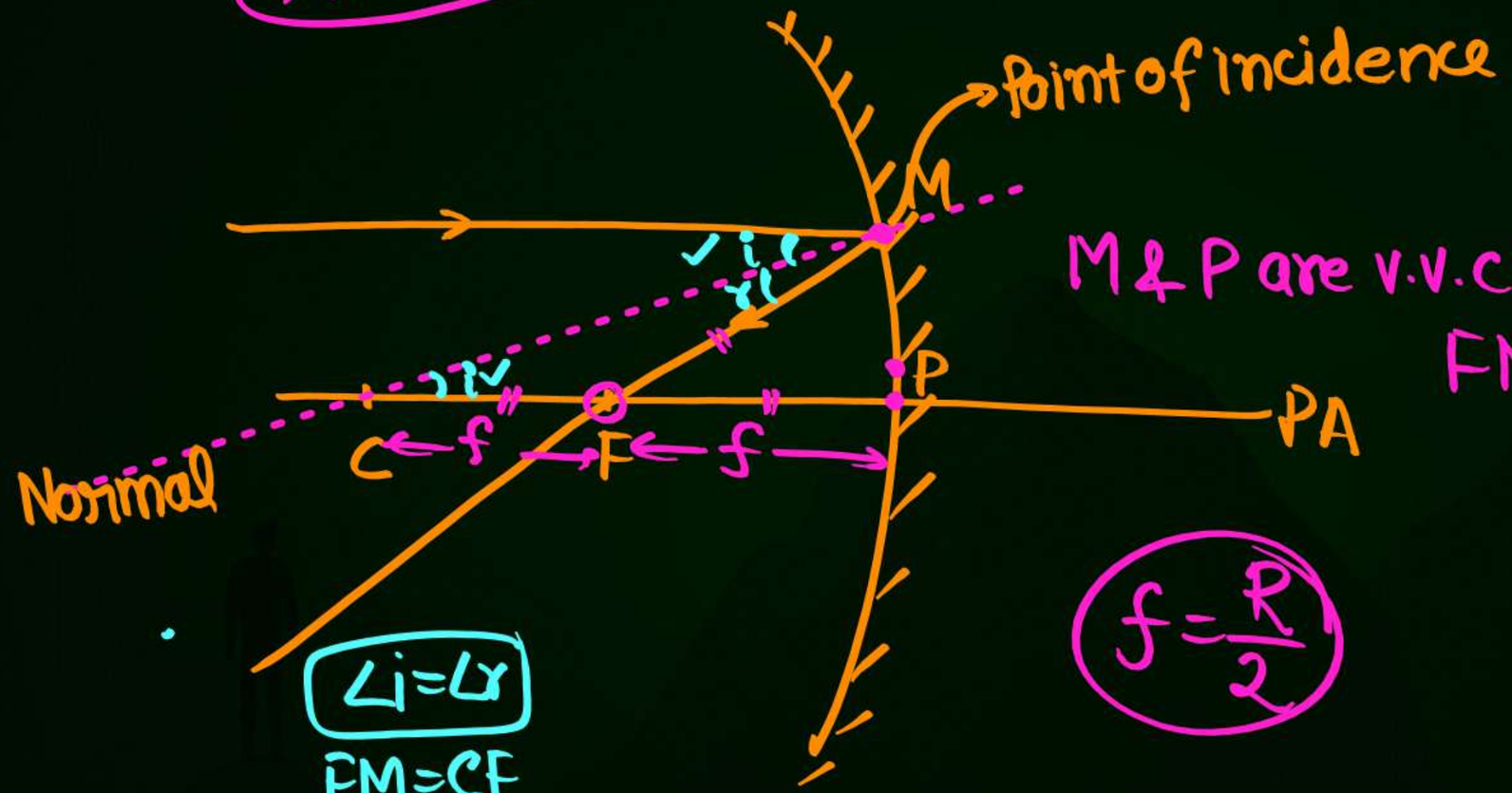


small
Same size
large

Summary of the Images Formed by a Concave Mirror

Position of object	*Position of image*	*Size of image*	*Nature of image*
1. Within focus (between pole *P* and focus *F*)	Behind the mirror	Enlarged	Virtual and erect
2. At focus (*F*)	At infinity	Highly enlarged	Real and inverted
3. Between *F* and *C*	Beyond *C*	Enlarged	Real and inverted
4. At C 2f	At C or 2f	Equal to object	Real and inverted
5. Beyond C	Between *F* and *C*	Diminished	Real and inverted
6. At infinity	At focus (*F*)	Highly diminished	Real and inverted

XII level



M & P are v.v. close points.

$FM \approx FP$

$f = \frac{R}{2}$

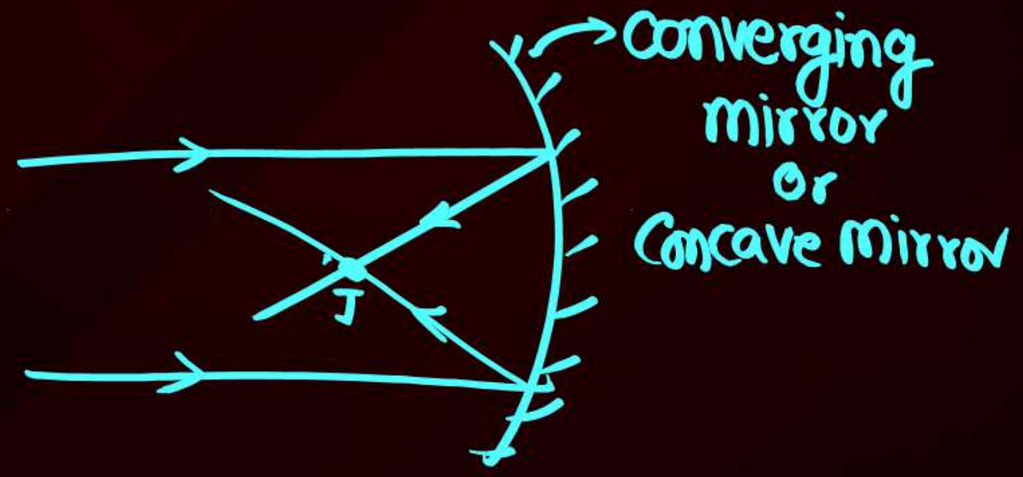
$\angle i = \angle r$

$FM = CF$

$FP = CF$

Uses of Concave Mirrors

(i) Concave mirrors are used as shaving mirrors to see a large image of the face.
(ii) Concave mirrors are used by dentists to see the large images of the teeth of patients.
(iii) Concave mirrors are used as reflectors in torches, vehicle head-lights and search lights to get powerful beams of light.
(iv) Concave mirrors are used as doctor's head-mirrors to focus light coming from a lamp on to the body parts of a patient (such as eye, ear, nose, throat, etc.) to be examined by the doctor.
(v) Concave dishes are used in TV dish antennas to receive TV signals from the distant communications satellites.

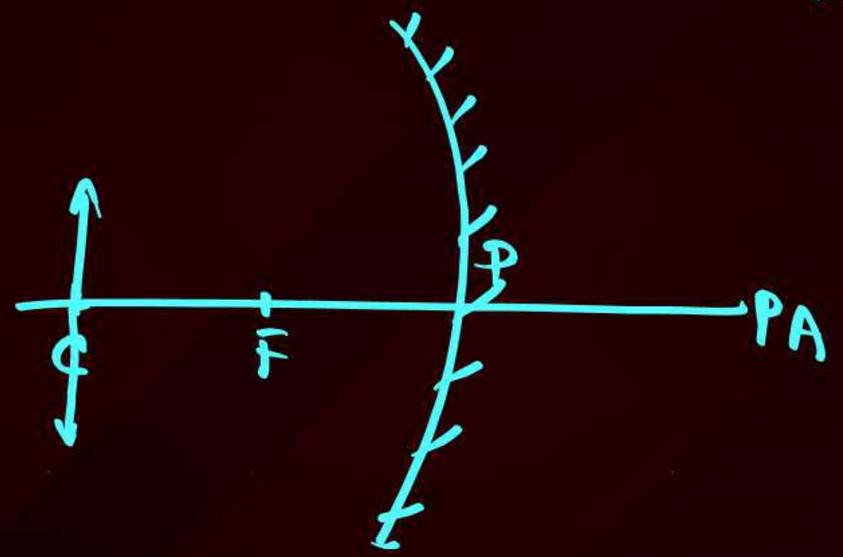


Question

A concave mirror has a focal length of 10 cm. Where should an object be placed in front of this concave mirror so as to obtain an image which is real, inverted and same size as the object?

$f = 10cm$

at $C = 2f = 2 \times 10 = 20 cm$



Question

Inverted

The real image formed by a concave mirror is larger than the object when the object is :

2f

(A) at a distance equal to radius of curvature ✗

(B) at a distance less than the focal length ✗

(C) between focus and centre of curvature ✓

(D) at a distance greater than radius of curvature

Question

Inverted

The real image formed by a concave mirror is smaller than the object if the object is:

(A) between centre of curvature and focus

(B) at a distance greater than radius of curvature

(C) at a distance equal to radius of curvature

(D) at a distance equal to focal length

Question

The image formed by a concave mirror is real, inverted and of the same size as the object. The position of the object must then be:

A. at the focus

B. between the centre of curvature and focus

C. at the centre of curvature

D. beyond the centre of curvature

Question

The image formed by a concave mirror is real, inverted and highly diminished (much smaller than the object). The object must be:

(A) between pole and focus

(B) at focus

(C) at the centre of curvature

(D) at infinity

Question

The angle of incidence for a ray of light passing through the centre of curvature of a concave mirror is:

along Normal

(A) 45°

(B) 90°

(C) 0°

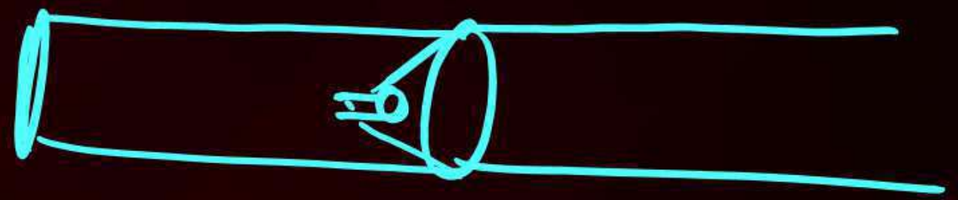
(D) 180°

Question

In the concave reflector of a torch, the bulb is placed :

(A) between the pole and focus of reflector

(B) at the focus of reflector



(C) between focus and centre of curvature of reflector

(D) at the centre of curvature of reflector

Question

The focal length of a small concave mirror is 2.5 cm. In order to use this concave mirror as a dentist's mirror, the distance of tooth from the mirror should be :

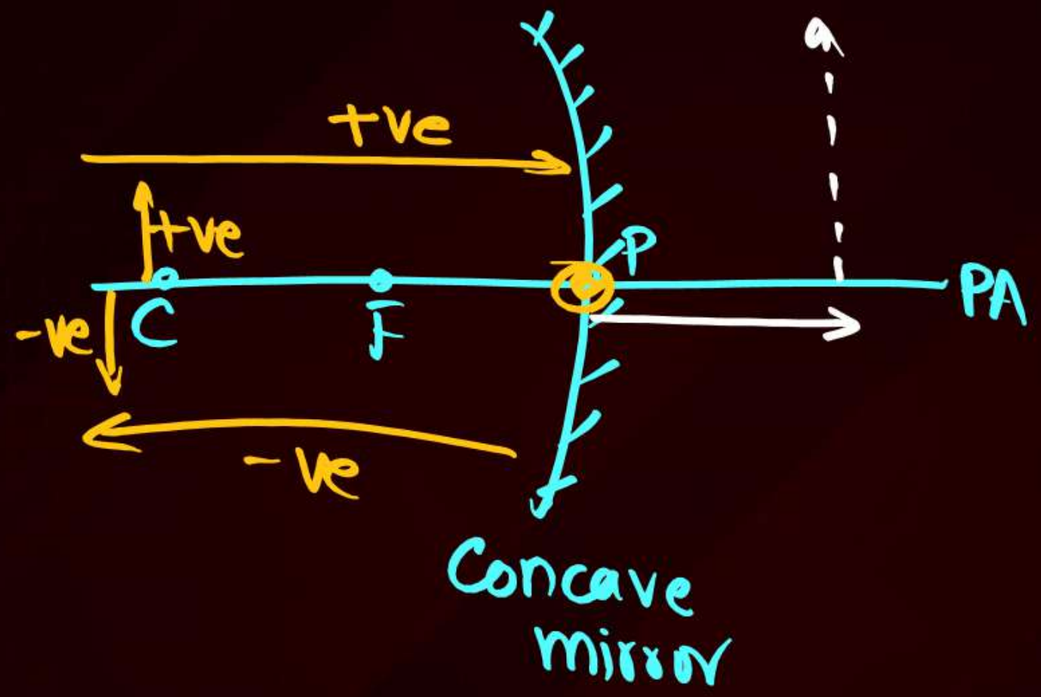
(A) 2.5 cm

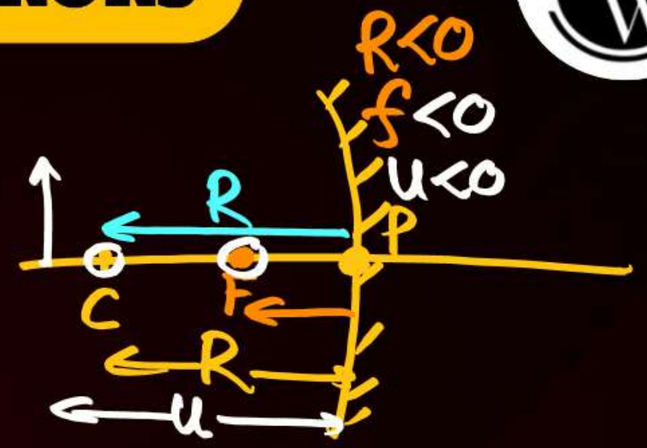
(B) 1.5 cm

(C) 4.5 cm

(D) 3.5 cm

SIGN CONVENTION FOR SPHERICAL MIRRORS





Virtual Image Distance (v)

SIGN CONVENTION FOR SPHERICAL MIRRORS

(i) All the distances are measured from pole of the mirror as origin.

(ii) Distances measured in the same direction as that of incident light are taken as positive.

(iii) Distances measured against the direction of incident light are taken as negative.

(iv) Distances measured upward and perpendicular to the principal axis are taken as positive.

(v) Distances measured downward and perpendicular to the principal axis are taken as negative.

Question

According to New Cartesian Sign Convention :

(A) focal length of concave mirror is positive and that of convex mirror is negative

(B) focal length of both concave and convex mirrors is positive

(C) focal length of both concave and convex mirrors is negative

(D) focal length of concave mirror is negative and that of convex mirror is positive

Question

One of the following does not apply to a concave mirror. This is

(A) focal length is negative

(B) image distance can be positive or negative

virtual — Real

Case I — Case II to VI

(C) image distance is always positive

(D) height of image can be positive or negative

MIRROR FORMULA

A formula which gives the relationship between image distance (v), object distance (u) and focal length (f) of a spherical mirror is known as the mirror formula

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

$v_{Real} < 0$

$v_{virtual} > 0$

Real Object

$u < 0$

$f_{concave} < 0$

$f_{convex} > 0$

Linear Magnification Produced by Mirrors

The size of image formed by a spherical mirror depends on the position of the object from the mirror. The linear magnification produced by a mirror is equal to the ratio of the image distance to the object distance, with a minus sign.

$$m = \frac{h_i}{h_o} = -\frac{v}{u}$$

Question

An object 2 cm high is placed at a distance of 16 cm from a concave mirror which produces a real image 3 cm high.

(i) What is the focal length of the mirror?

(ii) Find the position of the image. (In front of mirror)

$h_o = 2cm$

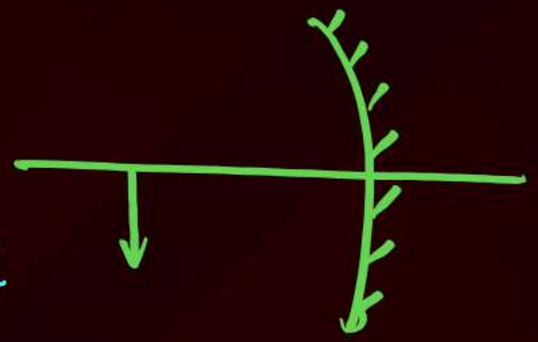
$u = -16cm$

Real Image → Inverted Image

$\boxed{h_i = -3cm}$

$m = \frac{h_i}{h_o} = -\frac{v}{u}$ → Image Distance

$\frac{-3}{2} = -\frac{v}{-16}$ ⇒ $\boxed{v = -24cm}$



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

$\frac{1}{f} = \frac{1}{-24} + \frac{1}{-16}$

$= \frac{-2-3}{48}$

$\frac{1}{f} = \frac{-5}{48}$

$\boxed{f = \frac{-48}{5} cm}$

Question

$m = -3$

A concave mirror produces three times magnified (enlarged) real image of an object placed at 10 cm in front of it. Where is the image located ?

Inverted

In front of mirror

$u = -10cm$

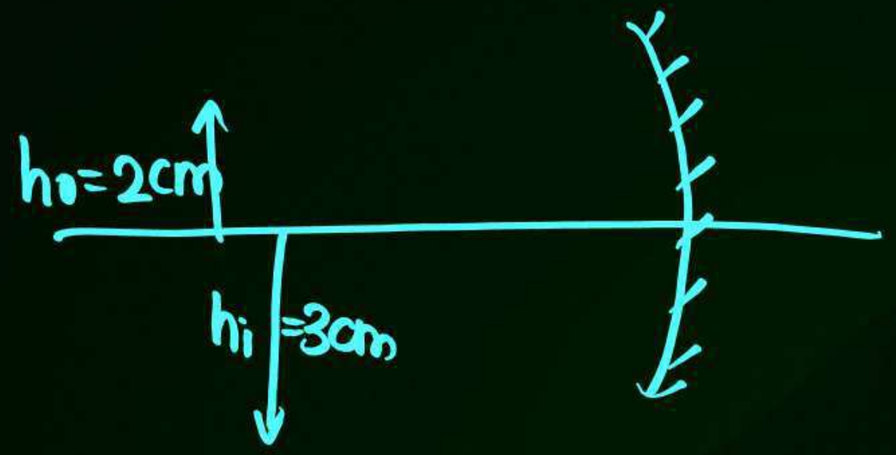
$v = ?$

$m = -3$

$-\frac{v}{u} = -3$

$-\frac{v}{-10} = -3$

$\boxed{v = -30cm}$


$h_o = 2cm$
$h_i = 3cm$

$m_{\text{plane mirror}} = +1$

$m = +1$

Erect
Virtual

Same size

$m = \frac{h_i}{h_o} = 1$

$h_i = h_o$

$m = -1$

Inverted
Real

Same size

$m = +2$

Erect
Virtual

Magnified

$m = \frac{h_i}{h_o} = 2 \Rightarrow h_i = 2h_o$

$m = -2$

Inverted
Real

Magnified

$m = +\left(\frac{1}{2}\right)$

Erect
Virtual

Diminished

$m = -\left(\frac{1}{3}\right)$

Inverted
Real

Diminished

Question

HW

The magnification produced by a plane mirror is +1. What does this mean?

Question

Linear magnification produced by a concave mirror may be:

(A) less than 1 or equal to 1

(B) more than 1 or equal to 1

(C) less than 1, more than 1 or equal to 1

Diminished Magnified Same size

(D) less than 1 or more than 1

Question

Magnification produced by a plane mirror is:

(A) less than one

(B) greater than one

(C) zero

(D) equal to one

Question

Inverted, Real
same size

If a magnification of, –1 (minus one) is to be obtained by using a converging mirror, then the object has to be placed:

Concave mirror

(A) between pole and focus

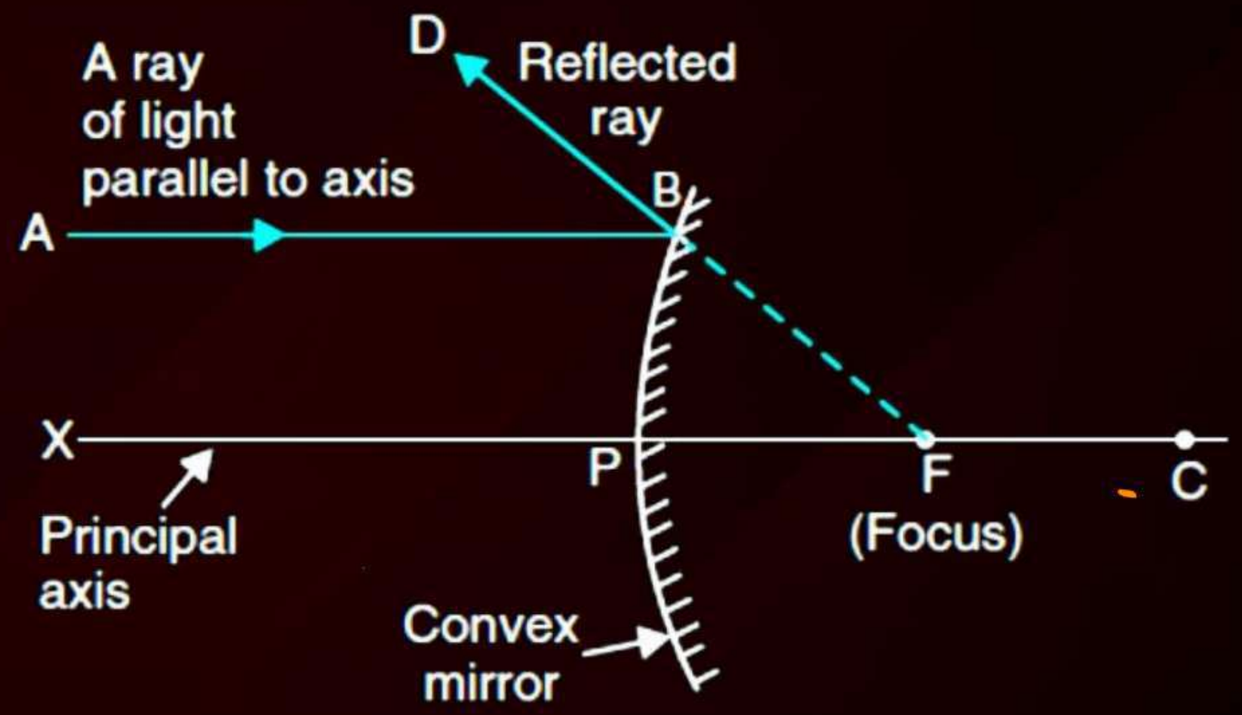
(B) at the centre of curvature

(C) beyond the centre of curvature

(D) at infinity

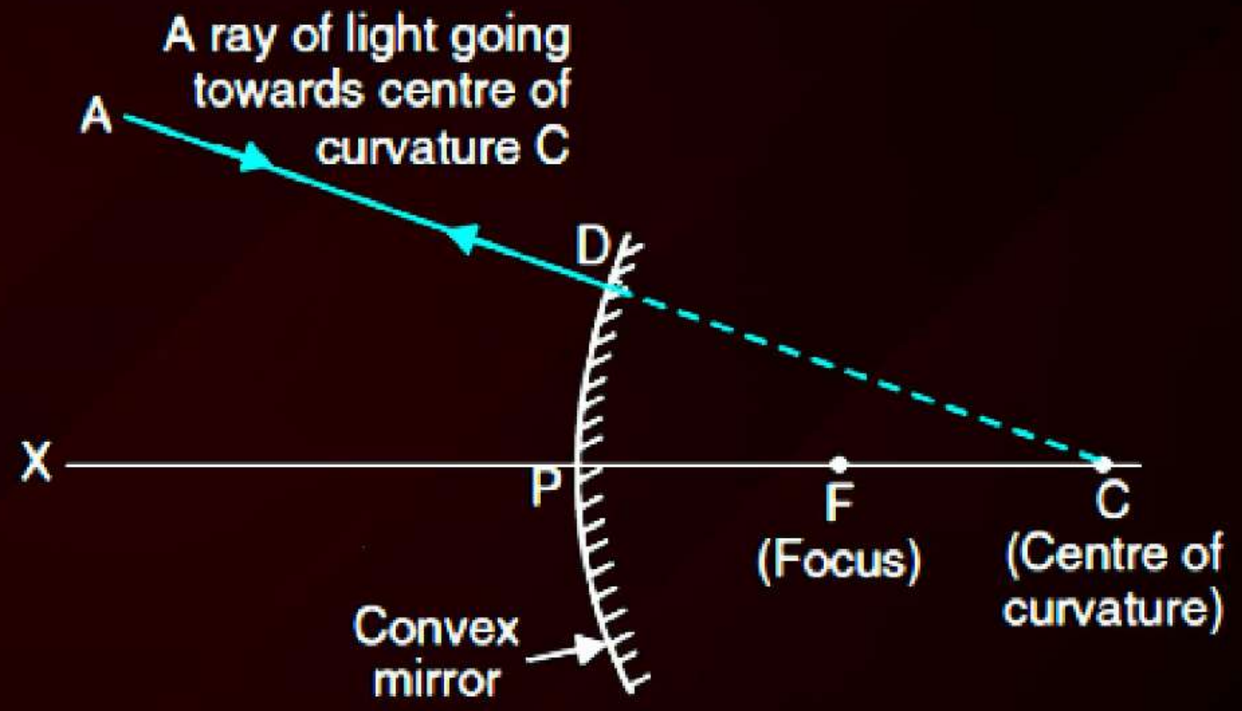
RULES FOR OBTAINING IMAGES FORMED BY CONVEX MIRRORS

Rule 1: A ray of light which is parallel to the principal axis of a convex mirror, appears to be coming from its focus after reflection from the mirror.



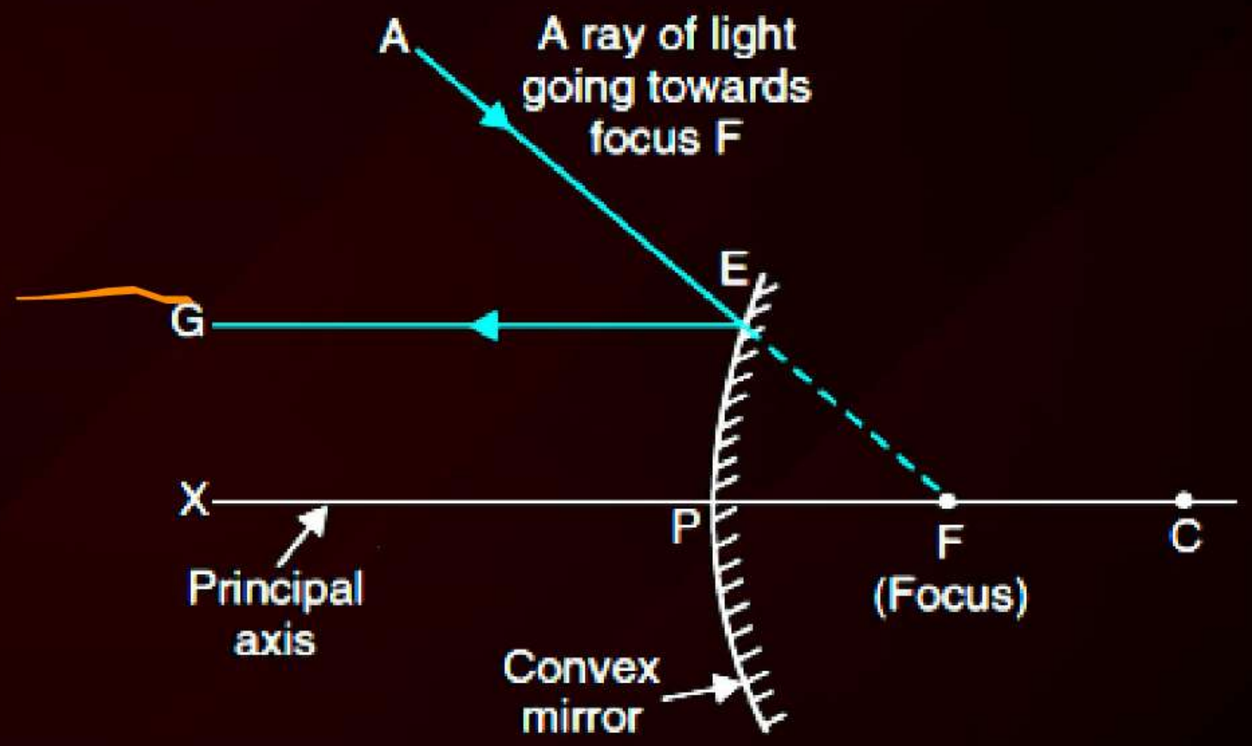
RULES FOR OBTAINING IMAGES FORMED BY CONVEX MIRRORS

Rule 2: A ray of light going towards the centre of curvature of a convex mirror is reflected back along the same path.



