Page 01
Date 2

Chapter – 10

Light – The Reflection and Refraction

Topics To be covered :–

○ DUAL NATURE OF LIGHT –

▷ Isac Newton invented the light is in the form of particles.

▷ After some time, A physican Heinsburg invented that light is not a form of particles although is in form of waves.

▷ After 200 – 250 years, Elbert Einstein and Maxwell both worked on light and invented that Light is a form of waves and particles.

Page 02
Date

- Dedroglie invented the defination of Light.

◇ Light - It is a form of energy that give us a sensation of region.

◇ It is a form of electromagnetic radiation.

◇ Source of light

▷ Luminous objects

- These sources emite light of their own.
  eg. Sun, candles, star.

▷ Non-Luminous

- These sources does not emite light of their own. eg. Moon, table, Book.

◇ Medium of Light

The substances through which light propogate is called Medium of Light.

▷ Transparent - Medium through light propogate completely. e.g. Air.

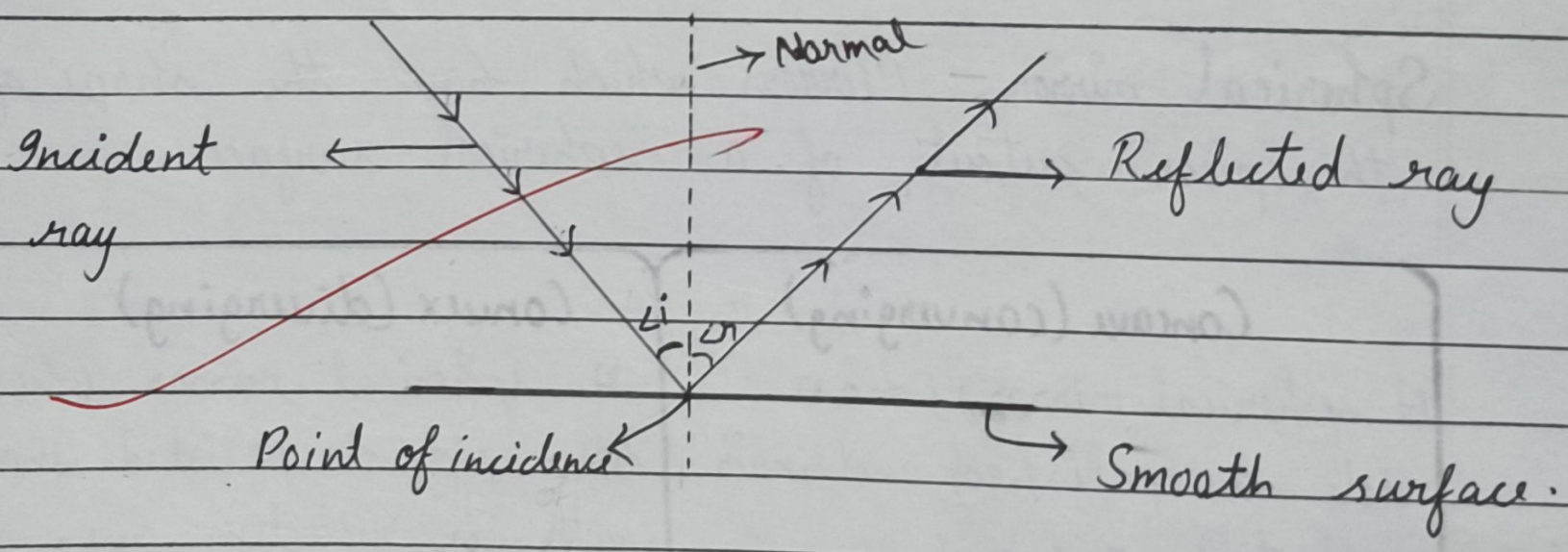
▷ Translucent - Medium through light propogate partially. e.g. Froasted glass.

▷ Opaque - Medium through which light does not propogates. e.g. Metals, wood.

▷ Beam of Light — A bundle of rays of light is called Beam of Light.

◇ REFLECTION OF LIGHT —
The Phenomenon of ~~light~~ bouncing back of light after falling on a polished smooth surface into same medium is called reflection of light.

▷ Laws of Reflection —
i) The angle of incidence is equal to angle of reflextion.
$\angle i = \angle r$.
ii) The incident rays, reflected ray and normal all are lie on same plane.



▷ Image — The point at which the reflective ray actually meet or appear to meat.

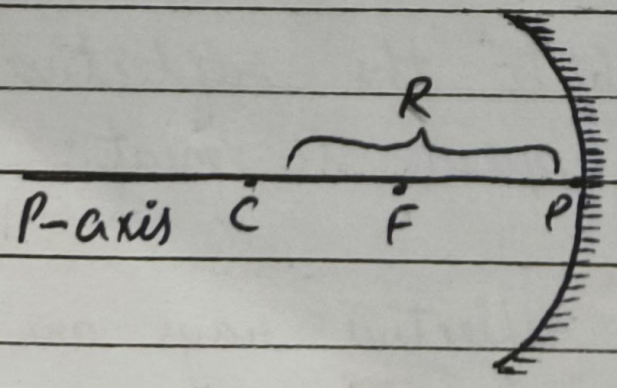
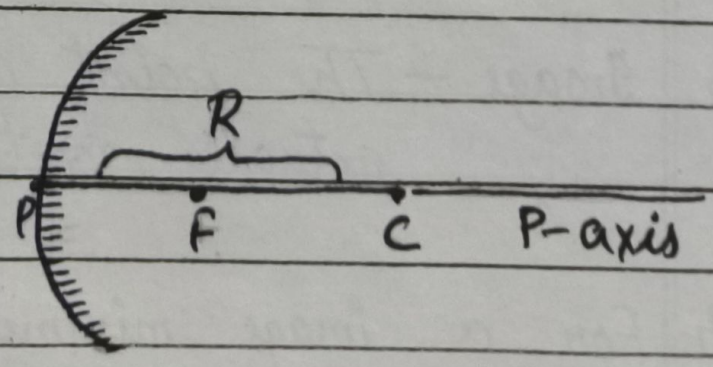
Note: For a image minimum 2 reflective rays are intersect.

▷ Real Image — If the light rays after reflection actually meet then the real image is formed.
- It is always inverted.
- It is always obtain on screen.

