Light

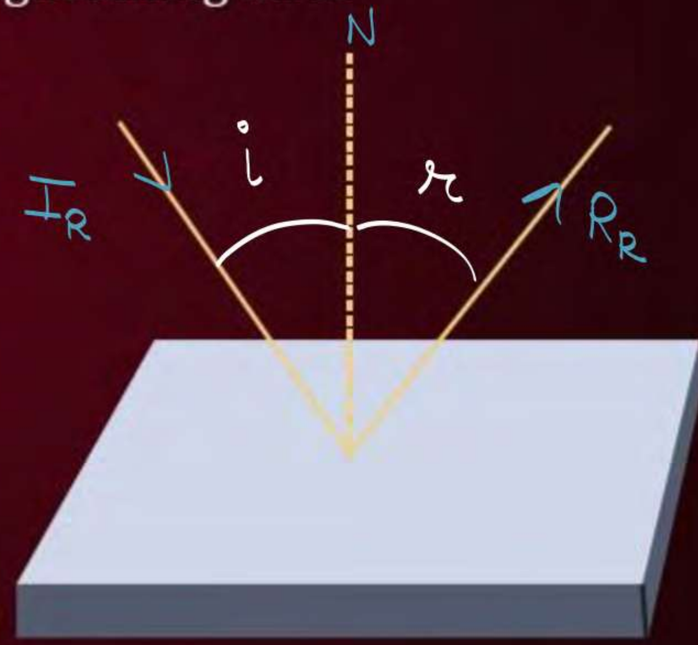
Light is a from of energy that produces the sensation of sight.

Properties of Light

- It propagates with 3×10^8 m/s vacuum or free space.
- It tends to travel in a straight line.

Reflection

A polished surface such as mirror, reflects most of the light falling on it.



Law of Reflection

- Angle of incidence (i) is equal to the angel of reflection (r).
- Incident ray, Reflected ray and Normal, all lie in the same plane.

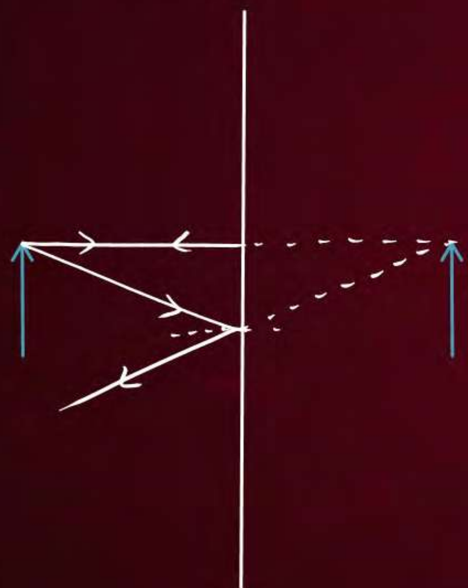
Types of Imges

Real Image	Virtual Image
❖ Light rays actually meet.	❖ Light rays do not actually meet.
❖ Real images are always inverted.	❖ Virtual images are always erect.
❖ Always form on screen like retina	❖ Always form behind the mirror like in plane mirror

Types of Mirrors

- Plane mirror
- Spherical mirror
  - Concave mirror
  - Convex mirror

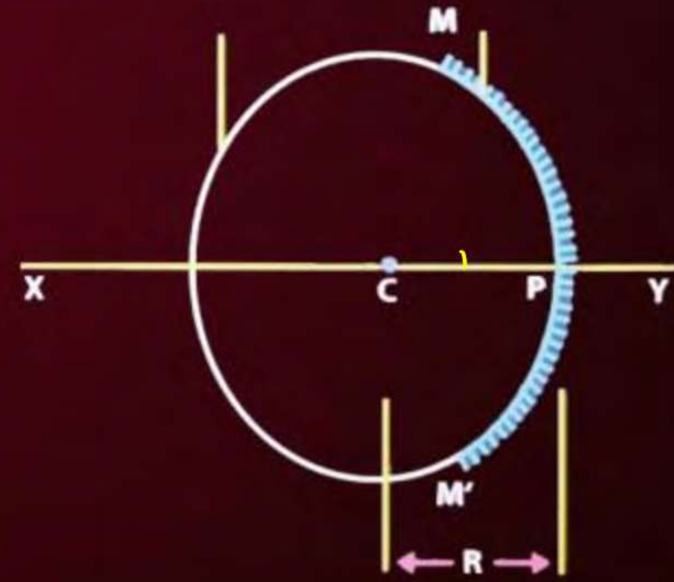
Formation of Images in Plane Mirror



- Virtual and erect images will form.
- Same size image as object is formed.
- Laterally inverted image is formed.
- Image is at equal distance inside mirror.

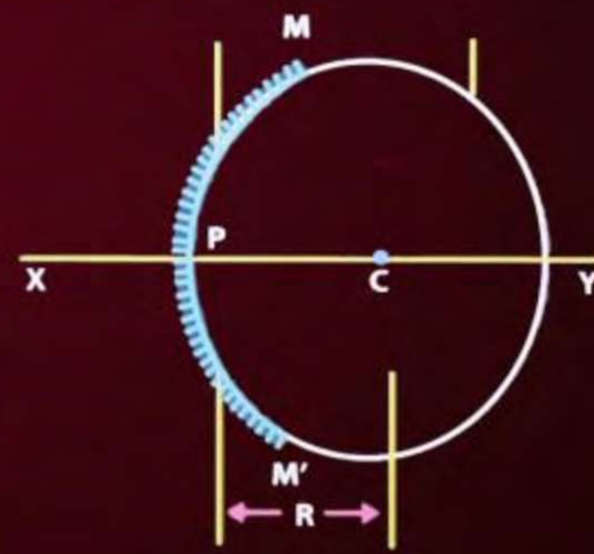
Concave Mirror

❖ A spherical mirror whose reflecting surface is curved inwards i.e., faces towards the centre of the sphere is called a concave mirror.