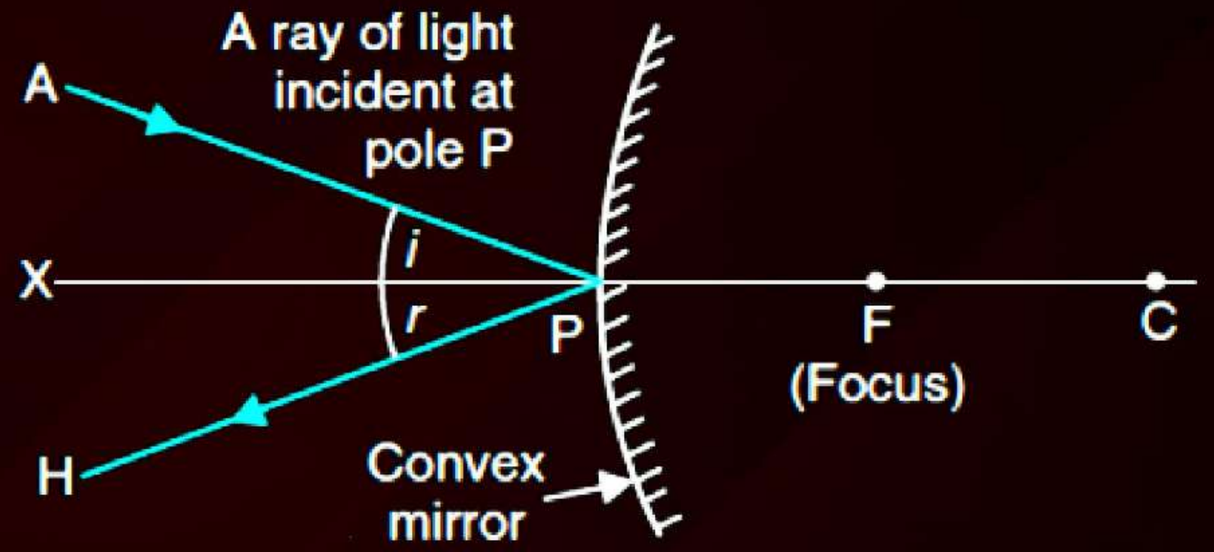
RULES FOR OBTAINING IMAGES FORMED BY CONVEX MIRRORS

Rule 3: A ray of light going towards the focus of a convex mirror becomes parallel to the principal axis after reflection.



RULES FOR OBTAINING IMAGES FORMED BY CONVEX MIRRORS

Rule 4: A ray of light which is incident at the pole of a convex mirror is reflected back making the same angle with the principal axis.

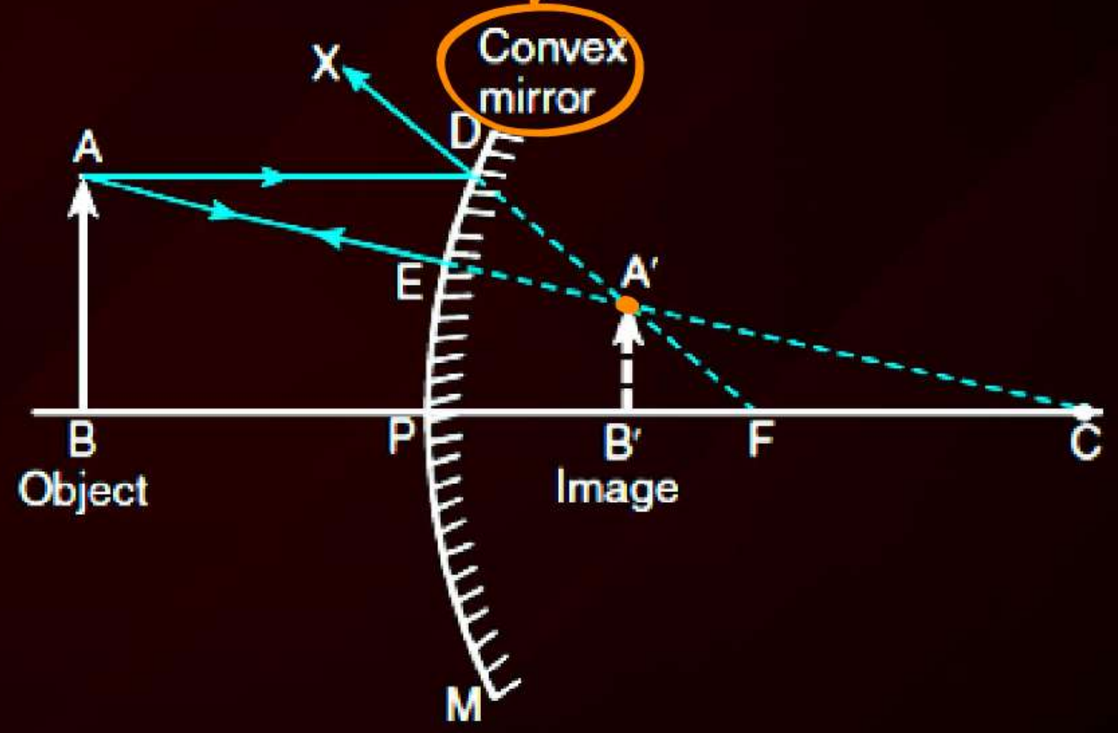


FORMATION OF IMAGE BY A CONVEX MIRROR

When an object is placed anywhere between pole (P) and infinity in front of a convex mirror, the image formed is :

(i) behind the mirror between pole (P) and focus (F),
(ii) virtual and erect, and
(iii) diminished (smaller than the object).

Virtual, Erect
छोटी



FORMATION OF IMAGE BY A CONVEX MIRROR

When an object is at infinity from a convex mirror, the image formed is :

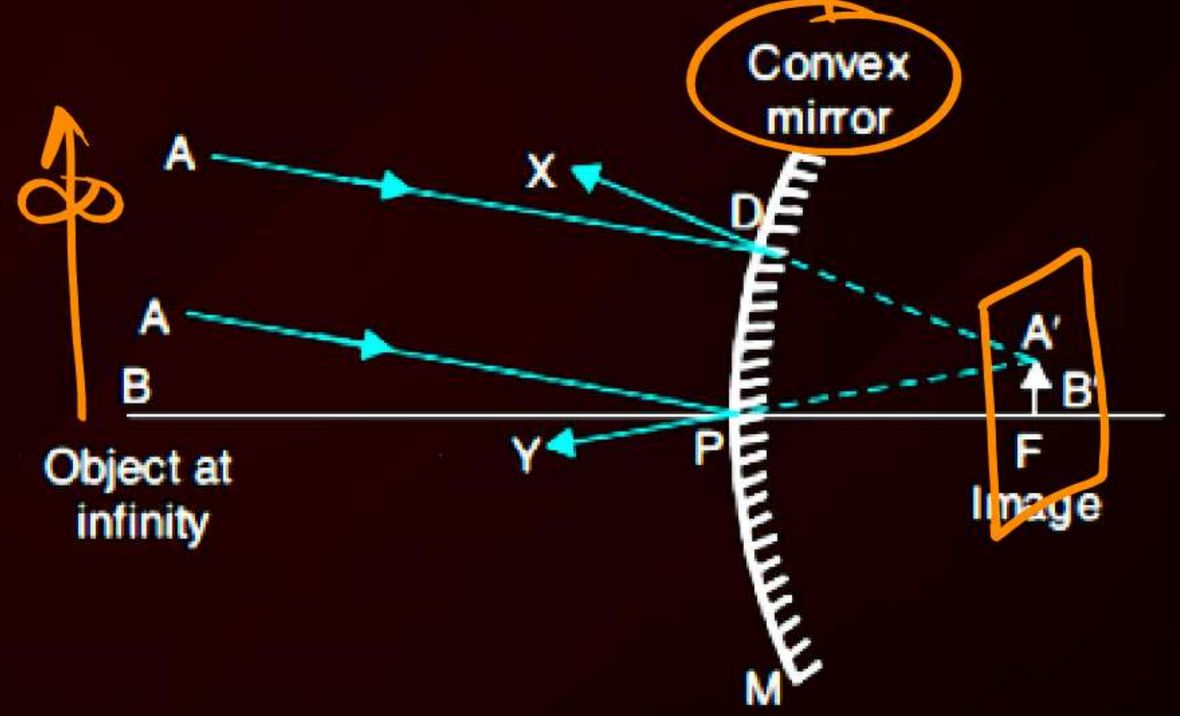
(i) behind the mirror at focus (F),

(ii) virtual and erect, and

(iii) highly diminished (much smaller than the object).

Virtual
Erect

बहुत छोटी



Uses of Convex Mirrors

(i) Convex mirrors are used as rear-view mirrors in vehicles (like cars, trucks and buses) to see the traffic at the rear side (or back side).

Uses of Convex Mirrors

(ii) Big convex mirrors are used as 'shop security mirrors'

Question

No matter how far you stand from a mirror, your image appears erect. The mirror may be:

(A) Plane → V.E. same size

(B) concave ✗

(C) convex → V.E. Diminished

(D) either plane or convex ✓

Question

The image formed by a spherical mirror is virtual. The mirror will be:

(A) concave ✓ V. E. magnified

(B) convex → V. E. D.

(C) either concave or convex

(D) metallic

Question

Whatever be the position of the object, the image formed by a mirror is virtual, erect and smaller than the object. The mirror then must be:

(A) plane

(B) concave

(C) convex

(D) either concave or convex

Question

Consider two statements A and B given below:

A : real image is always inverted

B: virtual image is always erect

Out of these two statements:

(A) only A is true

(B) only B is true

(C) both A and B are true

(D) none is true

Question

An object 5 cm high is placed at a distance of 10 cm from a convex mirror of radius of curvature 30 cm. Find the nature, position and size of the image.

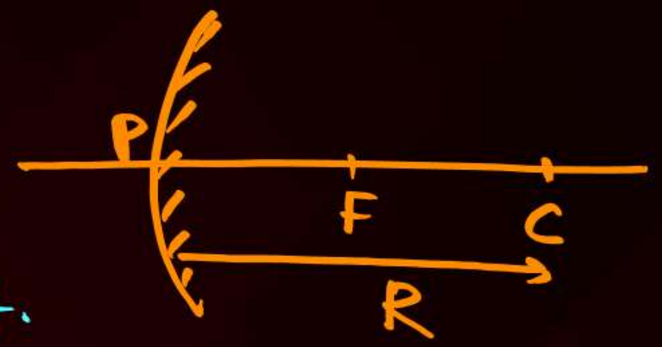
$h_o = 5cm$

$u = -10cm$

$R = +30cm$

$\boxed{f = \frac{R}{2} = 15cm}$

$\boxed{V = 6cm}$ → Virtual, Erect.



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

$\frac{1}{15} = \frac{1}{v} + \frac{1}{-10} \Rightarrow \frac{1}{v} = \frac{1}{15} + \frac{1}{10} = \frac{2+3}{30} = \frac{5}{30} = \frac{1}{6}$

$m = -\frac{v}{u} = \frac{h_i}{h_o}$

$\frac{6}{10} = \frac{h_i}{5} \Rightarrow \boxed{h_i = 3cm}$

Diminished

$$\Downarrow$$

$$\boxed{R_{plane} = \infty}$$

$$f = \frac{R}{2} = \frac{\infty}{2} = \infty$$

$$\boxed{f_{plane\ mirror} = \infty}$$

R ↓

ज्यादा curve

R ↑

कम curve

Refraction of light

Optically Rarer Medium and Optically Denser Medium

A medium in which the speed of light is more is known as optically rarer medium (or less dense medium). Air is an optically rarer medium as compared to glass and water.

A medium in which the speed of light is less, is known as optically denser medium. Glass is an optically denser medium than air and water.

Air → Rarer

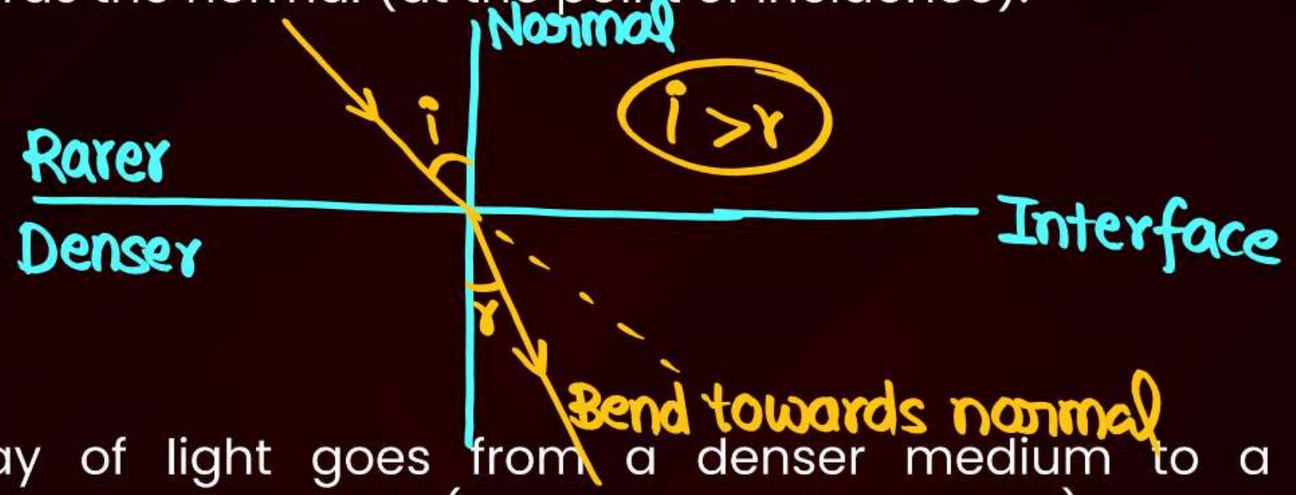
Water → Denser

Water → rarer

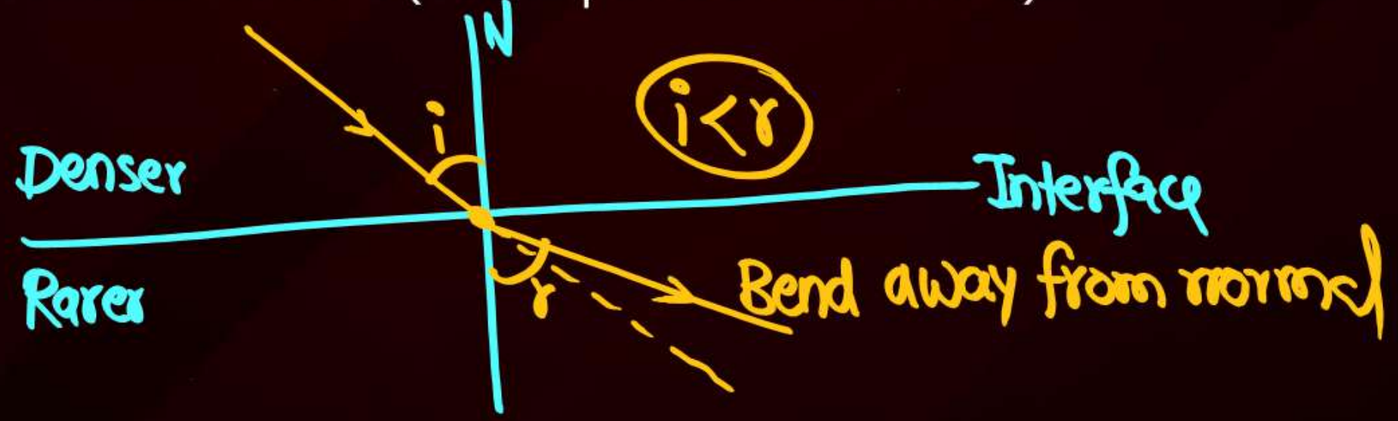
Glass → denser

Optically Rarer Medium and Optically Denser Medium

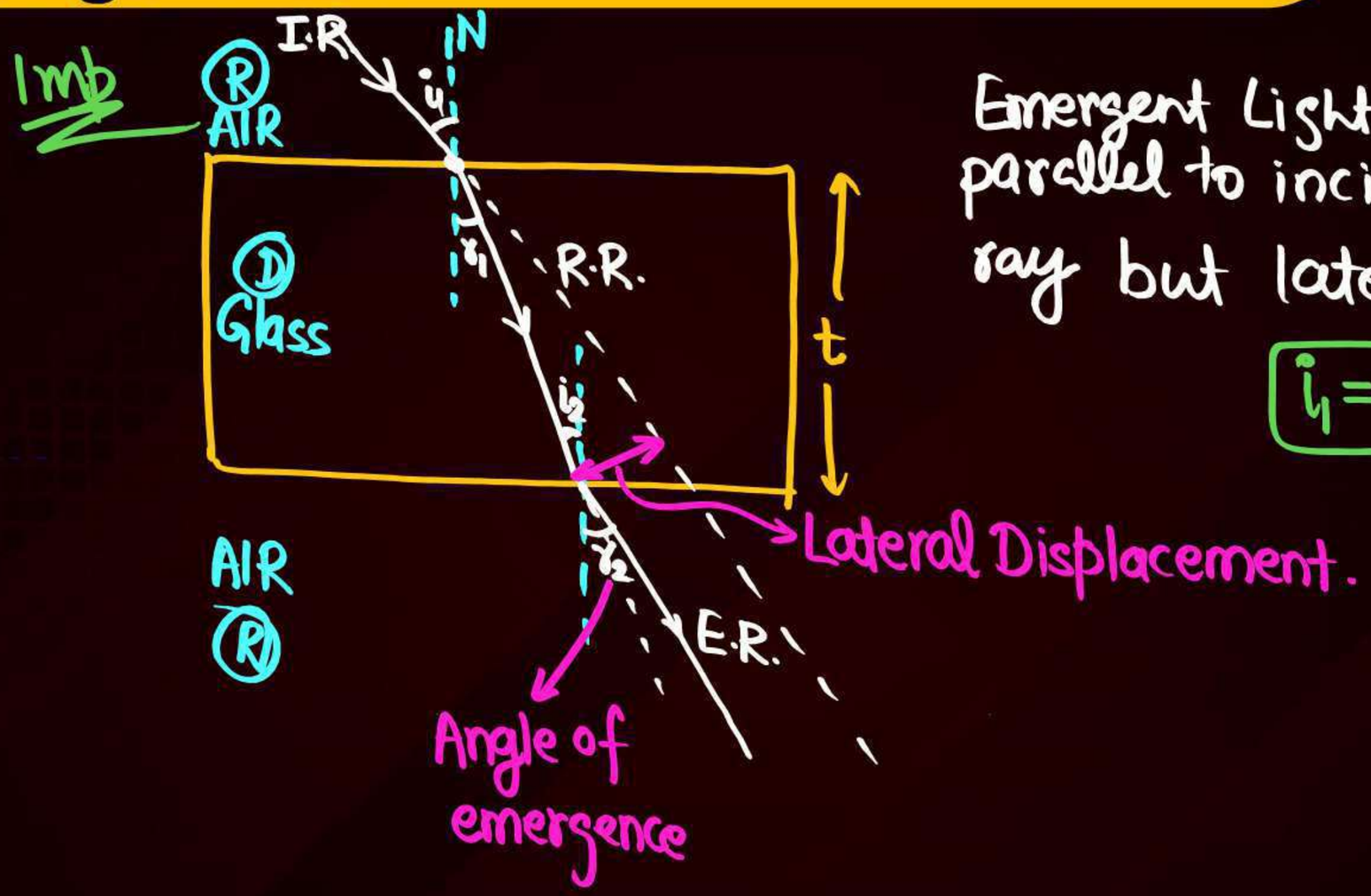
1. When a ray of light goes from a rarer medium to a denser medium, it bends towards the normal (at the point of incidence).



2. When a ray of light goes from a denser medium to a rarer medium, it bends away from the normal (at the point of incidence).



The Case of Light Going From Air into Glass and Again into Air



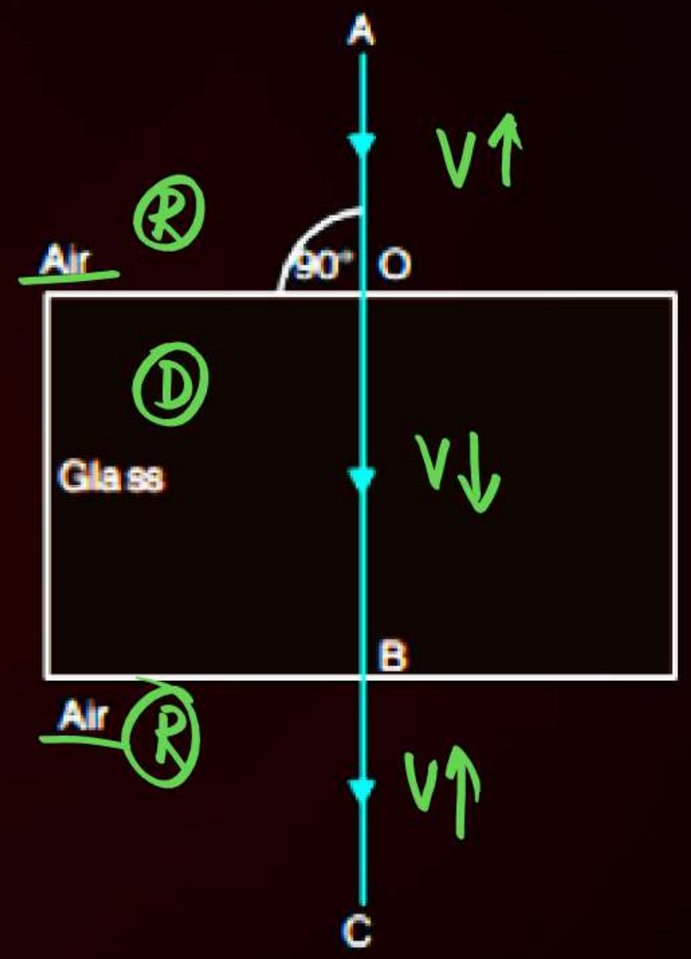
Emergent Light Ray is parallel to incident light ray but laterally shifted.

$$\boxed{i_1 = r_2}$$

❖ The Case of Light Falling Normally (or Perpendicularly) on a Glass Slab

No refraction

$$\mu = \frac{c}{v} \Rightarrow \boxed{v = \frac{c}{\mu}}$$

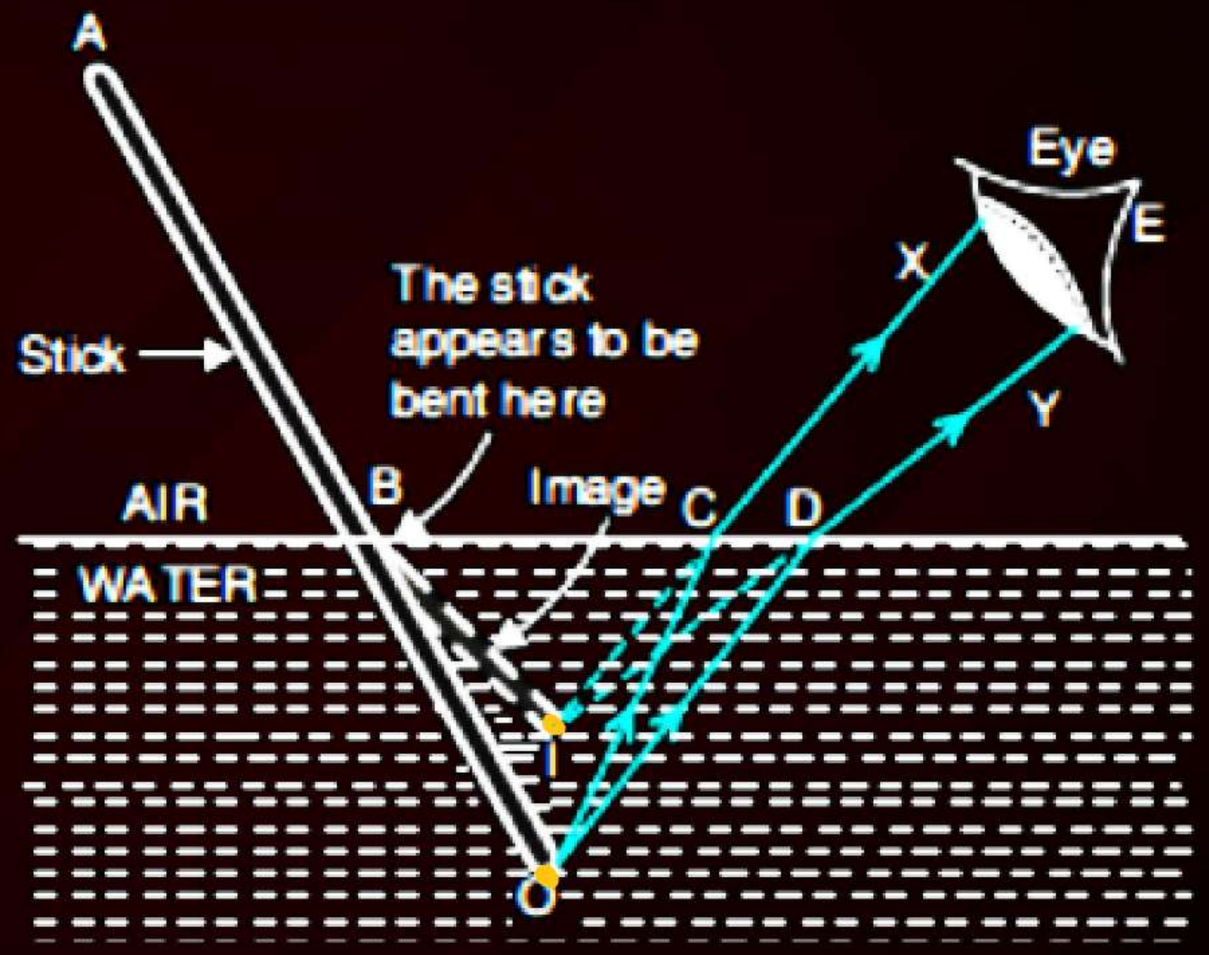


EFFECTS OF REFRACTION OF LIGHT

1. A Stick Partly Immersed in Water Appears to be Bent at the Water Surface

EFFECTS OF REFRACTION OF LIGHT

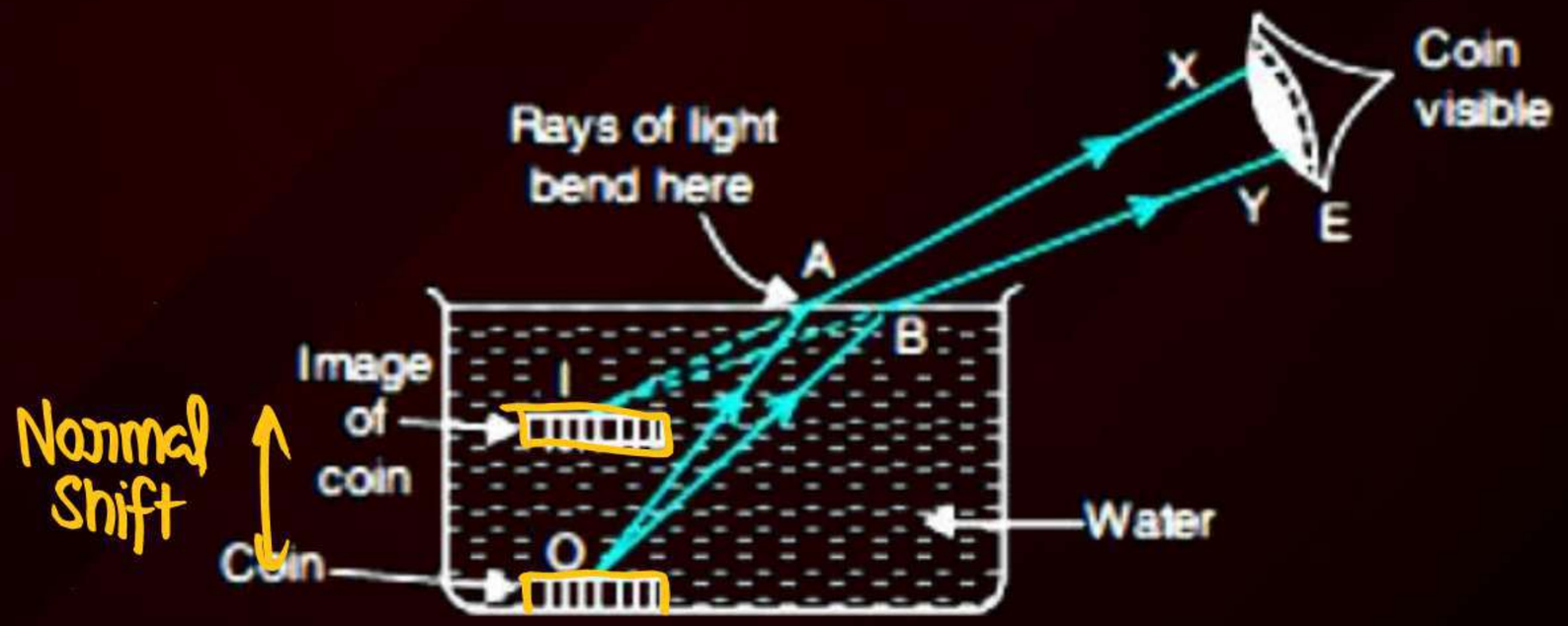
1. A Stick Partly Immersed in Water Appears to be Bent at the Water Surface



