CHENNAI PUBLIC SCHOOL

• Anna Nagar • Chennai -600 101

LIGHT : REFLECTION AND REFRACTION

i) Light is a form of energy which helps us to see objects.

ii) When light falls on objects, it reflects the light and when the reflected light reaches our eyes then we see the objects.

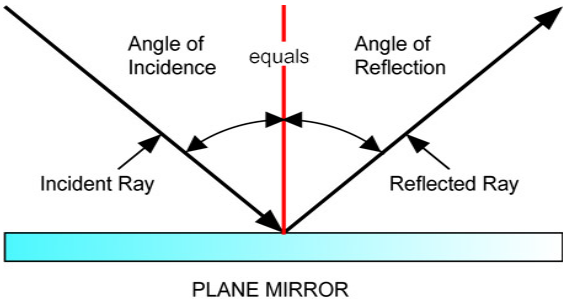
iii) Light travels in straight line.

Reflection of light :- When light falls on a highly polished surface like a mirror most of the light is sent back into the same medium. This process is called reflection of light.

Laws of reflection of light :-

i) The angle of incidence is equal to the angle of reflection.

ii) The incident ray, the reflected ray and the normal to the mirror at the point of incidence all lie in the same plane.



Properties of image formed by a plane mirror

i) The image is erect.

ii) The image is same size as the object.

iii) The image is at the same distance from the mirror as the object is in front of it.

iv) The image is virtual (cannot be obtained on a screen).

v) The image is laterally inverted.

Spherical mirrors :- Spherical mirror is a curved mirror which is a part of a hollow sphere. Spherical mirrors are of two types. They are concave mirror and convex mirror.

i) **Concave mirror :-** is a spherical mirror whose reflecting surface is curved inwards. Rays of light parallel to the principal axis after reflection from a concave mirror meet at a point (converge) on the

principal axis.

ii) <u>Convex mirror</u> :- is a spherical mirror whose reflecting surface is curved outwards. Rays of light parallel to the principal axis after reflection from a convex mirror get diverged and appear to come from a point behind the mirror.

Terms used in the study of spherical mirrors :-

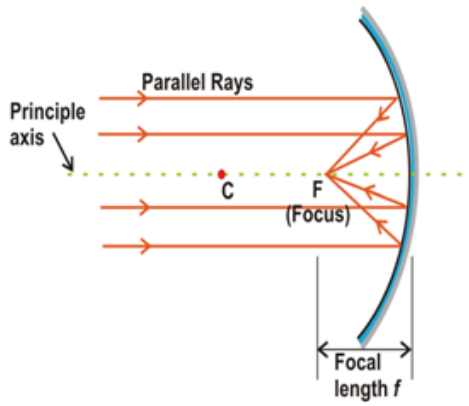


Figure 3a. Concave Mirror

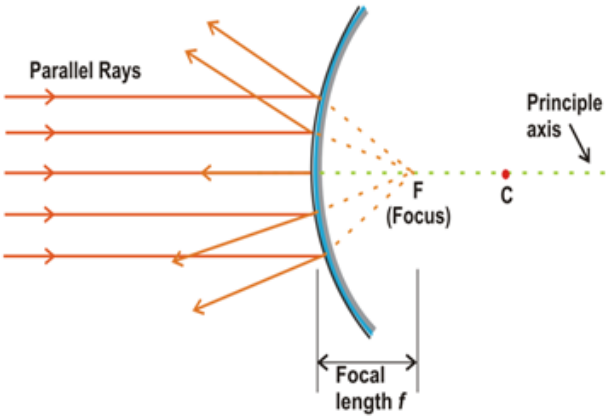


Figure 3b. Convex Mirror

i) <u>Center of curvature</u> (C). is the centre of the sphere of which the mirror is a part

ii) <u>Radius of curvature</u> (R):- is the radius of the sphere of which the mirror is a part

(iii) Pole (P). is the centre of the spherical mirror

(iv) Principal axis is the straight line passing through the centre of curvature and the pole

(v) Principal focus :-

In a concave mirror, rays of light parallel to the principal axis after reflection meet at a point on the principal axis called principal focus(F).