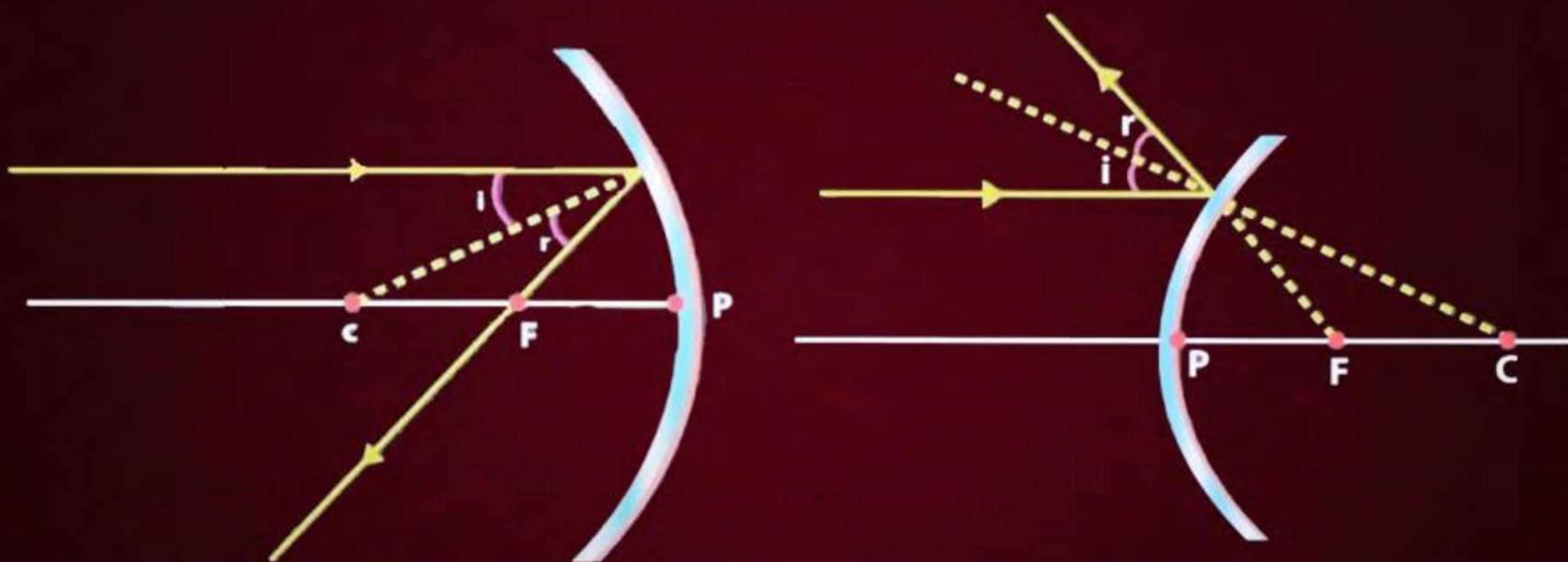


Convex Mirror

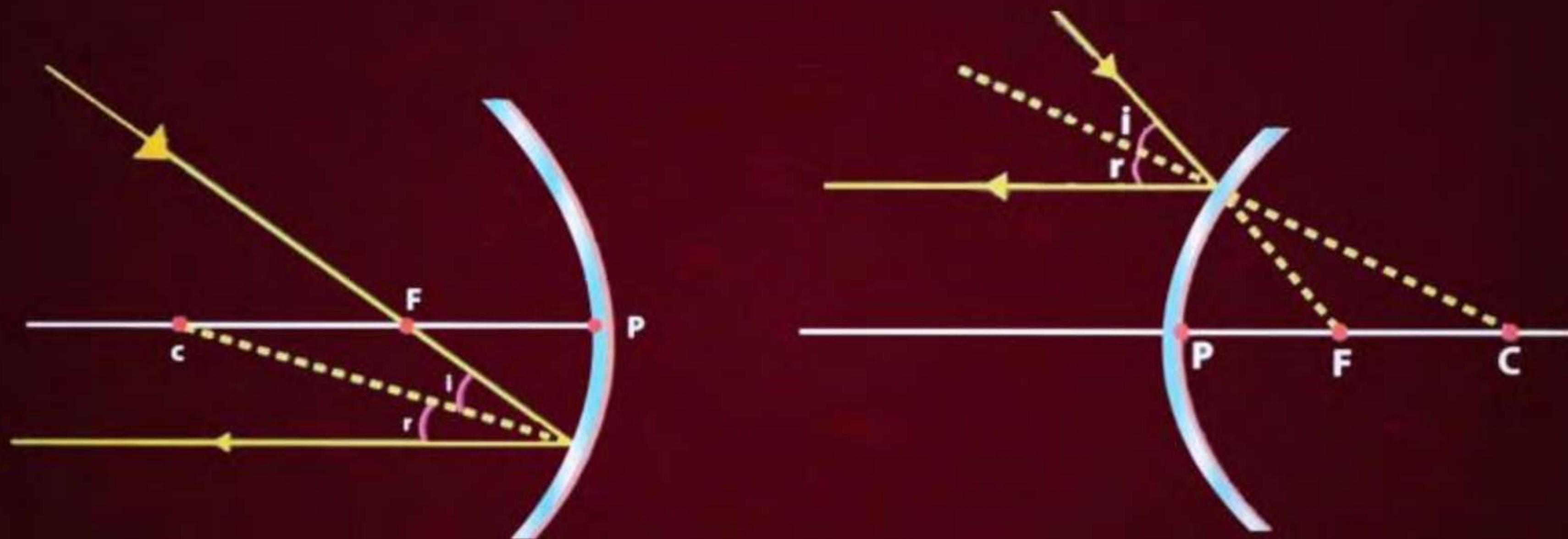
❖ A spherical mirror whose reflecting surface is curved outwards is called a convex mirror.