EFFECTS OF REFRACTION OF LIGHT

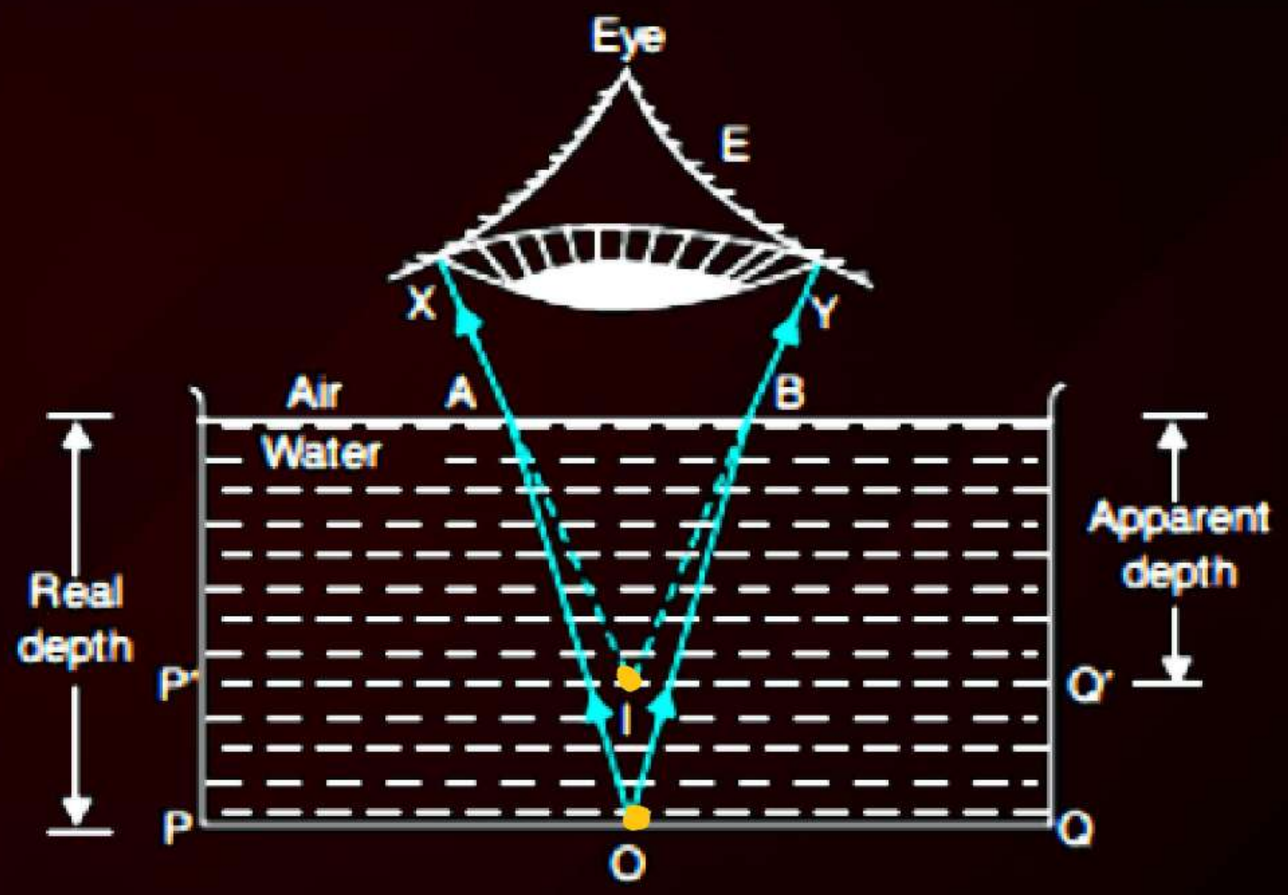
2. An Object Placed Under Water Appears to be Raised :

When the coin is under water then due to refraction of light, a virtual image of the coin is formed nearer to the water surface. And since the virtual image of coin which we see, is nearer to the water surface, so the coin appears to rise on adding water in the basin.



EFFECTS OF REFRACTION OF LIGHT

3. A Pool of Water Appears to be Less Deep than it Actually is



Question

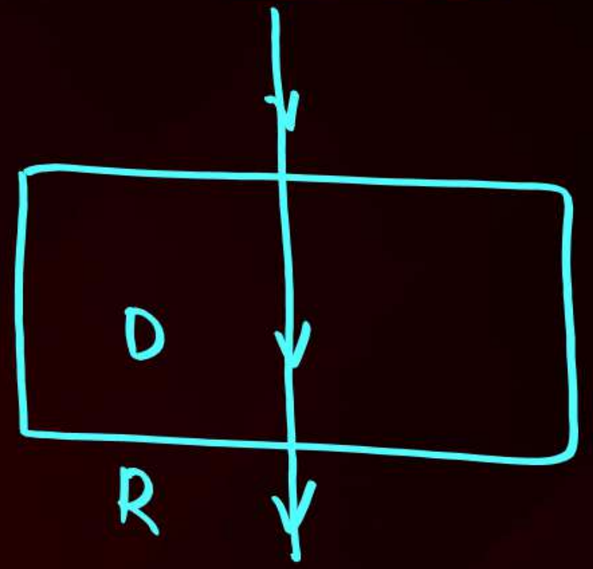
Light travelling from a denser medium to a rarer medium along a normal to the boundary:

(A) is refracted towards the normal

(B) is refracted away from the normal

(C) goes along the boundary

(D) is not refracted



Question

A ray of light passes from glass into air. The angle of refraction will be

$\angle r > \angle i$

(A) equal to the angle of incidence

(B) greater than the angle of incidence

(C) smaller than the angle of incidence

(D) 45°

Refractive Index

$$v = \frac{c}{\mu} = \frac{3\times10^8}{\mu}$$

v → Speed of light in medium

μ → Refractive Index

$$\boxed{\mu \uparrow \quad v \downarrow}$$

$$\boxed{\mu = \frac{c}{v}}$$

$\mu = 1 \Rightarrow \boxed{v = c} \Rightarrow$ vacuum or air

$\underbrace{\mu > 1}_{\text{medium}} \Rightarrow \boxed{v < c}$

Refractive index is defined as ratio of speed of light in vacuum to the speed of light in medium.

$$\boxed{\mu = \frac{c}{v}}$$

Question

Light enters from air into a glass plate having refractive index 1.50. What is the speed of light in glass? (The speed of light in vacuum is 3×10^8 m s^{-1}).

A → G

$\mu_g = 1.5$

$\mu_g = \frac{c}{v}$

$1.5 = \frac{3 \times 10^8}{v}$

$v_g = \frac{2\cancel{3} \times 10^8}{\cancel{1.5}} = 2 \times 10^8$ m/s

Question

If the refractive index of water for light going from air to water be 1.33, what will be the refractive index for light going from water to air?

$$A \longrightarrow W$$

$$_a\mu_w = \frac{\mu_w}{\mu_a} = 1.33$$

$$W \longrightarrow A$$

$$_w\mu_a = \frac{\mu_a}{\mu_w} = \frac{1}{1.33} = \frac{1}{\left(\frac{4}{3}\right)} = \frac{3}{4} = 0.75$$

Laws of Refraction

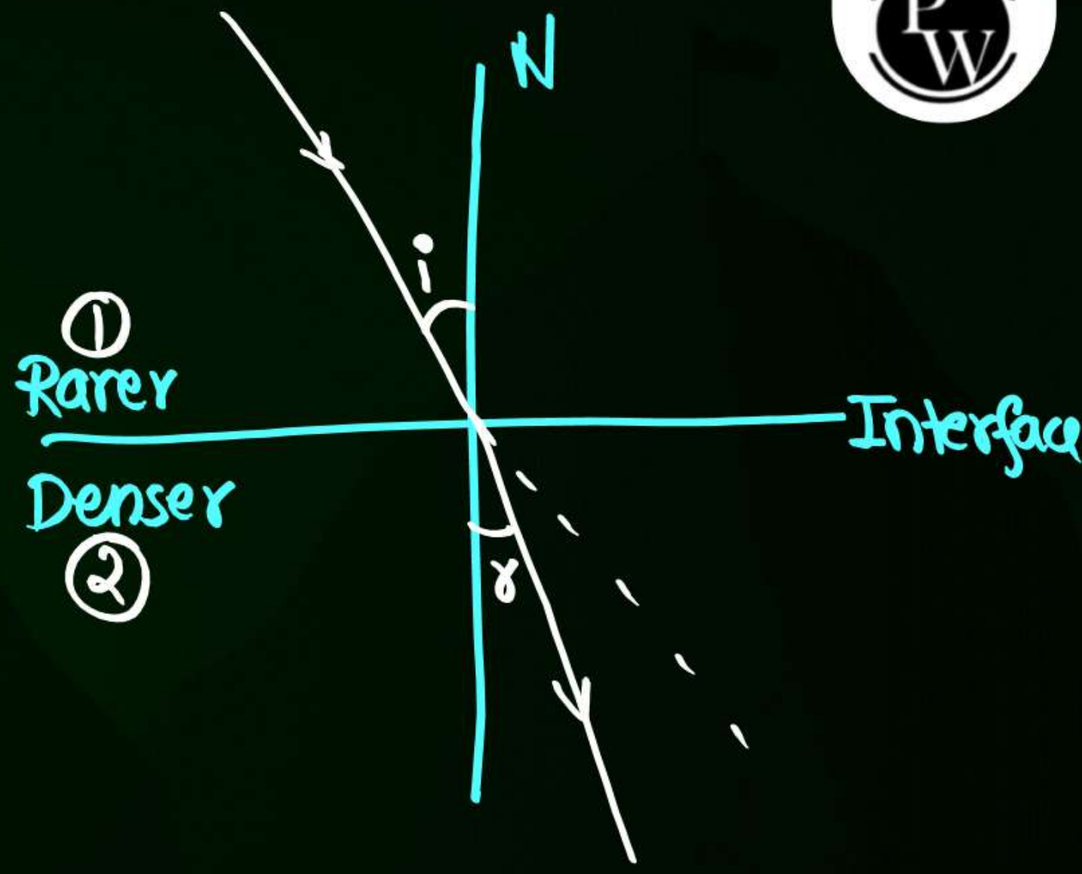
① Incident Ray, normal at the point of incidence and refracted ray, all lies in same plane.

② **Snell's Law**

Ratio of sine of angle of incidence to the sine of angle of refraction is always constant.

$$\frac{\sin i}{\sin r} = \text{Constant} = \frac{\mu_2}{\mu_1} = {}_1\mu_2$$

→ Refractive index of second medium w.r.t. first medium.



$$A \longrightarrow G$$

$$\frac{\sin i}{\sin r} = \frac{\mu_g}{\mu_a} = {}_a\mu_g$$

$$W \longrightarrow G$$

$$\frac{\sin i}{\sin r} = \frac{\mu_g}{\mu_w} = {}_w\mu_g$$

$$W \longrightarrow A$$

$$\frac{\sin i}{\sin r} = \frac{\mu_a}{\mu_w} = {}_w\mu_a$$

$${}_1\mu_2 = \frac{\mu_2}{\mu_1}$$

$$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1} = \frac{\cancel{f}\lambda_2 v_2}{\cancel{f}\lambda_1 v_1} = \frac{v_1}{v_2} = \frac{\cancel{f}\lambda_1}{\cancel{f}\lambda_2} = \frac{\lambda_1}{\lambda_2}$$

$$\mu = \frac{c}{v}$$

$$v = f\lambda$$

$f \rightarrow$ same

(Because it is property of source)

$$\boxed{\frac{\sin i}{\sin r} = \text{constant} = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}}$$

Question

The refractive indices of four substances P, Q, R and S are 1.50, 1.36, 1.77 and 1.31 respectively. The speed of light is the maximum in the substance:

$v \uparrow \quad \mu \downarrow$

(A) P

(B) Q

(C) R

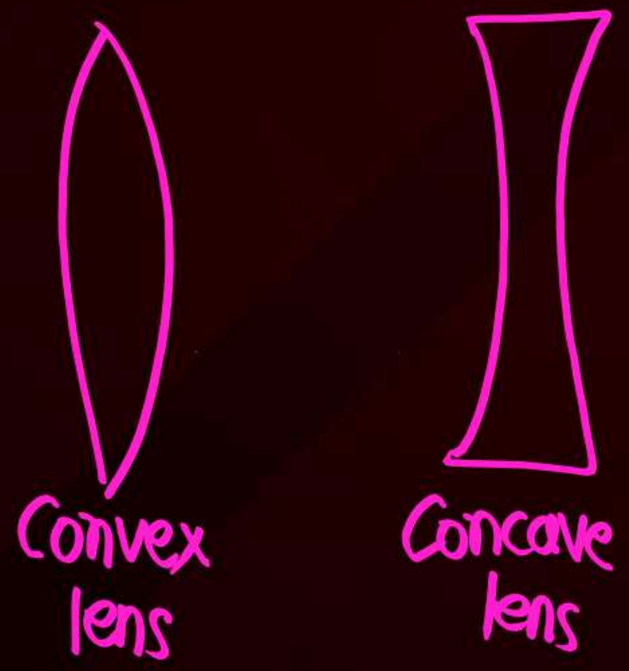
(D) S

REFRACTION OF LIGHT BY SPHERICAL LENSES

A lens is a piece of transparent glass bound by two spherical surfaces.

(i) A convex lens is thick at the centre but thinner at the edges

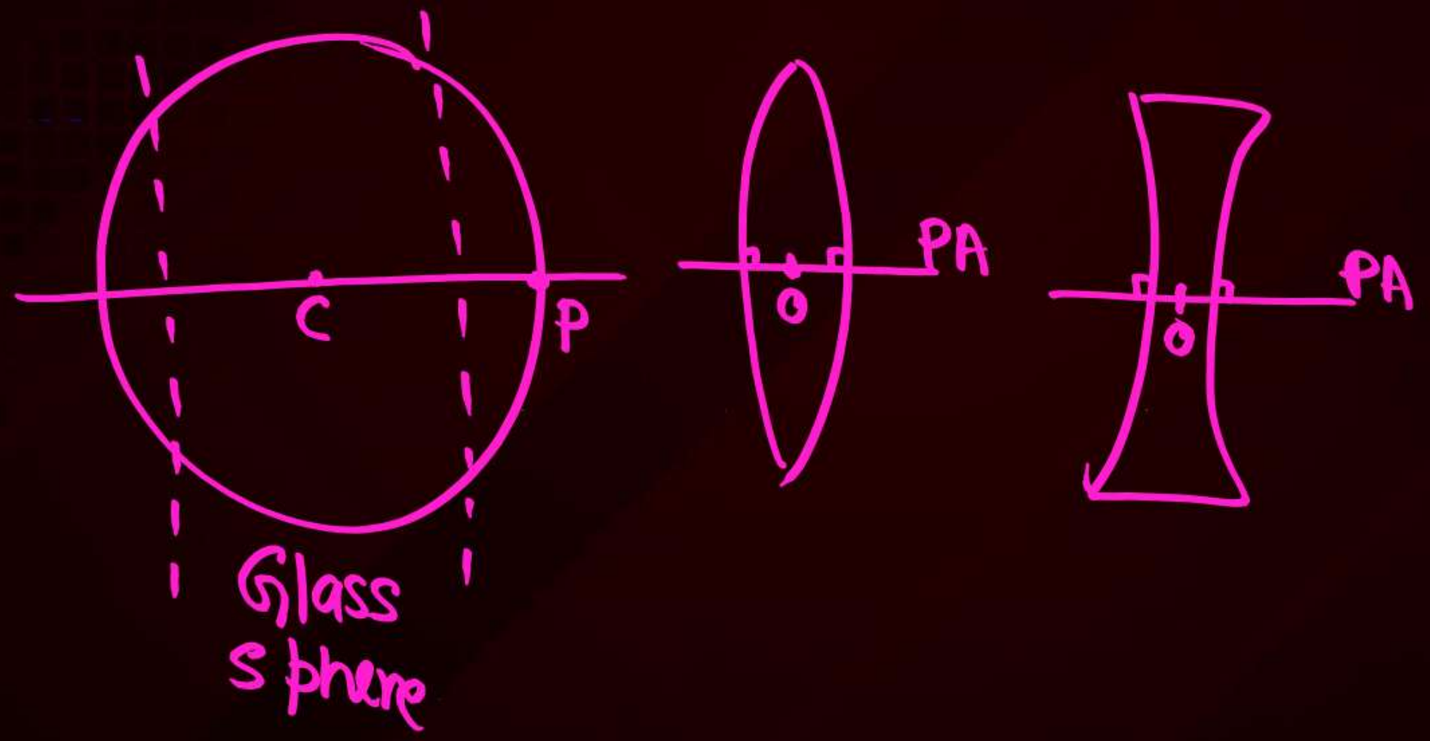
(ii) A concave lens is thin in the middle but thicker at the edges



Optical Centre and Principal Axis of a Lens

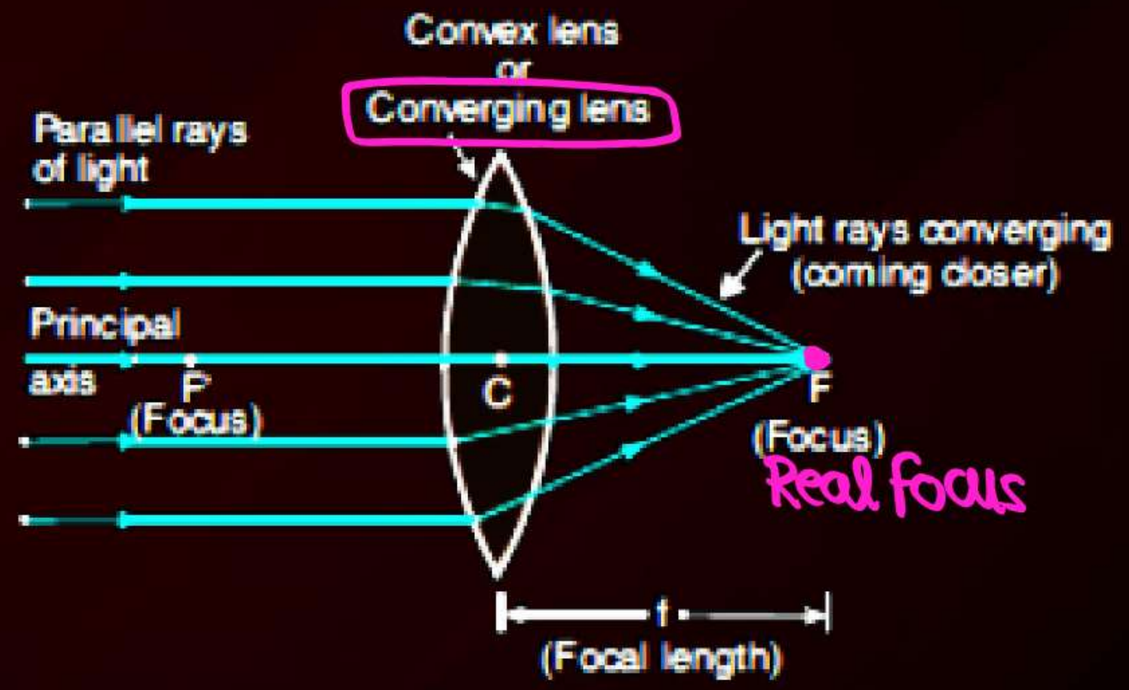
The centre point of a lens is known as its optical centre. The optical centre of a lens is usually denoted by the letter C.

The principal axis of a lens is a line passing through the optical centre of the lens and perpendicular to both the faces of the lens.



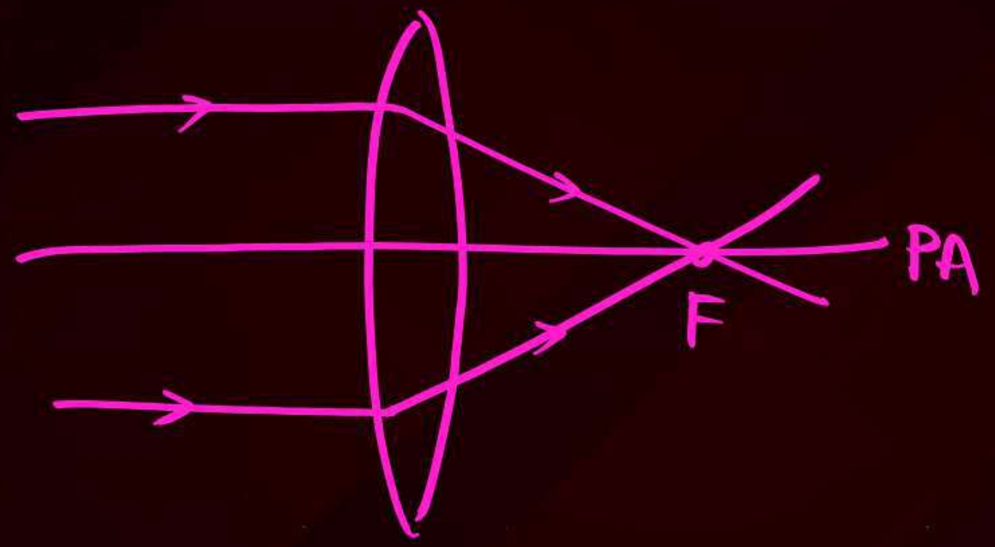
Principal Focus and Focal Length of a Convex Lens

The principal focus of a convex lens is a point on its principal axis to which light rays parallel to the principal axis converge after passing through the lens. The focal length of a lens is the distance between optical centre and principal focus of the lens.



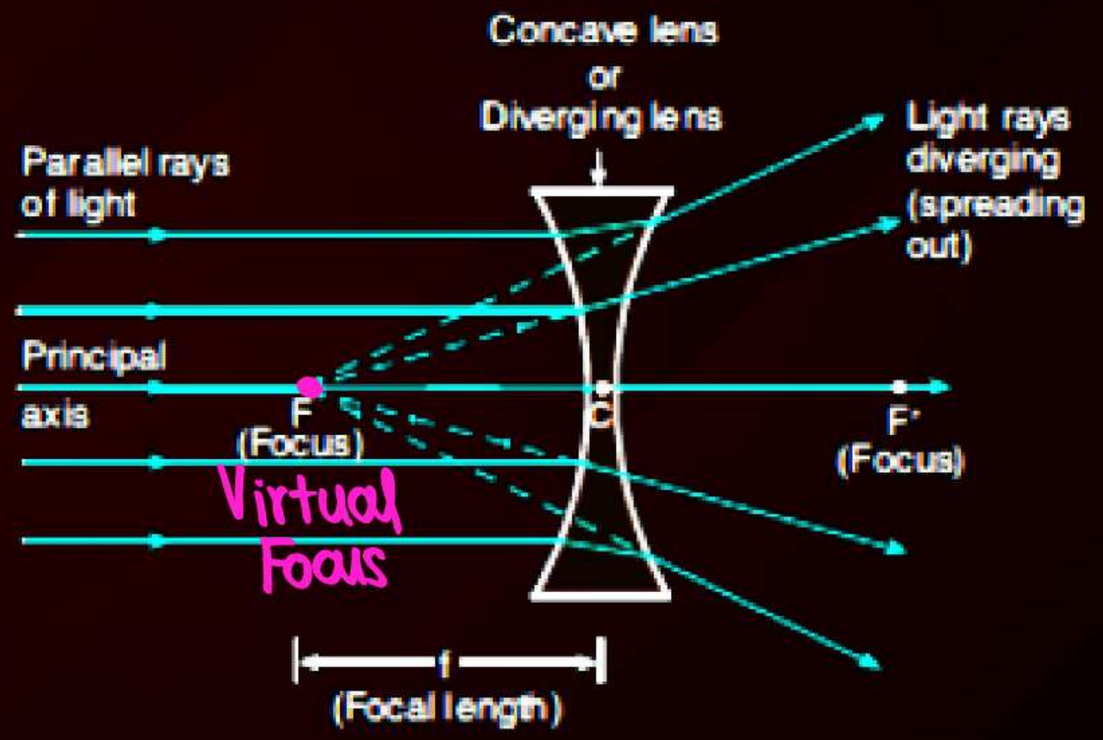
Principal Focus and Focal Length of a Convex Lens

A convex lens is also known as a converging lens because it converges (brings to a point), a parallel beam of light rays passing through it.



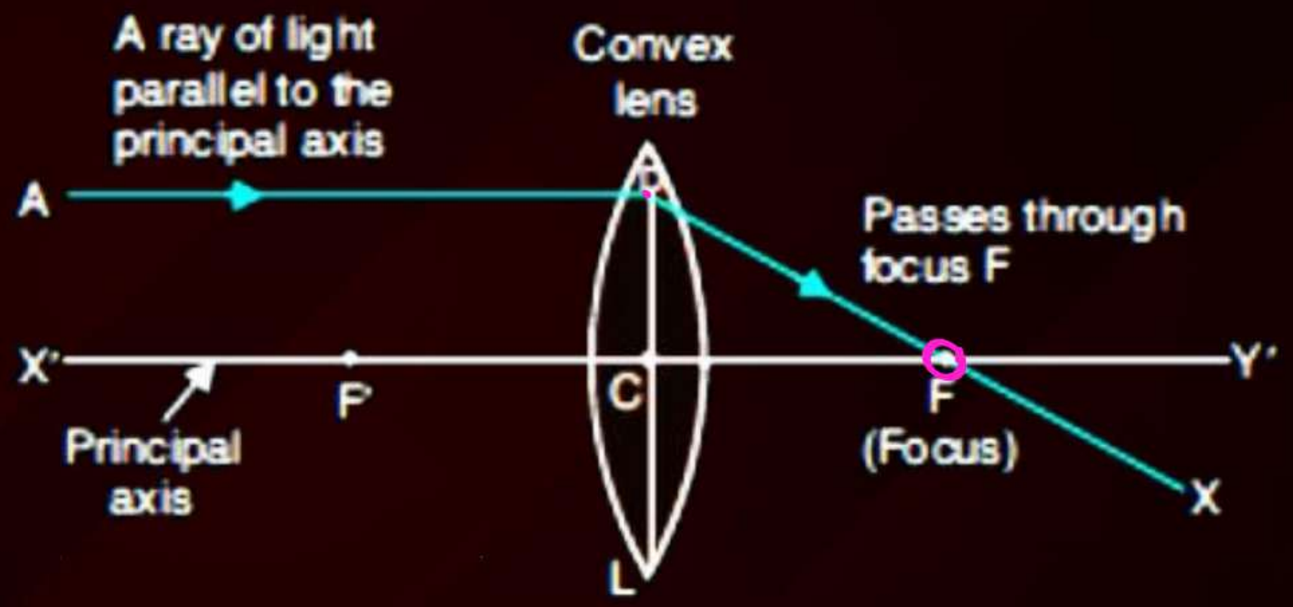
Principal Focus and Focal Length of a Concave Lens

The principal focus of a concave lens is a point on its principal axis from which light rays, originally parallel to the axis, appear to diverge after passing through the concave lens. A concave lens is also known as a diverging lens because it diverges a parallel beam of light rays



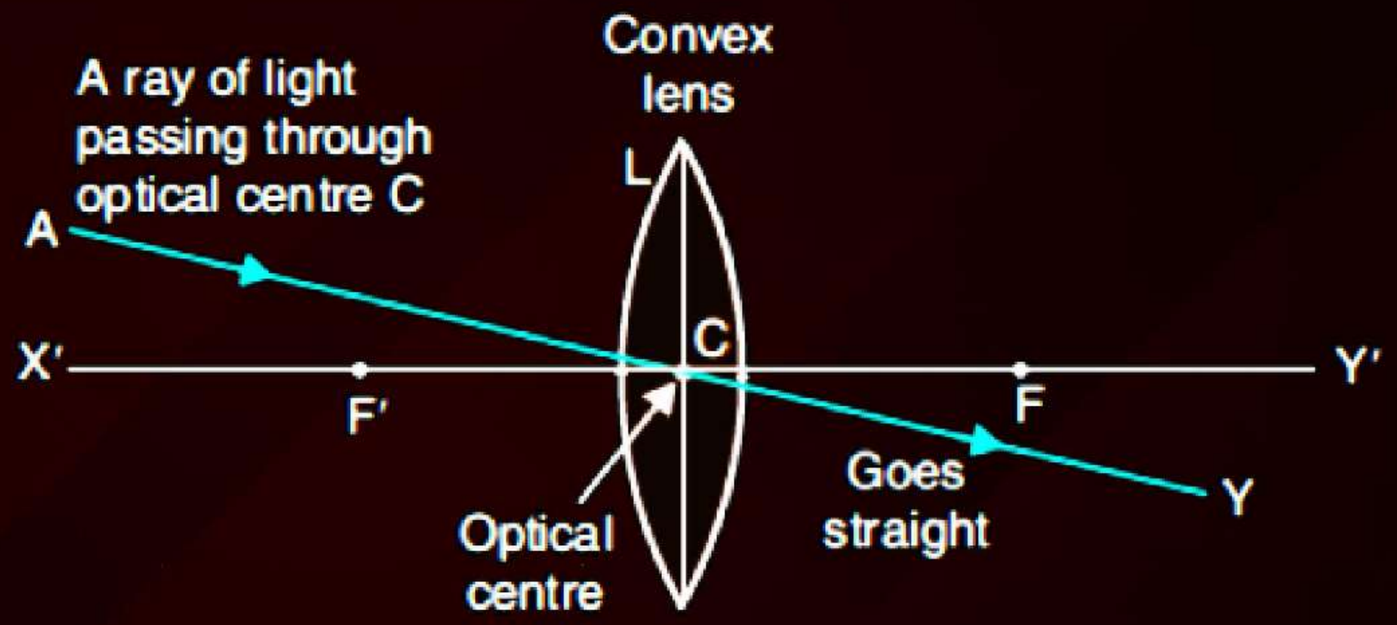
Rules for Obtaining Images Formed by Convex Lenses

Rule-1: A ray of light which is parallel to the principal axis of a convex lens, passes through its focus after refraction through the lens.



