Chapter :- Reflection and Refaraction of Light.

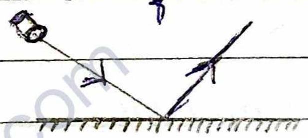
Notes :-

∴ Properties of light

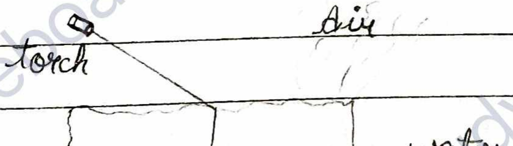
Light (photon) travels in straight line.
light travels with the speed of 3×10^8 in vaccum.
no material particle can have speed greater than the speed of light.

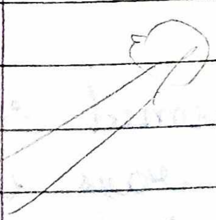
$[3 \times 10^8 = 300000000 \text{ m/sec}]$

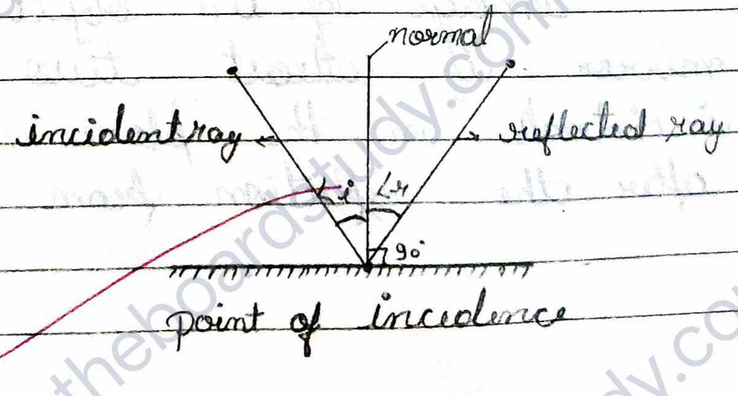
(i) Reflection : bouncing back of light in the same medium when it falls on the shiny surface / other surface



(ii) Refraction : The bending of light when from one medium to another medium





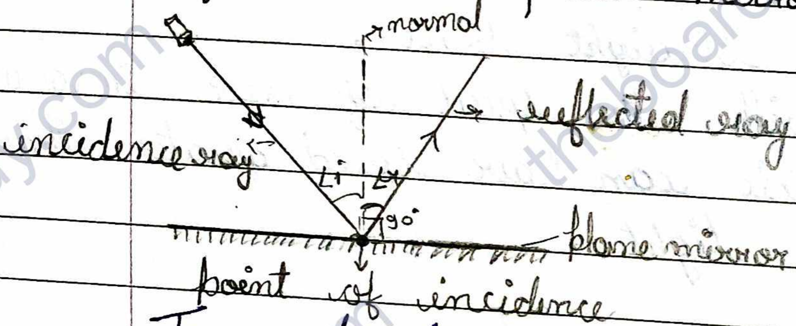


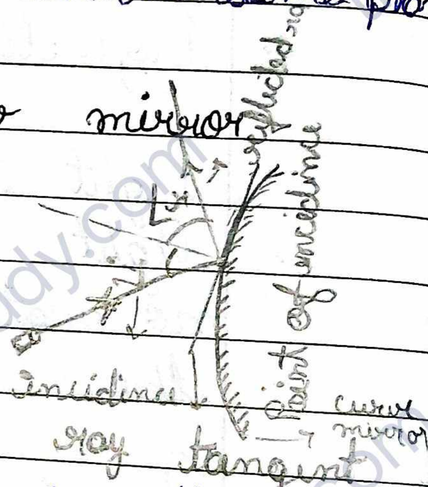
∴ Laws of reflection :-

(i) angle of incident = angle of reflection.
$[\angle i = \angle r]$

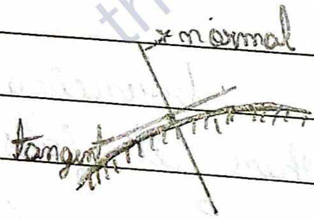
(ii) incident ray, reflected ray and normal at the point of incidence lies on the same pla

∴ Reflection on plane mirror or curve mirror

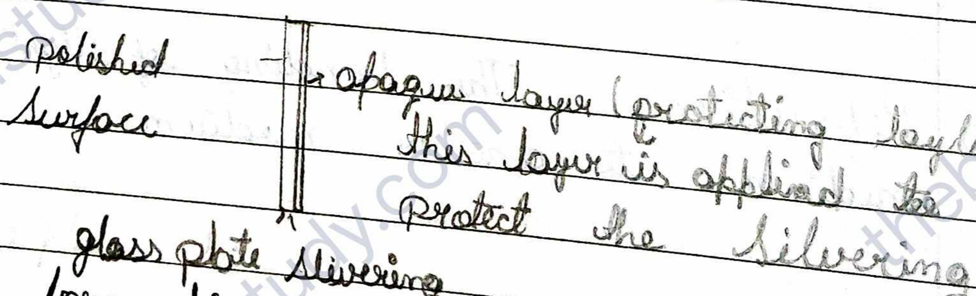




Tangent line : A line which touches the center at a point.



∴ Construction of mirror



∴ Image formation by plane mirror condition for image formation :

Image of an object is formed in a mirror if atleast two light rays which incidents on the plane mirror intersects after the reflection from the mirror.

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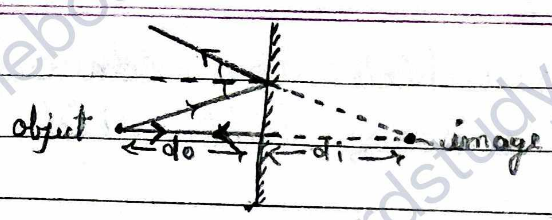
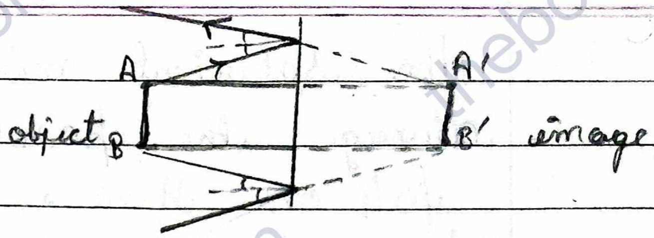




Plane mirror

- Properties of image formed by plane mirror.
- $d_o = d_i$ $u = v$
- Image inversion is virtual and erect.
- Lateral inversion i.e, left and right sides interchanged.
- Size of image and object are same. $h_i = h_o$

+ Real image: when two real light rays intersects after the reflection real image is formed at the point of intersection.

virtual image :- when two virtual light rays intersects after the reflection of real light rays then the virtual image is formed at the point of intersection.

Uses of plane Mirrors

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

(ii) plane are fitted at blind turns of some ~~way~~ busy roads so that drivers can see the vehicles coming from the other side and prevent accidents.

