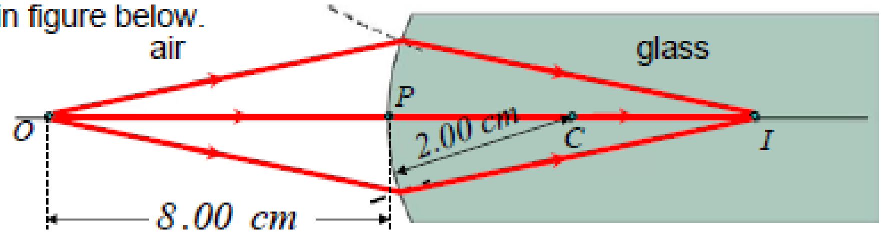
## Example 5 :

A cylindrical glass rod in air has refractive index of 1.52. One end is ground to a hemispherical surface with radius, r =2.00 cm as shown in figure below.




37

Find,

a. the position of the image for a small object on the axis of the rod, 8.00 cm to the left of the pole as shown in figure.

b. the linear magnification.

(Given the refractive index of air , $n_a$= 1.00)

Example 34.5, pg. 1302, University Physics with Modern Physics,11th edition, Young & Freedman.

<u>Solution</u>: $n_g=1.52,\ u=8.00\ cm,\ r=+2.00\ cm$

a. By applying the equation of spherical refracting surface,

$$\frac{n_1}{u}+\frac{n_2}{v}=\frac{(n_2-n_1)}{r}$$

$$\frac{n_a}{u}+\frac{n_g}{v}=\frac{(n_g-n_a)}{r}$$

$$v=+11.26\ cm$$

**The image is 11.26 cm at the back of the convex surface.**

b. By using the equation of linear magnification for refracting surface,

$$M=\frac{h_i}{\ }=-\frac{n_1 v}{\ } \Rightarrow M=-\frac{n_a v}{n_g u}$$

$$M=-0.93$$

Negative sign indicate the image is inverted.

38

## Example 6 : (H.W)

A small strip of paper is pasted on one side of a glass sphere of radius 5 cm. The paper is then view from the opposite surface of the sphere. Find the position of the image.

(Given refractive index of glass =1.52 and refractive index of air=1.00)

Ans. : 20.83 cm in front of the concave surface (second refracting surface)

## Example 7 : (H.W)

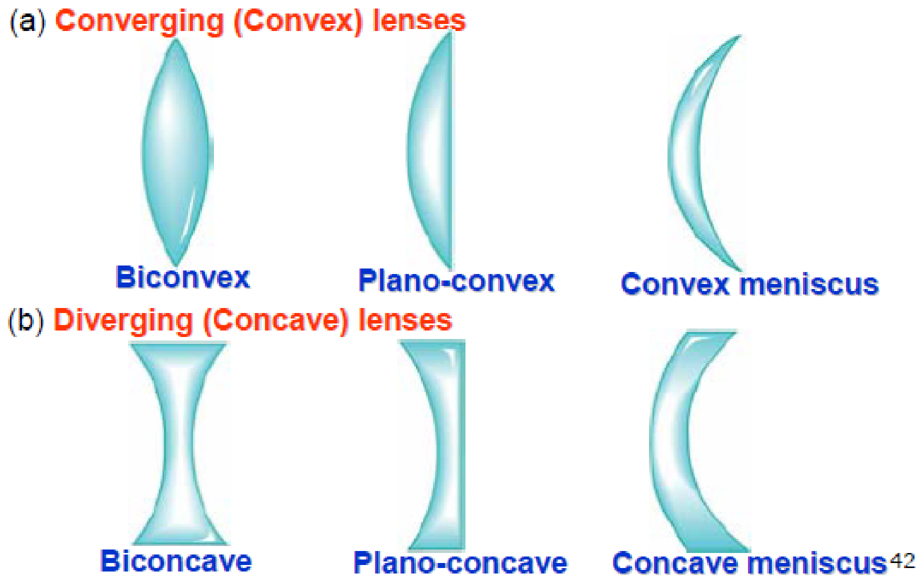
A point source of light is placed at a distance of 25.0 cm from the centre of a glass sphere of radius 10 cm. Find the image position of the source. (Gc.830.Exam.33-11)

(Given refractive index of glass =1.50 and refractive index of air=1.00)