▷ Virtual Image — If the light rays after reflection appear to meet then the virtual image is formed.
- It is always erect and does not required on screen.

◇ MIRROR — Plane mirror — It is a flat and reflects the light in order they are recieved.
- Image is laterally inverted

Spherical mirror — Mirrors which have the shape of the piece cutout of a spherical surface.

Concave (converging)	Convex (diverging)
A spherical mirror whose side is polished and inner reflecting one.	A spherical mirror whose inner side is polished and outer is reflecting one.
	

Pole (P) — It is the geometrical centre of apperture.
Apperture (A) — Diamiter of the reflecting surface of spherical mirror is called apperture.

Principal axis (P-axis) — The imaginary line joining the centre of curvature and pole. It may draw the object.

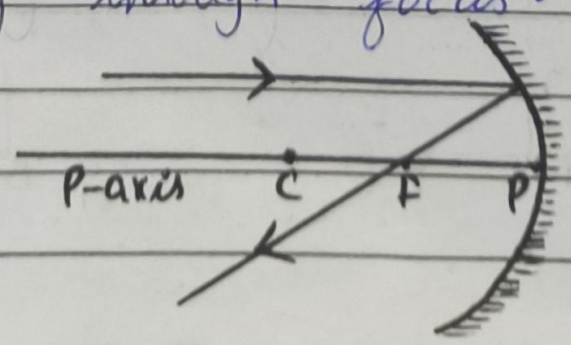
Centre of curvature (C) — It is the centre of the imaginary sphere of which, mirror is apart.

Radius of curvature (R) — The distance b/w C & P.
In mathematical form — $2F = R$
$F = R/2$

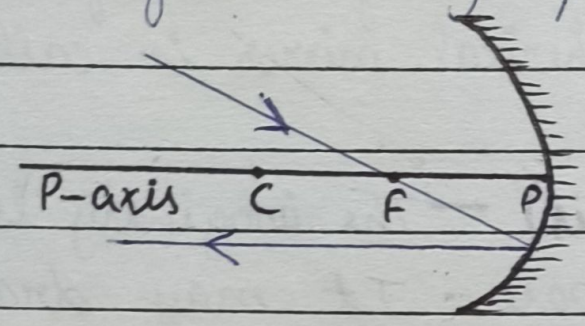
Principal Focus — It is a point on the principal-axis of which all the parallel rays coming from infinity actually converge (in case of concave mirror) or appear to converge (in case of convex mirror) after reflection from respective mirror.

Rules of Image Formation

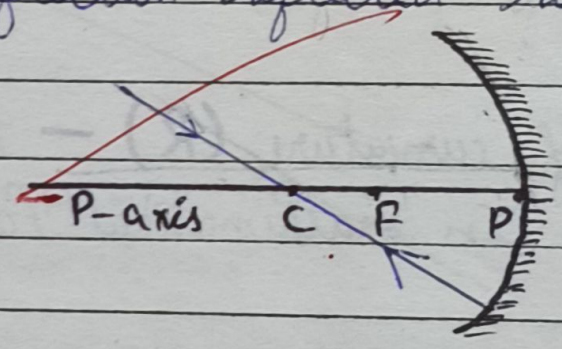
Concave Rules — ① When the incident ray falling on concave mirror and parallel to P-axis, then after reflection passing through focus.



② When the incident ray passing through focus then after reflection reflected ray parallel to p-axis



③ When the incident ray passing through centre of curvature, then after reflection reflected rays same path.



④ When the incident ray passing through Pole. so after reflection reflected ray bend at same angle.

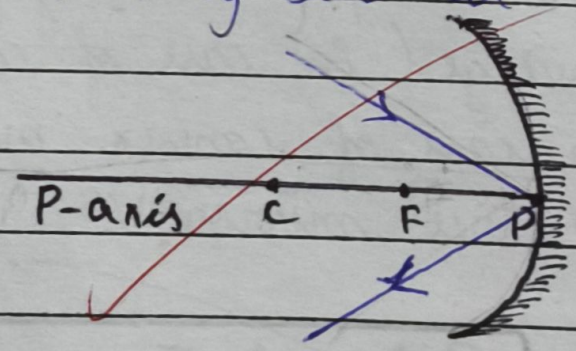
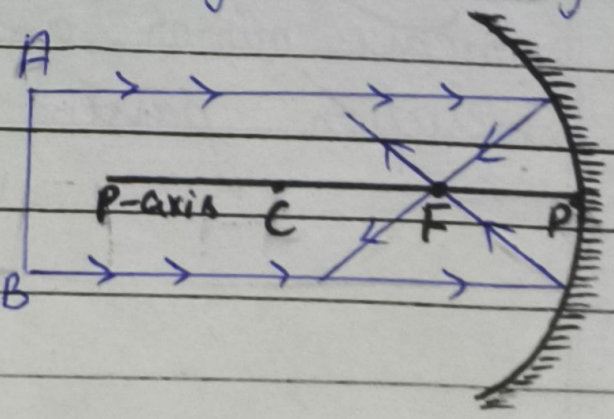


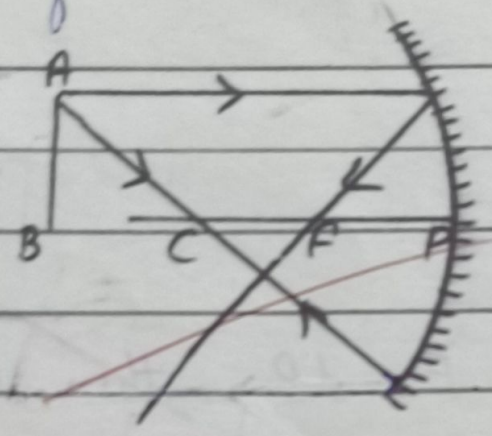
IMAGE FORMATION BY CONCAVE MIRROR.

