Reflection Of Light

Light - It is a form of energy which enables us to see objects from which it come (or from which it is reflected).

Luminuous objects - Sun, candle, lamp

Though the objects like chair, table etc. don't have light of their own but we can see them because they reflect the light falling on them (from a luminuous object like lamp).

Nature of Light

- Light waves are e-m waves
- wavelength → 4×10^{-7} m – 8×10^{-7} m
- Speed depends upon the nature of medium in vacuum (highest) – 3×10^{8} m/s

Reflection of Light

When light falls on an object it may be

(i) **absorbed** – then the object will appear perfectly black eg. black board,

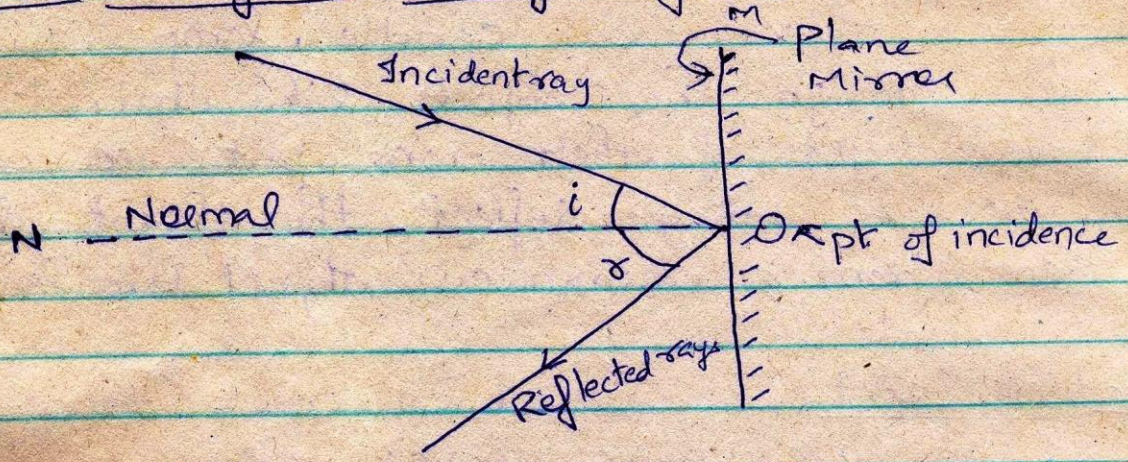
(ii) **transmitted** – then the object will appear transpalent eg ordinary glass

(iii) reflected

Reflection - The process of sending back the light rays which falls on the surface of an object is called reflection of light.

Best Reflector - Silver Metal

Laws of Reflection of Light



1) The incident ray, the reflected ray & the normal all lie in the same plane.
2) The angle of incidence is equal to angle of reflection

$\angle i = \angle r$

If a light ray falls normal (or $\perp^r$) to the surface of mirror then it is reflected back along the same path as $\angle i = 0 = \angle r$.

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

Eg - bulb, tree, face

Real Image

The image which can be obtained on screen is called a real image.

eg → image formed on a cinema screen.

Real images are formed by -

1) concave mirror 2) convex lens

Virtual Image

The images which cannot be obtained on screen is called a virtual image. A virtual image can be seen only by looking into a mirror or a lens.

eg → Image of our face in a plane mirror.

A virtual image is formed when light rays coming from an object appear to meet at a pt. when produced backwards.

A virtual image cannot be formed on a screen because light rays do not actually pass through a virtual image.