In a convex mirror, rays of light parallel to the principal axis after reflection get diverged and appear to come from a point on the principal axis behind the mirror called principal focus (F).

(iv) Focal length is the distance between the pole and principal focus (f).

Aperture: Diameter of the reflecting surfaceof a spherical mirror.

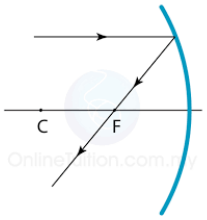
Note:

In a spherical mirror the radius of curvature is twice the focal length.

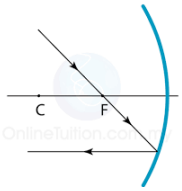
R = 2f or f = R/2

Rules for ray diagrams-concave mirrors

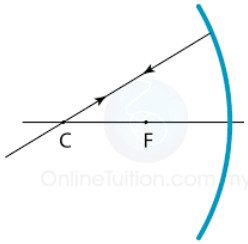
i) **In a concave mirror a ray of light parallel to the principal axis after reflection passes through the focus.**



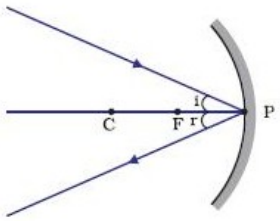
ii) **In a concave mirror a ray of light passing through the focus after reflection goes parallel to the principal axis.**



iii) **In a concave mirror a ray of light passing through the centre of curvature after reflection is reflected back along the same direction.**



iv) **In a concave mirror a ray of light directed obliquely at the pole is reflected obliquely making equal angles with the principal axis.**



Images formed by concave mirrors

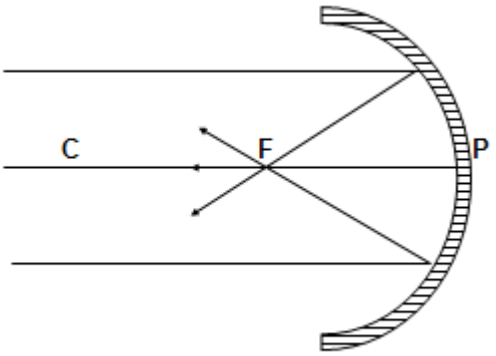
(i) **Object: At infinity**

Image : At the focus

NATURE and SIZE :