1. When the object placed at infinity the image is at focus.
   - Real & Inverted
   - Point sized



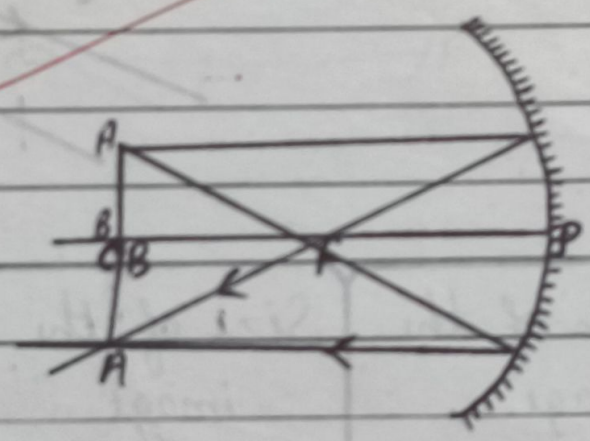
Page 07
Date

2. When object is placed beyond C, then after reflection the image is formed b/w F and C.



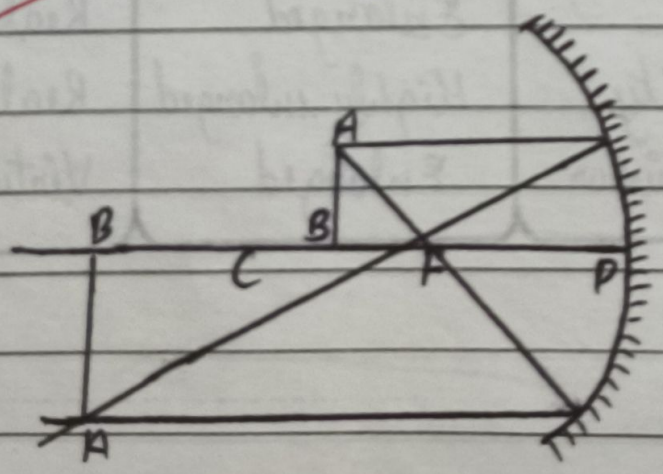
— Deminished
— Real & Inverted

3. When object is placed at C, then after reflection. the image is formed at C and same size.



—Real & Inverted

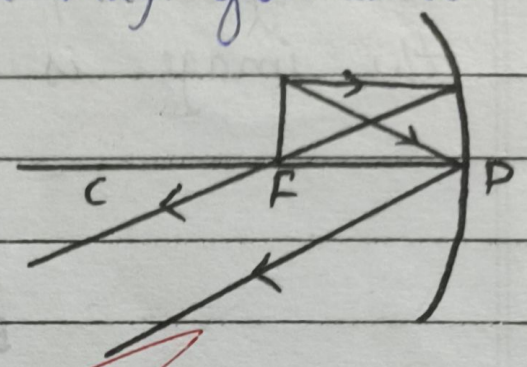
4. When object is placed b/w C and F, then after reflection. the image is formed beyond C.



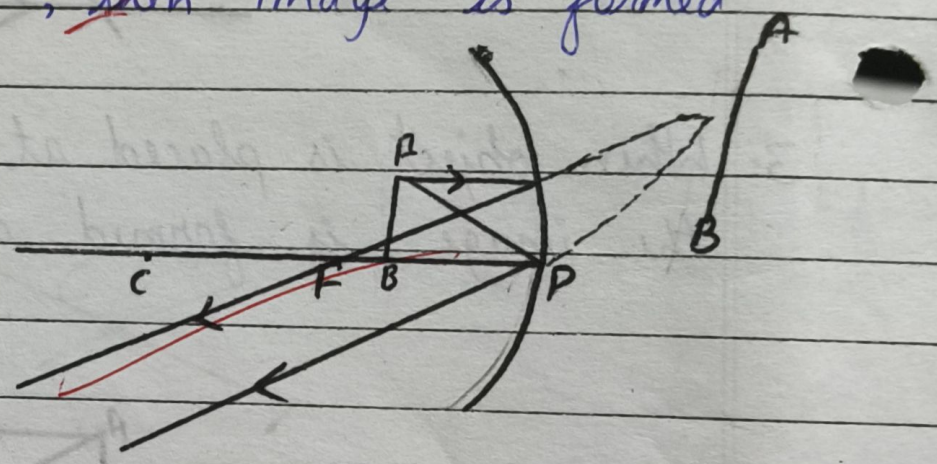
— Enlarged
— Real and Inverted

Page 08
Date

5. When object is placed at F, then the image formed at infinity
- Highly enlarged
- Real and Inverted



6. When object is b/w F and P, then image is formed behind the mirror.
- Enlarge
- Virtual and erect

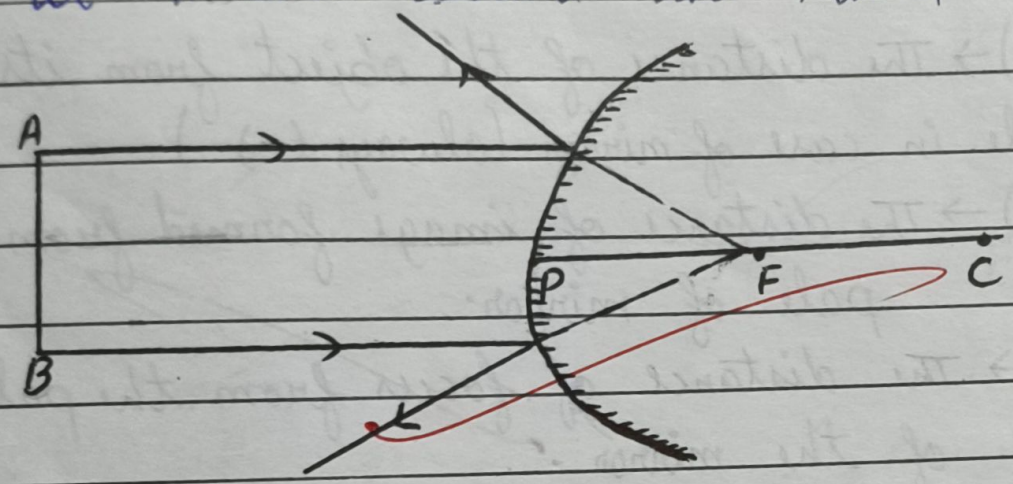


Position of the Object	Position of the image	Size of the image	Nature of the image
At Infinity	At the Focus	Point size, H.Dim.	Real & Inverted
Beyond C	B/w F & C	Diminished	Real & Inverted
At C	At C	Same size	Real & Inverted
B/w C & F	Beyond C	Enlarged	Real & Inverted
At F	At infinity	Highly enlarged	Real & Inverted
B/w F & P	Behind the mirror	Enlarged	Virtual & Erect