(iii) plane mirrors are used in making periscopes.

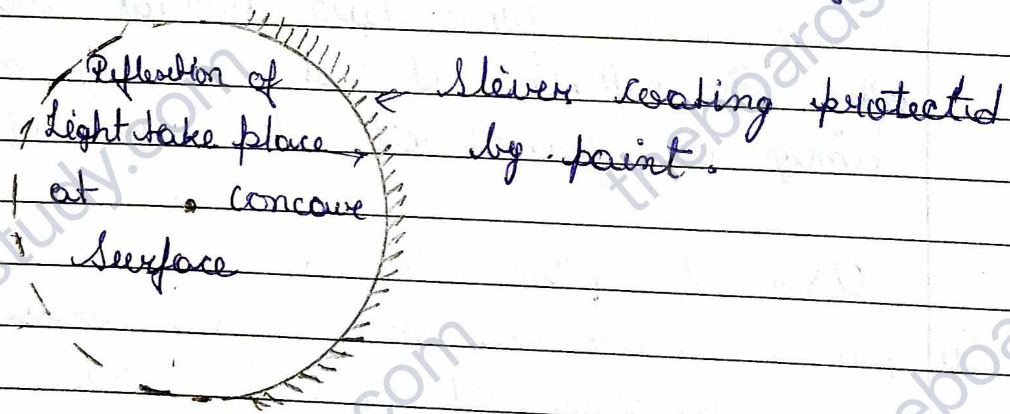
Reflection of light from curved Surface:
Spherical Mirrors.

The spherical mirrors which can converge or diverge the parallel rays of light which fall on them.
The spherical mirrors have curve-like surface, so they are also curved curved mirrors.

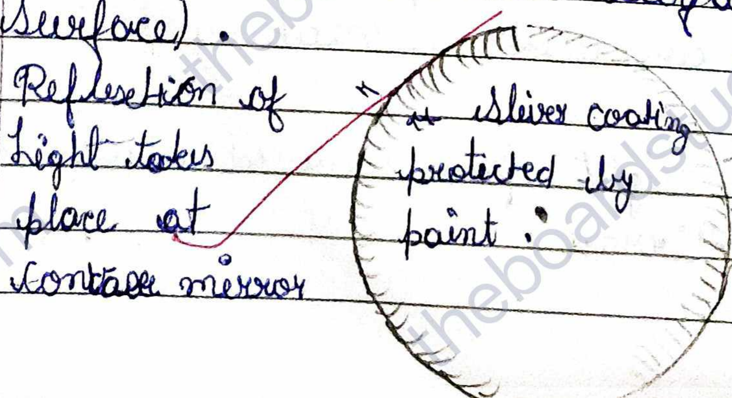
A sperical mirror is that mirror whose reflecting surface is the part of a hollow sphare of glass.

The spherical mirror are of two types :-
① Concave mirrors ② Convese mirrors.

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



(ii) A convese mirror :- A convese mirror is that spherical mirror in which the reflection of takes place at the convese surface (or briging-out-surface).



A spherical mirror (concave or convex mirror) works on the reflection of light

Centre of curvature, Radius of curvature, pole and principal Axis of Sperical mirror.

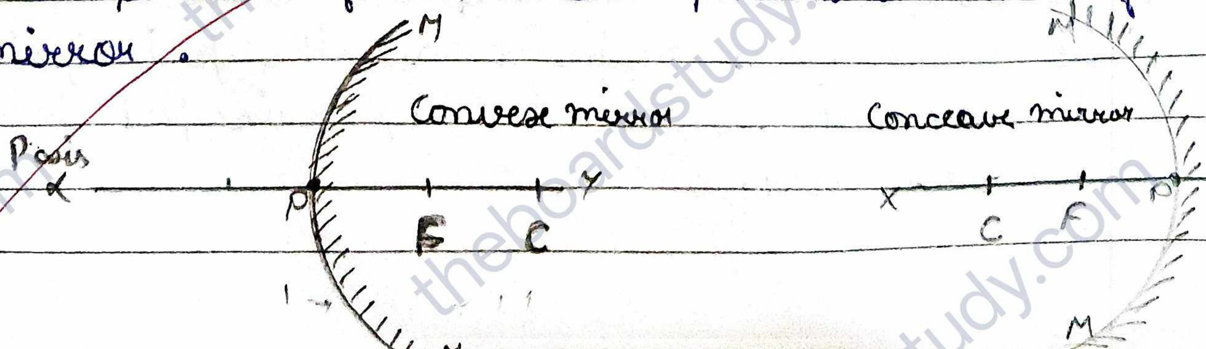
- The center of curvature of a spherical mirror is the centre of the hollow spare of Glass of which the mirror is a part. Reprecented of centre of Curvature by the letter C.
- It is not a part of the mirror.

- The radius of curvature of a sperical mirror is the radius of th hollow sphere of glass of which the mirror is a part.
- Reprecented of radius of curvature by the letter R.

- The center of a spherical mirror is called its pole. Denoted by P

- The straight line(XY) passing through the centre of Curvature(C) and pole(P) of spherical mirror is called its principal axis.

- That portion of a mirror from which the reflection of light actually takes place is called the aperture of the mirror.
- The aperture of a mirror represents the size of the mirror.



Principal Focus and Focal Length of Concave Mirror.

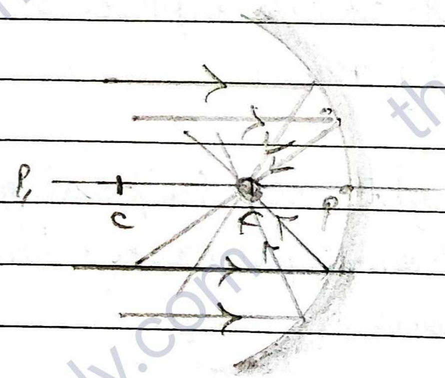
- Principal focus :- The reflected rays appear to come from a point on the principal axis. This point is called the principal focus of concave mirror.

after Reflection

- The distance between pole and the principal focus of a spherical mirror is called the focal length. It is represented by the letter f.

- A concave mirror has a real focus. The focus of a concave mirror is front of the mirror.

- A concave mirror converges a parallel beam of light rays; it is also called a converging mirror.



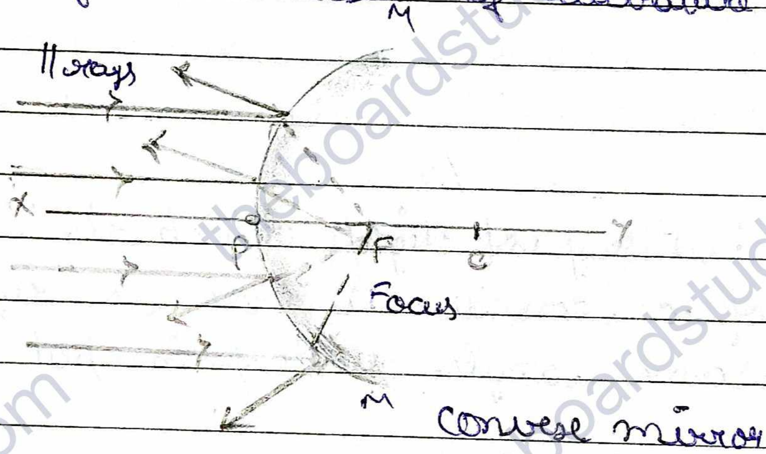
Principal focus and focal length of a convex Mirror

- Principal focus:- The reflected rays rays appear to come from a point on the principal axis. This point is called the principal focus of convese mirror.