Lateral Inversion

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

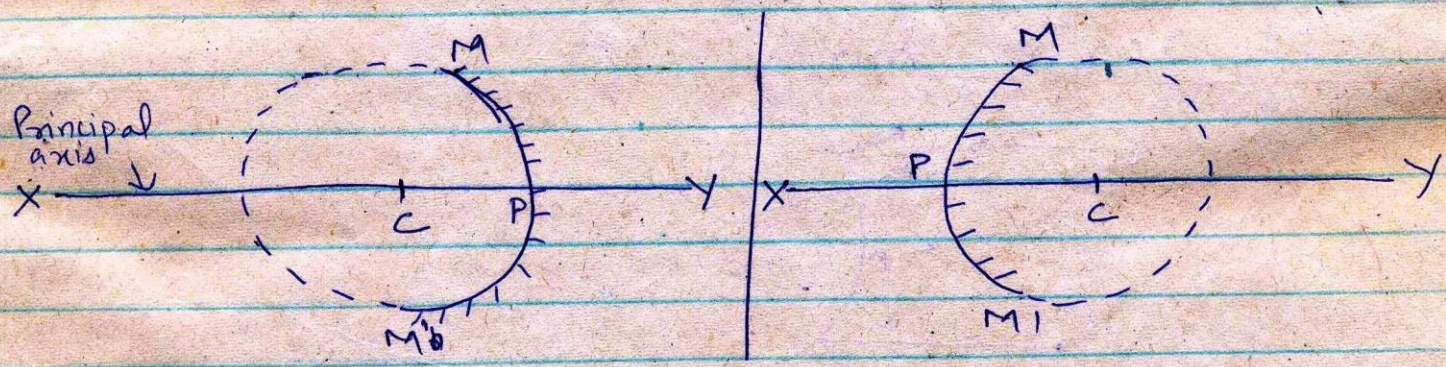
Spherical Mirrors

A spherical mirror is that mirror whose reflecting surface is the part of a hollow sphere of glass.

(a) Concave mirror

(b) convex mirror

Centre of Curvature, Radius of Curvature, Pole & Principal Axis of a Spherical Mirror



Centre of Curvature - Centre of hollow sphere

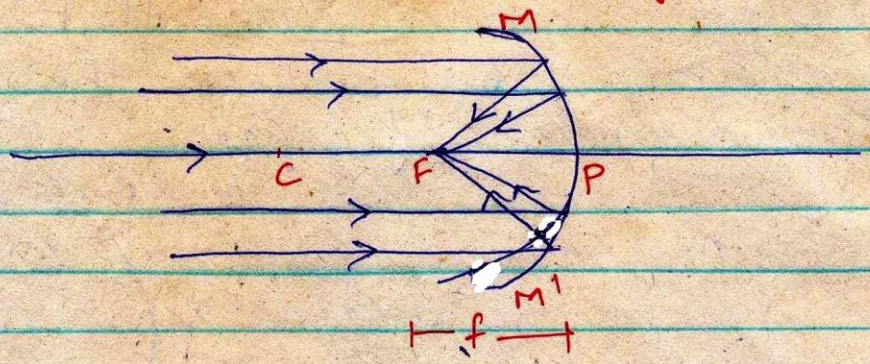
Radius of curvature - CP

Pole - The middle pt. of a spherical mirror.
eg. P is the pole.

Principal Axis - The straight line passing through C & P of a spherical mirror.
eg XY

Apeiture - That part from which reflection takes pla
eg MM'

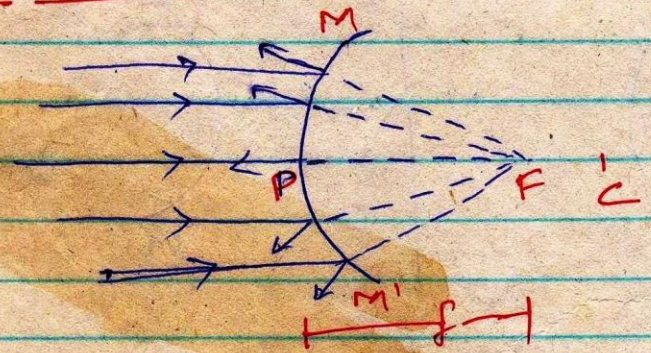
Principal focus & focal length of a Concave Mirror



Principal focus - That pt. at which all light rays which are parallel & close to axis converge after reflection from the concave mirror.

Focal length(f) — distance bet^n F & P

for a convex mirror



Relation bet^n R & f

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

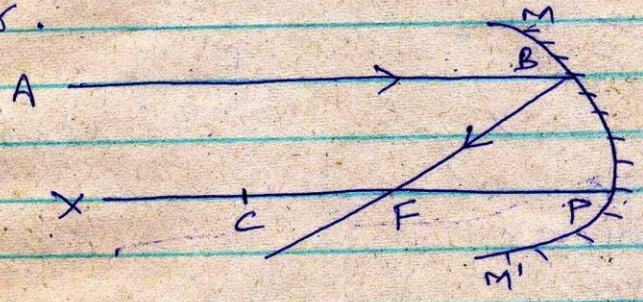
Rules for obtaining Images formed by Concave Mirrors

When an object is placed in front of a concave mirror, an image is formed. The image is formed at that pt. where

at least 2 reflected rays intersect (or appear to intersect).