Page 09
Date

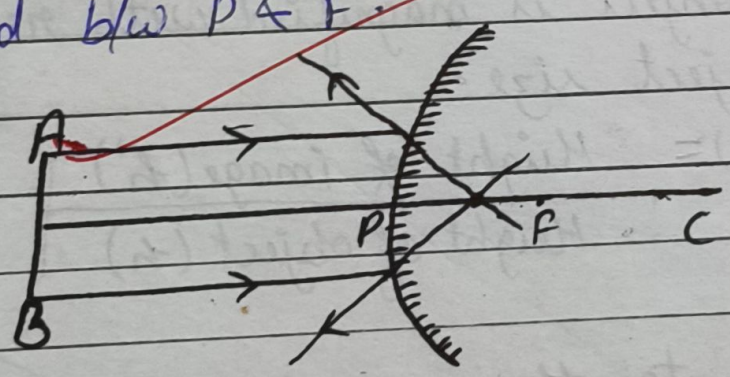
Formation of Image By Convex Mirror

1. When object is at infinity (∞). Then image is formed at F and behind the mirror.



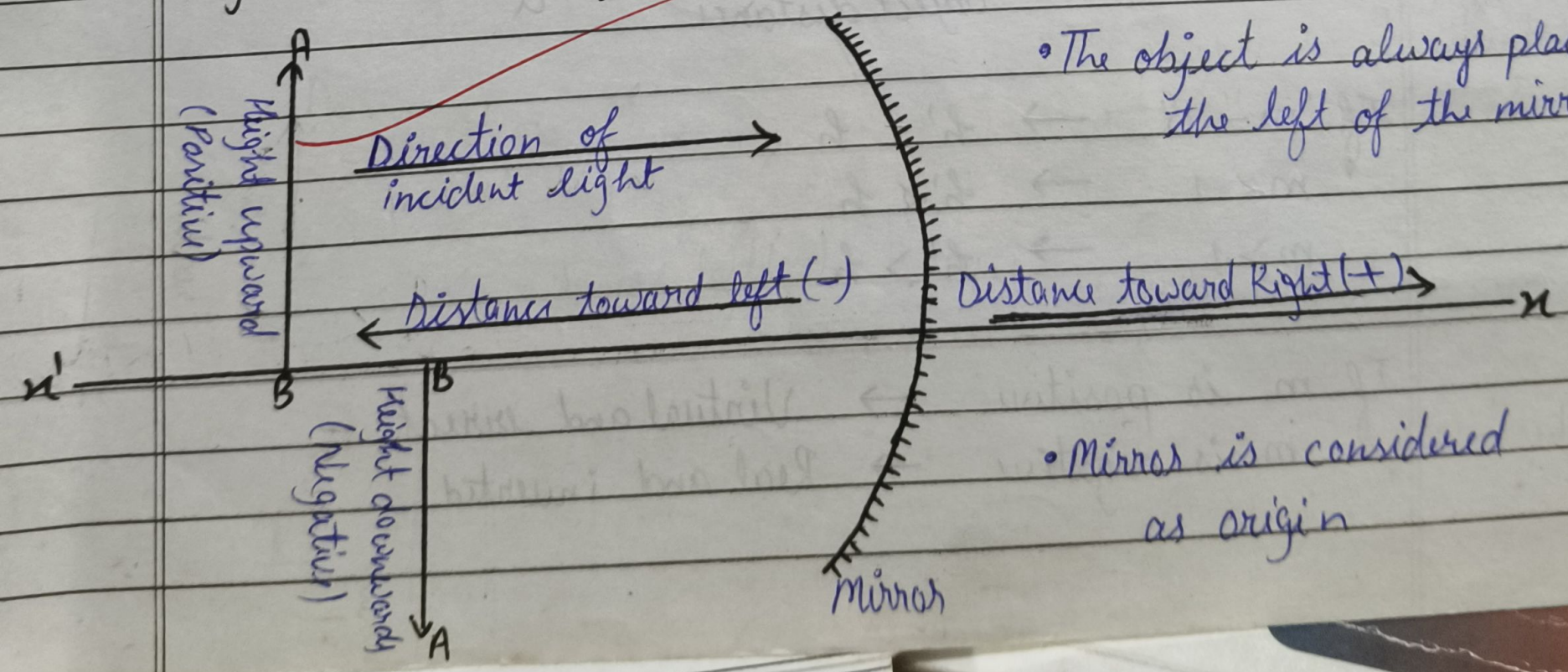
Size - Point size
Nature - Virtual and erect

2. When object is b/w P-axis and Pole, then image is formed b/w P & F.



Nature - Virtual & Erect
Position - B/w P & F
Size - Diminished

Sign convention for Reflection By Spherical Mirrors



- The object is always placed the left of the mirror.
- Mirror is considered as origin

Formula of mirror → It is relation b/w quantities u, v and F. It can expressed as $\boxed{\frac{1}{v} + \frac{1}{u} = \frac{1}{F}}$

- Object distance (u) → The distance of the object from its pole in case of mirror (always (-))
- Image distance (v) → The distance of image formed from pole of mirror.
- Focal length (f) → The distance of focus from the pole of the mirror.

Linear Magnification → It gives the relative extent to which the object is magnified with respect to the object size.

$$\text{Magnification (m)} = \frac{\text{Height of image } (h')}{\text{Height of object } (h)}$$

It also relatid to the u and v.

$$m = \frac{\text{Image distance}}{\text{Object distance}} = \frac{-v}{u}$$

If $m = 0 \rightarrow h' = h$

$m < 1 \rightarrow h' < h$

$m > 1 \rightarrow h' > h$

If m is positive → Virtual and erect

m is negative → Real and inverted

Page
Date

Refraction → The phenomenon of bending of light ray when passes from one medium to another is called refraction of light

1. When light ray passed from rarer to denser it bends towards the normal. (Refer Fig 1)

2. When it passed from Denser to rarer it bends away from the normal. (Refer Fig 2)

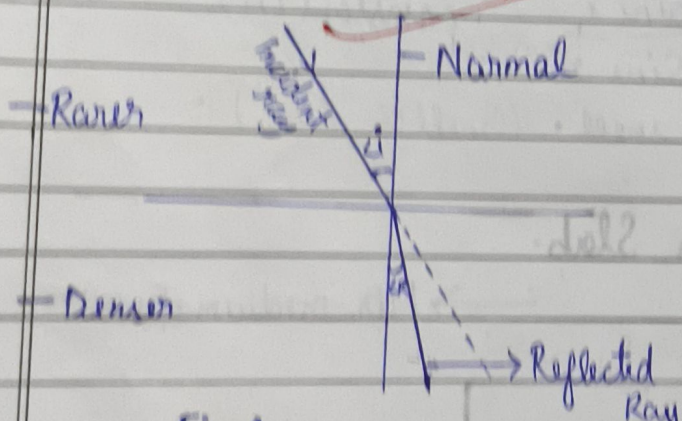


Fig. 1.