- A convese mirror has virtual focus. the focus of a convese mirror is situated behind the mirror
- It is a diverging mirror.

- The focal length of a spherical mirrors is equal to half of its radius of curvature.

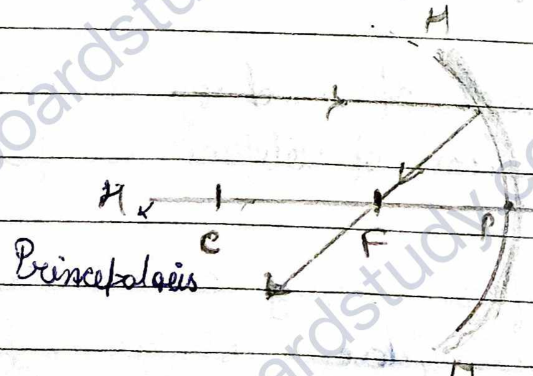
$F = \frac{R}{2}$



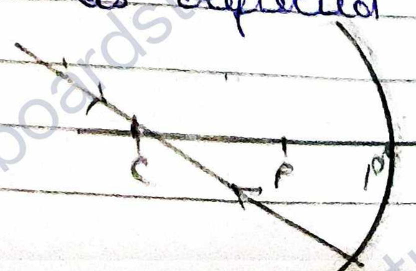
converse mirror

Rules for Obtaining Image formed by Concave Mirrors.

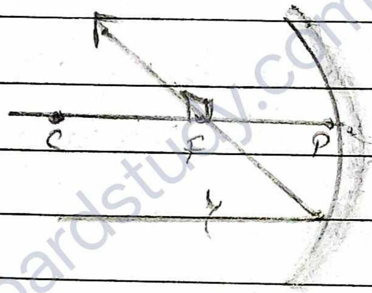
Rule 1 :- A ray of light which is parallel to the principal axis of a concave mirror, passes through its focus after reflection from the mirror.



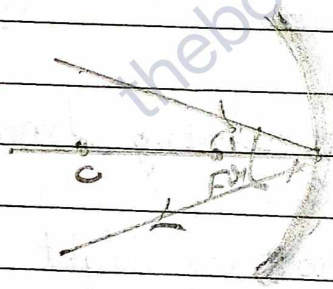
Rule 2 :- A ray of light passing through the centre of a concave mirror is reflected back along the same path.



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



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



Formation of Diffrent 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.

Case 1:- Image formed by a concave mirror when the object is placed between pole and focus of the mirror (Object B/w P and F)

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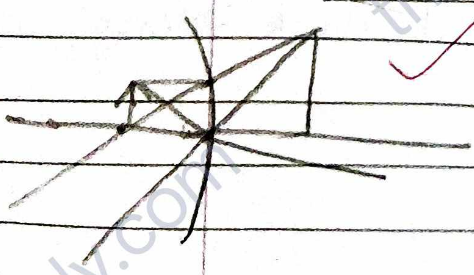

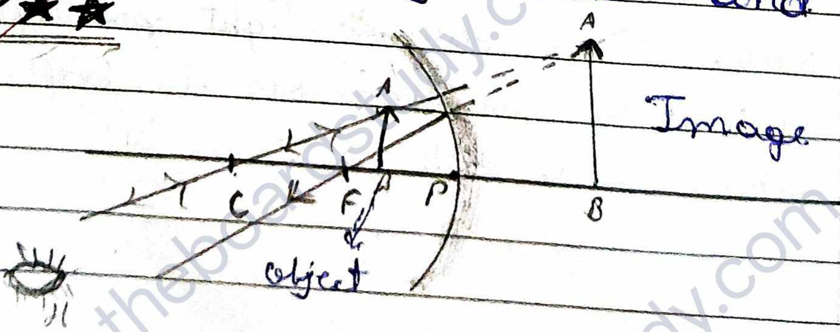

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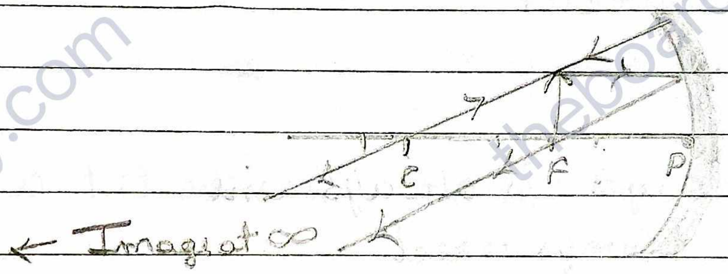
When an object is placed the pole (P) and focus(F) of a concave mirror, the image formed is :
(i) Behind the mirror,
(ii) Virtual and Erect.
(iii) Larger than object (or magnified).

Uses of this case of concave mirror :- Shaving mirror, make-up mirror, Dentists. Torush, Soradar panel.

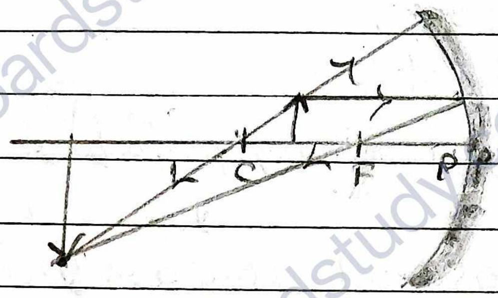
Case 2 :- When the object is placed at the focus of a concave mirror (object at F)



When an object is placed it at the focus of a concave mirror, the image formed is :
(i) at Infinite,
(ii) real and Inverted,
(iii) highly magnified or highly Inlarged.

Exera :- when a lighted bulb is placed at the focus of a concave mirror reflector, the diverging light rays of the bulb are collected by the concave reflector and then reflected to produce a strong parellel - sided beam of light

Case 3 :- when the object is placed between focus and center of curvature (object between F and C)

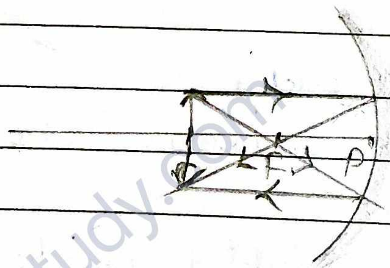


When an object is placed between the focus (F) and centre of curvature (C) of a concave mirror, the image formed is :

(i) beyond the centre of curvature
(ii) Real and Inverted
(iii) Enlarged.