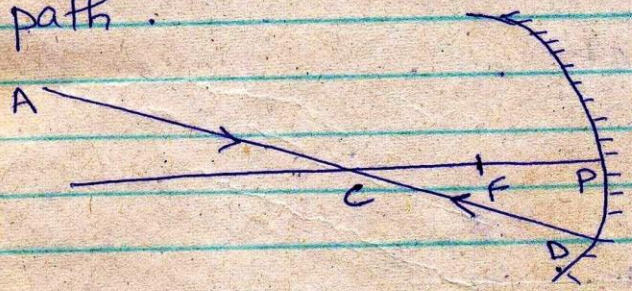
Rule 1

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



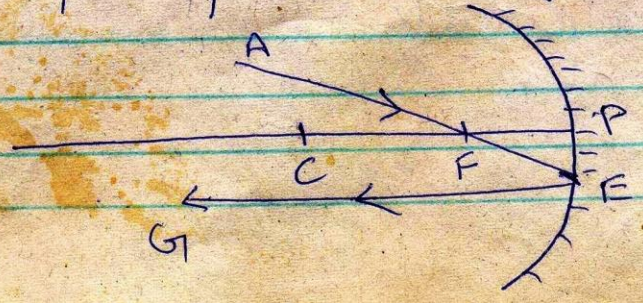
Rule 2

A ray of light passing through 'C' of a concave mirror is reflected back along the same path.



Rule 3

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



Formation of Different Types of Images by a Concave Mirror

Case 1 Object bet^n P & F

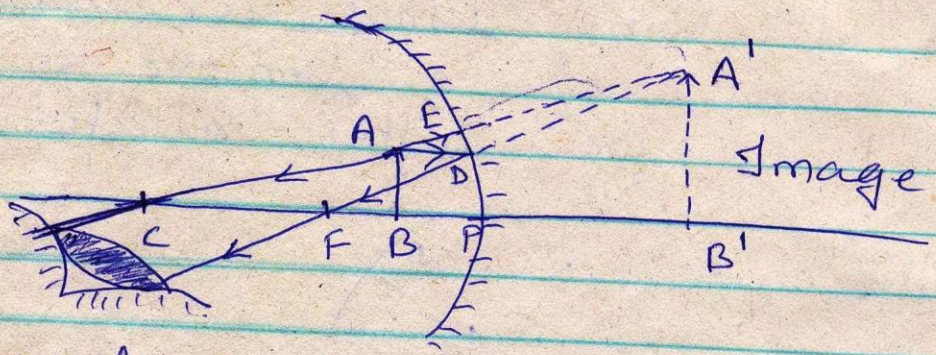


Image formed is :-
i) behind the mirror
ii) virtual & erect
iii) larger than object.

A concave mirr
is used while shaving as the face loo
closer.

Case 2 Object at F.

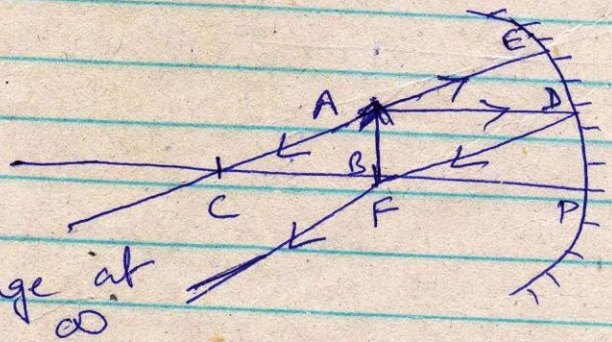


Image at ∞

Image formed is :-
i) at ∞
ii) real & inverted
iii) highly enlarged.

Case 3 Object bet^n F & C

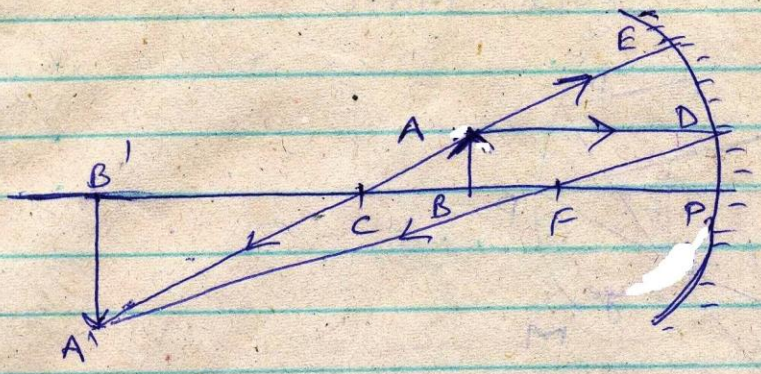


Image formed is
i) beyond C.
ii) real & inverted
iii) larger than object.