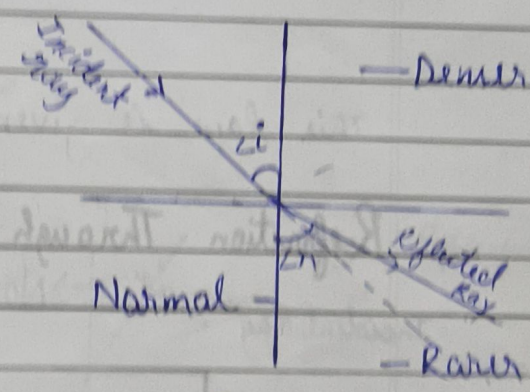


Fig. 2.

Cause of Refraction.

In every medium, the speed of light. It may be lesser in denser medium and higher in rarer medium. So, When light enters a denser medium it's speed decreases and it bends towards the normal when its enters a rarer medium, so speed increase and it bends away from normal.

Laws of Refraction

Ist Law- The incident ray, refracted ray and normal ray, all are lies on a same plane

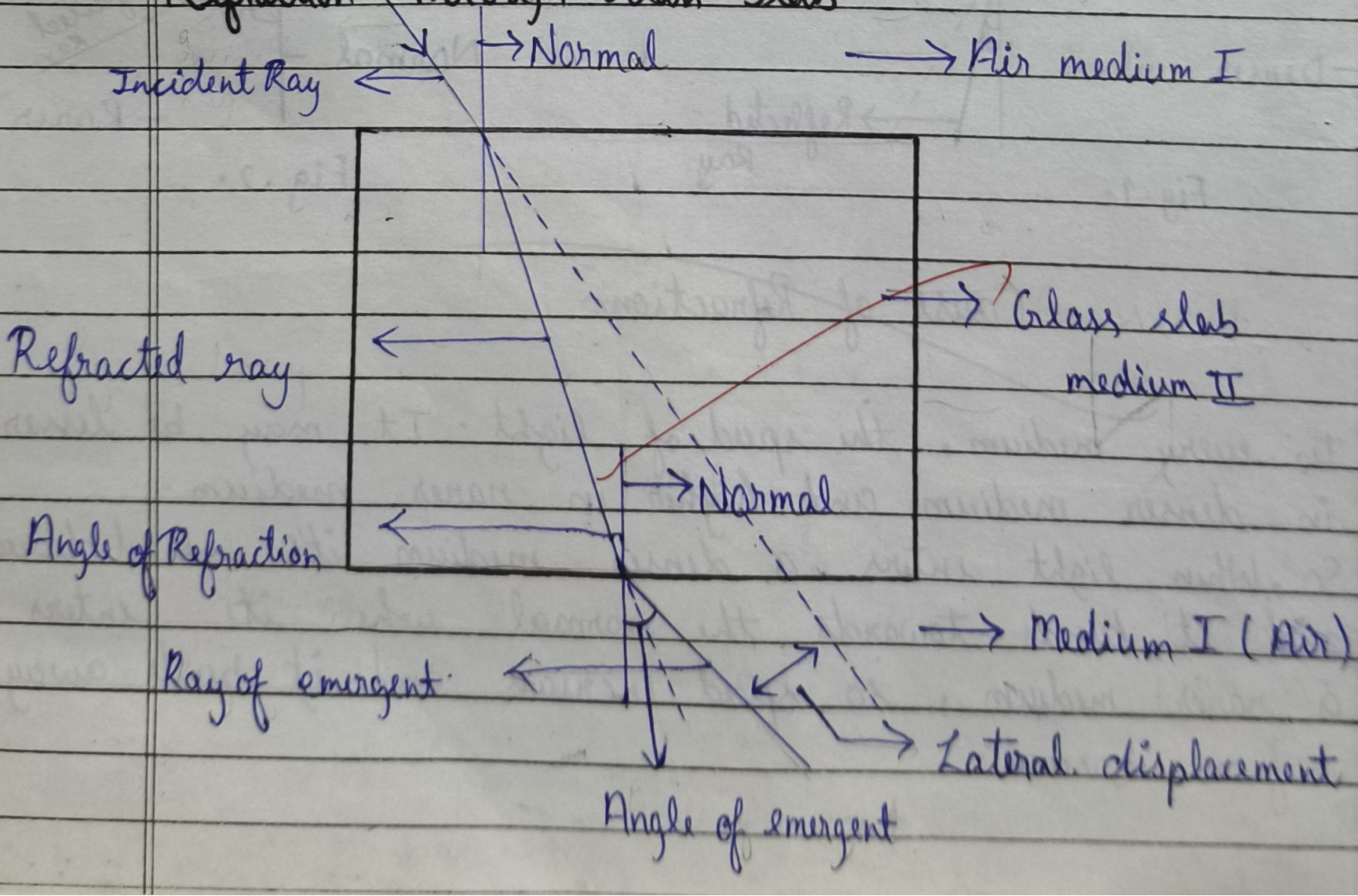
IInd Law- The ratio of sine of angle of incident to sine of angle of refration for light of a given colour is constant for a given pairs of media.

In mathematically form -

$$\frac{\text{Sin } i}{\text{Sin } r} = \text{constant } (n).$$

This law is given by snell. (Snell's Law)

Refraction Through Glass Slab.



Refractive Index → For a given pair of media n_{21} represent refractive index of medium 2 with respect to medium I, When light passes from medium 1 to medium 2.