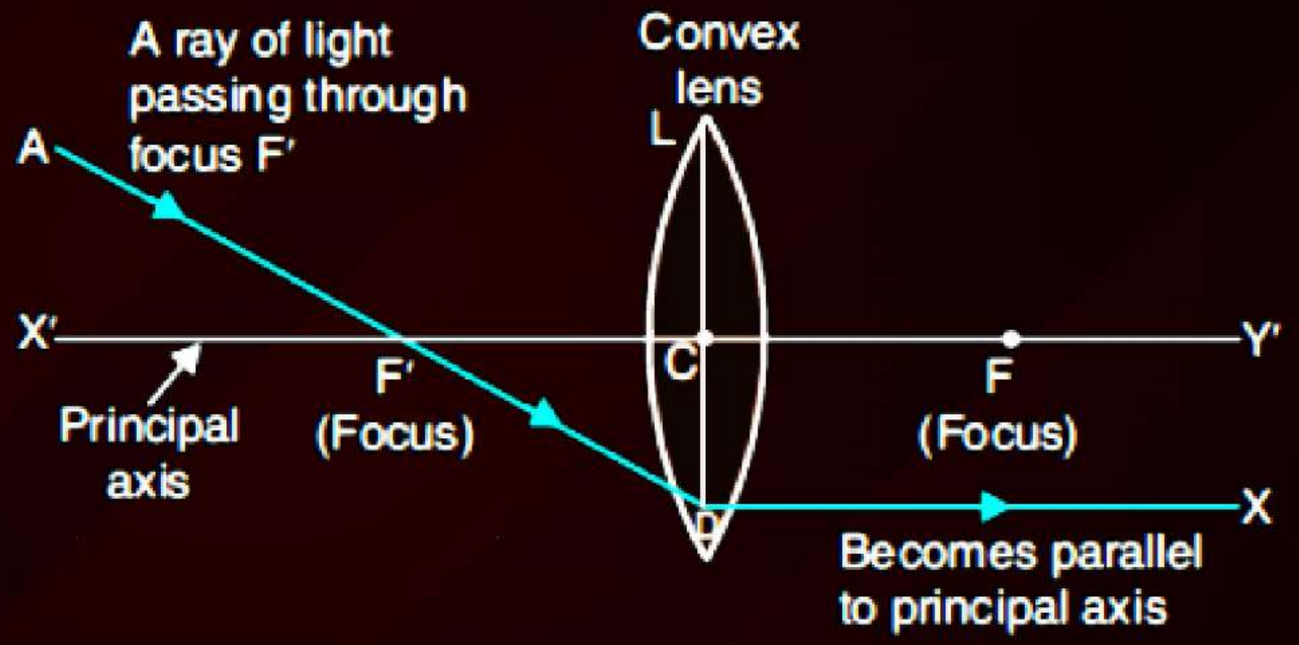
Rules for Obtaining Images Formed by Convex Lenses

Rule-2: A ray of light passing through the optical centre of a convex lens goes straight after refraction through the lens.



Rules for Obtaining Images Formed by Convex Lenses

Rule-3: A ray of light passing through the focus of a convex lens becomes parallel to its principal axis after refraction through the lens.



FORMATION OF DIFFERENT TYPES OF IMAGES BY A CONVEX LENS

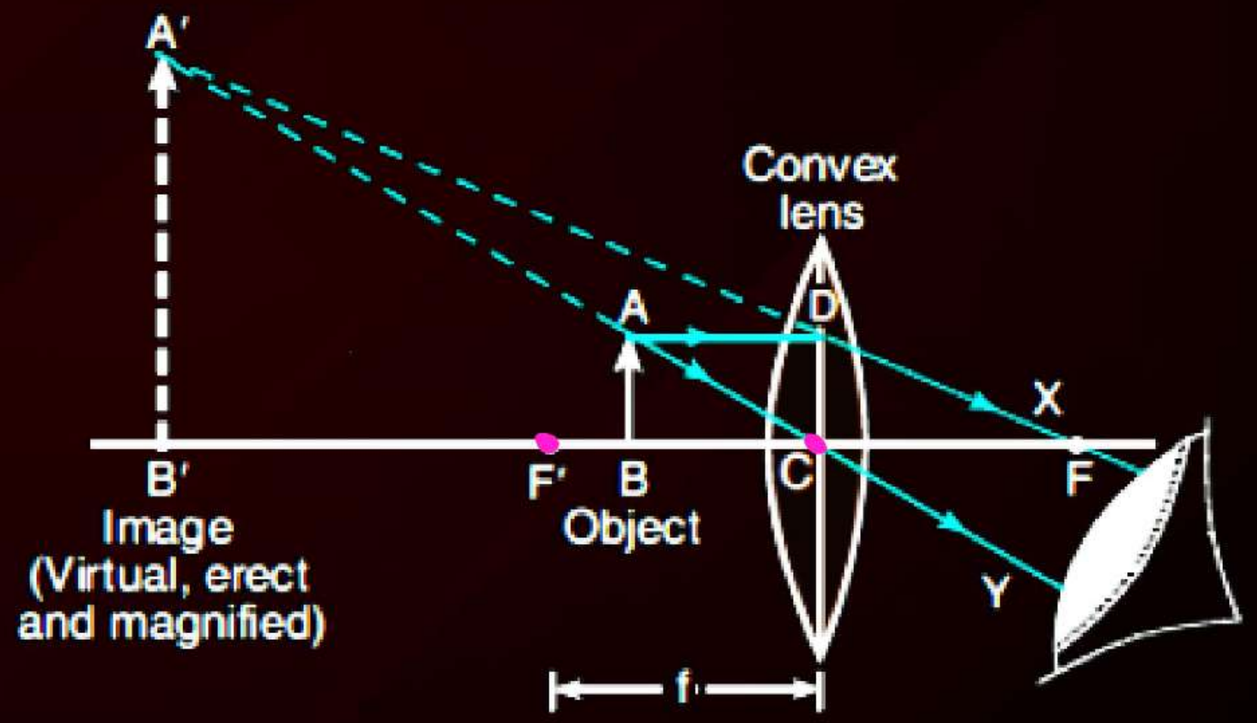
Object between C and F

The image formed is:
(i) behind the object (on the left side of lens),
(ii) virtual and erect, and
(iii) larger than the object (enlarged or magnified).

$u<0$

$v<0$

$f_{convex}>0$



FORMATION OF DIFFERENT TYPES OF IMAGES BY A CONVEX LENS

Object at F

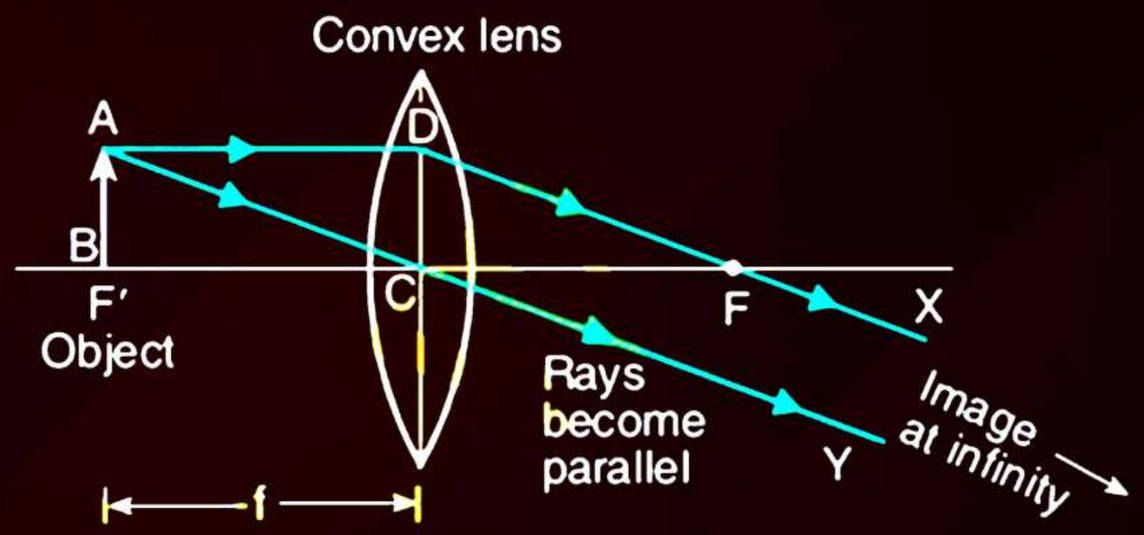
when an object is placed at the focus of a convex lens, the image formed is:

(i) at infinity,
(ii) real and inverted, and
(iii) highly enlarged.

$u<0$

$f>0$

$v>0 \Rightarrow v=+\infty$



FORMATION OF DIFFERENT TYPES OF IMAGES BY A CONVEX LENS

Object between f and 2f

The image formed is:

(i) beyond 2F,

(ii) real and inverted, and

(iii) larger than the object (or magnified).

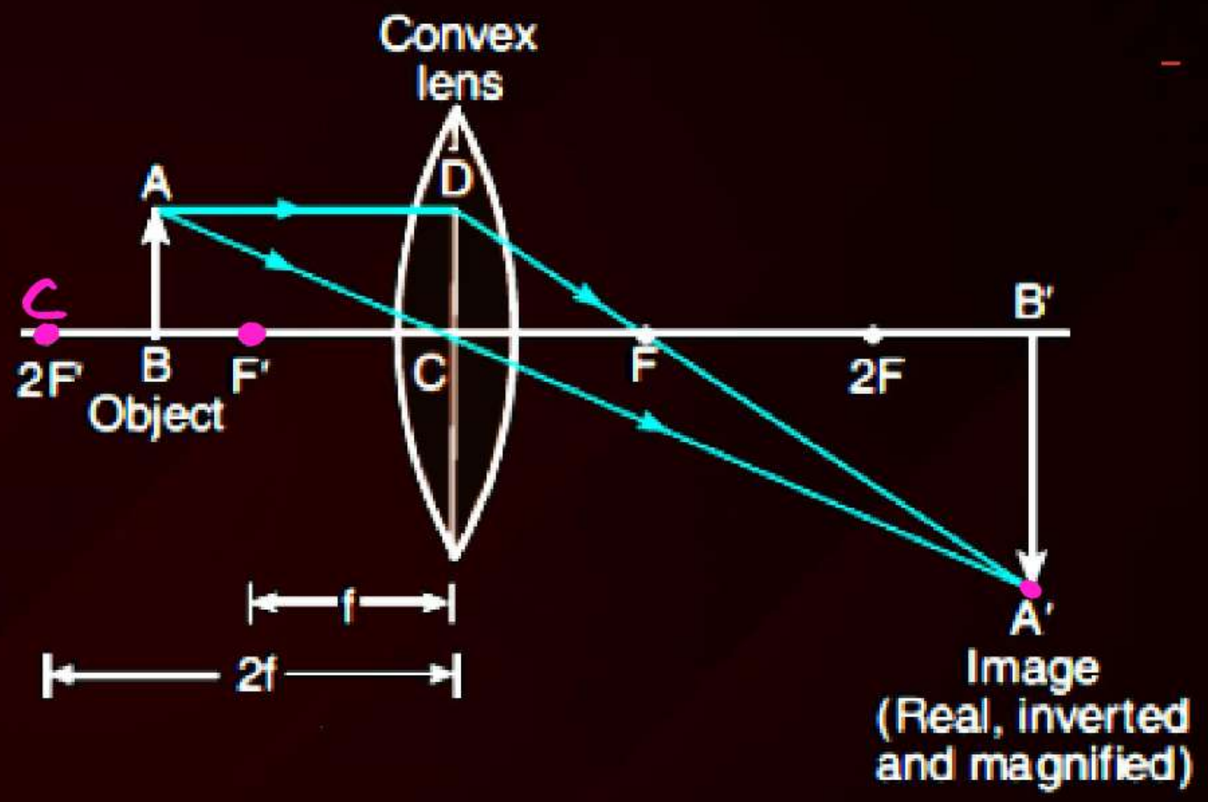
$u<0$

$f>0$

$v>0$

$h_o>0$

$h_i<0$ → inverted

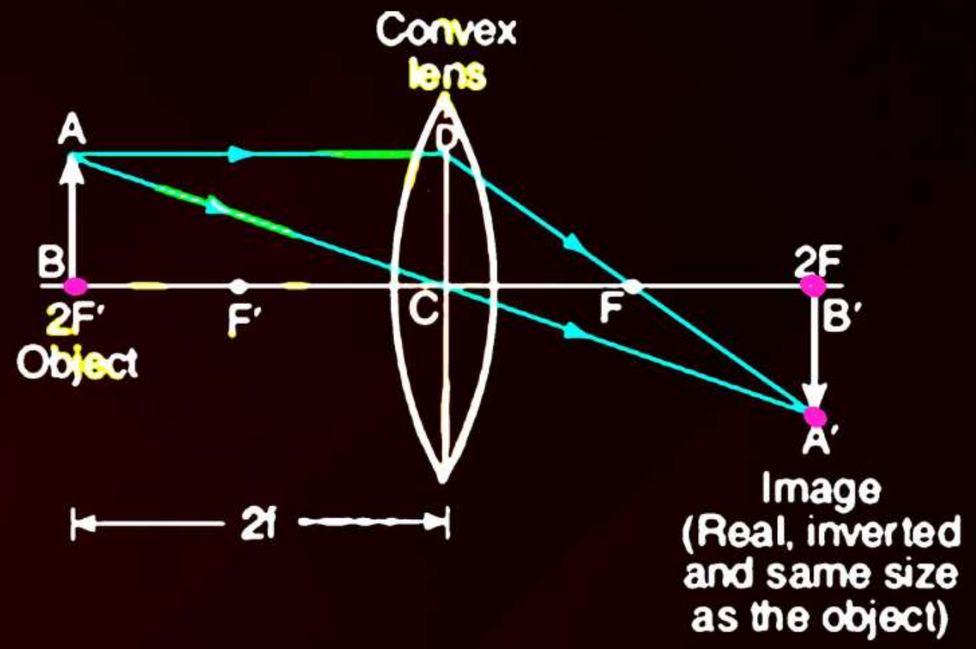


FORMATION OF DIFFERENT TYPES OF IMAGES BY A CONVEX LENS

Object at 2f

the image formed is :
(i) at a distance 2 f on the other side of the lens,
(ii) real and inverted, and
(iii) of the same size as the object.

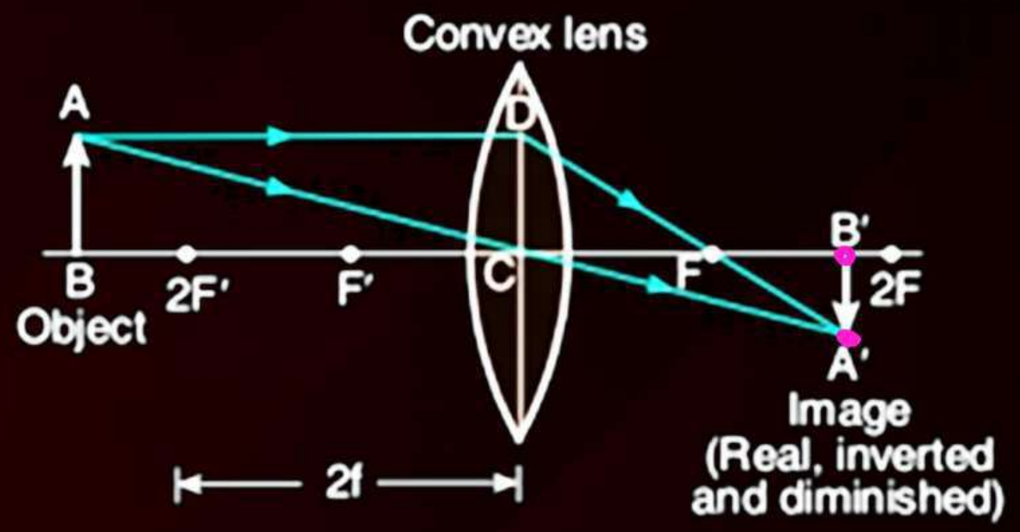
$u<0$
$f>0$
$v>0$
$h_o>0$
$h_i<0$



FORMATION OF DIFFERENT TYPES OF IMAGES BY A CONVEX LENS

Object beyond 2f

the image formed is :
(i) between f and 2 f on the other side of the lens,
(ii) real and inverted, and
(iii) Diminished



FORMATION OF DIFFERENT TYPES OF IMAGES BY A CONVEX LENS

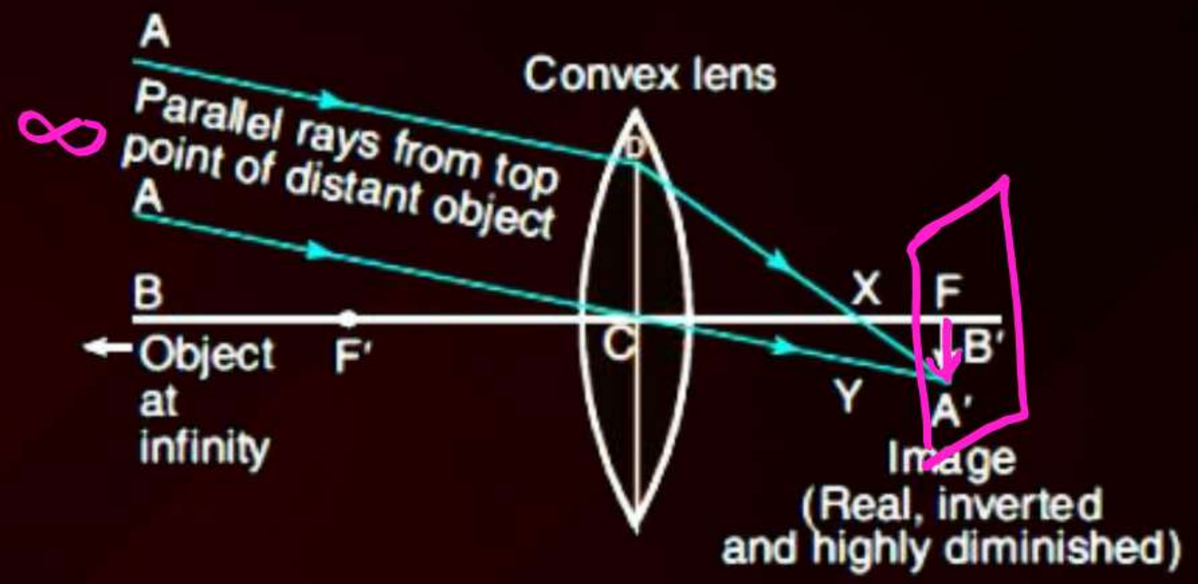
When the object is at infinity

The image formed is:

(i) at the focus,

(ii) real and inverted, and

(iii) much smaller than the object (or highly diminished).



FORMATION OF DIFFERENT TYPES OF IMAGES BY A CONVEX LENS

Position of object	*Position of image*	*Size of image*	*Nature of image*
1. Between f and lens	On the same side as object	Enlarged	Virtual and erect
2. At f (at focus)	At infinity	Highly enlarged	Real and inverted
3. Between f and $2f$	Beyond $2f$	Enlarged	Real and inverted
4. At $2f$	At $2f$	Same size as object	Real and inverted
5. Beyond $2f$	Between f and $2f$	Diminished	Real and inverted
6. At infinity	At f (at focus)	Highly diminished	Real and inverted

Uses of Convex Lenses

(i) Convex lenses are used in spectacles to correct the defect of vision called hypermetropia (or longsightedness).

(ii) Convex lens is used for making a simple camera.

(iii) Convex lens is used as a magnifying glass (or magnifying lens) (by palmists, watchmakers, etc.).

(iv) Convex lenses are used in making microscopes, telescopes and slide projectors (or film projectors).

Question

Where should an object be placed so that a real and inverted image of the same size is obtained by a convex lens?

A. at the focus of the lens.

B. at twice the focal length.

C. at infinity.

D. between the optical centre of lens and its focus.

Question

Which of the following lens would you prefer to use while reading small letters found in a dictionary?

(A) A convex lens of focal length 50 cm.

(B) A concave lens of focal length 50 cm.

(C) A convex lens of focal length 5 cm.

(D) A concave lens of focal length 5 cm.

Magnifying Glass
↓
Convex lens.

Erect → Object between O and f

Question

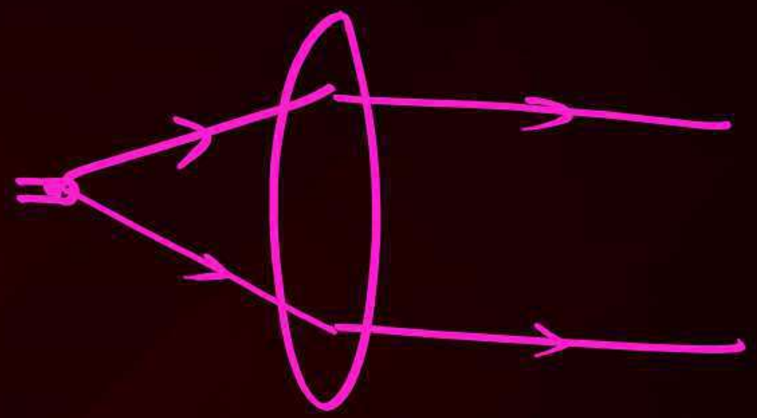
A small bulb is placed at the focal point of a converging lens. When the bulb is switched on, the lens produces:

(A) a convergent beam of light

(B) a divergent beam of light

(C) a parallel beam of light

(D) a patch of coloured light



Lens Formula

A formula which gives the relationship between image distance (v), object distance (u), and focal length (f) of a lens is known as the lens formula.

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

Magnification Produced by Lenses

The linear magnification is the ratio of the height of the image to the height of the object.

$$m = \frac{h_i}{h_o} = \frac{v}{u}$$

$u < 0$ Real Object.

$f_{convex} > 0$

$f_{concave} < 0$

$v_{real} > 0$

$v_{virtual} < 0$

Question

If an object of 7 cm height is placed at a distance of 12 cm from a convex lens of focal length 8 cm, find the position, nature and height of the image.

$h_o = 7cm$

$u = -12cm$

$f = 8cm$

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

$\frac{1}{8} = \frac{1}{v} - \frac{1}{-12}$

$\frac{1}{v} = \frac{1}{8} - \frac{1}{12} \Rightarrow \frac{1}{v} = \frac{3-2}{24} = \frac{1}{24}$

$\boxed{v = 24cm}$

Real & Inverted

$m = \frac{h_i}{h_o} = \frac{v}{u}$

$\frac{h_i}{7} = \frac{24}{-12} \Rightarrow h_i = -14cm$

magnified

Question

The magnification produced by a spherical lens is +2.5. What is the:

(a) nature of image?

(b) nature of lens?

Magnified

Erect

Virtual

Convex lens

or

Concave mirror

Question

Linear magnification produced by a convex lens can be:

(A) less than 1 or more than 1

(B) less than 1 or equal to 1

(C) more than 1 or equal to 1

(D) less than 1, equal to 1 or more than 1

Question

Magnification produced by a concave lens is always:

smaller image.

(A) more than 1

(B) equal to 1

(C) less than 1

(D) more than 1 or less than 1

Question

If a magnification of –1 (minus 1) is obtained by using a converging lens, then the object has to be placed

Real
Inverted
Same size

(A) within f

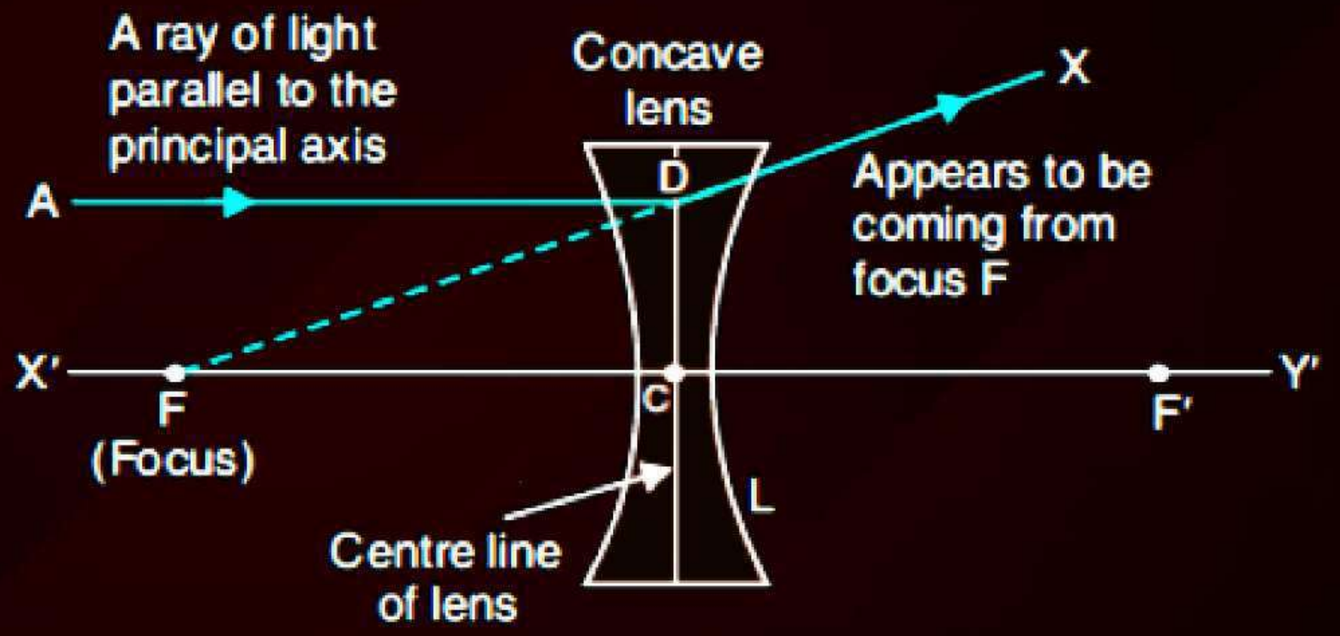
(B) at $2f$

(C) beyond $2f$

(D) at infinity

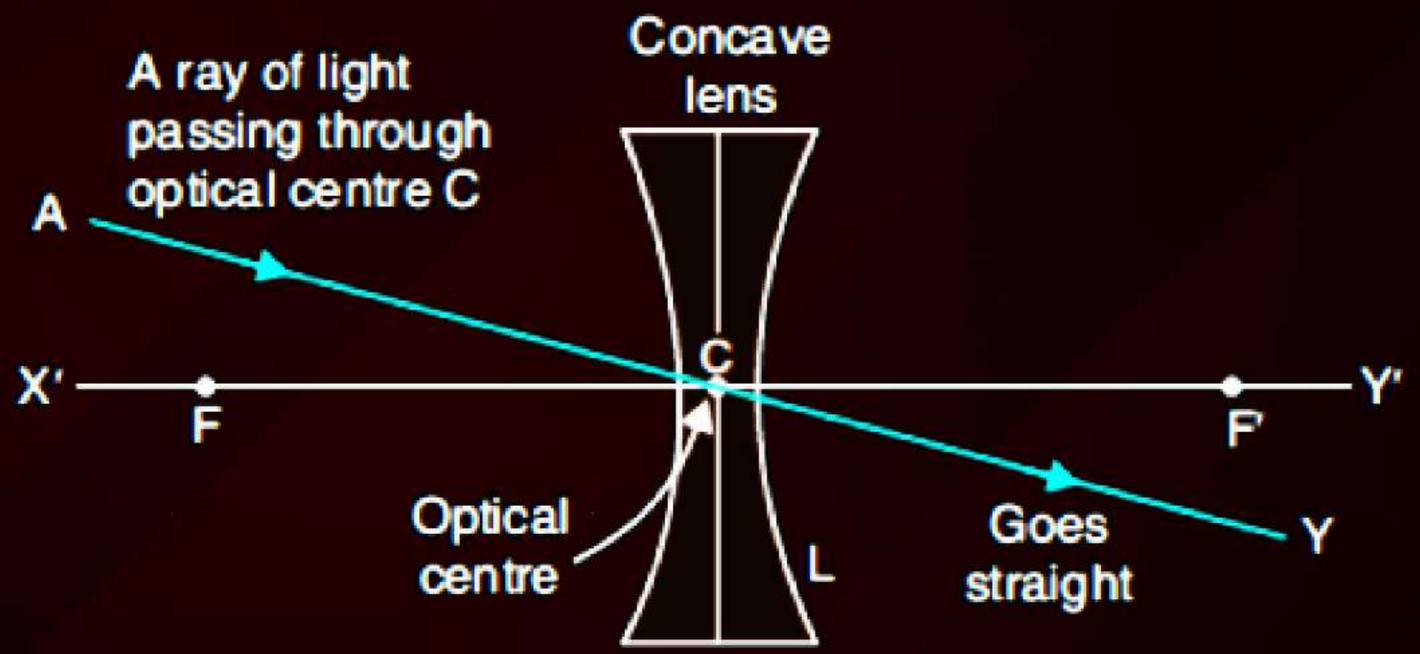
RULES FOR OBTAINING IMAGES FORMED BY CONCAVE LENSES

Rule-1: A ray of light which is parallel to the principal axis of a concave lens, appears to be coming from its focus after refraction through the lens.