A ray parallel to the principal axis

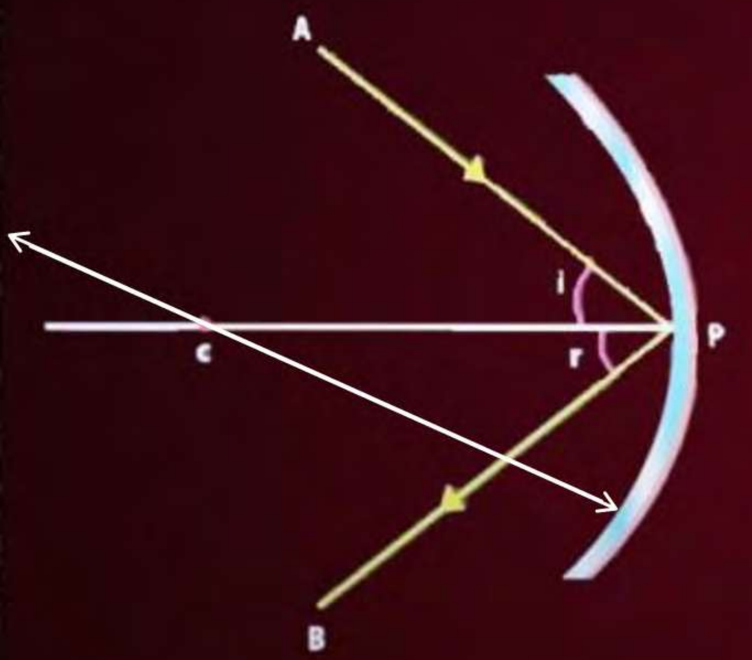


A ray passing through the principal focus



A ray incident obliquely to the principal axis

At Pole



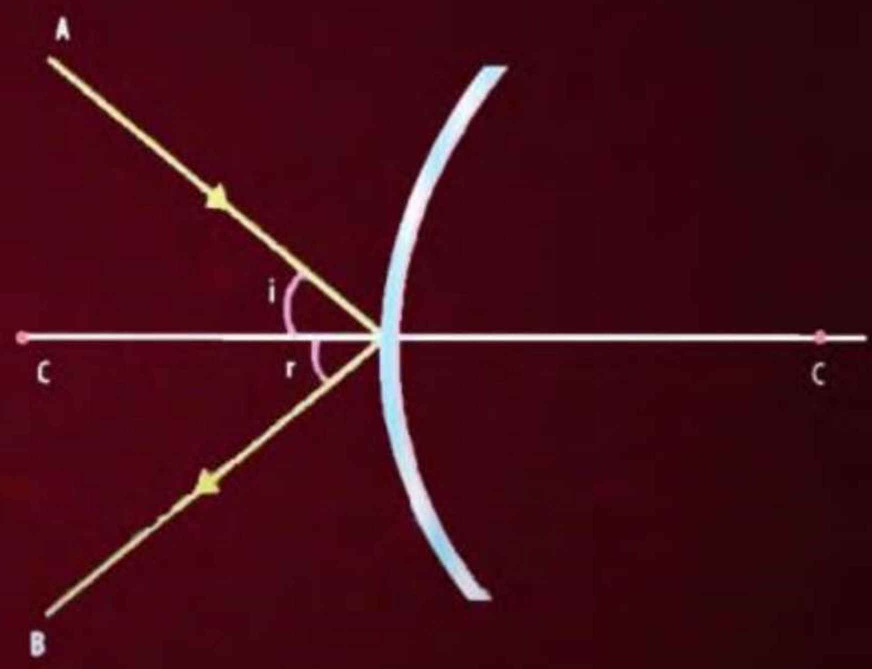


Image formation in concave mirror

1. **When an object is at infinity**
    - At the focus F
    - Highly diminished,
    - Point-sized
    - Real and inverted