→ If the refractive index of medium is taken with respect to vaccum. It is called absolute refractive index.

$$n_{21} = \frac{\text{Speed of light in medium I}}{\text{Speed of light in medium II}}$$

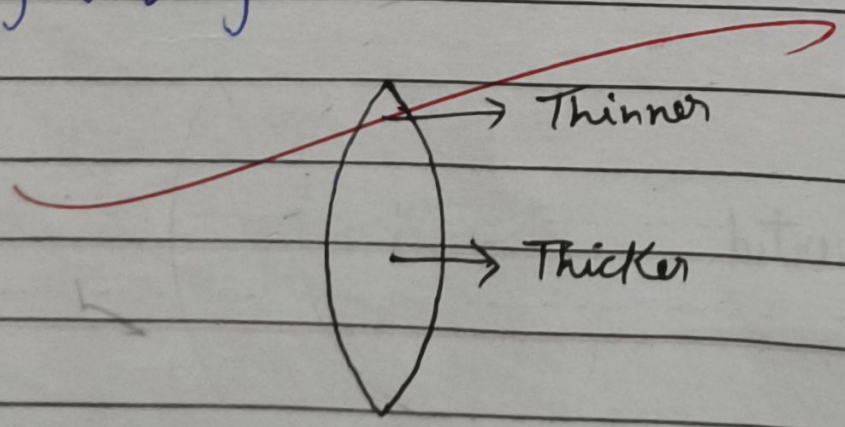
Lenses → It is transparent medium bounded by two surface.

- It is of 2 types. — (i) Convex lens (ii) Concave lens

Convex Lens

A lens which is ~~to~~ thicker at centre and thinner at end.

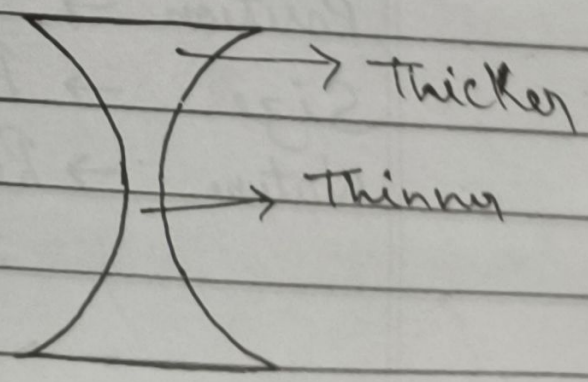
Converging lens because it converges a parallel beam of light ray.



Concave Lens.

A lens which is thinner at centre and thicker at end.

Diverging lens because it diverges a parallel beam of light ray.



Optical centre → The geometrical centre of a lens is called its optical centre.

Rules of Image formation by Lenses -

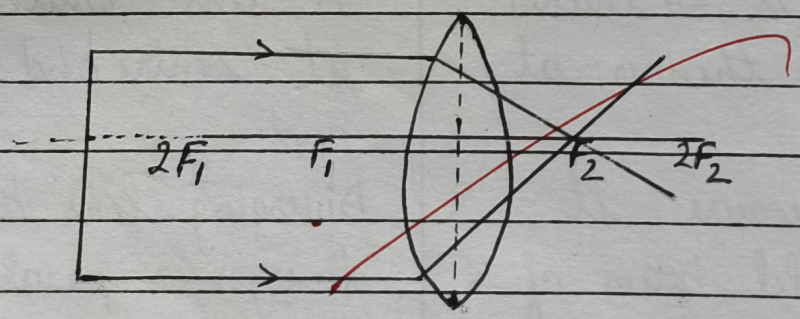
① Rays parallel to the principal focus then passes through second focus of spherical lens.

② Rays passing through focus after refraction parallel to p-axis.

③ Rays passing through the optical centre, will emerge without any deviation after refraction through the lens.

Image formation by convex lens.

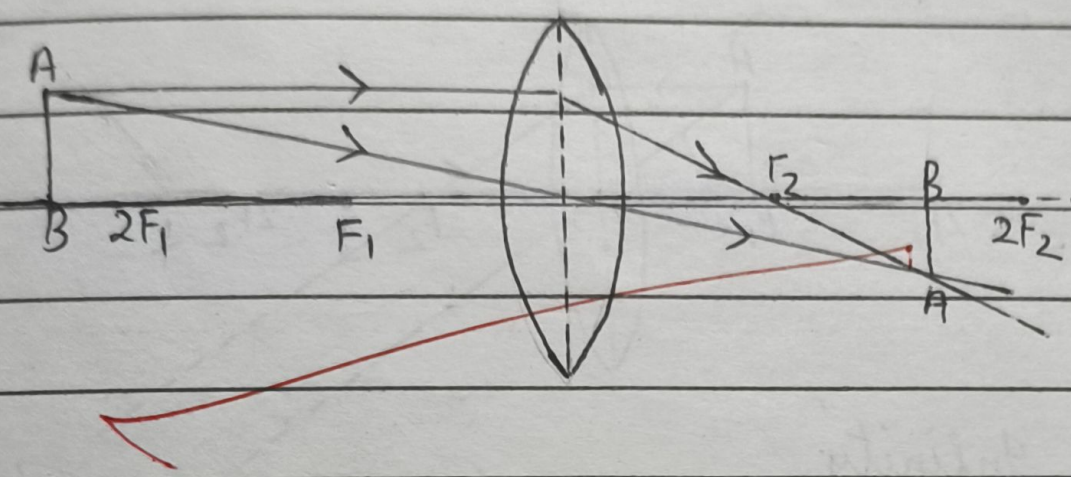
① When the object is placed at infinity.