* A real ~~Image is~~ always inverted and A virtual Image is always erect

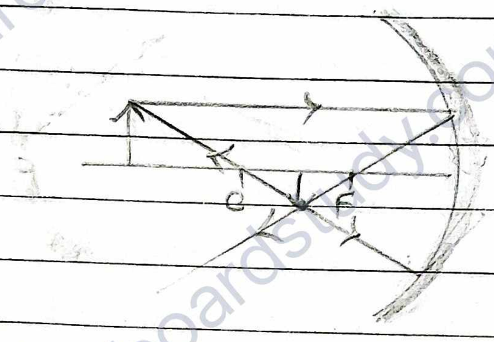
Case 4 :- when the object is placed at the centre of a concave mirror (object at C).



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

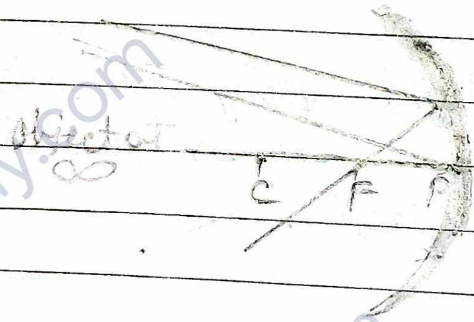
(i) at the center of curvature
(ii) Real and Inverted
(iii) Same size.

Case 5:- when the object is beyound the centre of curvature of the concave mirror (object beyound C)



when an object is placed at Beyond the centre of curvature of a concave mirror, image is formed:
(i) B/w the Centre of curvature and focus,
(ii) Real & Inverted,
(iii) Dimenised (Smaller than the object)

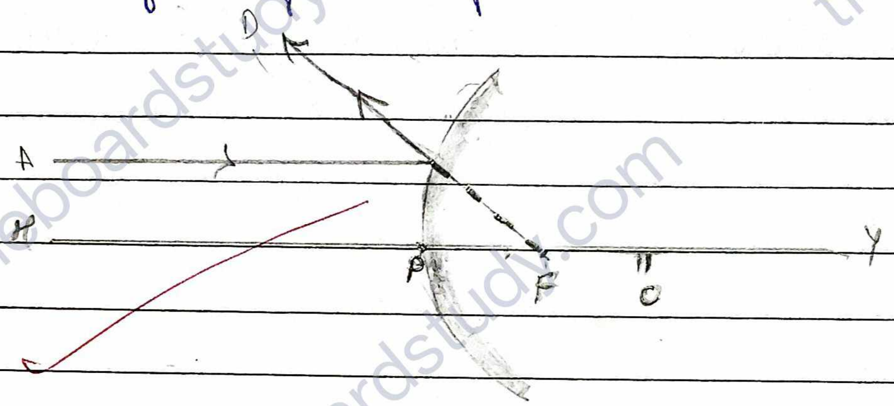
Case 6:- when an object at Infinity.



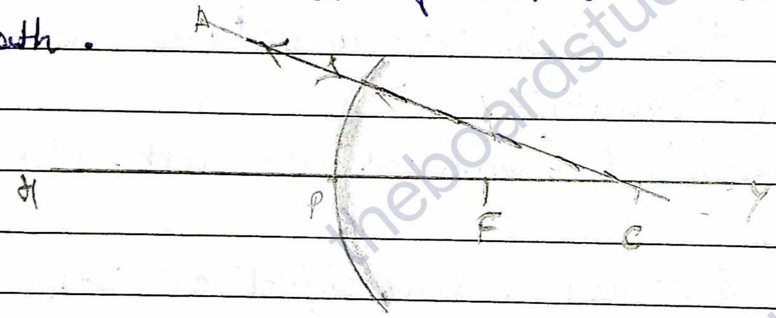
When an object is placed at Infinity from a concave mirror, Image is formed:
(i) at ~~Focus~~ Focus.
(ii) Real & Inverted
(iii) much smaller than the object (or highly deminished).

Rules for Obtaning Image formed by Convese Mirrors.

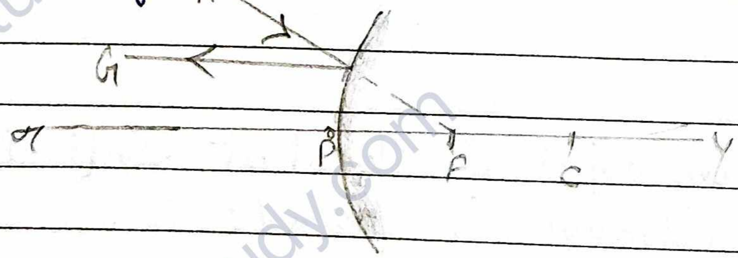
Rule 1:- A ray of light which is parallel to the principal axis of a convese mirror, appears to be coming from its focus after reflection from the mirror.



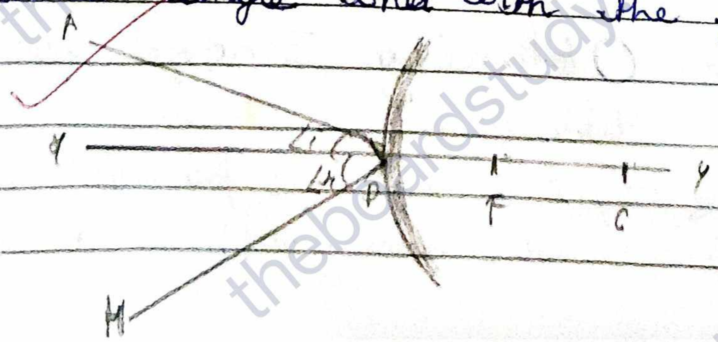
Rule 2:- A ray of light going towards the centre of curvature of a convex mirror is reflected back along the same path.



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



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



Formation of Image By a Convex mirror.

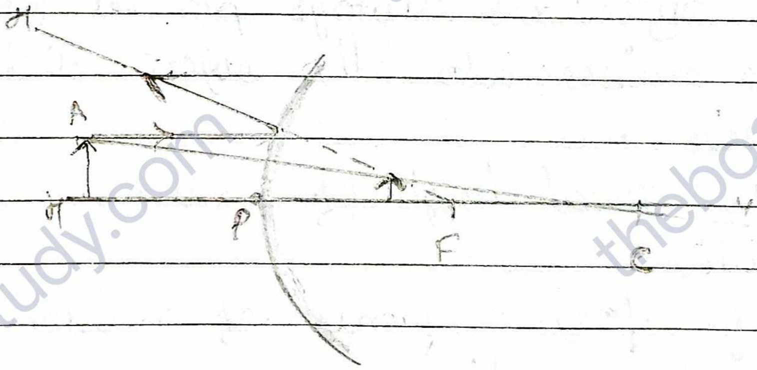
Case 1:- when an object is placed anywhere between pole (P) and infinity in front of a convex mirror, the image formed is :

(i) Behind the mirror between pole (P) and focus (F),
(ii) Virtual and Erect, and
(iii) diminised (Smaller than the object)