Real and inverted

Highly diminished



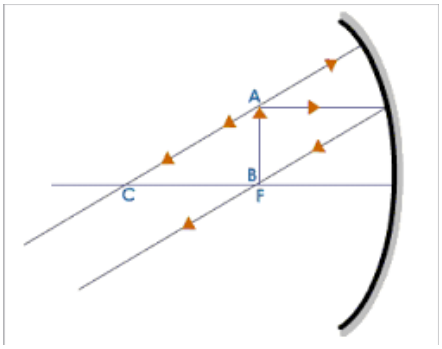
(ii) **Object: AT the focus**

Image : infinity

NATURE and SIZE

Real and inverted

Highly enlarged



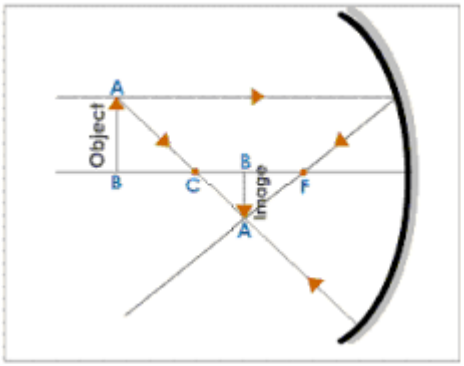
(iii) Object: Beyond C

Image : Between C and F

NATURE and SIZE

Real and inverted

diminished



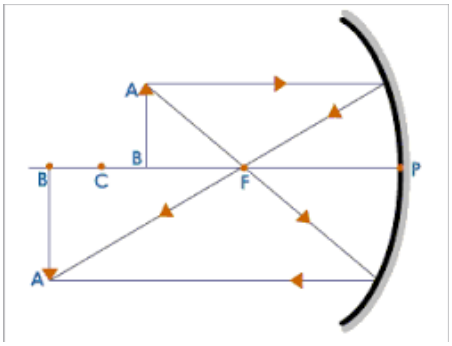
(iv) Object: : Between C and F

Image : Beyond C

NATURE and SIZE

Real and inverted

Enlarged



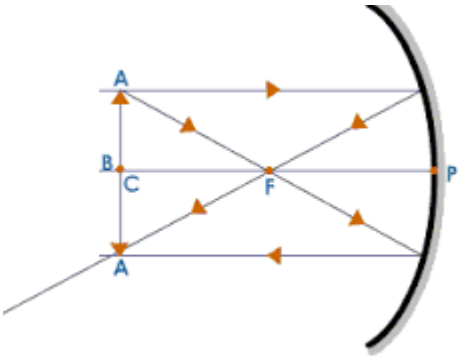
(v) Object: At C

Image : At C

NATURE and SIZE :

Real and inverted

Same size



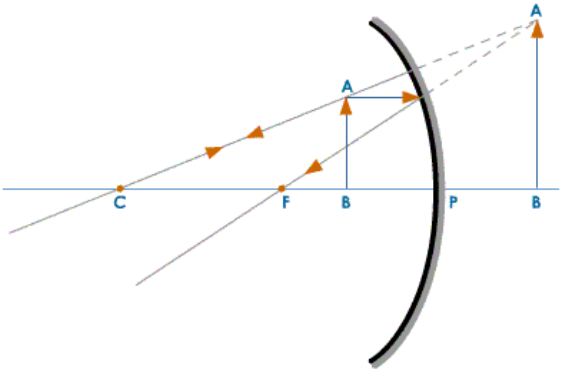
(vi) Object: Between F and P

Image : Behind the mirror

NATURE and SIZE

Virtual and erect -

Enlarged

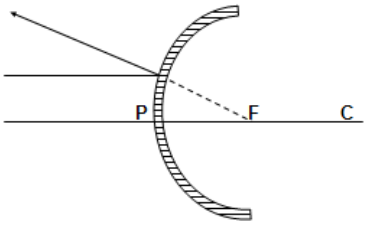


Uses of concave mirrors

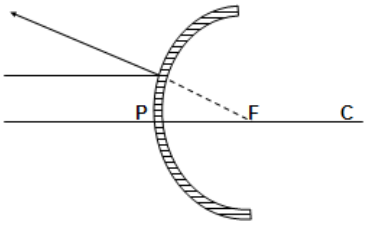
- **Concave mirrors are used in torches, search lights and head lights of vehicles to get parallel beams of light.**
- **They are used as shaving mirrors to see larger image of the face.**
- **They are used by dentists to see larger images of the teeth.**
- **Large concave mirrors are used to concentrate sunlight to produce heat in solar furnaces.**

Rules for ray diagrams-convex mirrors

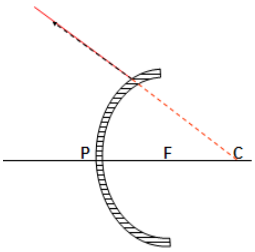
(i) **In a convex mirror a ray of light parallel to the principal axis after reflection appears to diverge from the focus.**



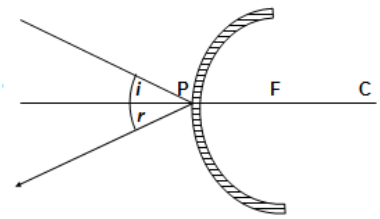
(ii) **In a convex mirror a ray of light directed towards the focus after reflection goes parallel to the principal axis.**



(iii) **In a convex mirror a ray of light directed towards the centre of curvature after reflection is reflected back along the same direction.**

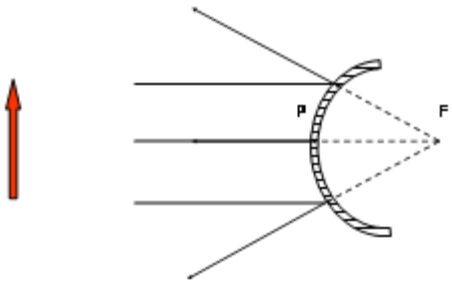


(iv) **In a convex mirror a ray of light directed obliquely at the pole is reflected obliquely making equal angles with the principal axis.**