Position → F_2
Size → Point size
Nature → Real and Inverted

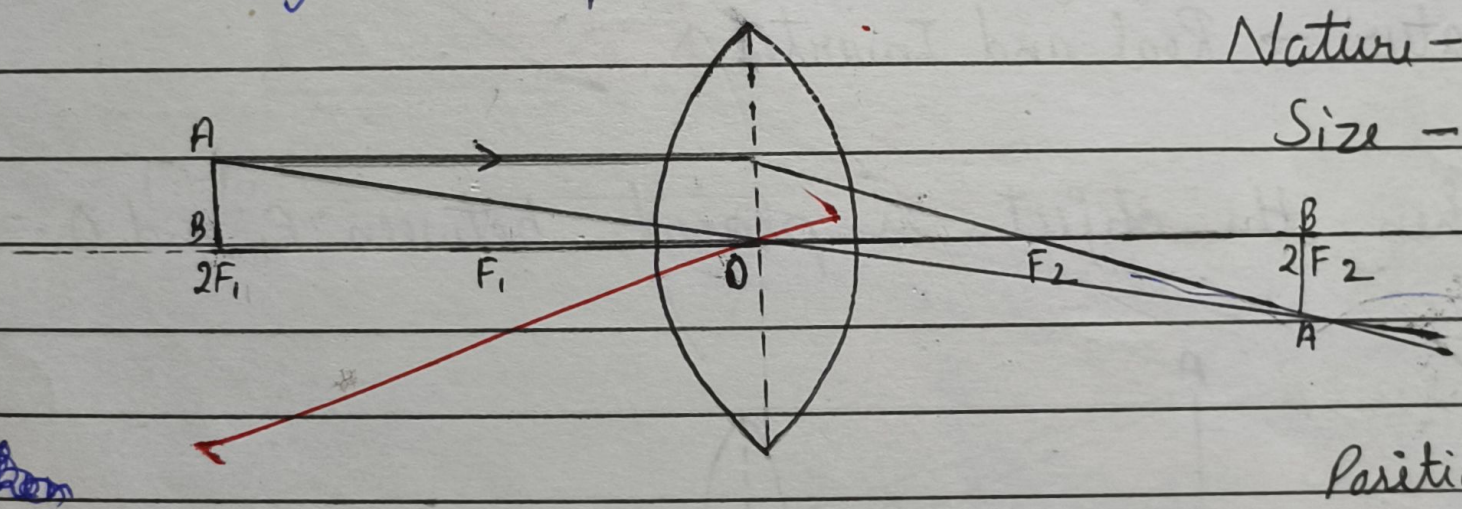
Page 15
Date

② When the object is placed beyond the $2F_1$.



Position - B/w F_2 & 2F
Size - Diminished
Nature - Real and Inverted

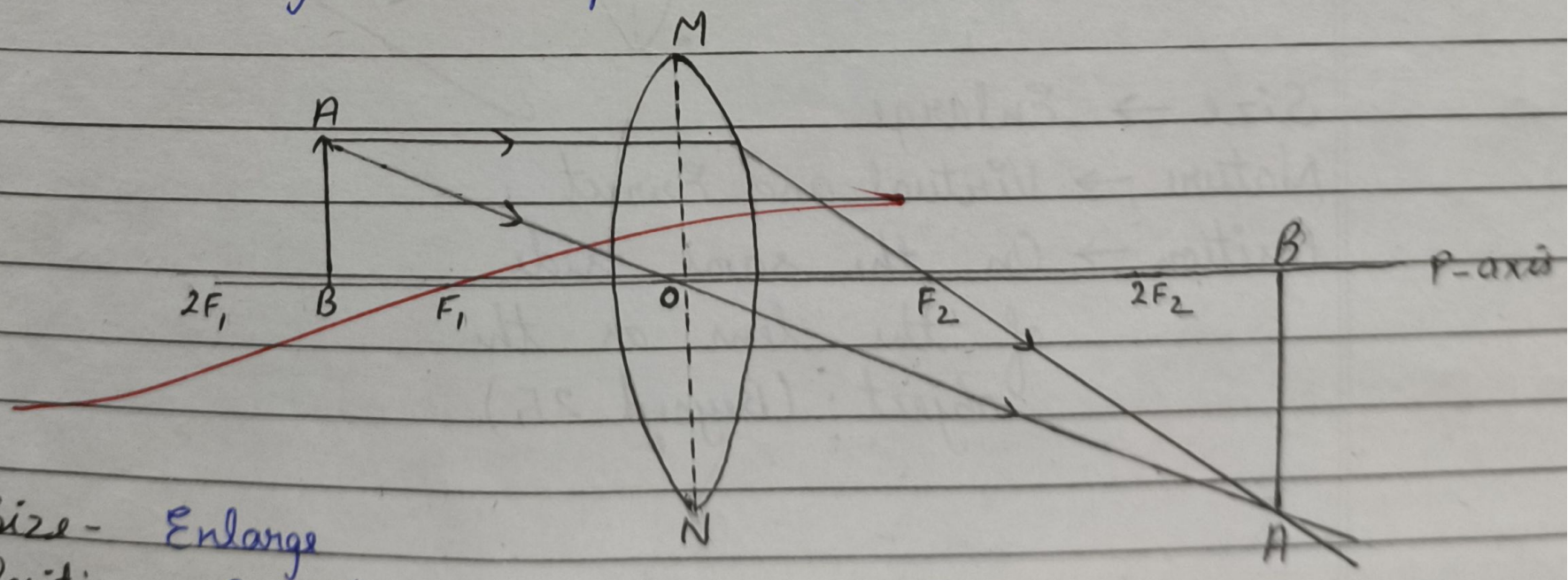
③ When the object is placed at $2F_1$.



Nature - Real & Inverted
Size - Same size

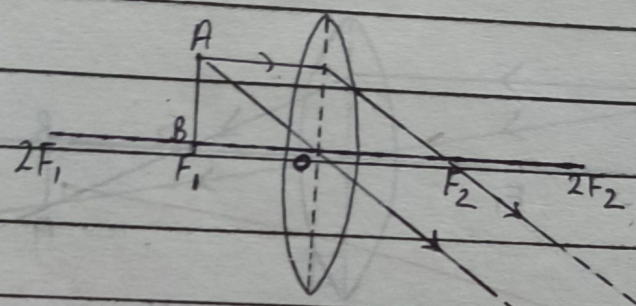
Position → At $2F_2$

④ When the object is placed b/w F_1 and $2F_1$.



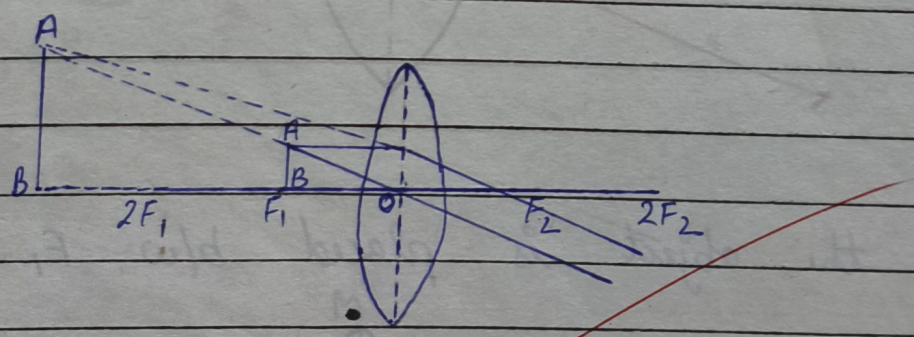
Size - Enlarge
Position → Beyond $2F_2$
Nature → Real and Inverted.