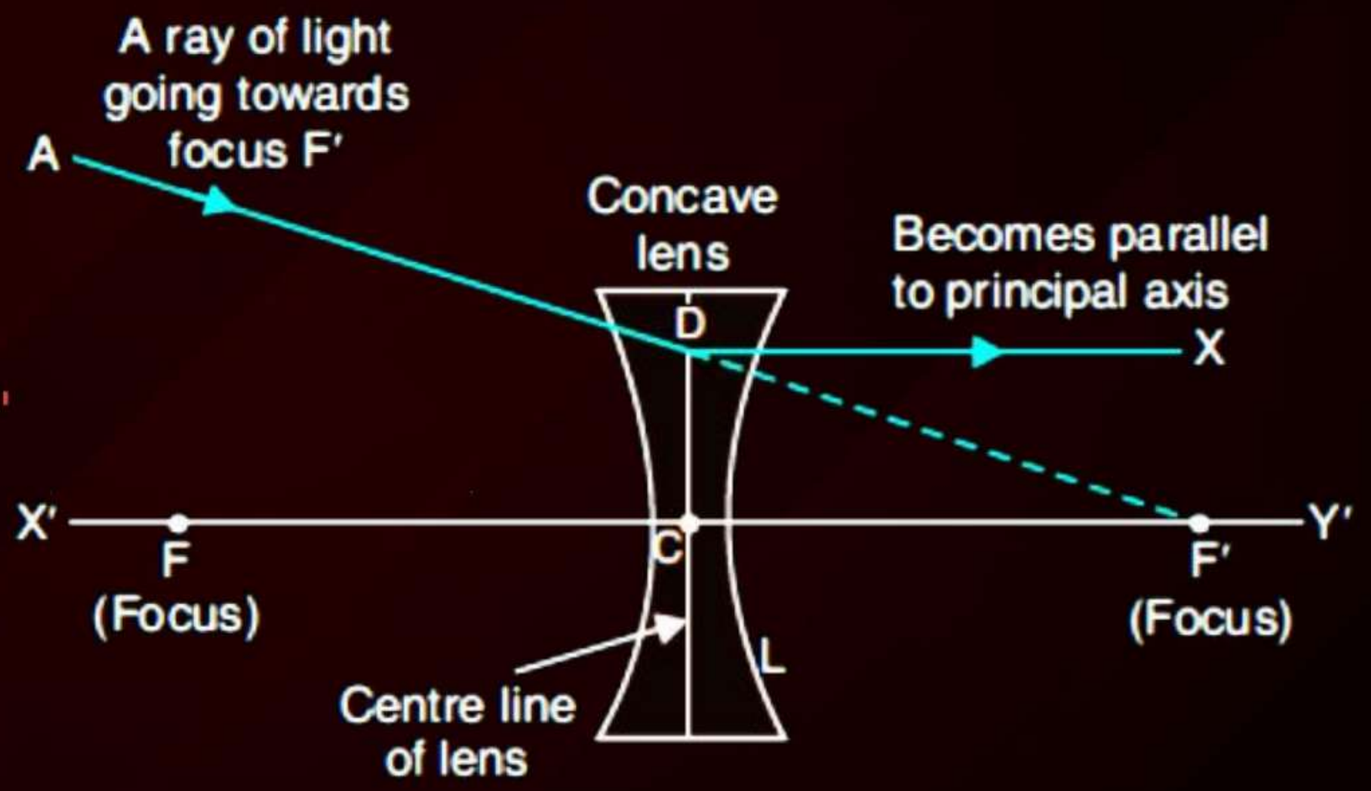
RULES FOR OBTAINING IMAGES FORMED BY CONCAVE LENSES

Rule-2: A ray of light passing through the optical centre of a concave lens goes straight after passing through the lens.



RULES FOR OBTAINING IMAGES FORMED BY CONCAVE LENSES

Rule-3: A ray of light going towards the focus of a concave lens, becomes parallel to its principal axis after refraction through the lens.



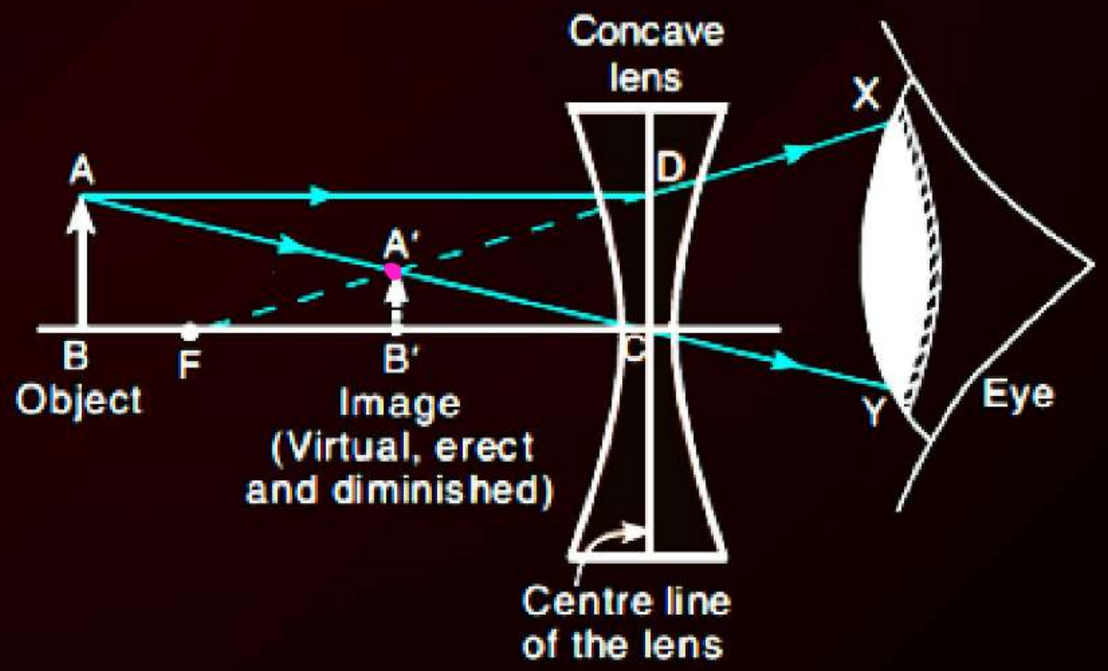
Formation of Image by a Concave Lens

When an object is placed anywhere between optical centre (C) and infinity in front of a concave lens, the image formed is:

(i) between optical centre (C) and focus (F),

(ii) virtual and erect, and

(iii) diminished (smaller than the object).



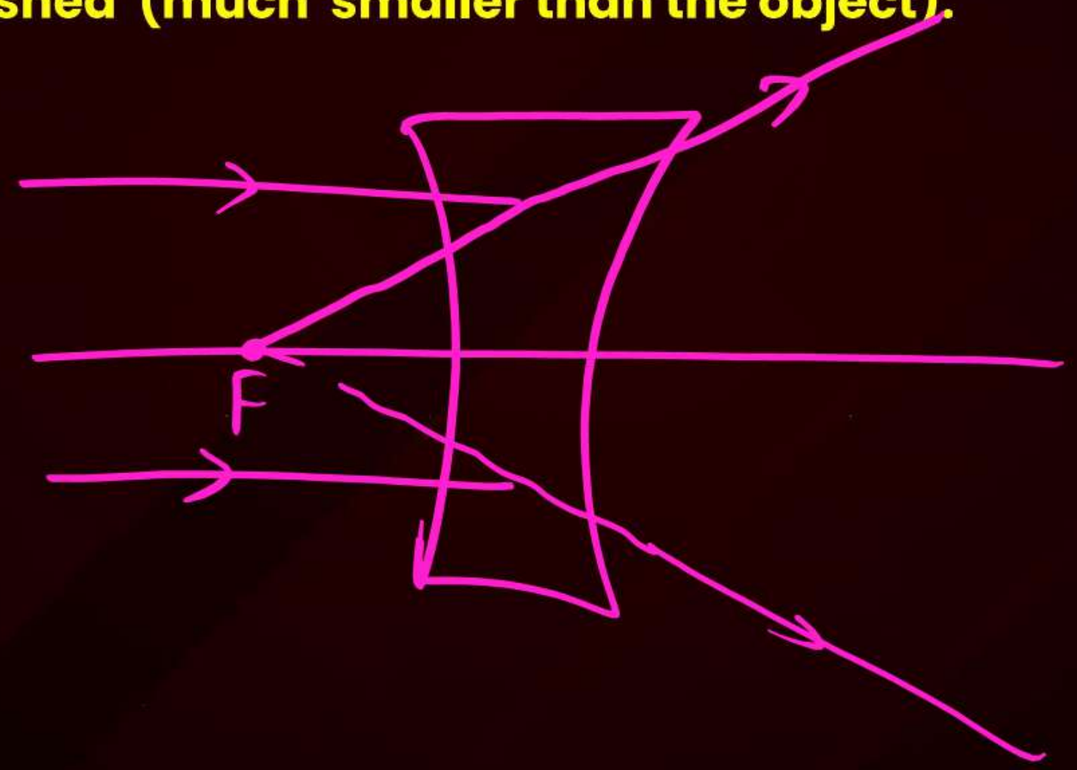
Formation of Image by a Concave Lens

When an object is at infinity from a concave lens, the image formed is:

(i) at focus (F),

(ii) virtual and erect, and

(iii) highly diminished (much smaller than the object).



Summary of the Images Formed by a Concave Lens

Position of object	*Position of image*	*Size of image*	*Nature of image*
1. Anywhere between optical centre (C) and infinity.	Between optical centre (C) and focus (F)	Diminished	Virtual and erect
2. At infinity	At focus (F)	Highly diminished	Virtual and erect

Uses of Concave Lenses

(i) Concave lenses are used in spectacles to correct the defect of vision called myopia (or shortsightedness).

(ii) Concave lens is used as eye-lens in Galilean telescope.

(iii) Concave lenses are used in combination with convex lenses to make high quality lens systems for optical instruments.

(iv) Concave lens is used in wide-angle spyhole in doors.

Question

An object is placed at a distance of 50 cm from a concave lens of focal length 20 cm. Find the nature and position of the image.

$u = -50\,cm$

$f = -20\,cm$

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

$\frac{1}{-20} = \frac{1}{v} - \frac{1}{-50}$

$-\frac{1}{20} - \frac{1}{50} = \frac{1}{v}$

$\frac{-5-2}{100} = \frac{1}{v}$

$\frac{1}{v} = -\frac{7}{100}$

$v = -\frac{100}{7}\,cm$

Virtual
Erect.

POWER OF A LENS

The power of a lens is defined as the reciprocal of its focal length in metres.

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

(in m)

$$P = \frac{100}{f}$$

(in cm)

Unit : Dioptre

Question

A convex lens is of focal length 10 cm. What is its power?

$$P = \frac{100}{f}$$

$$= \frac{100}{10}$$

$$\boxed{P = 10D}$$

Question

A lens has a power of, –2.5D. What is the focal length and nature of the lens?

$$P = \frac{100}{f}$$

$$f = \frac{100}{P}$$

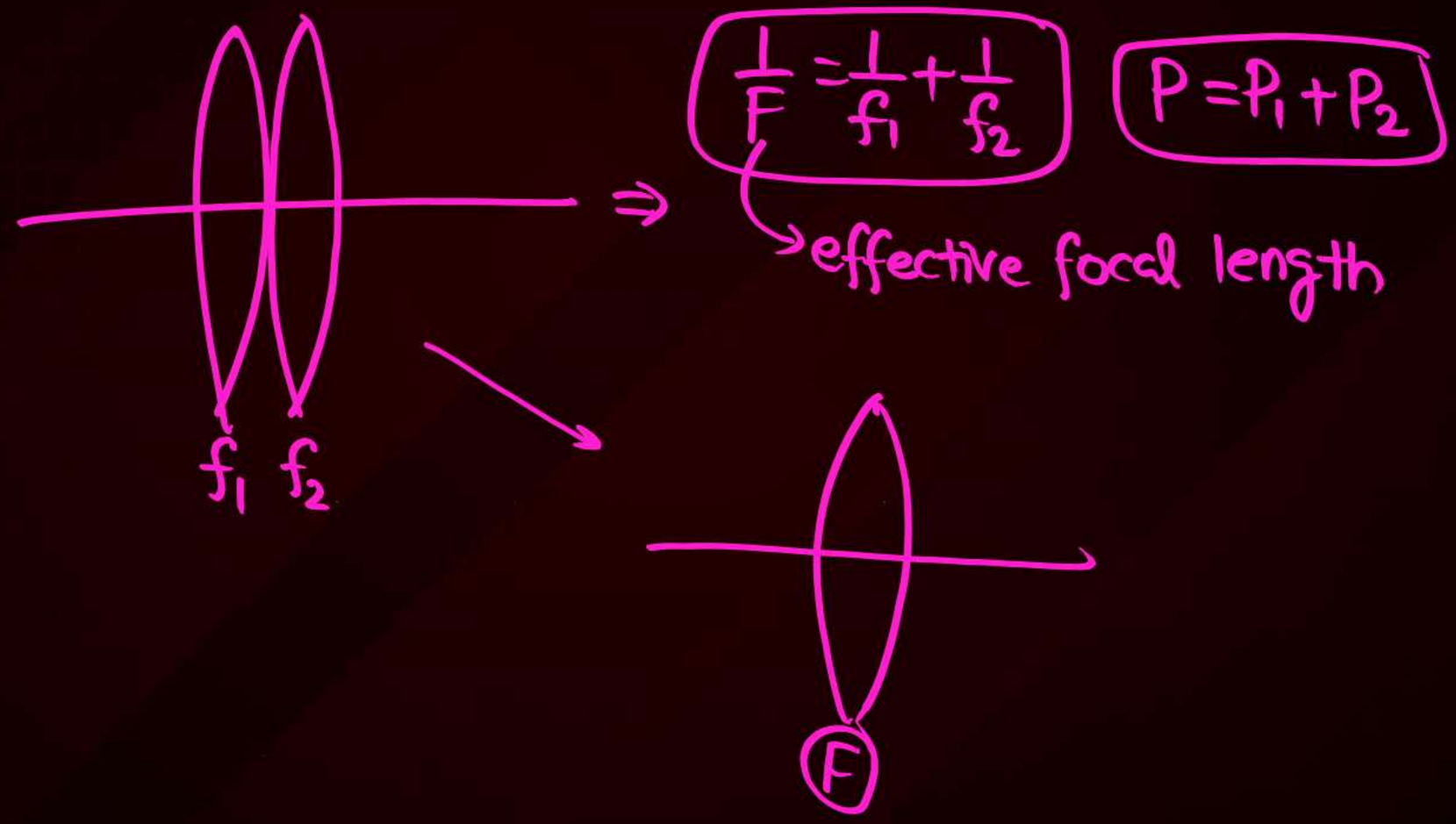
$$= \frac{100}{-2.5}$$

$$\boxed{f = -40\,cm}$$

Concave

Power of a Combination of Lenses

If a number of lenses are placed in close contact, then the power of the combination of lenses is equal to the algebraic sum of the powers of individual lenses.



Question

Imp

Convex → Concave.

Two thin lenses of power, +3.5D and, –2.5D are placed in contact. Find the power and focal length of the lens combination.

$P_1 = 3.5\,D$

$P_2 = -2.5\,D.$

$P = P_1 + P_2$

$= 3.5 + (-2.5)$

$\boxed{P = 1D}$

$f = \frac{100}{P} = \frac{100}{1} = 100\,cm$

This combination is behaving like convex lens of focal length 100cm.

Question

$P_1 = -10D$ $\quad$ $P_2 = 6D$

The power of a concave lens is 10D and that of a convex lens is 6D. When these two lenses are placed in contact with each other, the power of their combination will be

(A) +16D

(B) +4D

(C) –16D

(D) –4D

$P = P_1 + P_2$

$= -10 + 6$

$= -4D$

Question

$f_1 = 10\,cm$ $f_2 = -20\,cm$

A convex lens of focal length 10 cm is placed in contact with a concave lens of focal length 20 cm. The focal length of this combination of lenses will be:

(A) +10 cm

(B) +20 cm

(C) –10 cm

(D) –20 cm

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$$

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

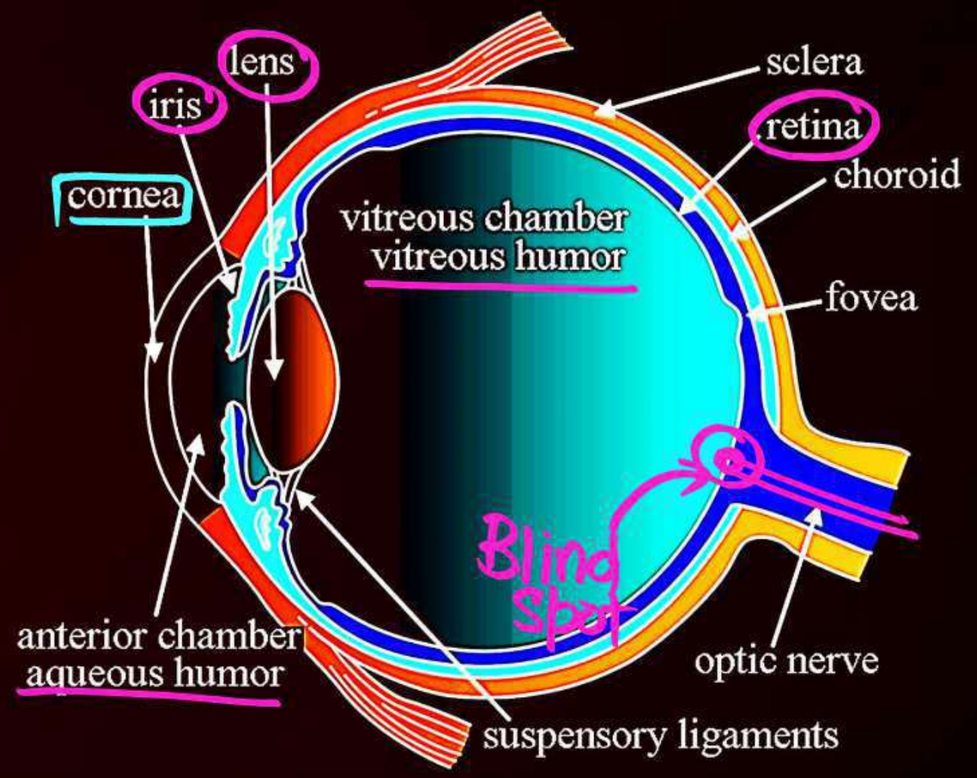
$$= \frac{2-1}{20}$$

$$\frac{1}{F} = \frac{1}{20}$$

$F = 20\,cm$

HUMAN EYE

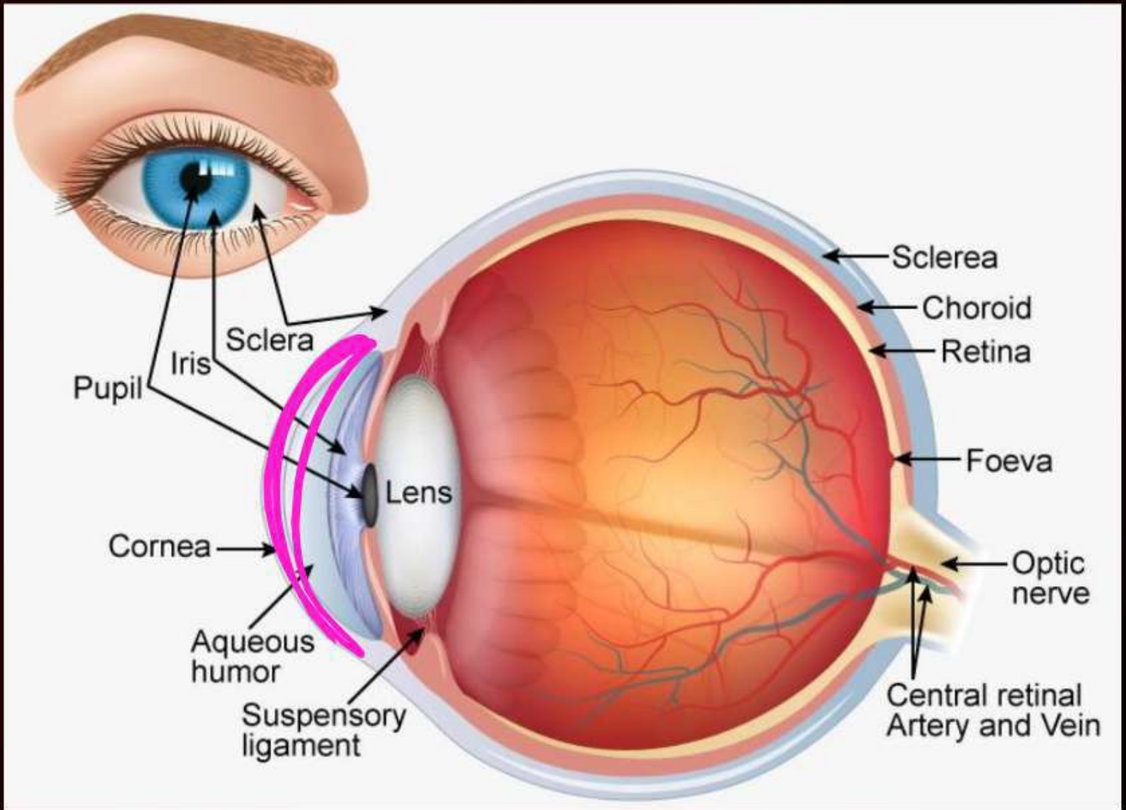
Our eye is the most important natural optical instrument. The eye resembles a – camera in many ways. It has "nearly a spherical shape.



Essential parts of the eye and their functions

(a) **Cornea:**

The front of the eye is covered by a transparent spherical membrane called the cornea. Light enters the eye through cornea. The space behind the cornea is filled with a clear liquid called aqueous humor.



Essential parts of the eye and their functions

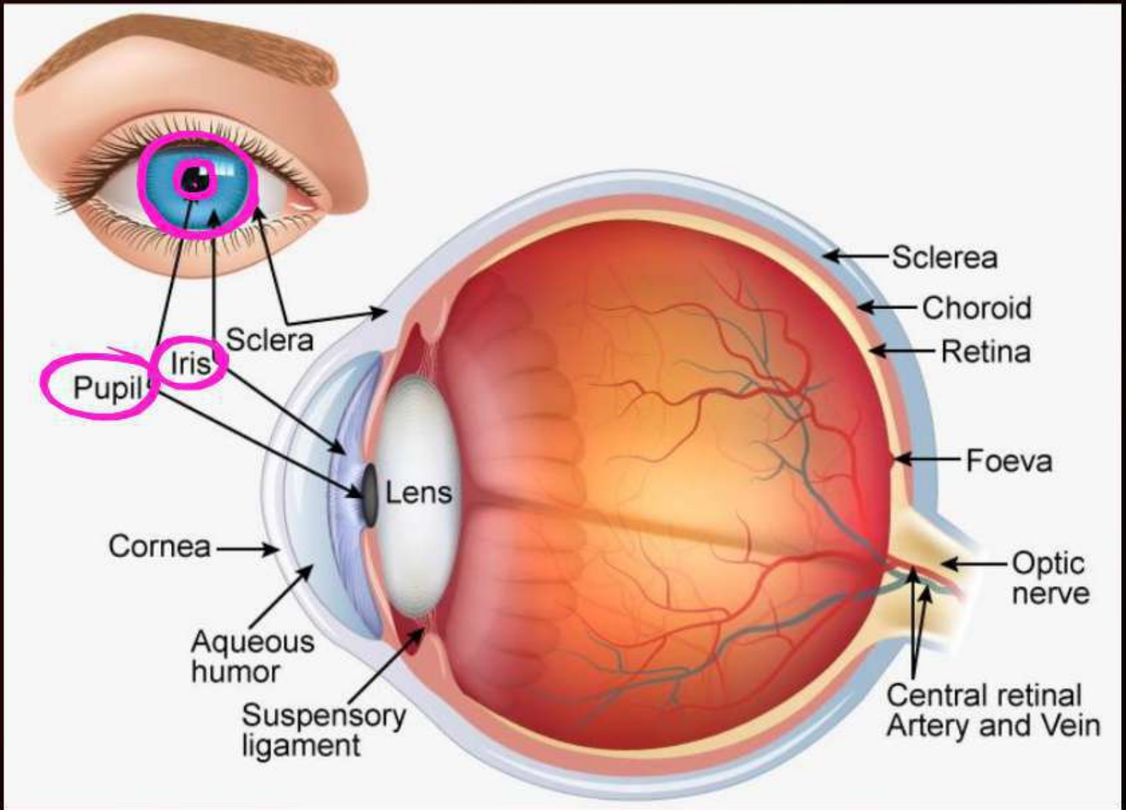
Imp

(b) Iris and pupil:

Iris is a dark coloured muscular diaphragm which has a small circular opening in its middle. The central circular aperture of iris is called pupil. The iris regulates the amount of light entering the eye by adjusting the size of the pupil. This is explained below :

(i) When the light is very bright (as on a sunny day), the iris makes the pupil to contract. As a result, the amount of light entering the eye decreases.