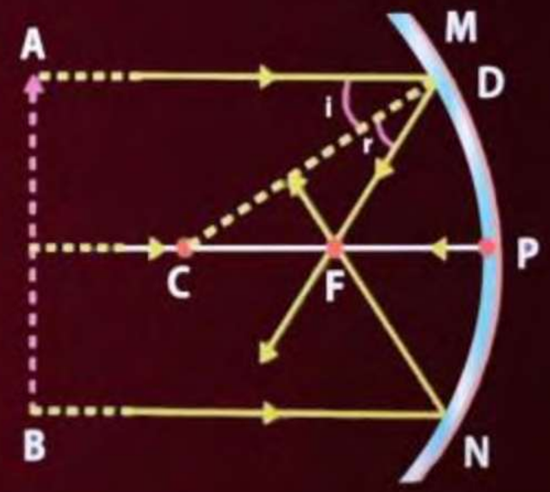


Image formation in concave mirror

2. When an object is beyond C

- Between F and C
- diminished
- Real and inverted

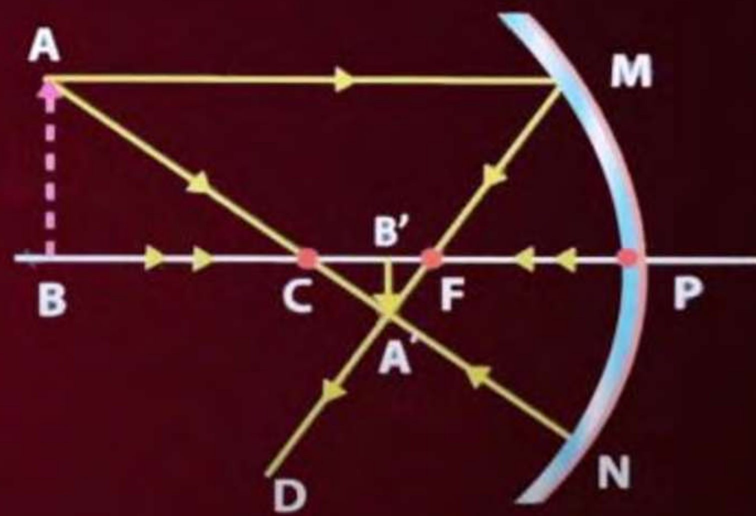


Image formation in concave mirror

3. When an object at C

- At C
- Same size
- Real and inverted

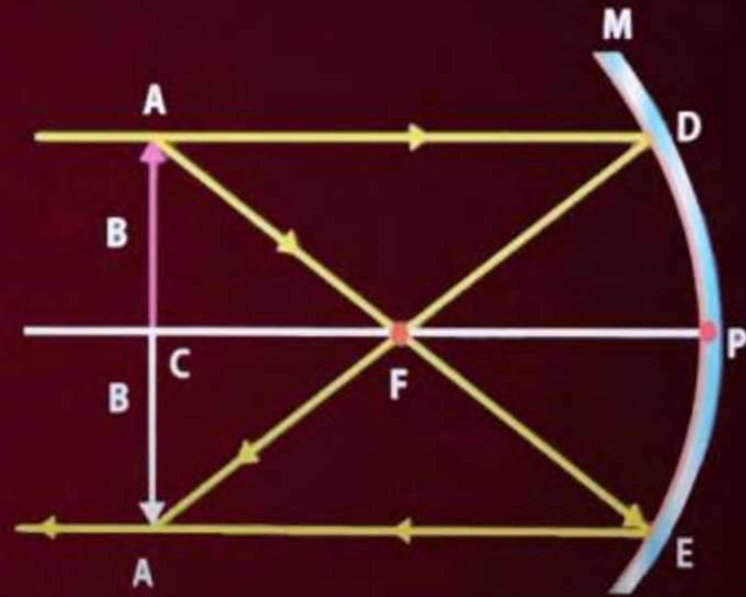


Image formation in concave mirror

4. When an object between C and F

- Beyond C
- Enlarged
- Real and inverted

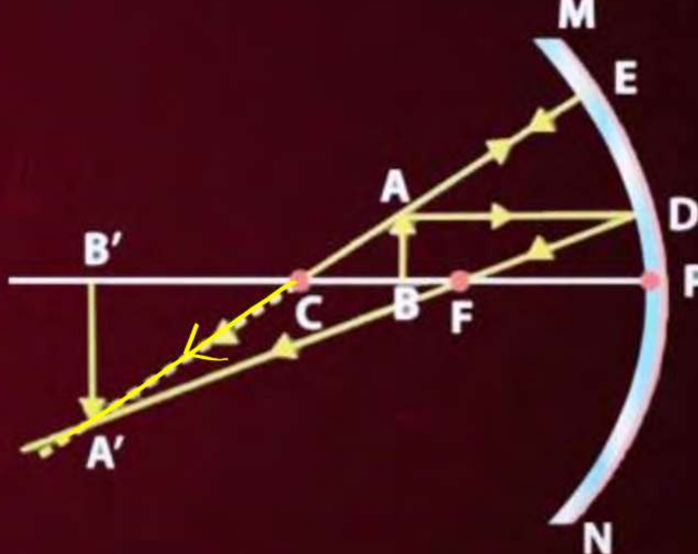


Image formation in concave mirror

5. When an object at F

- At infinity
- Highly Enlarged
- Real and inverted

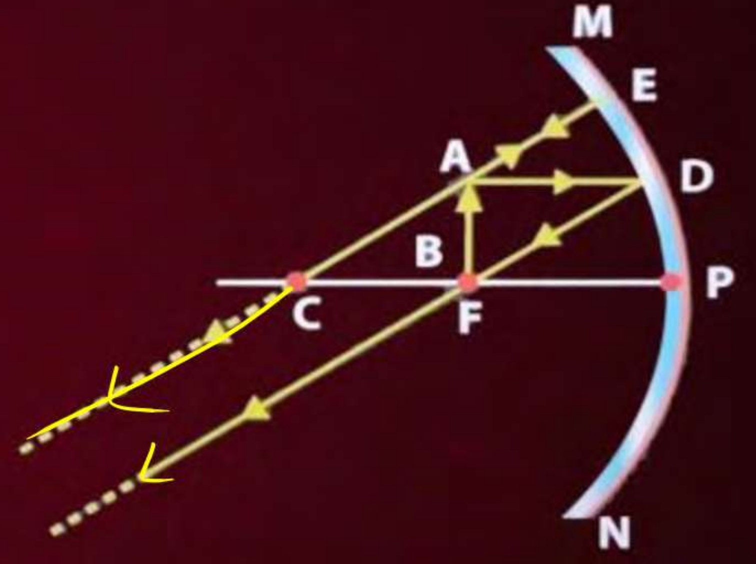
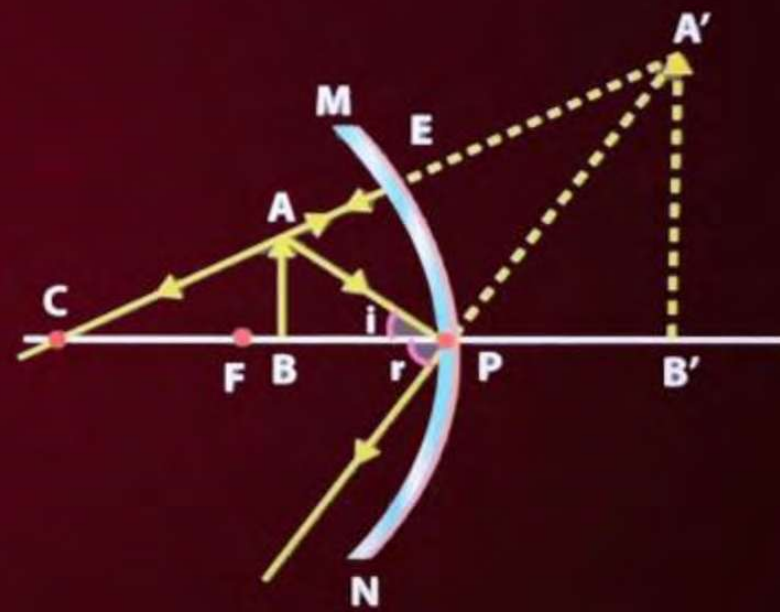


Image formation in concave mirror

6. When an object between P and F

- Behind the mirror
- Enlarged
- Virtual and erect




Use of Concave Mirror
Headlights
Torches
Dentists

Image Formation in Convex Mirror

1. **When an object is at infinity**
   - At the focus F, behind the mirror
   - Highly diminished, point-sized
   - Virtual and erect