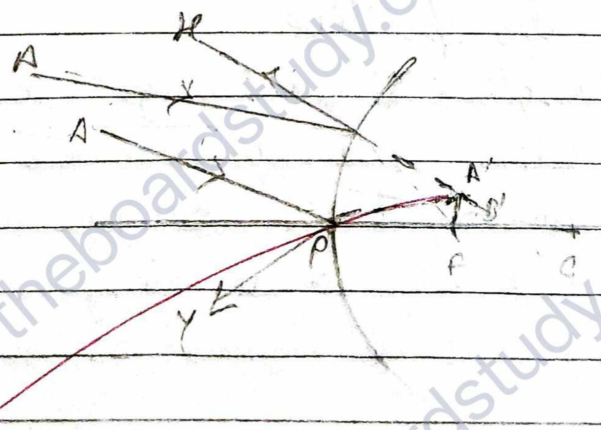
Case2:- When an object is at infinity from a convex mirror, the image formed is:

(i) Behind the mirror at focus (F)
(ii) virtual and erect, and
(iii) highly diminis (much Smaller than the object).

Case 1:-



Case 2:-

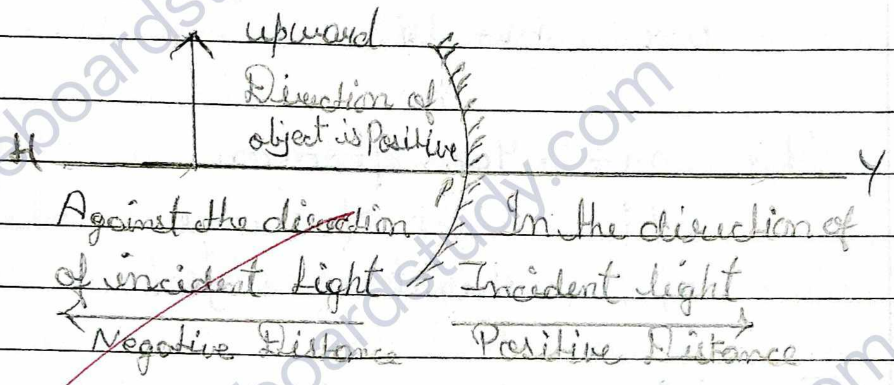


Sign Convention for Spherical Mirrors.

* All the distances are measured from pole of the mirror as origin.
Distance measured in the same direction as that of incident light are taken as positive.
Distance measured against the direction of incident light are taken as negative.
Distance measured upward and perpendicular to the principal axis are taken as positive.
Distance measured downward and perpendicular to the principal axis are taken as negative.

* Important points
* The object is always placed ~~pla~~ on the left side of the mirror so the object distance is always negative.
* The focal length of concave mirror is always negative
* Image formed front of mirror, The Image will be negative.
* Image formed Behind the mirror, The Image is always be positive.
* The focal length and ~~ca~~ Image are always positive In the case of convex mirror.
* The height of object is always considerd positive.
* The height of the ~~a~~ all images are real and Inverted images is taken as negative.

Mirror formula



Sing convention for mirrors.

Mirror formula

A formula which gives the relationship between image distance (v), object distance (u) and focal length (f) of a sperical mirror formula.

$$\frac{1}{\text{Image distance}} + \frac{1}{\text{object distance}} = \frac{1}{\text{Focal length}}.$$

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

where. v = distance of image from mirror
u = distance of ~~image~~ object from mirror
f = focal length of the mirror.

Linear Magnification produced by Mirrors -

The ratio of the height of image to the height of object is known as linear magnification

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$$\text{Magnification} = \frac{\text{height of image}}{\text{height of object}}$$

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

wher m = Magnification
h_i = hight of image
h_o = hight of object.

* The Linear magnification produced by a mirror is equal to the ratio of the image distance to the object distance, with a minus sign.

$$\text{Magnification} = -\frac{\text{Image distance}}{\text{Object distance}}$$

or $m = \frac{-v}{u}$

> A positive sign in the value of the magnificati indicates that the image is virtual and Erect.

> A Negative sign in the value of the Magnific indicats that the image is real and Inverted.

if
$m = 0 > 1$ $m < 1$ - Deminised $= 0 < m > 1$
$m = 1$ Same size
m = greater than 1 $m > 1$ Enlarged
$m = -$ real and Inverted
$m = +$ virtud and Erect.

Refraction of Light

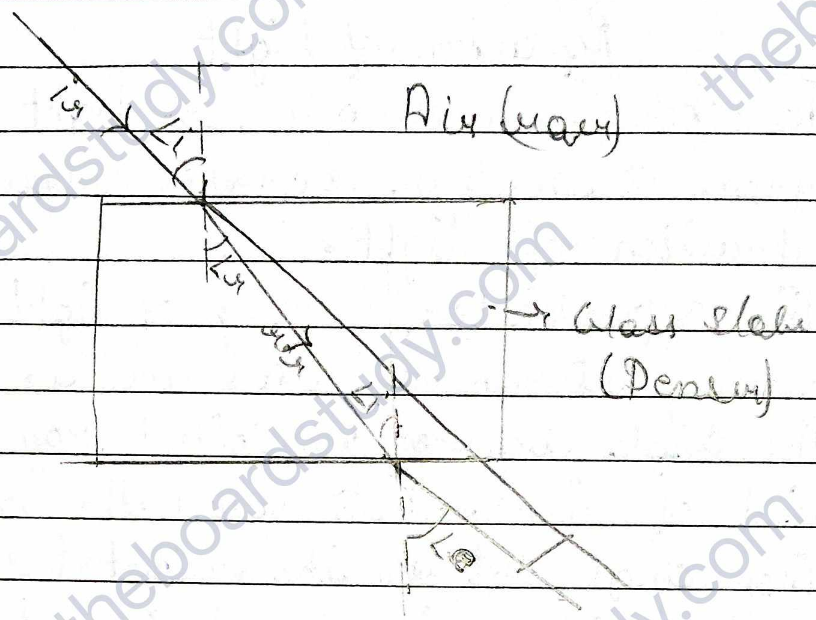
* The change in direction of light when it passes from on medium to another obliquely is called refraction of light.
* The refraction (or bending) of light takes place at the boundary between the two media.
* The angle between incident ray and normal (at the point of incidence) is called the angle of incidence.
* The angle between the refracted rays and the normal (at the point of incidence) is called the angle of reflection
* In the refraction of light, the angle of refraction is usually not equal to the angle of incidence.

Cause of Refraction

* The speed of light is different from different medium
* Light travels faster in air but slower in glass.
* The refraction of light is due to the changes in the speed of light on going from one medium to another.
* Greater the difference in the speeds of light in the two media, greater will be the amount of refraction (or bending) of light.

Why a change in speed of light causes Refraction of light (or Bending of light)

* A beam of light is made up tiny waves.
* The speed of light waves on one side of a beam of light changes a little before the change in speed of light waves on its other side, causes a change in the direction of light. And this change in direction of light is called refraction of light.