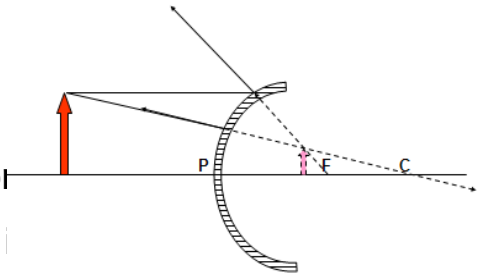


Images formed by convex mirror

(i) When the object is at infinity, the image is formed at F behind the mirror, it is highly diminished, virtual and erect.



(ii) When the object is between infinity and pole, the image is formed behind the mirror, it is diminished, virtual and erect



Convex mirrors are used as rear-view mirro

- **Convex mirrors give erect diminished**
- **They also have a wider field of view than plane mirrors.**

9) New Cartesian sign convention for spherical mirrors :-

i) The object is always placed on the left of the mirror and light from the object falls from the left to the right.

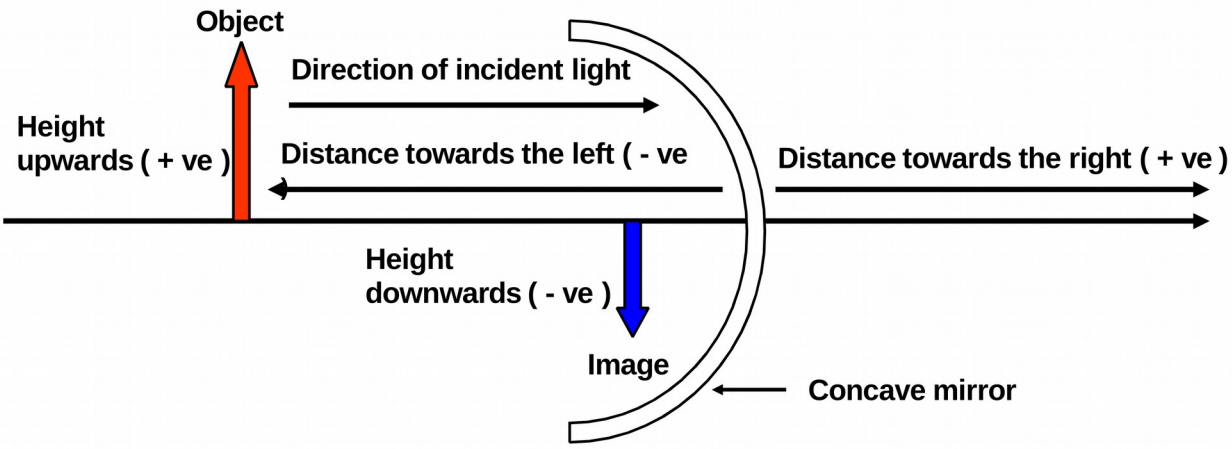
ii) All distances parallel to the principal axis are measured from the pole.

iii) All distances measured to the right of the pole are taken as + ve.

iv) All distances measured to the left of the pole are taken as – ve.

v) The height measured upwards perpendicular to the principal axis is taken as + ve.

vi) The height measured downwards perpendicular to the principal axis is taken as – ve.



Mirror formula for spherical mirrors :-

The mirror formula for spherical mirrors is the relationship between the object distance (u), image distance (v) and focal length (f).

The mirror formula is expressed as :-

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

Magnification for spherical mirrors :-

Magnification for spherical mirrors is the ratio of the height of the image to the height of the object.

$$\text{Magnification} = \frac{\text{Height of the image}}{\text{Height of the object}} \qquad m = \frac{h^i}{h^o}$$

The magnification is also related to the object distance and image distance. It is expressed as :-

$$\text{Magnification} \quad m = \frac{h^i}{h^o} = -\frac{v}{u}$$

Note:

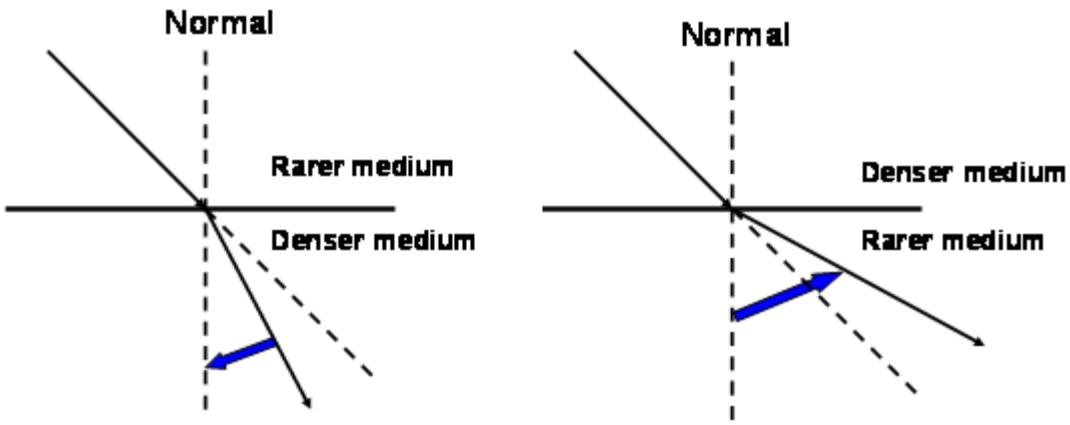
- Height of the object is taken as +ive when it placed above the principal axis
- Height of the image is taken as +ive for virtual image
- It is taken as negative for real images
- -ive sign in the value of magnification indicates image is real
- +ive sign in the value of magnification indicates image is virtual

Refraction of light :-

When light travels obliquely from one transparent medium into another it gets bent. This bending of light is called refraction of light.

When light travels from a rarer medium to a denser medium, it bends towards the normal.

When light travels from a denser medium to a rarer medium to a rarer medium, it bends away from the normal.



Laws of refraction of light :-

i) The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.

II) The ratio of the sine of angle of incidence to the sine of angle of refraction is a constant, for the light of a given colour and for the given pair of media.(This law is also known as Snell`s law of refraction.)

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

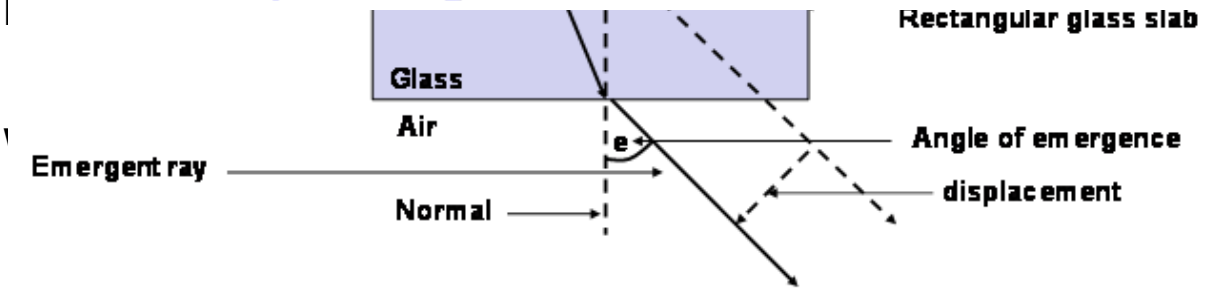
d) Refractive index :-

The absolute refractive index of a medium is the ratio of the speed light in air or vacuum to the speed of light in medium.

$$\text{Refractive index} = \frac{\text{Speed of light in air or vacuum}}{\text{Speed of light in the medium}} \qquad n = \frac{c}{v}$$

The relative refractive index of a medium 2 with respect to a medium 1 is the ratio of the speed of light in medium 1 to the speed of light in medium 2.

$$n_{21} = \frac{\text{Speed of light in medium 1}}{\text{Speed of light in medium 2}} \qquad n_{21} = v_1 / v_2$$



- Angle of incidence is equal to angle of emergence.
- Lateral displacement of light increases with an increase in the thickness of glass slab and with the increase in angle of incidence.

In case if the incident ray falls perpendicular to the surface of the glass

slab there is no bending of light.