Case 4 Object at C

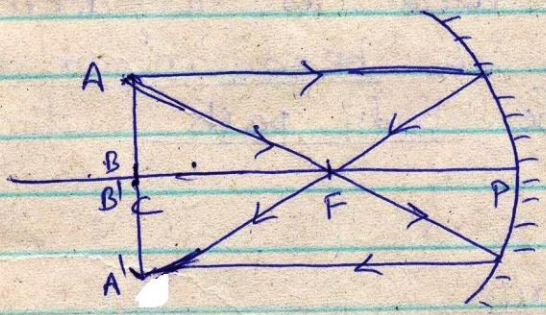


Image formed is :-
i) at C
ii) real & inverted
iii) same size as the object.

Case 5 Object beyond C.

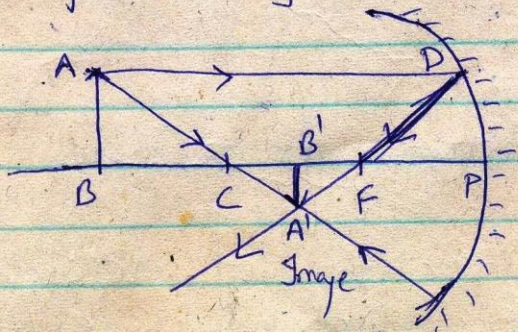


Image formed is
i) bet^n F & C
ii) real & inverted
iii) smaller than object.

Case 6 Object at ∞

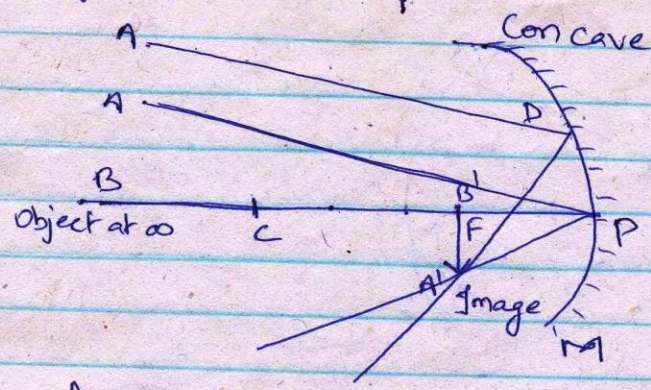


Image formed is
i) at focus (F).
ii) real & inverted
iii) much smaller than object.

As a concave mirror can concentrate all the parallel rays of light to focus, so it is used as a doctor's head mir It is used as a head mirror by doctors t conc. light on the body parts which are to be examined.

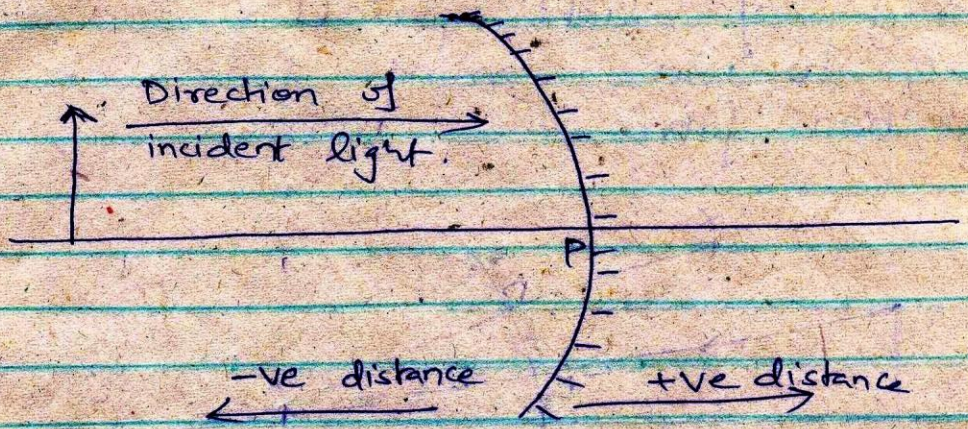
Uses of Concave Mirror

1) Shaving mirror
2) Reflector in car head-lights, search lights.
3) head mirror by doctors.
4) In field of solar energy to focus sun rays on the object to be heated.

Sign Conventions for Spherical Mirrors

1) All distances are measured from pole of the mirror as origin.
2) Distance in same direction of incident light are +ve & in opp. direction are −ve.

3) Distance measured upward & ⊥r to principal axis are +ve & downward & ⊥r to princip. axis are −ve.



Conclusions

1) object distance is always −ve.