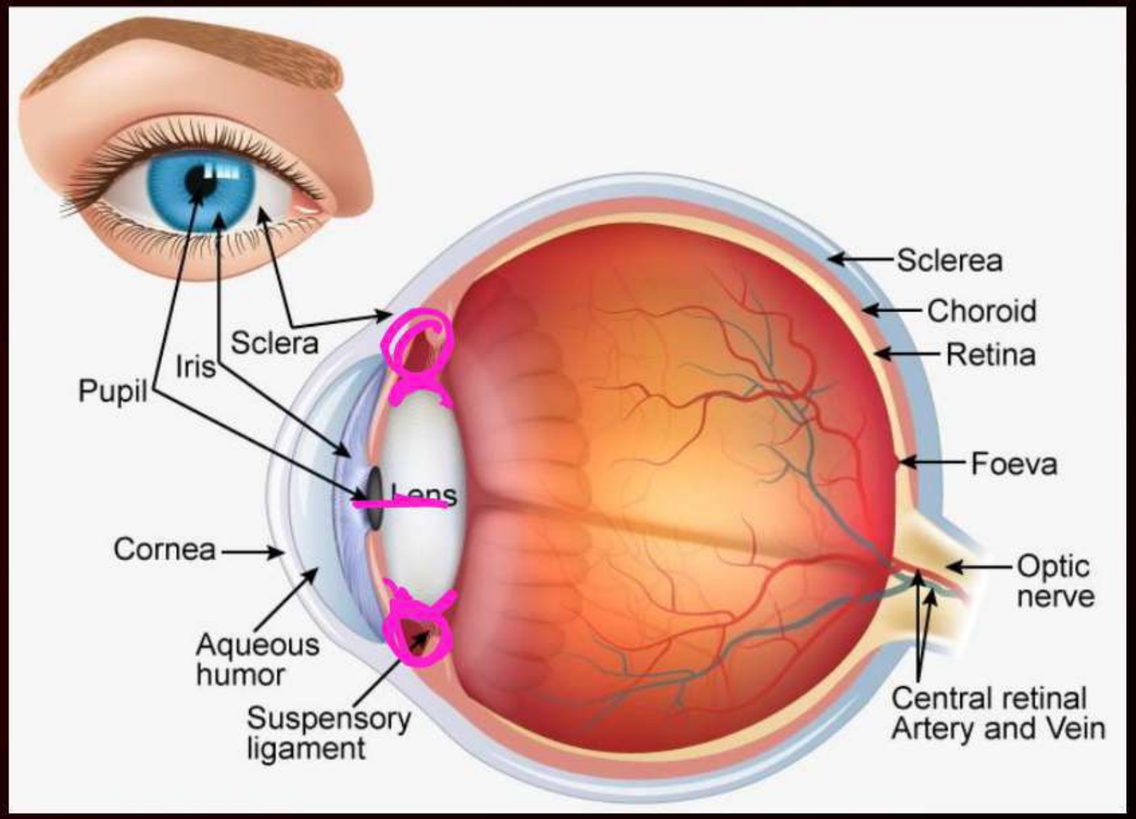
(ii) When the light is dim (as in a dark room), the iris makes the pupil to expand. As a result, more light can enter the eye.



Essential parts of the eye and their functions

(c) Eye lens:

The eye lens is a convex lens (converging lens) made of a transparent jelly-like material. The eye lens is hard at the middle and gradually becomes soft towards the outer edges. The eye lens is held in position by ciliary muscles. The curvature and therefore the eye lens may be changed by the action of the ciliary muscles.

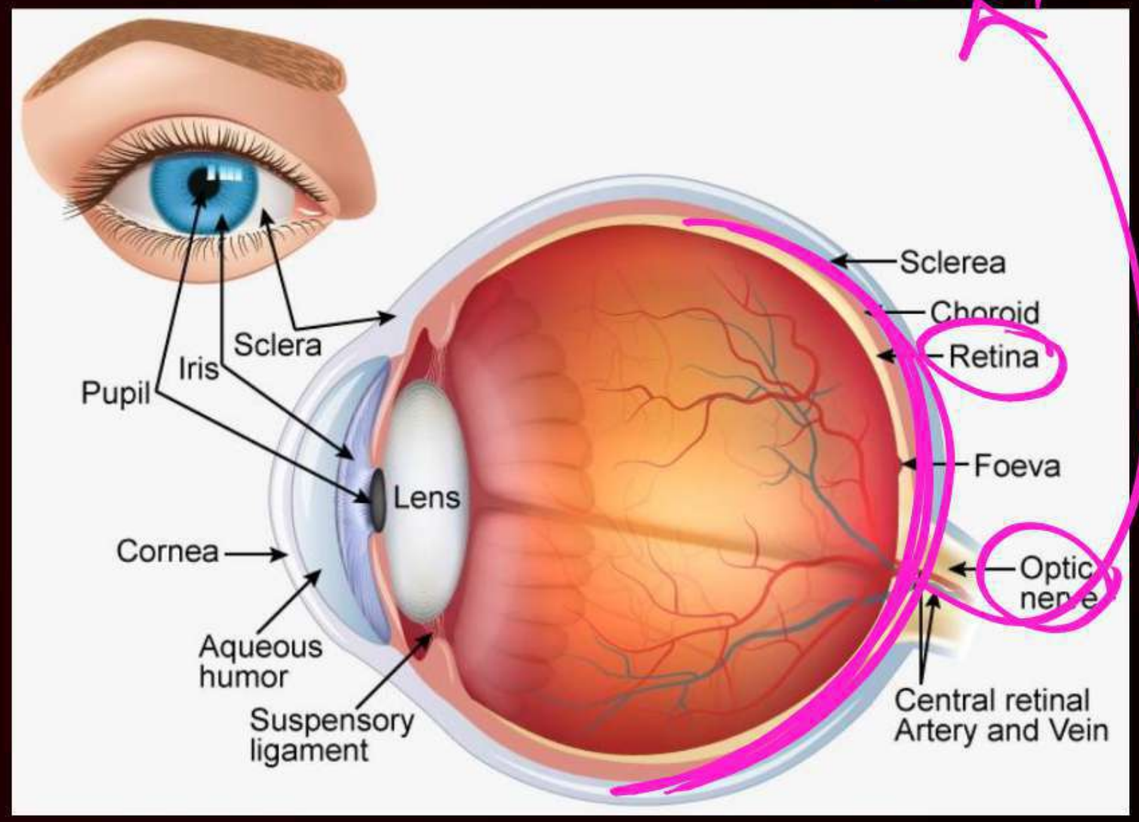


Essential parts of the eye and their functions

(d) Retina:

The inside surface of the rear part of the eye ball where the light entering the eye is focused is called retina. The surface of retina consist: of about 125 million light sensitive receptors. The receptors are of two types - **rods and cones**. When the light falls on these receptors, they send electrical signals to the brain through the optic nerve.

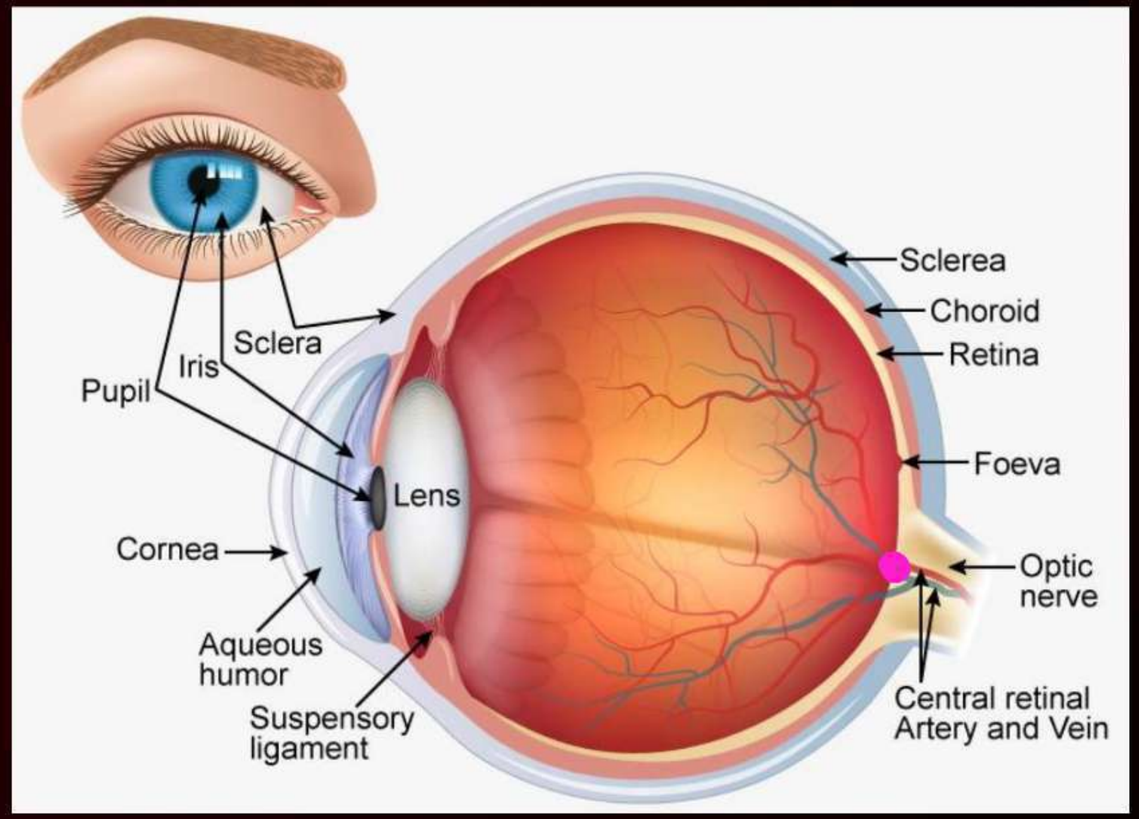
Brain



Essential parts of the eye and their functions

(e) Blind spot:

There are no rods cones at the point where optic nerves leave the eye ball to go to the brain. So, it any image is formed in this part of the retina, then no signal is sent to the brain. As a result the object is not seen. This part is therefore called the blind spot of the eye.



HOW DOES THE EYE WORK

The light coming from an object enters the eye through cornea and the pupil. The eye lens converges these light rays to form a real, inverted and high diminished image on the retina. The surface of retina consists of large number of light sensitive cells. When light falls on them, they get activated and generate electrical signals. These signals are then sent to the brain by the optic nerves and the observer sees the actual sized, erect image of the object.

QUESTION

HW

O → Pupil

Why does it take some time to see objects in a dim room when you enter the room from bright sunlight outside?

O → Pupil

In bright sunlight, iris makes the pupil to become small, so that only a small amount of light is able to enter the eye. When someone enters a dim room, very little light is available to the eye. The iris then makes the pupil to gradually expand (open up) to allow more light to enter the eye. This process takes some time. That is why the pupil takes a little time to adjust itself to dim light.

∞

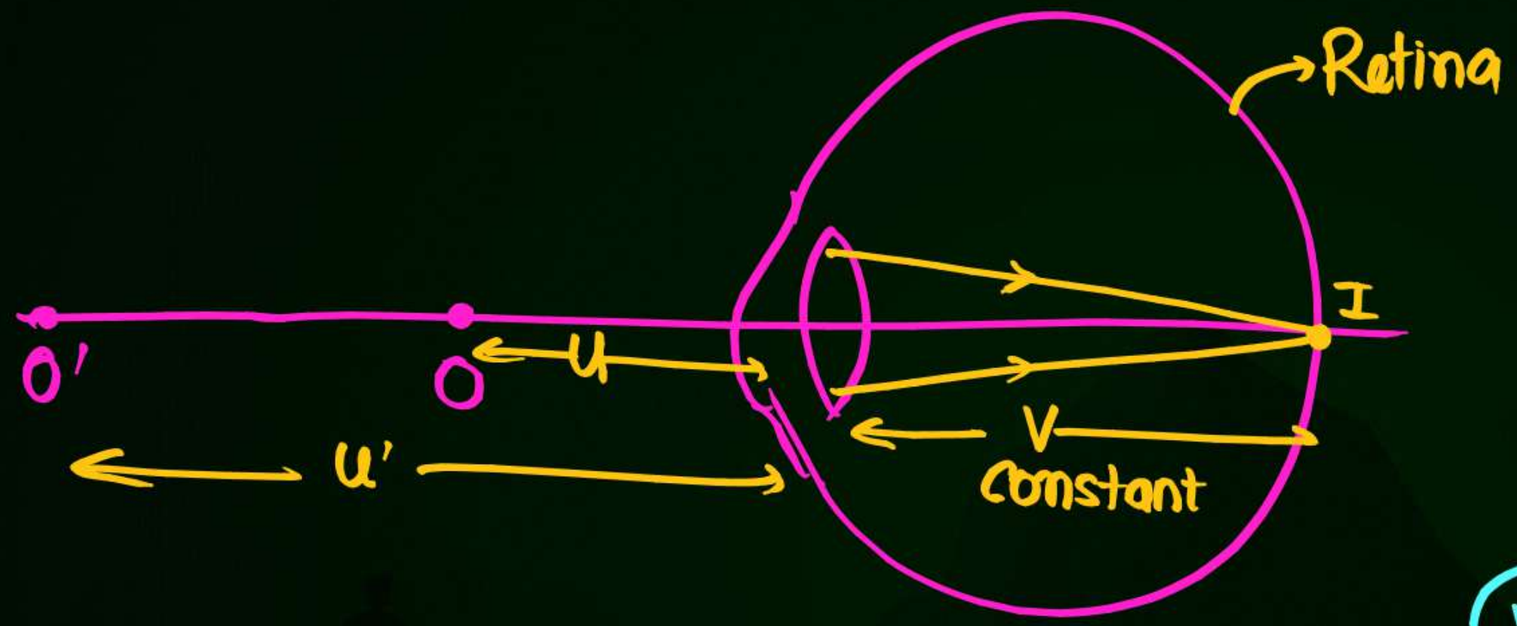
(a) **Far point:** The farthest point up to which an eye can see clearly is called the far point of the eye. For a normal eye, the far point is at infinity.

25cm

(b) **Near point:** The closest (nearest) point up to which an eye can see clearly is called the near point of the eye. The near point for a healthy normal eye of an adult lies about $25\ cm$ from the eye.

25cm

(c) **Least distance of distinct vision:** The minimum distance up to which an eye can see clearly without any strain is called the least distance of distinct which vision (denoted by d or D). For a normal eye of an adult, the least distance of distinct vision is about $25\ cm$. This distance usually increases with age.



u → variable

v → same

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

f → Variable

v → Constant

u → Variable

POWER OF ACCOMMODATION OF THE EYE

A normal eye can see both the distant and the nearby objects clearly. For a clear vision, the image of any object must fall on the retina.

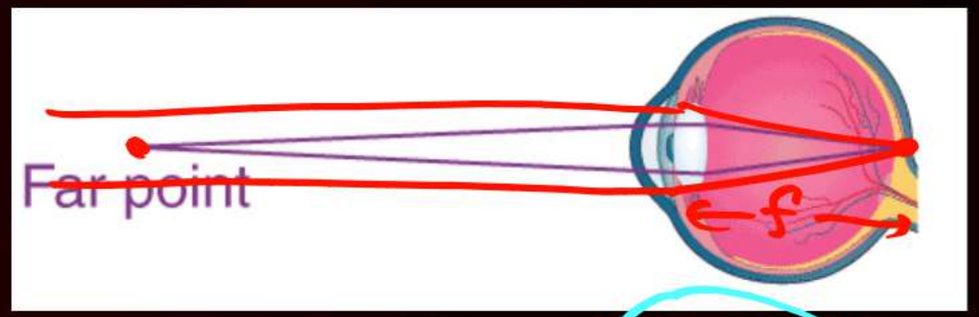
For a person, the distance between the retina and the eye lens is fixed. So, the distance of the image (v) from the eye lens is fixed.

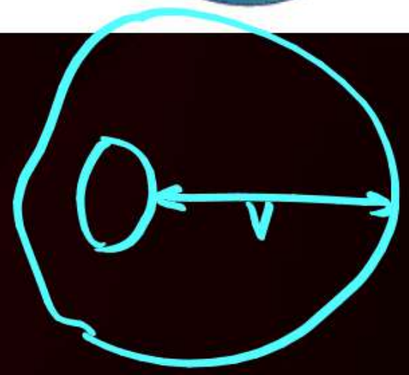
For objects at different distances, the values of u are different. So, to get the image at the same v, the focal length of the eye lens should be different. The eye lens can change its focal length by changing its thickness with the help of its ciliary muscles.

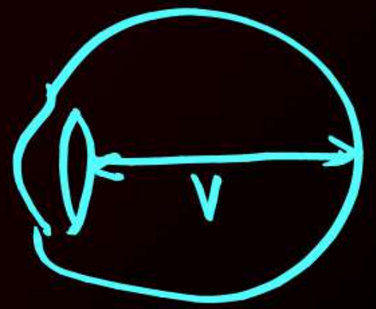
The property due to which eye lens is able to change its focal length is called accommodation of the eye.

POWER OF ACCOMMODATION OF THE EYE

When the eye is focused on distant objects (objects at infinity), the ciliary muscle is fully relaxed. When the ciliary muscle is in the relaxed state, the thickness of the lens is minimum and the focal length maximum : equal to the distance of the retina from the eye lens. Therefore, the parallel rays coming from any distant object are focused on the retina, and the object is seen clearly.



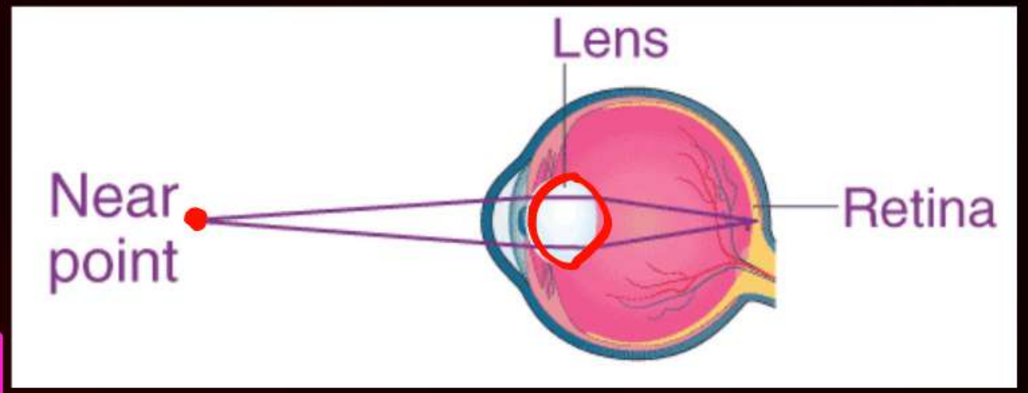




POWER OF ACCOMMODATION OF THE EYE

When the eye is focused on a nearby object, the ciliary muscle gets strained (tense). Tension in the ciliary muscle decreases the focal length of the eye lens by slightly increasing its thickness in such a way that the image is formed on the retina. Thus, the eye focuses on the nearby objects by tensing the ciliary muscle.

These adjustments in the focal length of the eye lens take place so fast that we do not realize such changes.



QUESTION

HW

What is meant by the limit of accommodation?

The eye can accommodate only up to a limit. A normal eye can accommodate up to the least distance of distinct vision about 25 cm for a healthy adult. The objects which are very close to the eye produce blurred image. Thus, a normal eye can accommodate objects lying between infinity and the least distance of distinct vision.

QUESTION

HW

What is the range of vision?

The range of distance over which the eye can see clearly is its range of vision. A normal human eye can see objects clearly which lie between infinity and the least distance of distinct vision.

QUESTION

HW

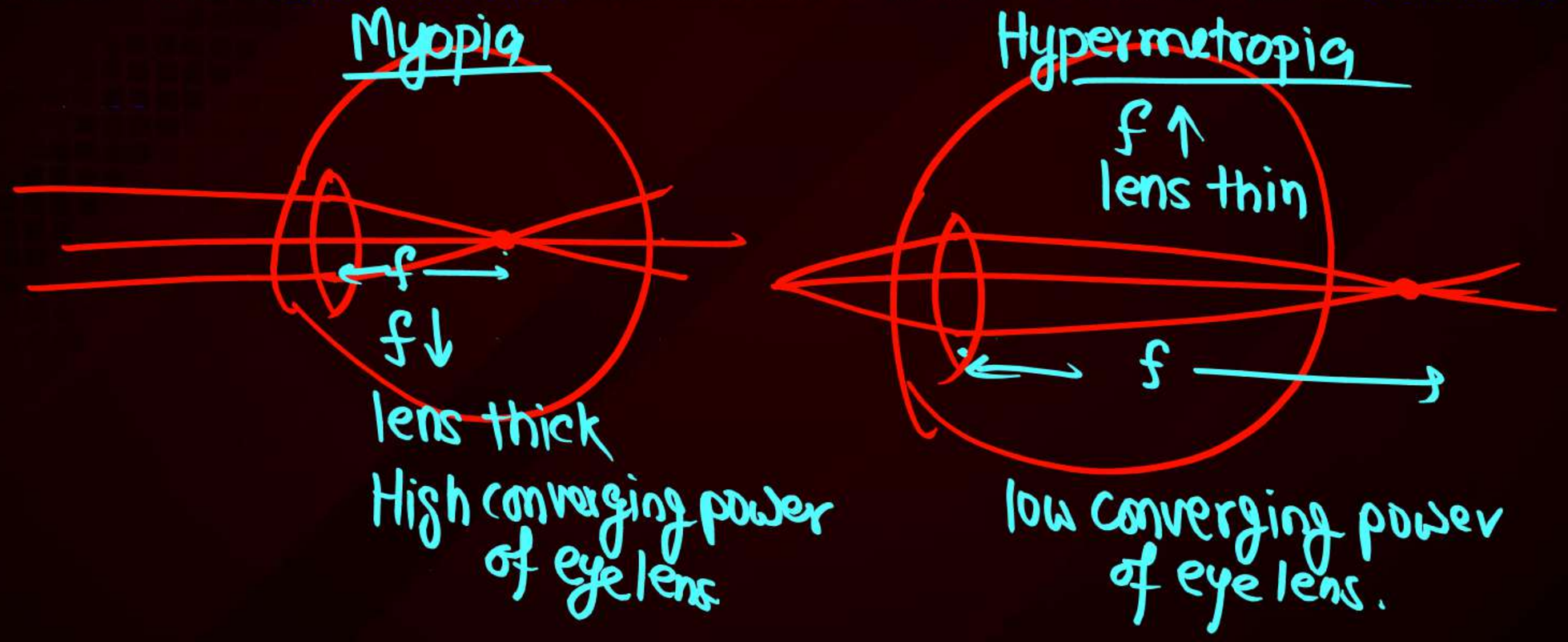
What is meant by the persistence of vision?

The ability of the eye to retain the image for about $1/16^{th}$ of a second even after we have stopped seeing the object is called persistence of vision.

$\frac{1}{16}$

DEFECTS OF VISION AND THEIR CORRECTION

Sometimes the eye of a person cannot focus the image of an object on the retina properly. In such cases the vision of a person becomes blurred, and he cannot see either the distant objects or nearby objects (or both) clearly and comfortably. The person is said to have a *defect* of vision. The defects of vision are also known as defects of eye.



DEFECTS OF VISION AND THEIR CORRECTION

There are three common defects of vision (or defects of eye).

1. Myopia (Short-sightedness or Near-sightedness)
2. Hypermetropia (Long-sightedness or Far-sightedness), and
3. Presbyopia.
4. Cataract

1. Myopia (Short-sightedness or Near-sightedness)

Myopia (or short-sightedness) is that defect of vision due to which a person cannot see the distant objects clearly (though he can see the nearby objects clearly).

The far point of an eye suffering from myopia is less than infinity.

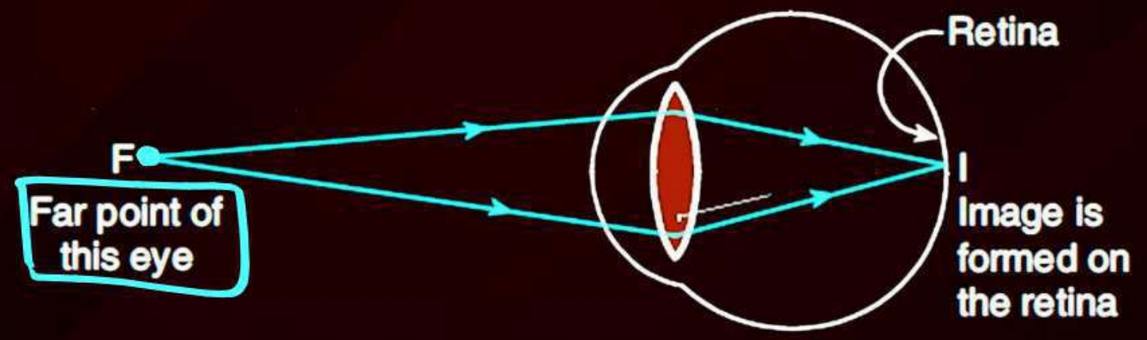
The defect of eye called myopia (or short-sightedness) is caused :

(i) due to high converging power of eye-lens (because of its short focal length),

(ii) due to eye-ball being too long.

1. Myopia (Short-sightedness or Near-sightedness)

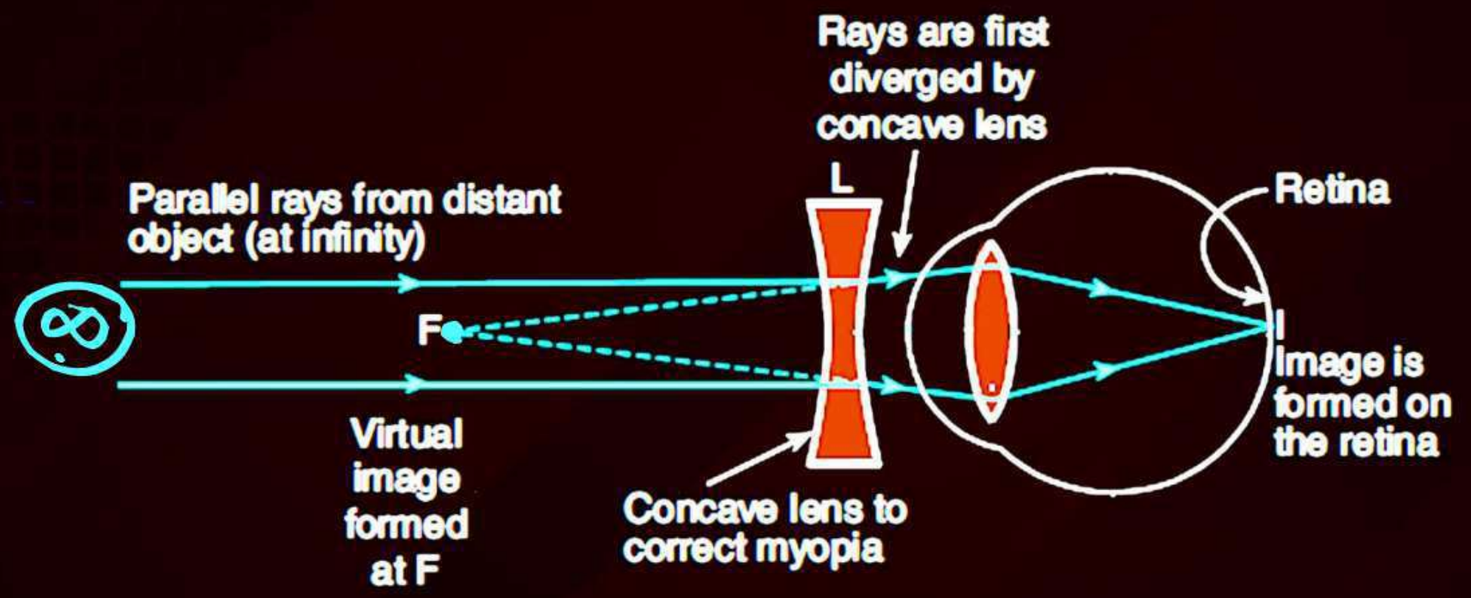
(*a*) In a myopic eye, image of distant object is formed in front of the retina (and not on the retina)



(*b*) The far point (*F*) of a myopic eye is less than infinity

1. Myopia (Short-sightedness or Near-sightedness)

Myopia (short-sightedness or near-sightedness) is corrected by using spectacles containing concave lenses.
The concave lens used for correcting myopia should be of such a focal length (or power) that it produces a virtual image of the distant object (lying at infinity) at the far point of the myopic eye.



(c) *Correction of myopia*. The concave lens placed in front of the eye forms a virtual image of distant object at far point (F) of the myopic eye

QUESTION

The far point of a myopic person is 80 cm in front of the eye. What is the nature and power of the lens required to correct the defect?