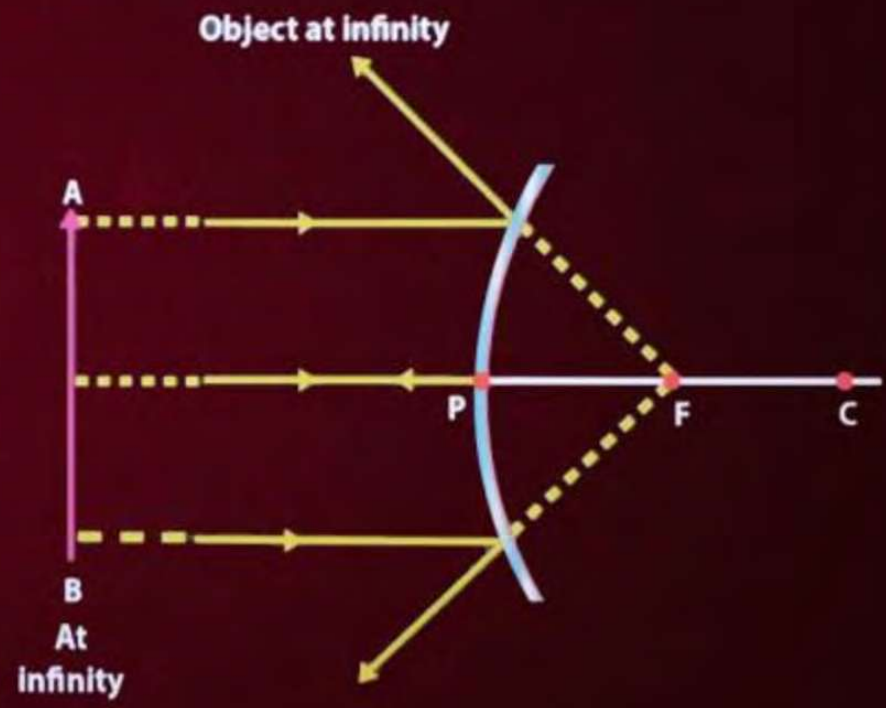
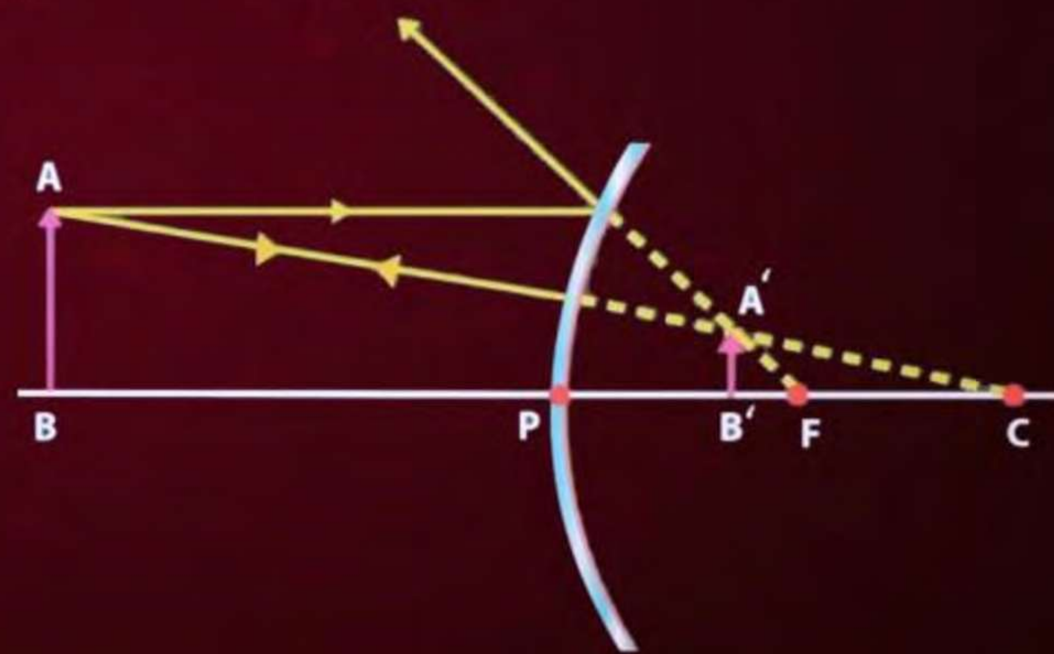


Image Formation in Convex Mirror

2. When an object between infinity and the pole P

- Between P and F behind the mirror
- diminished
- virtual and erect



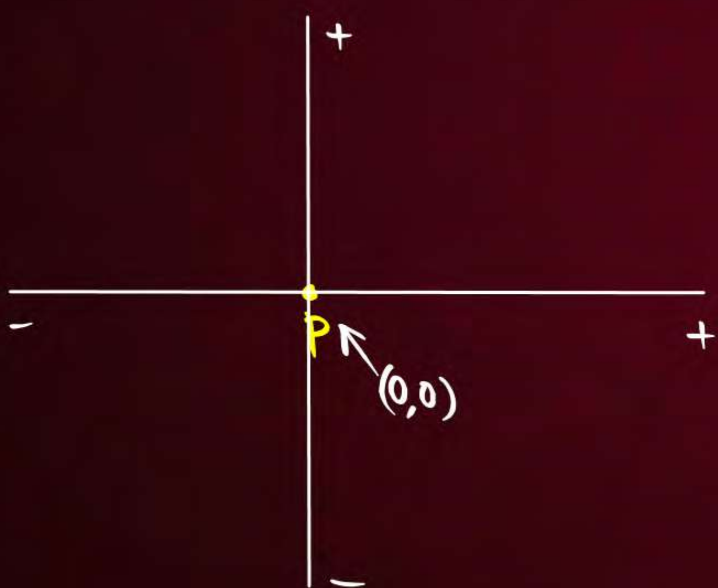
Use of Convex Mirror

Rear- View Mirror

Road View Mirror

Mirror Formula

* Sign convention



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

U = distance of an object from pole
V = distance of an image from pole
f = distance of principal focus from the pole

Magnification

* Tools :-

$0 < m < 1$: Diminished

$m = 1$: Same Size

$m > 1$: Enlarged

$m \to +$: Virtual + Erect

$m \to -$: Real + Inverted

m = height of an image/height of an object

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

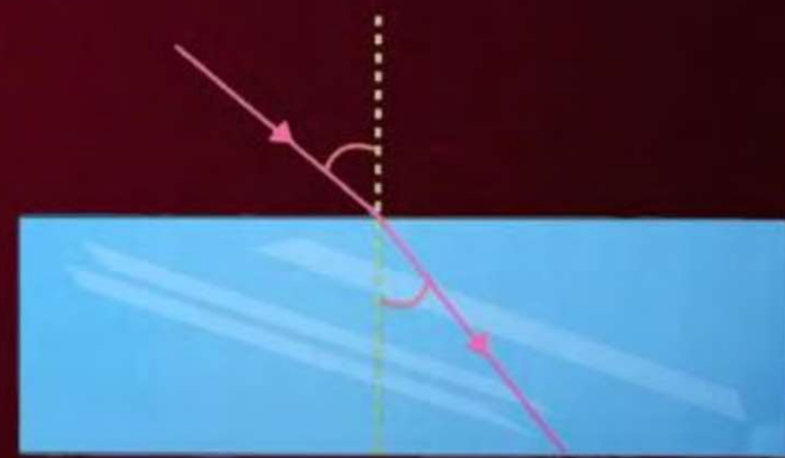
m = –distance of an image/distance of an object

$$m = -\frac{V}{U}$$

- ❖ If m = positive, shows image virtual.
- ❖ If m = negative, shows image is real.

Refraction

- The phenomenon of bending of light when it passes from one medium to another.
- Speed of light changes while entering



Laws of Refraction

1. Incident ray, Refracted ray and Normal ray all lie in the same plane.
2. The ratio of the sine of angle of incidence (i) to the sine of angle of refraction (r) is always constant for a given wavelength of light, for a given pair of Media.