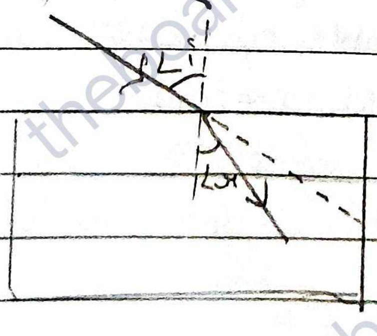


Optically Rarer Medium and Optically Denser Medium

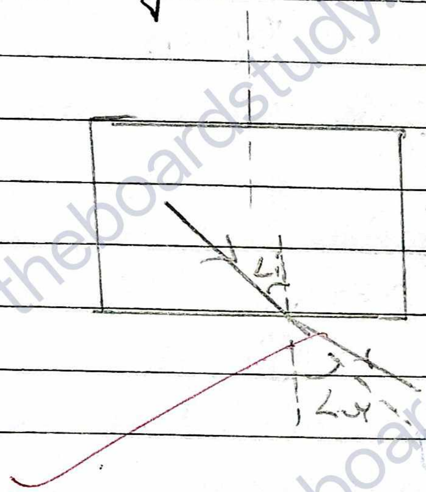
* A transparent substance in which light travels is known as a medium.
* A medium in which the speed of light is more is known as optically rarer medium
* A medium in which the speed of light is less is known as opitcally denser medium.

- When a ray of light goes from a rarer medium to a denser medium, it bends towards the normal
- When a ray of light goes from a denser medium it bends away from the normal.

In case of Rarer to Denser



In case of Denser to rarer



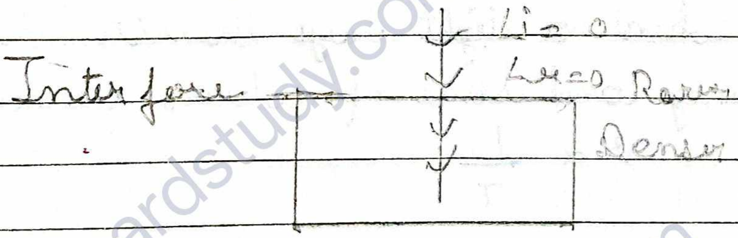
Effects of Refraction

(i) A stick (or pencil) held obliquely and partly immersed in water appears to be bent at the water surface

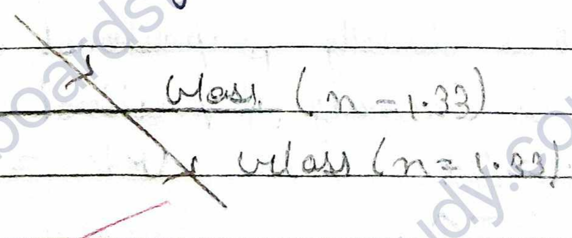
(ii) An object placed under water appears to be raised

When Refraction does not occur

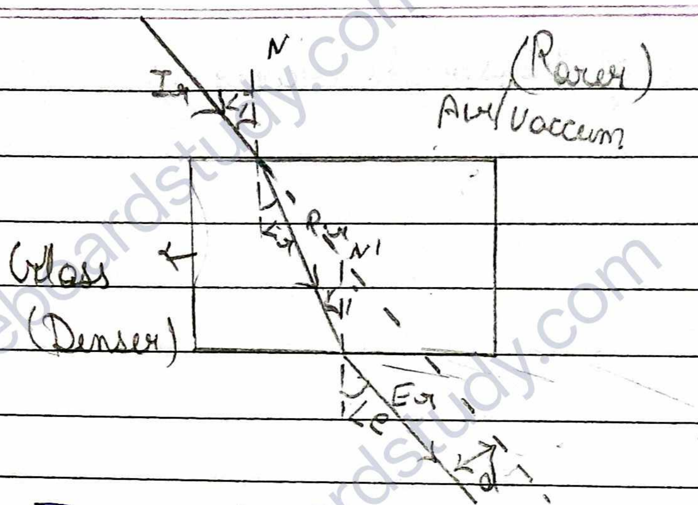
1) When light is incident Normally



2) When light towards transit through media having same optical density.



The case of Light Going from Air into Glass and Again into air.



I r = Incident ray
R r = Refracted ray
E r = Emergent ray
∠i = Angle of incedence
∠r = Angle of refraction
∠e = Angle of Emergence
N = Normal
N' = Normal
d = optical shift / lateral displacement)

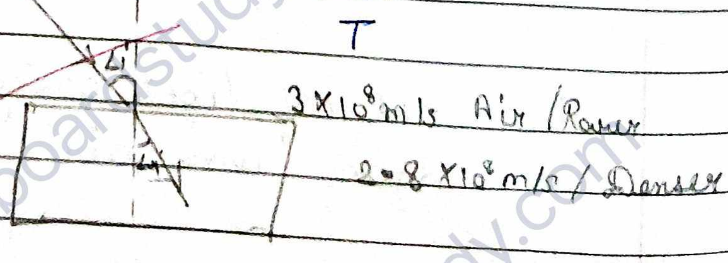
What happens when a light rays transits its medium
Because frequency and sense of colours remain same

$$\nu = \frac{1}{T}$$

It is source dependent
Speed, wavelength and direction change
v = lambda nu or $v = \lambda \nu$

* Speed is directly proportional to Distance and Speed is Inversely proportional to time.

$S\downarrow = \frac{D\downarrow}{T\uparrow}$ or $v\downarrow = \frac{\lambda\downarrow}{T}$



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Laws of refraction of Light

1.) According to the first law of refraction of light :- The incident ray, the refracted ray and the normal at the point of incidence, all lie in the same plane.

2) According to the Snell's Law of refraction of light :- The ratio of sine of angle of incidence to the sine of angle of refraction is constant for a given pair of media (ie, 'air and glass' or 'air and water'). That is

$$\frac{\text{Sine of angle of incidence}}{\text{Sine of angle of refraction}} = \boxed{\text{constant}}$$

or $\frac{\sin i}{\sin r} = \text{constant}$

* This constant is called refractive index.

• The value of the constant $\frac{\sin i}{\sin r}$ for a ray of light passing from air into a particular medium is called the refractive index of that medium. It is denoted by the symbol n.

Refractive index, $n = \frac{\sin i}{\sin r}$

where $\sin i$ = Sine of the angle of incidence (in air)

$\sin r$ = Sine of the angle of refraction (in medium)

* The refractive index is a ratio of two similar quantities (the sines of angles), it has no units.

Refractive Index and Speed of Light

→ The refractive index (n) can also be written as a ratio of speeds of light in two media.