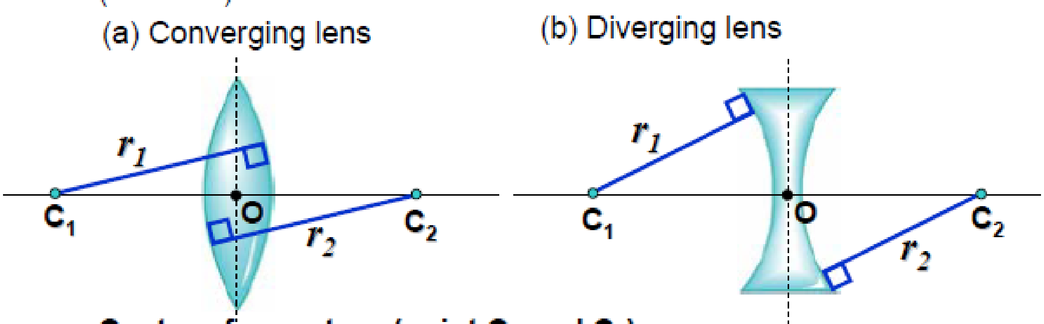
Ans. : 28 cm at the back of the concave surface (second refracting surface).

# 1.3.Thin Lens

- Definition – is defined as *a transparent material with two spherical refracting surfaces whose thickness is thin compared to the radii of curvature of the two refracting surfaces.*
- There are two types of thin lens. It is **converging** and **diverging** lens.
- Figures below show the various types of thin lenses, both converging and diverging.

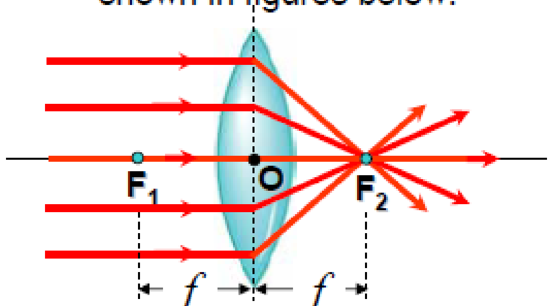


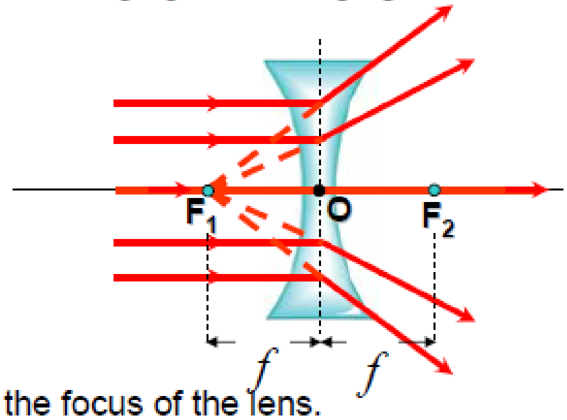

- Figures below show the shape of converging (convex) and diverging (concave) lenses.




- **Centre of curvature (point $C_1$ and $C_2$)**
  - is defined as *the centre of the sphere of which the surface of the lens is a part.*
- **Radius of curvature ($r_1$ and $r_2$)**
  - is defined as *the radius of the sphere of which the surface of the lens is a part.*
- **Principal (Optical) axis**
  - is defined as *the line joining the two centres of curvature of a lens.*
- **Optical centre (point O)**
  - is defined as *the point at which any rays entering the lens pass without deviation.* 43

- Consider the ray diagrams for converging and diverging lens as shown in figures below.




- From the figures,
  - Point $F_1$ and $F_2$ represent the focus of the lens.
  - Distance $f$ represents the focal length of the lens.
- **Focus (point $F_1$ and $F_2$)**
  - For **converging (convex)** lens – is defined as *the point on the principal axis where rays which are parallel and close to the principal axis converges after passing through the lens.*
    - Its focus is real (principal).
  - For **diverging (concave)** lens – is defined as *the point on the principal axis where rays which are parallel to the principal axis seem to diverge from after passing through the lens.*
    - Its focus is virtual.
- **Focal length ($f$)**
  - Definition – is defined as *the distance between the focus F and the optical centre O of the lens.*

## 1.4.Ray Diagrams For Thin Lenses

- Ray diagrams below showing the graphical method of locating an image formed by converging (convex) and diverging (concave) lenses
(a) Converging (convex) lens