This law is also called SNELL'S LAW

Refractive Index

Absolute ✓ Relative ✓

$$\boxed{n_A = \frac{c}{v_A}}$$

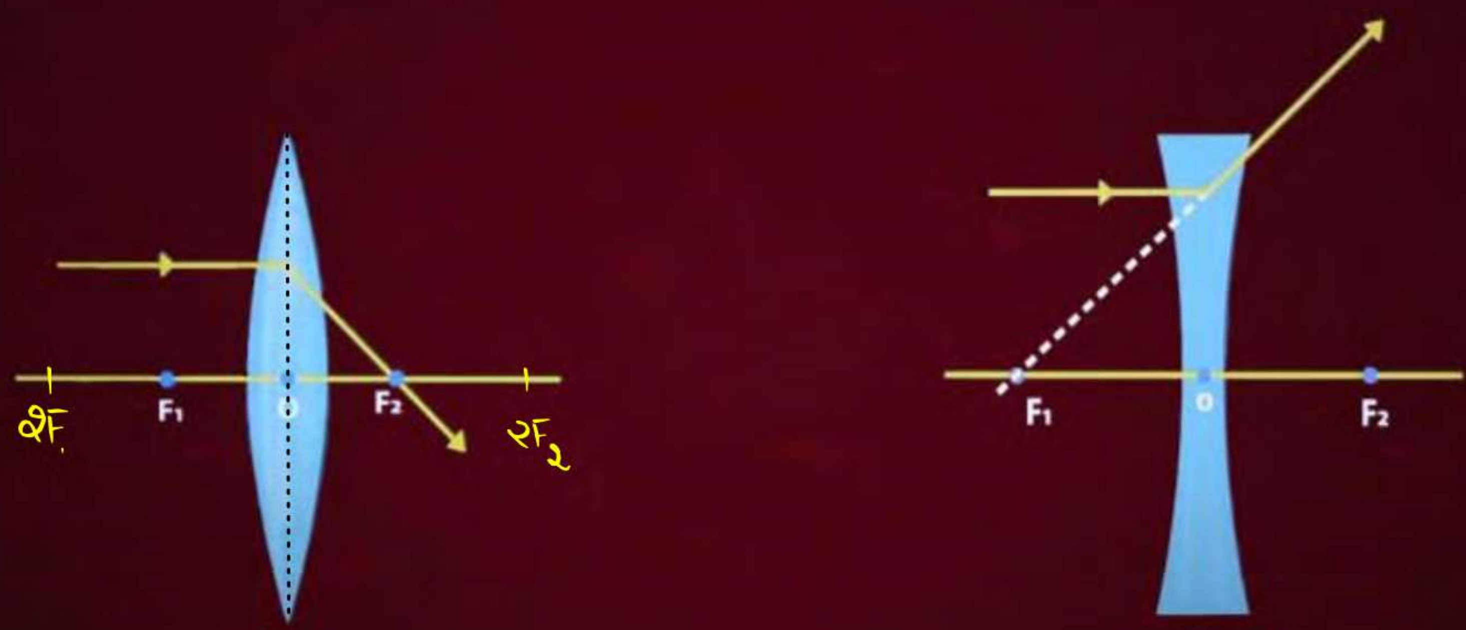
$$\boxed{n_{2,1} = \frac{v_1}{v_2}}$$

- The relative refractive index/index of refraction is defined as the ratio of the speed of light in medium 1 to the speed of the light in the medium 2.
- The absolute refractive index is defined as the ratio of the speed of light in vacuum/air to the speed of the light in the medium.

Refraction by Spherical Lenses

Convex lens Converging lens	Concave lens Diverging lens

A Ray Parallel to the Principal axis



A ray passing through the principal focus

A ray passing through the optical centre

Image Formation in Convex Lens

1. **When an object at infinity**
   - At focus F_2
   - Highly diminished
   - Real and inverted

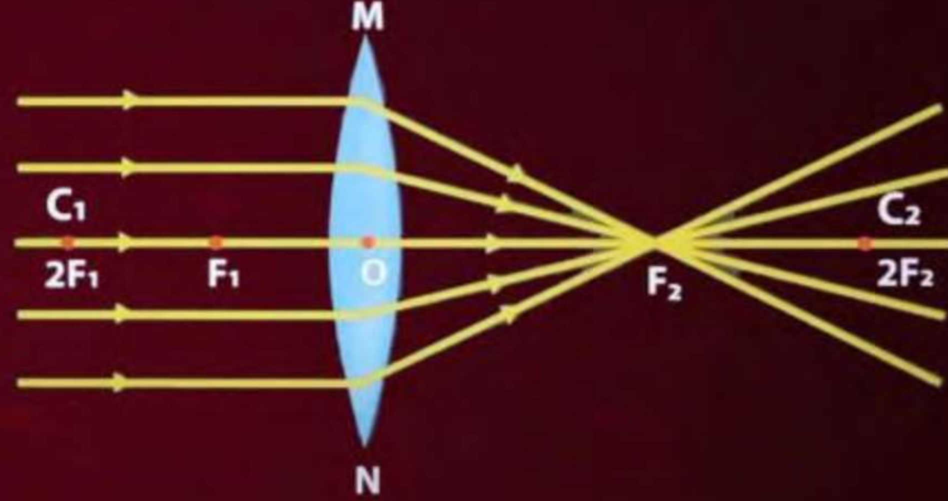


Image Formation in Convex Lens

2. When an object beyond $2F_1$

- Between F_2 and $2F_2$
- Diminished
- Real and inverted

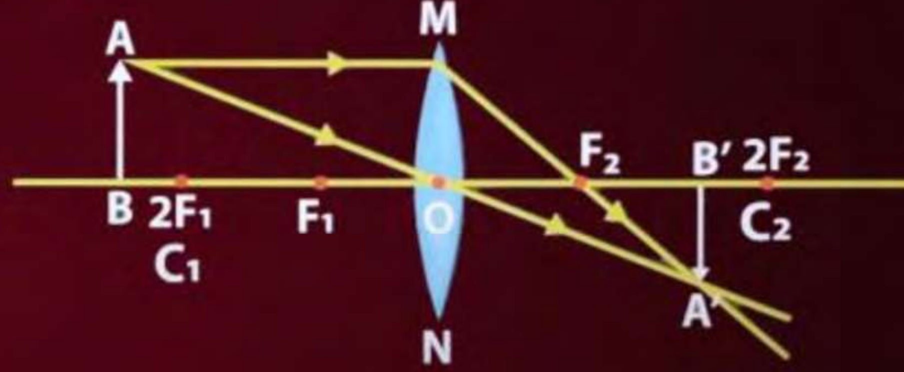


Image Formation in Convex Lens

3. **When an object at $2F_1$**
   - At $2F_2$
   - Same size
   - Real and inverted