Refractive Index $n_1 n_2$ = $\frac{\text{Speed of light in medium 1}}{\text{Speed of light in medium 2}}$

→ When $n\uparrow$, $r\downarrow$, $v\downarrow$, $\lambda\downarrow$ the medium is Denser.

$$\frac{\sin i}{\sin r(\downarrow)} = n(\uparrow) = \frac{c}{v(\downarrow)} = \frac{\lambda}{\lambda}$$

Refractive Index are two types.

① Absolute . ② Relative .

1) Absolute refractive Index :- when light is going from vacuum to another medium, then the value of refractive index is called the Absolute refractive index.

* With respect to air or vacuum

2) Relative refractive index :- when light is going from one medium (other than vaccum or air) to another medium, then the value of refractive index is called relative refractive index

~~write textbook questions also~~

Khushboo 23/8/23

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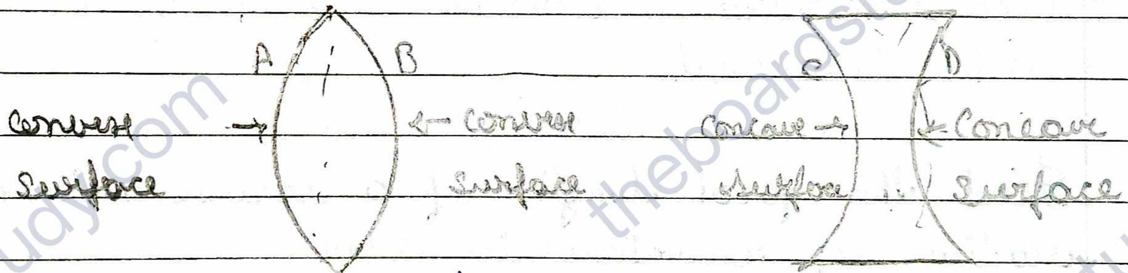
Refraction of Light by Spherical Lenses.

The working of a lens is based on the refaraction of light rays when they pass through it.
A lense is a piece of transparent glass bound by two sperical surfaces.

(i) A ~~lense~~ convese lense is thick at the center but thinner at the edges.

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



convese Lense concave lens

The center point of lense is known as its optical center.
The principal axis of a lens is line passing the optical center of the lens and perpendicular to both the face of the lens.
A lens has two foci [focus]. The Two foci of a lense are at equal distance from the optical center, one on either side of the lens.
The focal length of a lens is the distance between optical center and principal focus of the lens.
A convese lense is also known as converging
A concave lens is also known as diverging.

Intext Questions

Ques 1 The radius of curvature of a spherical mirror is 20 cm what is its focal length ?

Ans $r = 20\ cm$

$f = \frac{r}{2} \Rightarrow \frac{\cancel{20}}{\cancel{2}}\ 10 \Rightarrow f = 10\ cm$

focal Length is 10 cm

Ques 2 Why do we prefer a convex mirror as a rear-view mirror in vehicles ?

Ans Because in convex mirror image formed virtual, Erect and Enlargerd

Ques 3 Find the focal length of a convex mirror whose radius of curvature is 32 cm.

Ans $r = 32\ cm$

$f = \frac{r}{2} \Rightarrow \frac{\cancel{32}}{\cancel{2}} \Rightarrow 16 \qquad f = 16\ cm$

Ques 4 A concave mirror produce three times magnified (enlarged) real-image of an object placed at 10 cm in front of it. where is the image located ?

Ans $u = -10\ cm \qquad m = \frac{-v}{u} \Rightarrow -3 = \frac{-v}{-10}$

$m = -3$

$v = ?$

$-3 \times -10 = -v$

$-30\ cm = v$

Ques 5 A ray of light travelling in air enters obliquely into water. Does the light ray bend towards the normal or away from the normal ? why ?

Ans A ray of light travelling in air enters obliquely into water. The light ray bends towards the normal because the speed of light change in defferent midium. the refractive index of air low and the refractive index of water is high.

Ques 6. Light enter from air to glass having refractive index 1.50 what is the speed of light in the glass? The speed of light in vacuum is 3×10^8 m/s.

Ans n of glass = 1.50

v of light in vaccum = 3×10^8 m/s

$$n = \frac{c}{v} \Rightarrow 1.50 = \frac{3 \times 10^8}{v} \Rightarrow v = \frac{3 \times 10^8}{1.50}$$

$$v = 2 \times 10^8 \text{ m/s}$$

Speed of light in water is 2×10^8 m/s.

Ques 7. The refractive index of diamond is 2.42. what is the meaning of this statement?

Ans By saying that the refaractive index of diamond is 2.42 we mean that the speed of light in diamond is lower by a factor of 2.42 relative to that in vaccum.

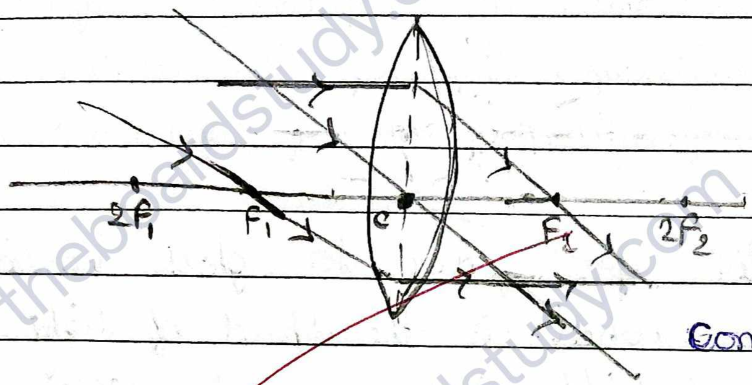
23/8/23

Rules for obtaining Images formed by convex mirror

(i) A ray of light parallel to the principal axis then pass through the focus.

(ii) A ray of light passing through optical center C then Goes return to the same path.

(iii) A ray of light passing through the focus 'F' then Becomes parallel to principal axis.

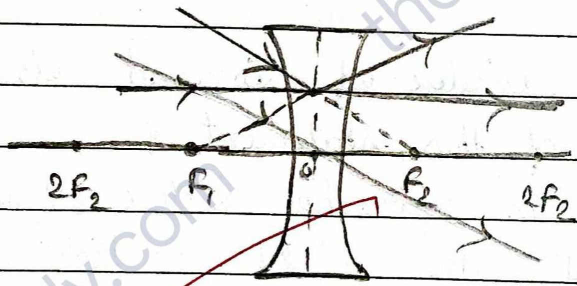


Convex Lens

\# ① A ray of light parallel to the principal axis then Appears to be coming from focus F.

② A ray of light passing through optical centre C then ~~return~~ Cross to the same path.

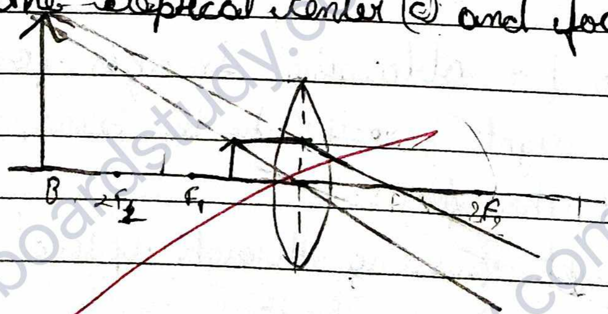
③ A ray of light going towards focus F' Then Becomes parallel to principal axis.



concave lens

Image formation by a convex lens.