2) Image

Concave mirror

(i) image behind the mirror — image distance (v) +ve

(ii) " in front of " — " " (v) −ve

Convex → v always +ve.

3) Focal length

Concave → −ve

Convex → +ve

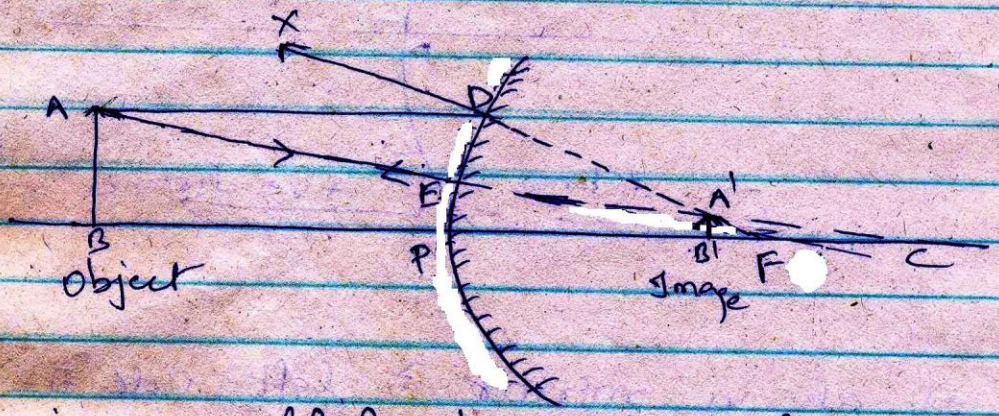
4) Height

Real, inverted image → height (−ve)

virtual, erect " → " (+ve).

Rules for Obtaining Images formed by Convex Mirrors

1) A ray of light parallel to principal axis appears to be coming from its focus after reflection from the mirror.



AD is parallel to principal axis. At D refle along DX but appears to come from F.

2) A ray of light going towards the centre of curvature is reflected back along its path.

AE. reflected at E as EA.

Image Formation by Convex Mirror

Case 1 Object bet^n P & ∞ (above fig.)

Image formed is
i) behind the mirror bet^n P & F.
ii) virtual & erect
iii) diminished (smaller than object).

Case 2 Object at ∞

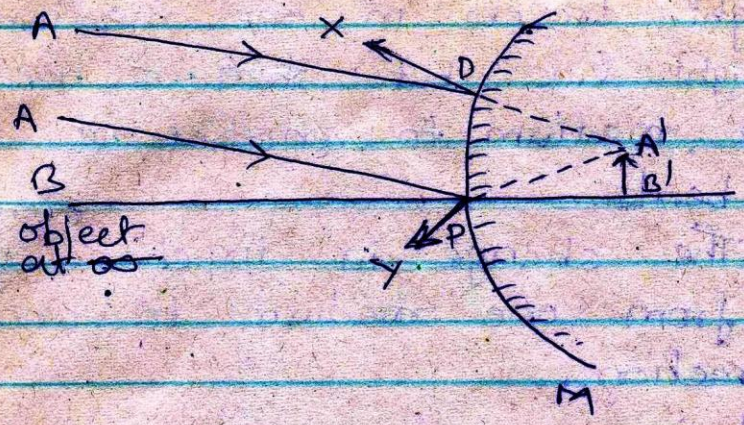


Image formed is
i) behind the mirror at F.
ii) virtual & erect
iii) highly diminished.

Uses of Convex Mirror

It is used as rear-view mirror in automobi
because:
i) it always produce an erect (R. side up) image of object.
ii) As the image is much smaller than the object so it gives a wide field of view of the traffic behind.

Distinguishion bet^n Plane, Concave & Convex Mirror

Plane - same image.

Concave - magnified (bigger; larger like Dara Sigh)

Convex - diminished (small like a child)

Mirror Formula

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

Magnification

It is defined as the ratio of the size of image to the size of the object.

$$\boxed{m = \frac{\text{size of image } (h')}{\text{size of object } (h)} = \frac{A'B'}{AB}}$$

* Size of object is always +ve. (in our study cases)

Some Conclusions

1) If $h' = +ve$, $m = +ve$, virtual & erect. image

$h' = -ve$, $m = -ve$, real & inverted image

2) $\boxed{m = \frac{h'}{h} = -\frac{v}{u}}$ [~~Relation of~~ m in terms of v & u]

3) In concave mirror, real image, $m = -ve$
virtual image, $m = +ve$

4) convex mirror, only virtual images, $m = +ve$.