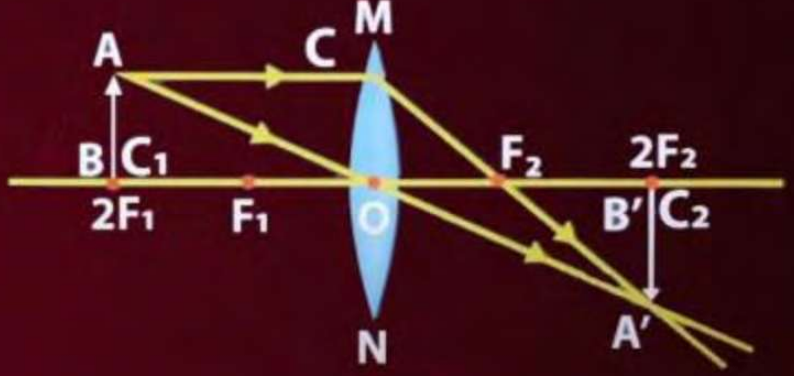


Image Formation in Convex Lens

4. When an object between F_1 and $2F_1$

- Beyond $2F_2$
- Enlarged
- Real and inverted

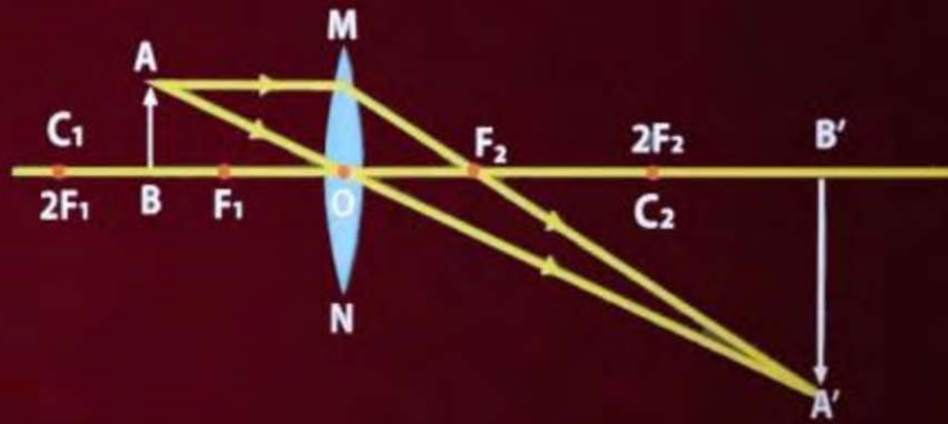


Image Formation in Convex Lens

5. **When an object at F_1**
   - At infinity
   - Highly Enlarged
   - Real and inverted

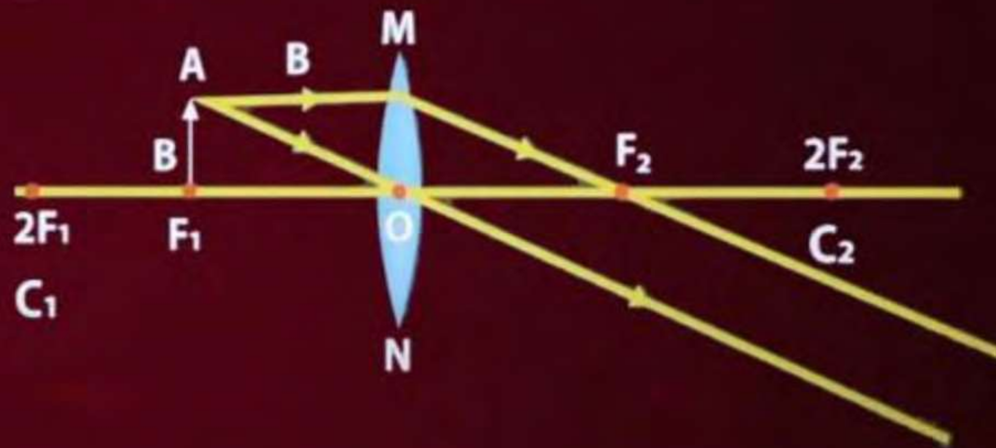


Image Formation in Convex Lens

6. **When an object between F_1 and O**
   - On the same side of the lens as the object
   - Enlarged
   - Virtual and erect

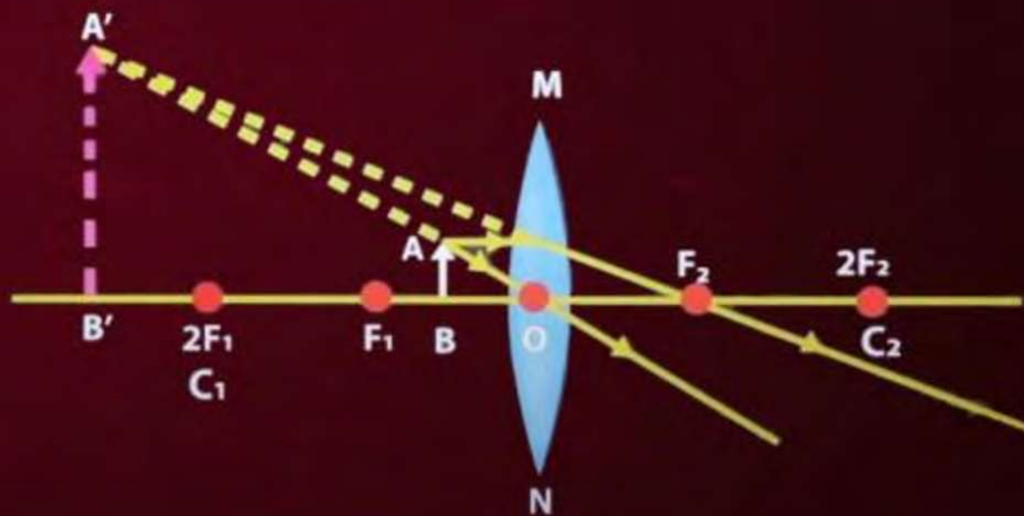


Image Fromation by Concave Lens

1. **When an object at infinity**
   - At focus F_1
   - Highly diminished
   - Virtual and erect