(i) Between the optical center (C) and focus (F').

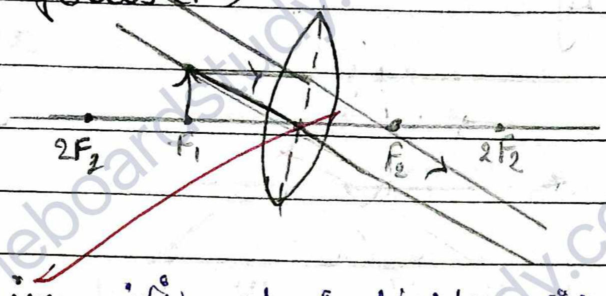


Nature of image is Behind the object (on the left side of lens),

(ii) Virtual and erect

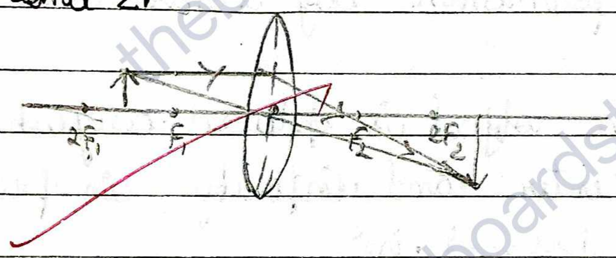
(iii) Larger than the object [enlarged or magnified]

2 At the focus (F')



Nature of image:- (i) at infinity, (ii) real and inverted. (iii) highly enlarged.

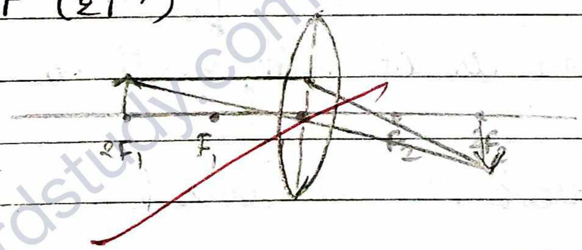
3 Between F' and 2F'



Nature of image:- (i) beyond 2F, (ii) real and inverted. (iii) Magnified.

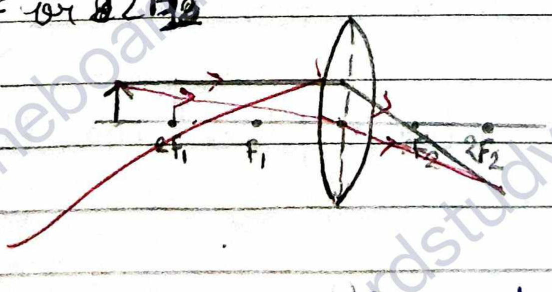
please mark the correct arrows in ray diagram.

4 At 2F (2F')



Nature :- (i) At a distance 2f on the other side of the lens, (ii) real and inverted (iii) of the same size as the object.

5 Beyond 2F' or 2F₂



Nature:- Between f and 2f on the other side of the lens, (ii) real and inverted (iii) diminished

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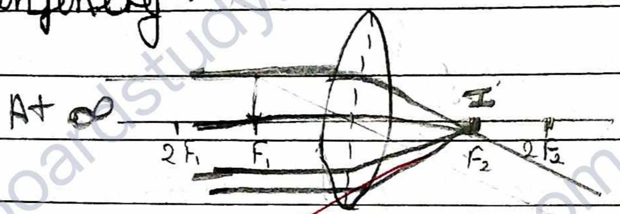
mark the images and objects properly & clearly.

6 At infinity.



Nature :- At the focus, is real and inverted and (iii) much smaller than the object (highly dimenised)

Image formation by concave lens.

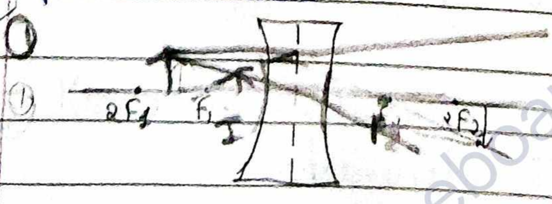
(1) when an object is placed anywhere between optical center and infinity in front of a concave lens the formed is:-
(i) between optical center (C) and focus (F),
(ii) virtual and erect and
(iii) diminsid (smaller than the object.

(2) when an object is at infinity from small a concave lens
(1) at focus (F),
(2) virtual and erect. (3) deminised

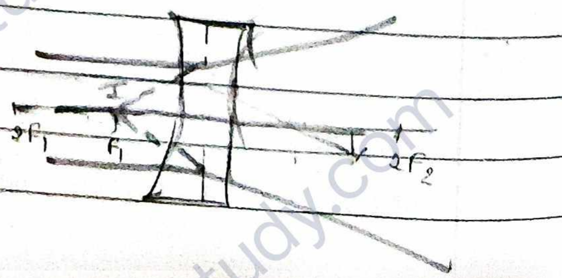
Sign convention for sperical lenses.

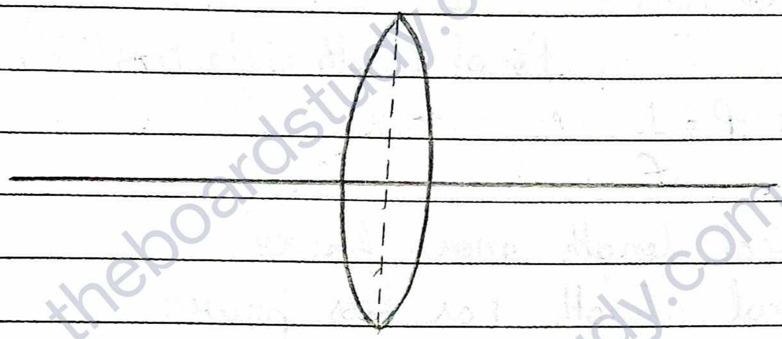
Focal length of concave lens is negative.
The focal length of a convex lens is considerd positive.
The object is always placed on the left side of the lenes.

(1)



(2)





Lense Formula

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

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

Magnification produced by Lenses

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

$$\text{Magnification} = \frac{\text{height of image}}{\text{height of object}} = \frac{\text{Image distance}}{\text{object distance}}$$

$M = 1$ same size

$M < 1$ virtual erect diminised $-m$. real inverted

$M > 1$ real ~~dt~~ inverted $+m$ virtual dimi erect

Enlarged

Power of Lens.

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

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Power of Lens = $\frac{1}{\text{focal Length of the Lens (in meters)}}$

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

Sort focal length more power
Long focal length has less power

The unit of power of lens is dioptre
One dioptre is the power of a focal lens whose focal length is 1 meter.
The power of convex lens is positive
The power of concave lens is negative