$u = \infty$

$v = -80cm$

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

$\frac{1}{f} = \frac{1}{-80} - \frac{1}{\infty}$

$\frac{1}{f} = -\frac{1}{80} \Rightarrow f = -80cm$ → Concave

$P = \frac{100}{f}$

$P = -\frac{10\cancel{0}}{8\cancel{0}}$

$P = -\frac{5}{4} D$

QUESTION

Assertion: A person suffering from myopia cannot see the distant object clearly.
Reason: Converging lens is used for the correction of myopic eye as it can form real as well as virtual images of the objects placed in front of it. **[2023]**

(a) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion.
(b) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion.
(c) Assertion is true but the Reason is false.
(d) The statement of the Assertion is false but the Reason is true.

Hypermetropia (Long-sightedness or Far-sightedness

Hypermetropia (or long-sightedness) is that defect of vision due to which a person cannot see the nearby objects clearly (though he can see the distant objects clearly).

The near-point of a hypermetropic eye is more than 25 centimeters away.

The defect of eye called hypermetropia (or longsightedness) is caused:

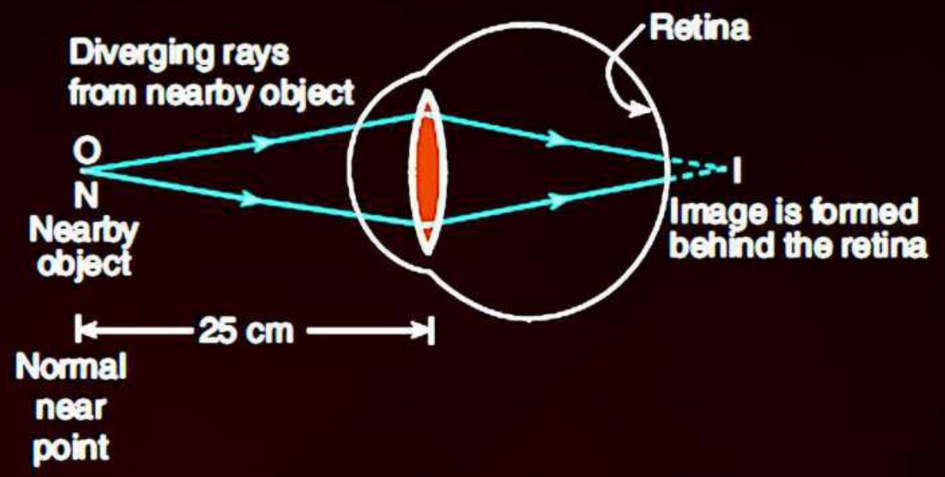
(i) due to low converging power of eye-lens (because of its large focal length), or

(ii) due to eye-ball being too short.

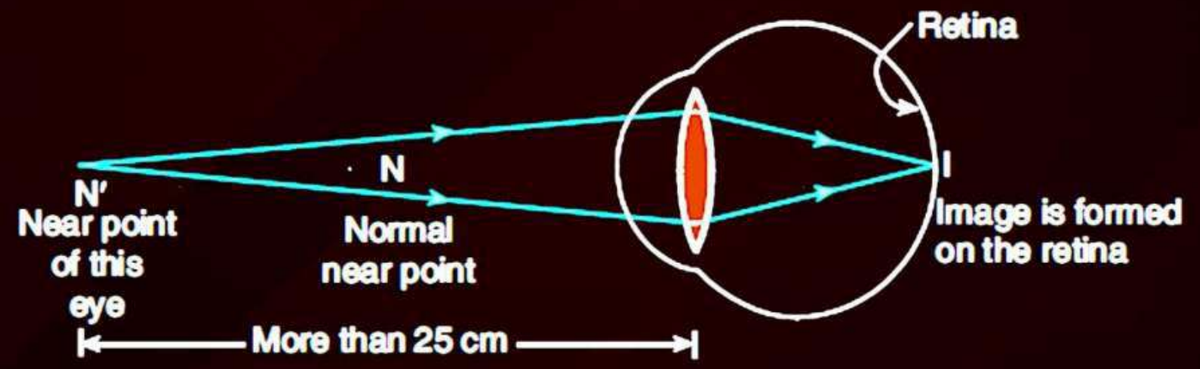
$u = -25cm$

$v \rightarrow$

2. Hypermetropia (Long-sightedness or Far-sightedness)



(*a*) In a hypermetropic eye, the image of nearby object lying at normal near point *N* (at 25 cm) is formed behind the retina.

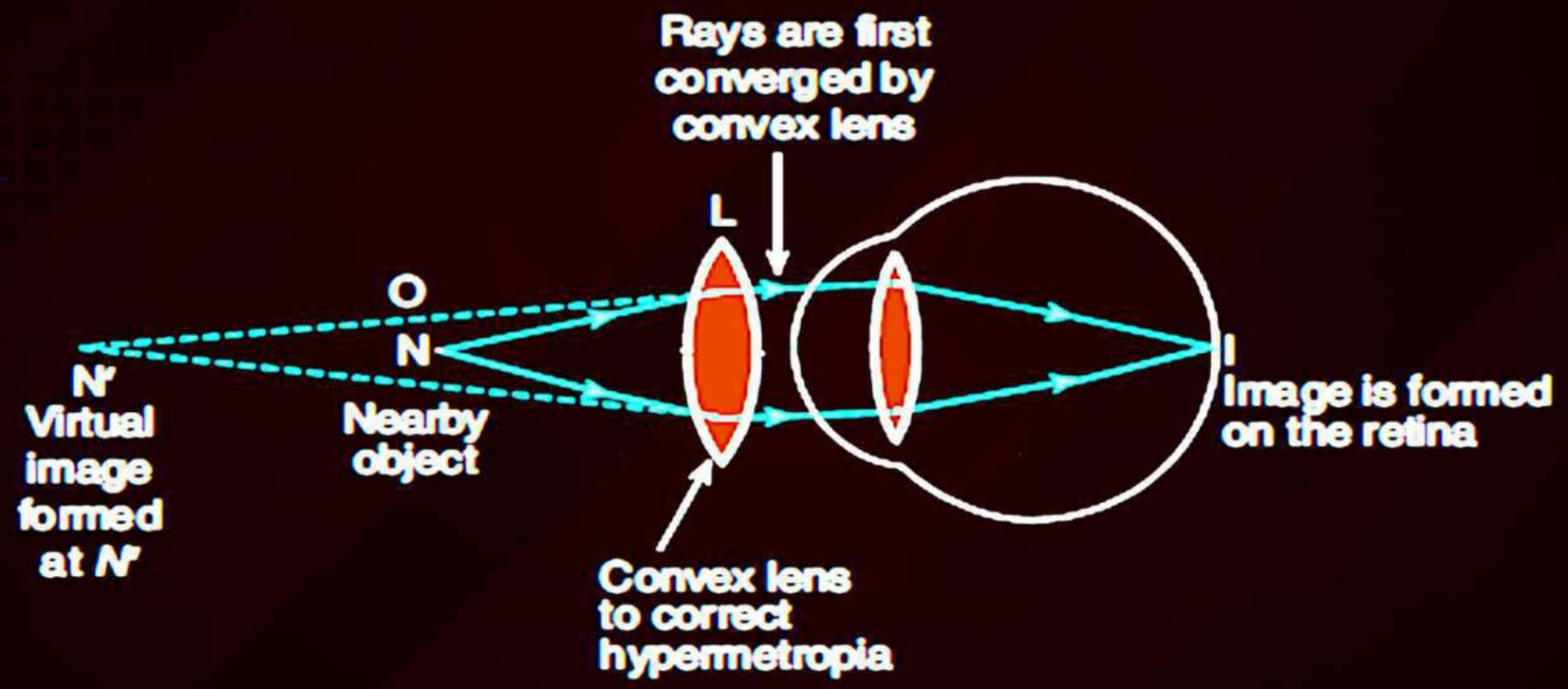


(*b*) The near point *N′* of hypermetropic eye is farther away from the normal near point *N*

2. Hypermetropia (Long-sightedness or Far-sightedness)

Hypermetropia (long-sightedness or far-sightedness) is corrected by using spectacles containing convex lenses.

The convex lens used for correcting hypermetropia (or long-sightedness) should be of such a focal length (or power) that it forms a virtual image of the object (placed at the normal near point *N* of 25 cm), at the near point of the hypermetropic eye.



QUESTION

The near point of a hypermetropic eye is 1 m. What is the nature and power of the lens required to correct this defect? (Assume that the near point of the normal eye is 25 cm).

convex

$u = -25\,cm$

$v = -100\,cm$

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

$= \frac{1}{-100} - \frac{1}{-25}$

$= \frac{-1+4}{100}$

$\frac{1}{f} = \frac{3}{100}$

$f = \frac{100}{3}\,cm$

$P = \frac{100}{f}$

$= \frac{100}{\left(\frac{100}{3}\right)}$

$P = 3D$

Myopia	Hypermetropia
$u = -\infty$	$u = -25\,cm.$
$v = -$(far point)	$v = -$(near point)
$f = ?$	$f = ?$
$P = ?$	$P = ?$
Concave lens	Convex

3. Presbyopia

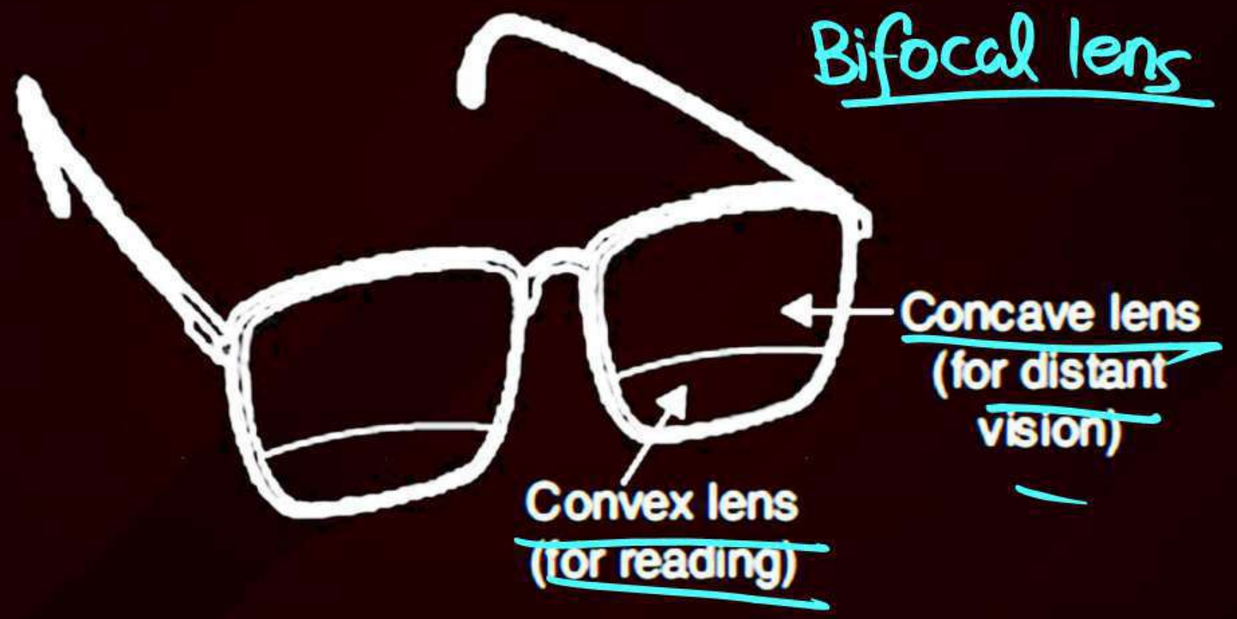
Presbyopia is that defect of vision due to which an old person cannot see the nearby objects clearly due to loss of power of accommodation of the eye.

The near-point of the old person having presbyopia gradually recedes and becomes much more than 25 centimeters away.

Presbyopia defect is corrected in the same way as hypermetropia by using spectacles having convex lenses.

3. Presbyopia

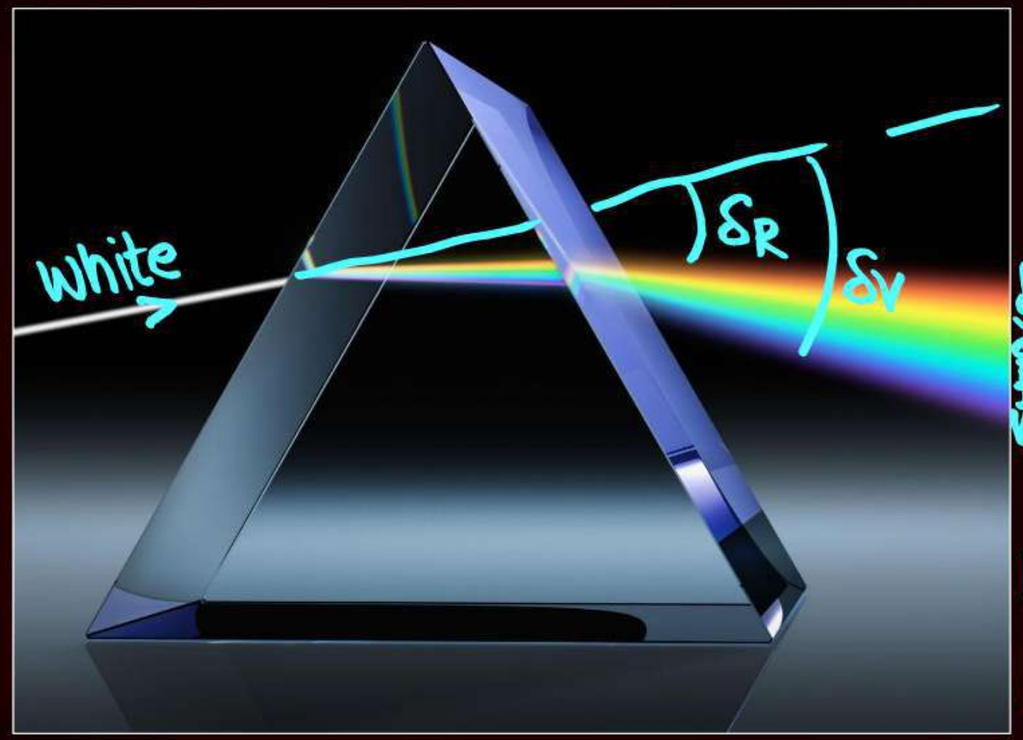
It is also possible that the same person has both the defects of vision - myopia as well as hypermetropia. A person suffering from myopia as well as hypermetropia uses spectacles having bifocal lenses in which upper part consists of a concave lens (to correct myopia) used for distant vision and the lower part consists of a convex lens (to correct hypermetropia) used for reading purposes.



Cataract मोतियाबिन्द

The medical condition in which the lens of the eye of a person becomes progressively cloudy resulting in blurred vision is called cataract.

GLASS PRISM

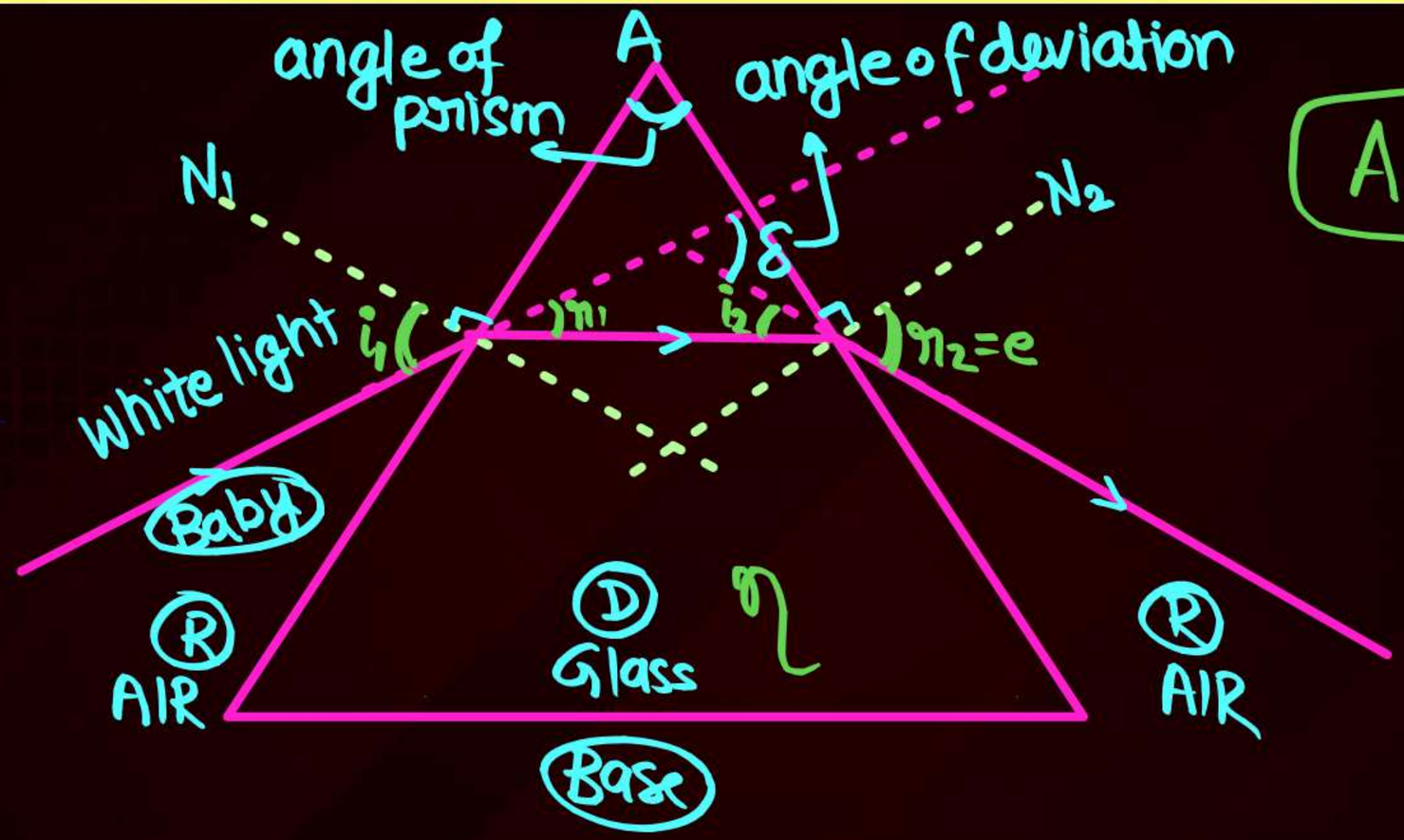


R O Y G B I V } Spectrum of light

least deviation → R

Most " → V

REFRACTION OF LIGHT THROUGH A GLASS PRISM



$$A+\delta=i_1+e$$

QUESTION

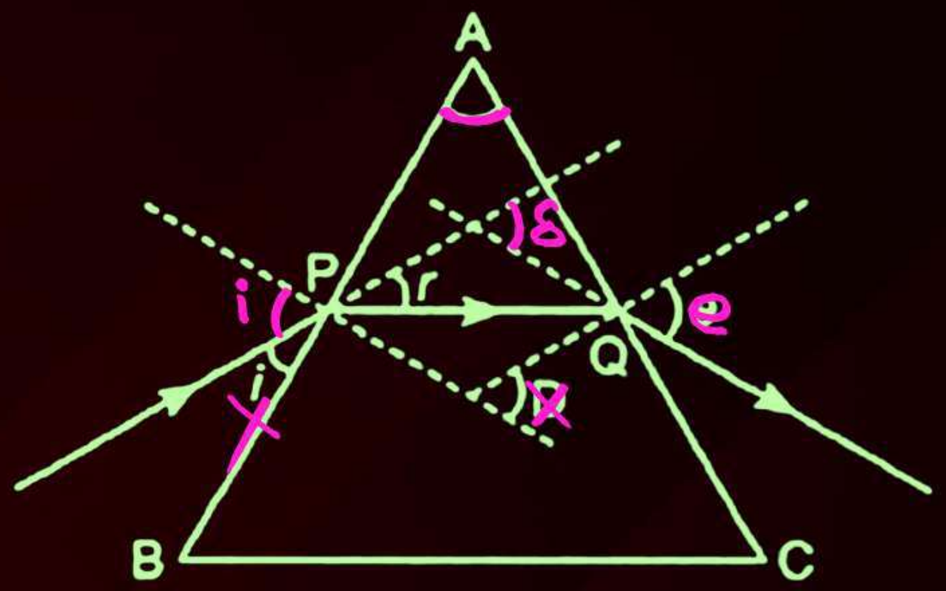
In the following diagram, the correctly marked angles are

(a) $\angle A$ and $\angle e$

(b) $\angle i, \angle A$ and $\angle D$

(c) $\angle A, \angle i$ and $\angle e$

(d) $\angle A, \angle r$ and $\angle D$



QUESTION

Assertion: The angle through which a ray of light bends on passing through a prism is called the angle of deviation.

Reason: The peculiar shape of a prism makes the emergent ray bend at angle to the direction of the incident ray.

[2023]

(a) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion.

(b) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion.

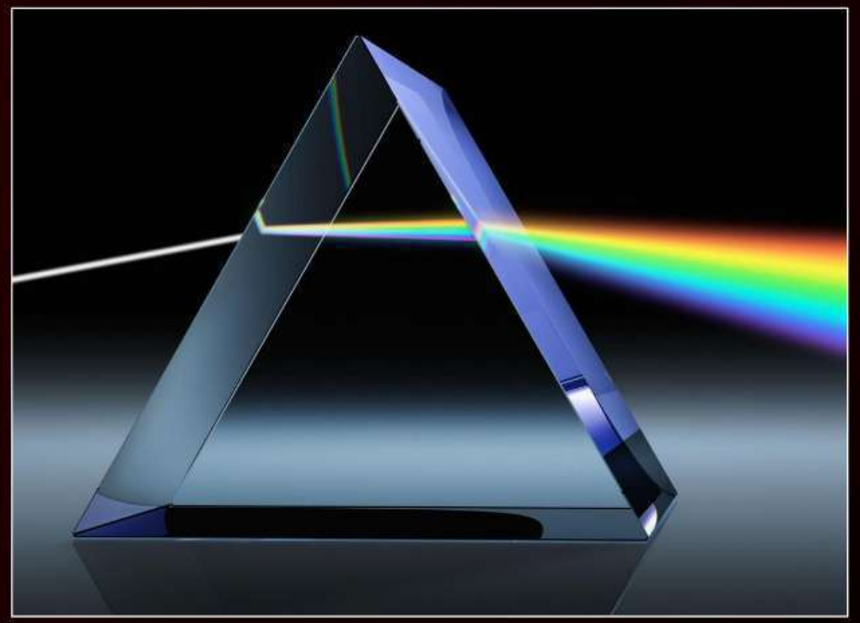
(c) Assertion is true but the Reason is false.

(d) The statement of the Assertion is false but the Reason is true.

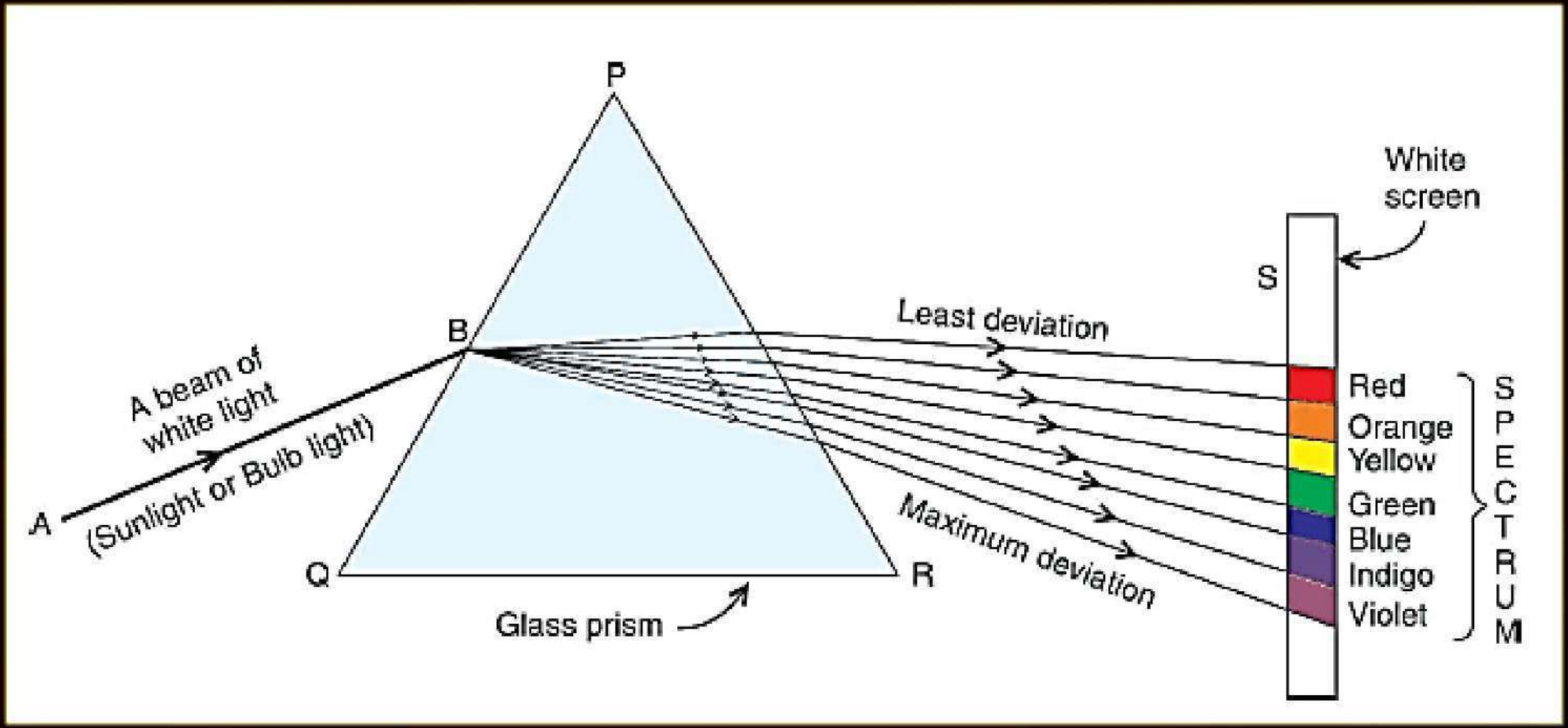
DISPERSION OF LIGHT

The splitting up of white light into seven colors on passing through a transparent medium like a glass prism is called dispersion of light.

The band of seven colors formed on a white screen, when a beam of white light is passed through a glass prism, is called spectrum of white light.



DISPERSION OF LIGHT



DISPERSION OF LIGHT

The dispersion of white light occurs because colors of white light travel at different speeds through the glass prism.

The red color has the maximum speed in glass prism, so the red color is deviated the least. The violet color has the minimum speed in glass prism, so the violet color is deviated the maximum.

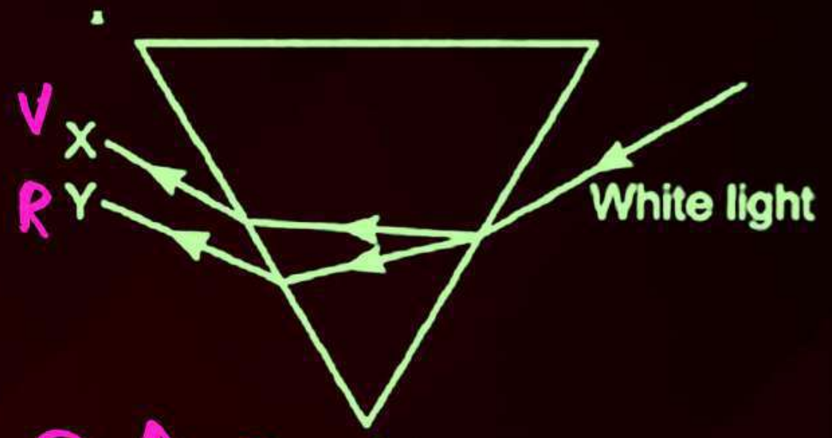
$\lambda_R > \lambda_V$

QUESTION

In the diagram given below, X and Y are the end colours of the spectrum of white light. The colour of 'Y' represents the

[2021]

(a) colour of sky as seen from earth during the day.
(b) colour of the sky as seen from the moon.
(c) colour used to paint the danger signals.
(d) colour of sun at the time of noon.