(5) When the object is placed at F_1.



Position → Infinity
Size → Highly Enlarge
Nature → Real and Inverted

(6) When the object is placed between F_1 and O.



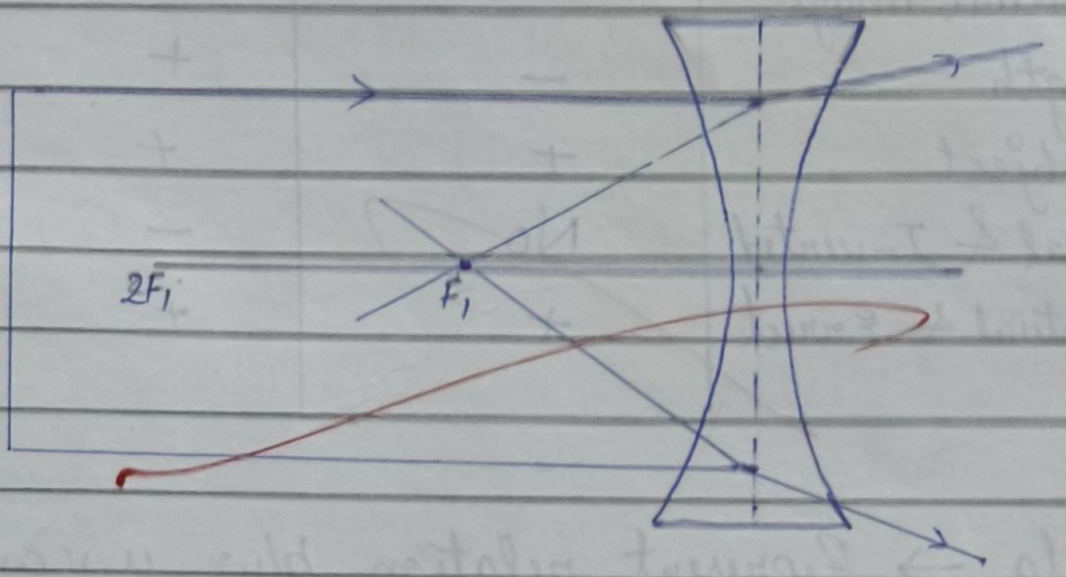
Size → Enlarge
Nature → Virtual and Erect
Position → On the same side of the lens as the object. (Beyond $2F_1$)

Serial No.

Page : 17
Date :

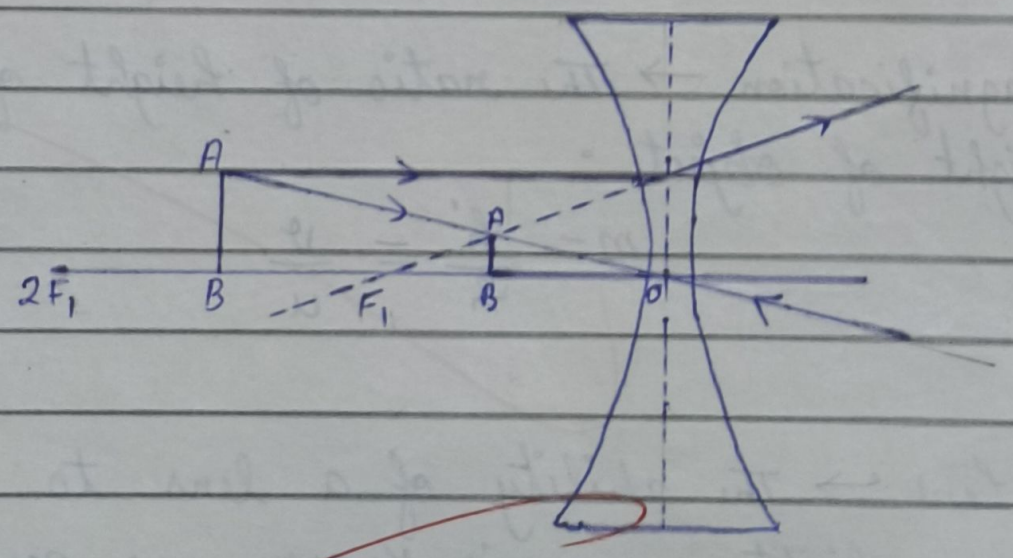
Image formation by concave lens.

① When the object is placed at infinity.



Position → F_1
Size → point size
Nature → Virtual and Erroct.

② When the object is placed between $2F_1$ and OF_1.



Position → B/W F_1 and O
Size → Diminished
Nature → Virtual and Erroct.

Signature of the checker

Serial No.

	Concave lens	Convex lens
Distance of object	−	−
Distance of real image	No	+
" " virtual image	−	−
Focal length	−	+
Height of object	+	+
" " Real & Inverted	No	−
" " Virtual & Erect	+	+

Lens Formula → Represent relation b/w u, v and f.

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

Linear magnification → The ratio of height of image and height of object.

$$m = \frac{h'}{h} = \frac{v}{u}$$

Power of Lens → The ability of a lens to converge or diverge light rays is known as power of lens.

- Denoted by 'P'.

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

- SI unit is dioptre (D) $\left(1D = \frac{1}{10}m\right)$
- For convex lens 'Power & focal length are positive'.
- For concave lens " " " " are negative.

Signature of the checker

Date 19
Page

Uses of Concave mirror.

- by a dentist
- In a searching light
- In a shaving mirror
- In head light
- In vehicles head light

Uses of convex mirror

- As a rear view mirror
- In shops to check theft
- To lighten large area

Uses of convex lens

- Wide angle syphare indoor
- Myophic eye ~~object~~ defect correction

Uses of concave lens.

- Telescope, Camera, Microscope, magnifying glass, Hypermetrophic eye ~~deft~~ defect correction.

V. Good
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03/07/23