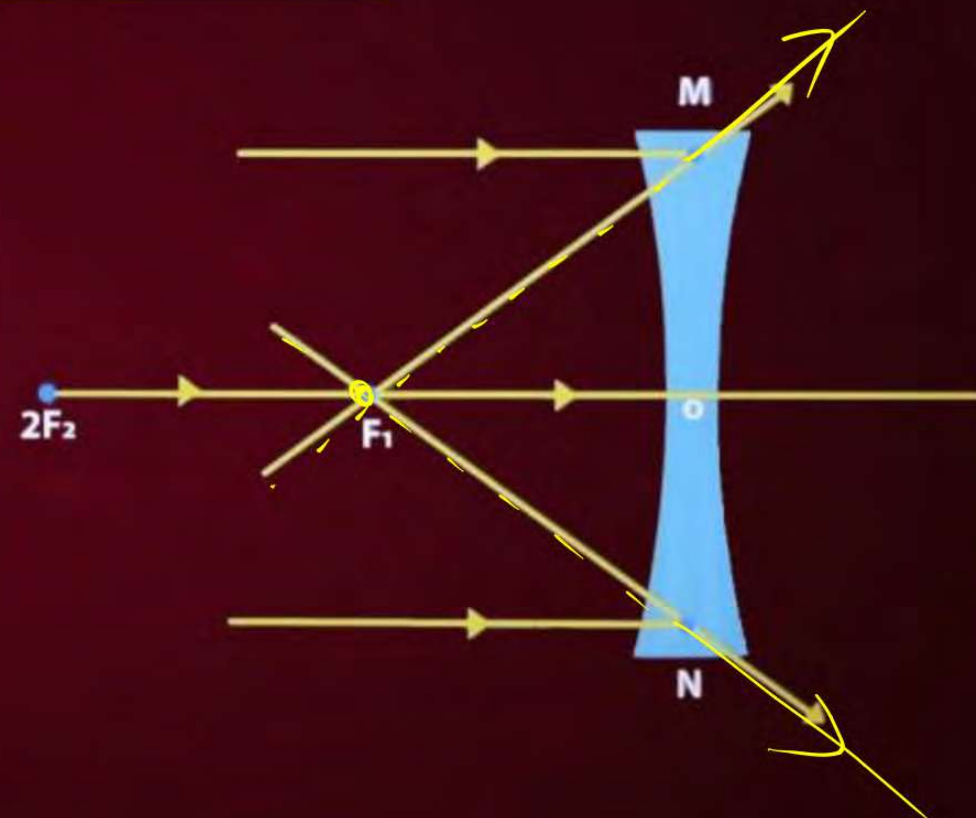
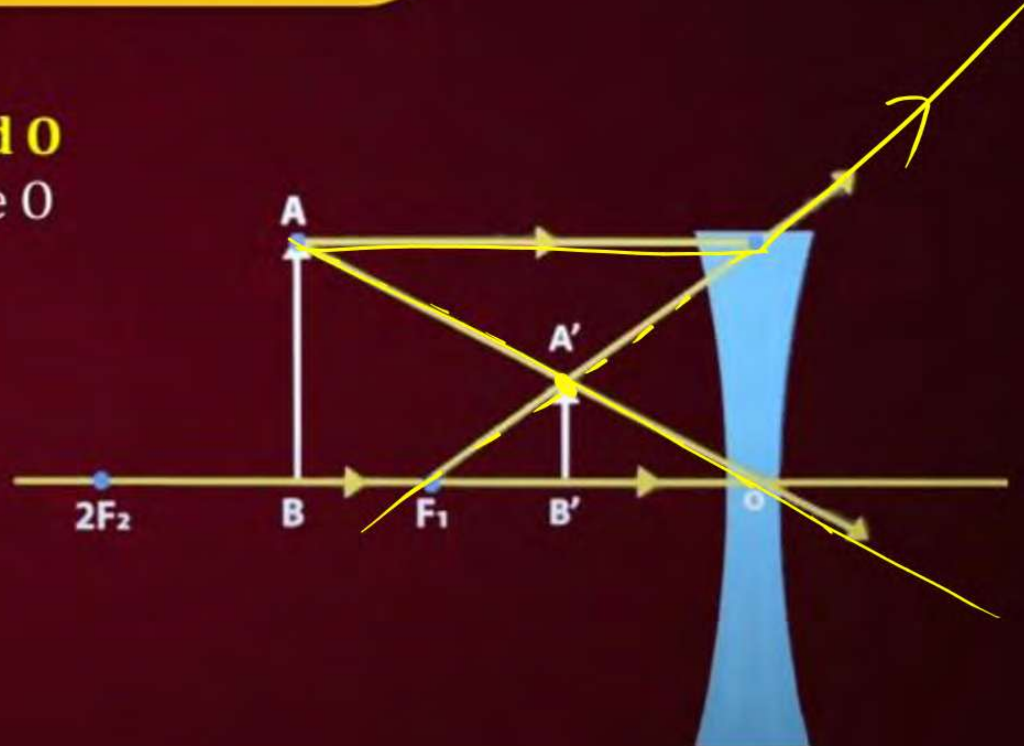


Image Fromation by Concave Lens

2. **When an object between infinity and O**
   - between focus F_1 and optical centre O
   - Diminished
   - Virtual and erect



Lens Formula

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

U = distance of an object from optical centre
V = distance of an image from optical centre
f = distance of principal focus from optical center.

Magnification

m = height of an image/height of an object

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

m = –distance of an image/distance of an object

$$m = -\frac{V}{U}$$

- ❖ If m = positive, shows image virtual.
- ❖ If m = negative, shows image is real.

Power of A Lens

$P = \frac{1}{f(m)}$

Dioptre

$\underset{(D)}{P} = \frac{100}{f(cm)}$

- The power of a lens is defined as the reciprocal of its focal length in metres.
- It is represented by the letter P.
  P = 1/f
- S.I. unit is Dioptre, denoted by D.
  1D = 1 per m
- Power of convex lens = positive
- Power of concave lens = negative

Formula sheet

Snell's Law

$$\frac{\sin i}{\sin r} = n_{2,1} = \frac{V_1}{V_2} = \frac{\lambda_1}{\lambda_2}$$

MIRROR

$$R = 2f$$

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

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

Lens

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

$$m = +\frac{v}{u}$$

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

Refractive Index

$$n_x = \frac{c}{V_x}$$

$$n_{1,2} = \frac{V_2}{V_1}$$

Power of the lens

$$P = \frac{1}{f(m)} = \frac{100}{f(cm)}$$

$$P_{net} = P_1 + P_2 + P_3 \ldots$$