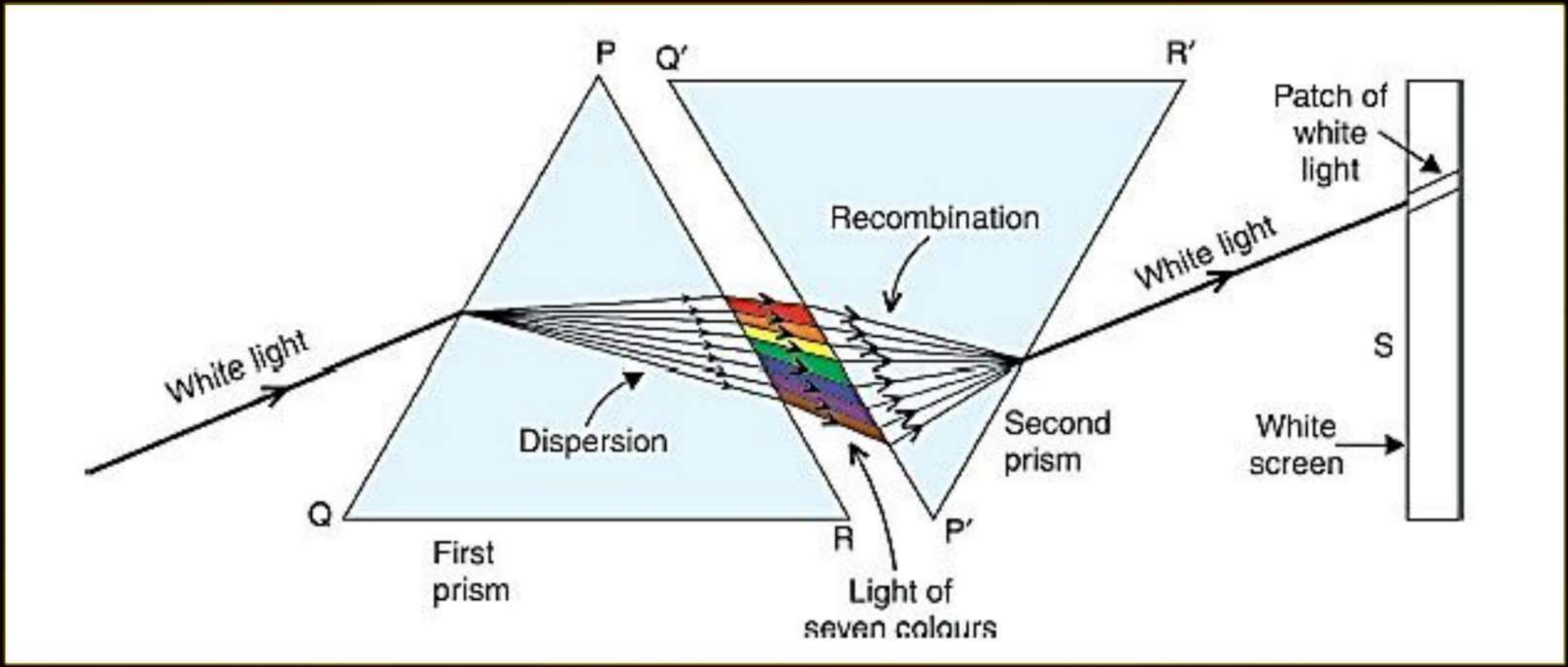


$\lambda \uparrow$ Scattering $\downarrow$

$$\boxed{\text{Scattering of light} \propto \frac{1}{\lambda^4}}$$

Rayleigh's law of scattering

Re-Combination of Spectrum Colours to Give White Light



QUESTION

When a narrow beam of white light passes through a glass prism it splits into its component colours. This phenomenon is called

[2023(C)]

(a) Diffusion of light

(b) Total reflection of light

(c) Scattering of light

(d) Dispersion of light

QUESTION

When a ray of light passes through a glass prism it suffers two refractions. During these refractions the ray bends:

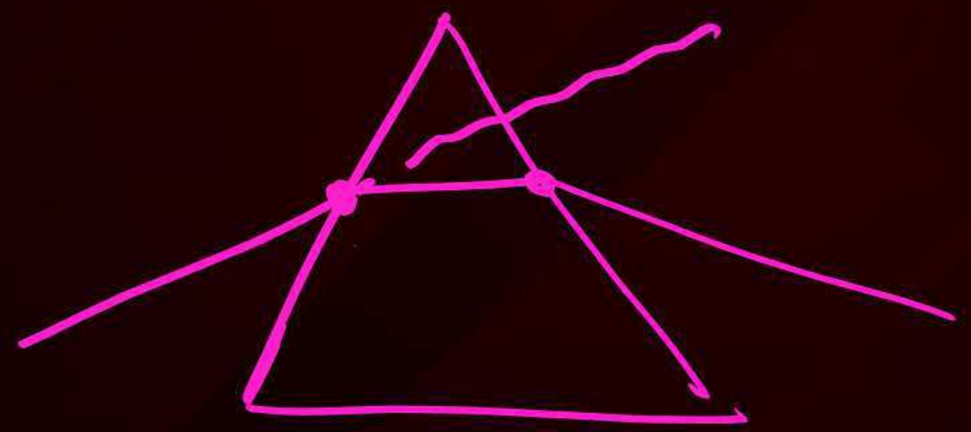
[2022]

(a) Away from the base in both cases

(b) Towards the base in both cases

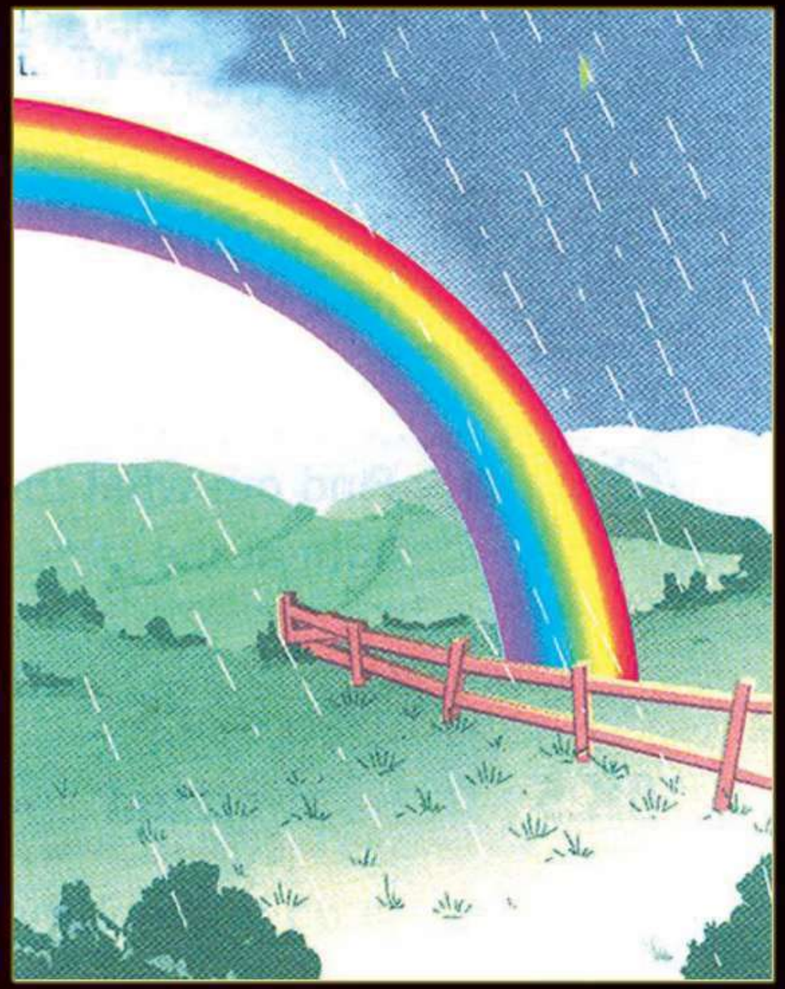
(c) Towards the base in first case and away from the base in second case

(d) Away from the base in first case and towards the base in second case

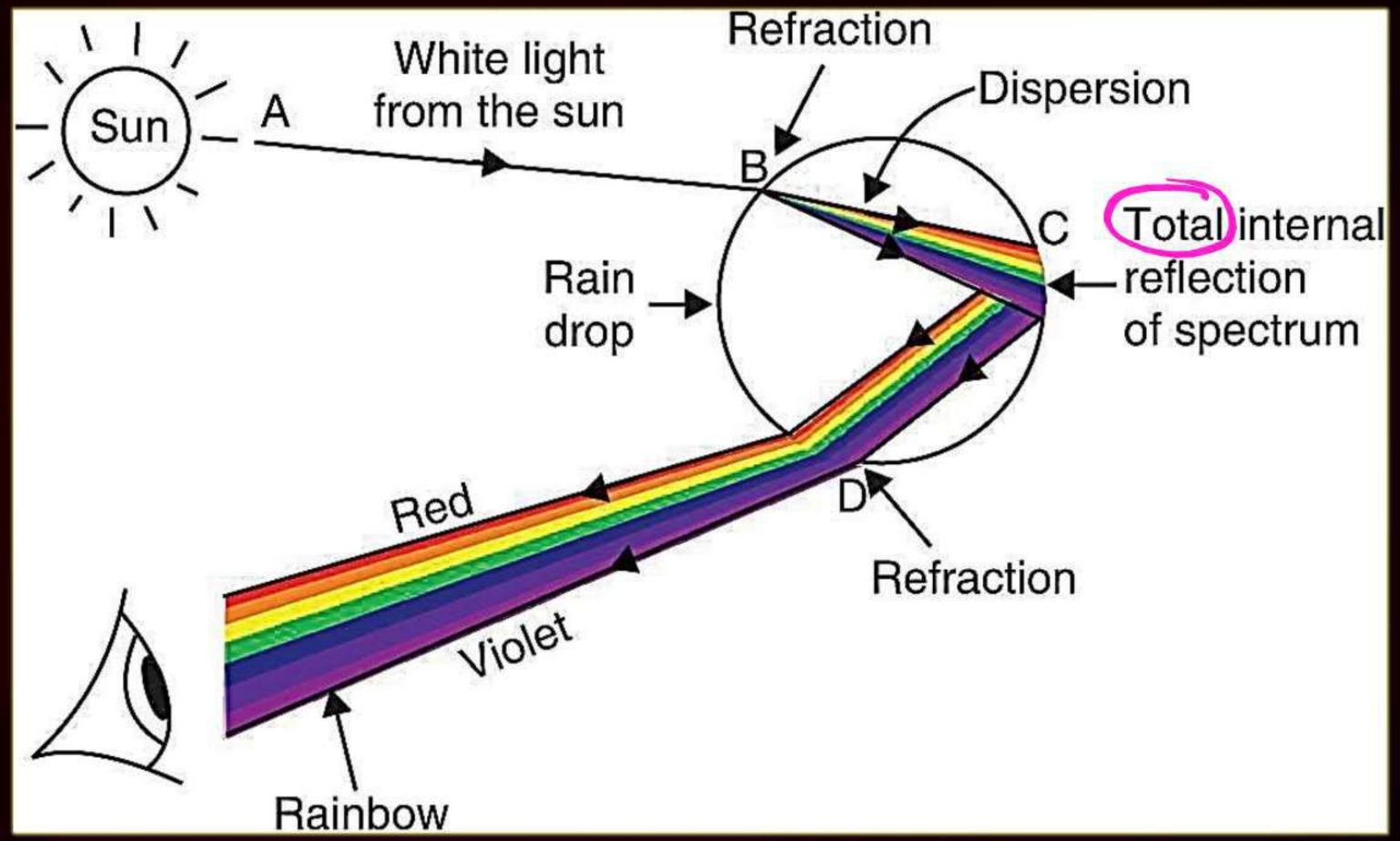


The Rainbow

The rainbow is an arc of seven colors visible in the sky which is produced by the dispersion of sun's light by raindrops in the atmosphere. A rainbow is produced by the dispersion of white sunlight by raindrops (or water drops) in the atmosphere. Each raindrop acts as a tiny glass prism splitting the sunlight into a spectrum.

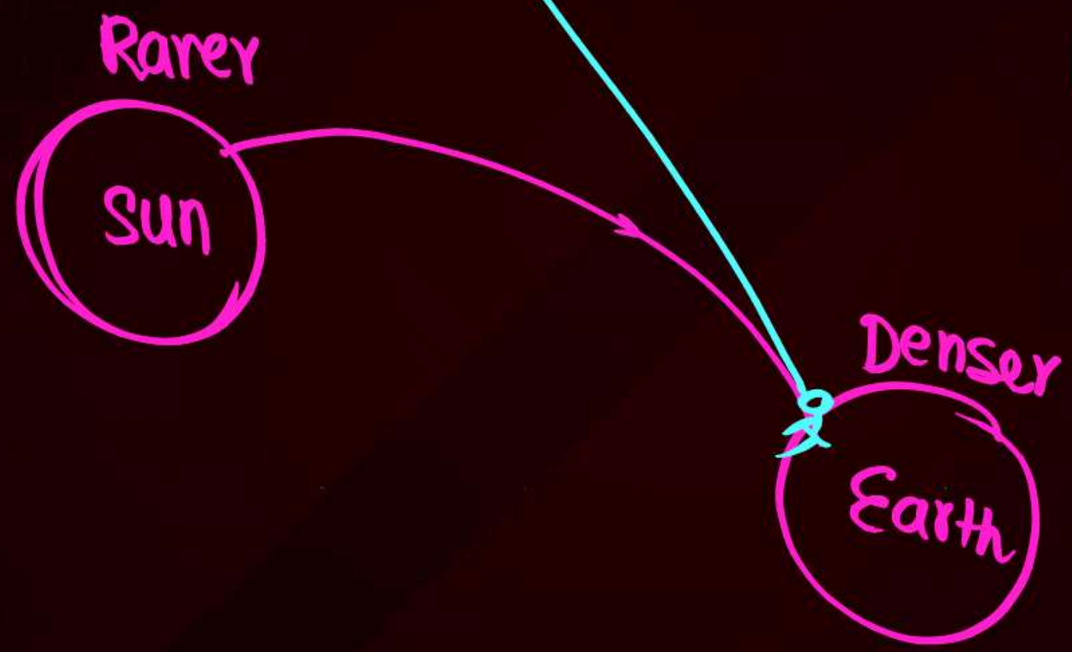


The Rainbow


Sun
A
White light
from the sun
Refraction
Dispersion
B
C
Total internal
reflection
of spectrum
Rain
drop
Red
D
Refraction
Violet
Rainbow

ATMOSPHERIC REFRACTION

The refraction of light caused by the earth's atmosphere (having air layers of varying optical densities) is called **atmospheric refraction**.



1. Twinkling of Stars

The twinkling of a star is due to the atmospheric refraction of star's light. The continuously changing atmosphere refracts the light from the stars by different amounts from one moment to the next.

When the atmosphere refracts more star-light towards us, the star appears to be bright and when the atmosphere refracts less star-light, then the star appears to be dim.

QUESTION

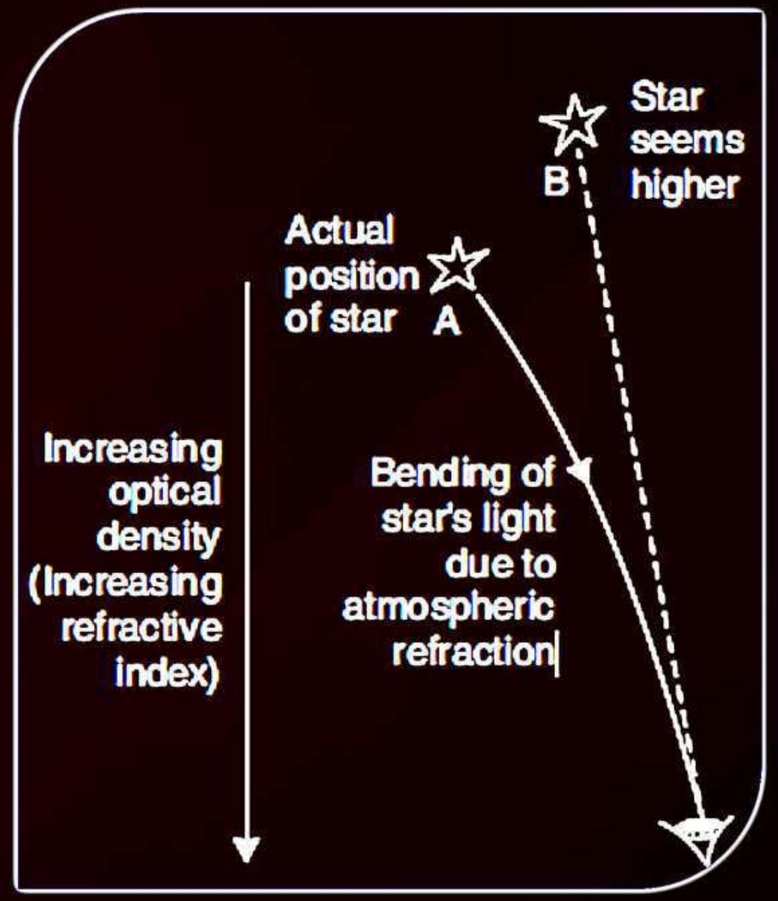
Which one of the following is the correct reason for twinkling of stars?

[2021C]

(a) Atmospheric reflection of starlight
(b) Atmospheric refraction of starlight
(c) Scattering of starlight
(d) Dispersion of starlight

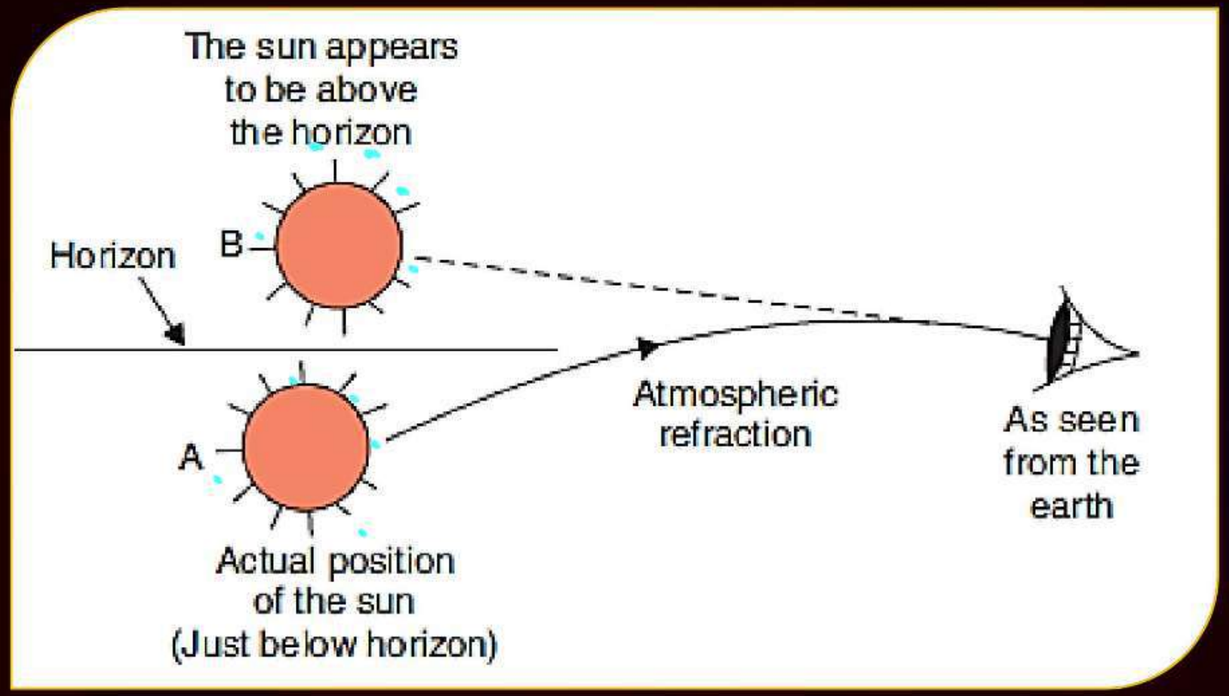
2. The Stars Seem Higher Than They Actually Are

Due to atmospheric refraction, the stars seem to be higher in the sky than they actually are.



3. Advance Sunrise and Delayed Sunset

We can see the sun about 2 minutes before the actual sunrise and 2 minutes after the actual sunset because of atmospheric refraction.



QUESTION

To an astronaut the sky on the moon appear dark because

[2022]

(a) there is no light on the moon.
(b) there is no atmosphere on the surface of the moon.
(c) moon is non-luminous object.
(d) the surface of the moon absorbs all the sunlights.

SCATTERING OF LIGHT

Scattering of light means **to throw light in various random directions**. Light is scattered when it falls on various types of suspended particles in its path.

Tyndall Effect

The scattering of light by particles in its path is called Tyndall effect.

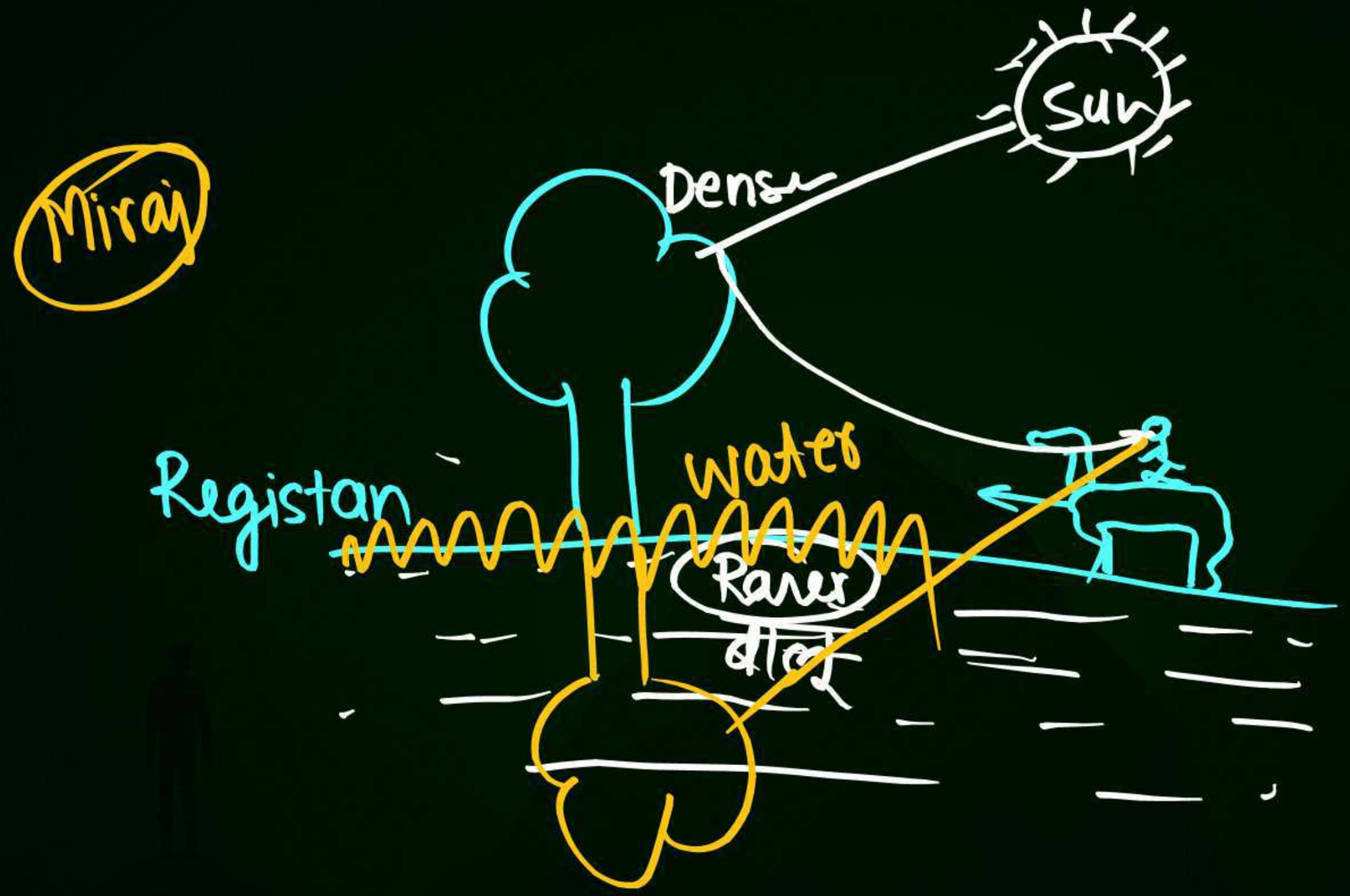
When a beam of sunlight enters a dusty room through a window, then its path becomes visible to us. This is because the tiny dust particles present in the air of room scatter the beam of light all around the room. And when this scattered light enters our eyes, we can see the beam of light

Tyndall Effect

Tyndall discovered that when white light consisting of seven colours is passed through a clear liquid having small suspended particles in it, then the blue colour having shorter wavelength is scattered much more than the red colour having longer wavelength.

$\lambda_R > \lambda_B$

$\lambda \uparrow$ scattering $\downarrow$


Mirage
Sun
Dense
Registan
water
Rays
बीच

QUESTION

HW

What is Tyndall effect? Give two examples where this phenomenon is observed. Give reason to explain this phenomenon.

[2023(c)]

Tyndall effect: Scattering of beam of visible light by the colloidal particles present in the colloidal solution is called Tyndall effect.

This phenomenon is seen when
(i) sunlight passes through a canopy of a dense forest.
(ii) a fine beam of sunlight enters a smoke-filled room through a small hole illuminates the particles in its path.

Reason: When a fine beam strikes the colloidal particles, such as water droplet in the mist in case (i) or smoke particles in case (ii), the light beam gets scattered and hence, the path of the beam becomes visible. This gives rise to Tyndall effect.

Why the Sky is Blue

The scattering of blue component of the white sunlight by air molecules present in the atmosphere causes the blue colour of the sky.

If the earth had no atmosphere consisting of air, there would have been *no scattering* of sunlight at all. In outer space, the sky looks dark and black instead of blue.

The colour of clear sky from the earth appears blue but from the space it appears black. Why?

[2023]

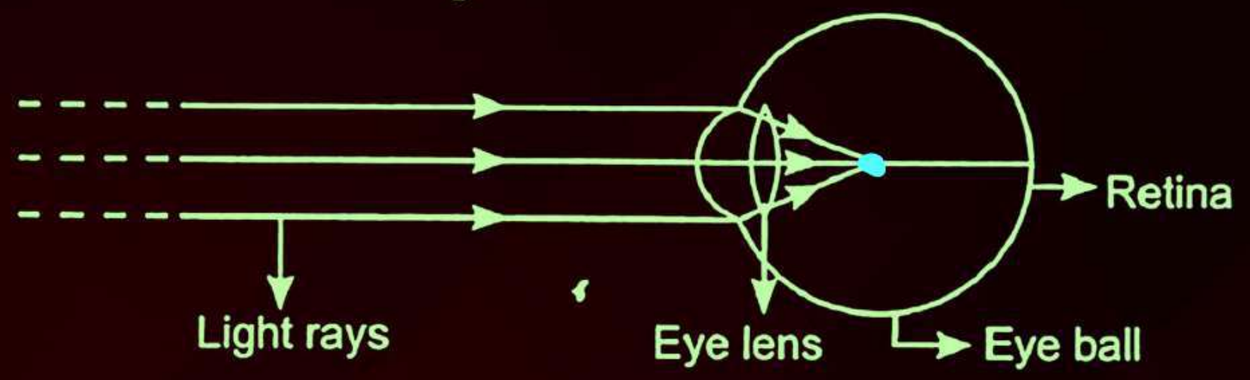
Why the Sun Appears Red at Sunrise & Sunset

The sun and the surrounding sky appear red at sunrise and at sunset because at that time most of the blue colour present in sunlight has been scattered out and away from our line of sight, leaving behind mainly red colour in the direct sunlight beam that reaches our eyes.

QUESTION

HW

Observe the following diagram and answer the questions following it:



(i) Identify the defect of vision shown.
(ii) List its two causes.
(iii) Name the type of lens used for the correction of this defect.
[2023]

Myopia

Concave

QUESTION

In the formation of rainbow, the role of water droplet presents in water fountains is to act as a [2021]

(a) glass slab

(b) convex lens

(c) concave lens

(d) prism

QUESTION

At noon, the sun appears white as

[2016]

(a) light is least scattered.

(b) all the colours of the white light are scattered away.

(c) blue colour is scattered the most.

(d) red colour is scattered the most.

QUESTION

Assertion: A rainbow is an artificial spectrum of white light appearing in the sky after a rain shower.

Reason: The water droplets acts like small prism.

[2023(C)]

(a) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion.

(b) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion.

(c) Assertion is true but the Reason is false.

(d) The statement of the Assertion is false but the Reason is true.

QUESTION

Assertion: Sky appears blue in the day time.
Reason: White light is composed of seven colours.

[2022]

(a) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion.
(b) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion.
(c) Assertion is true but the Reason is false.
(d) The statement of the Assertion is false but the Reason is true.

Thank You