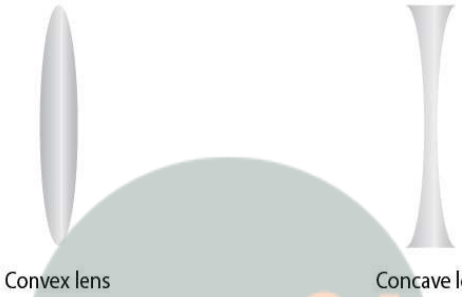
EXERCISE 5(A)

Solution:
A lens is defined as ‘a transparent refracting medium bounded by either two spherical surfaces or one surface spherical and other surface plane’.

Solution:
There are two types of lenses.
(i) Convex or converging lens and
(ii) Concave or diverging lens

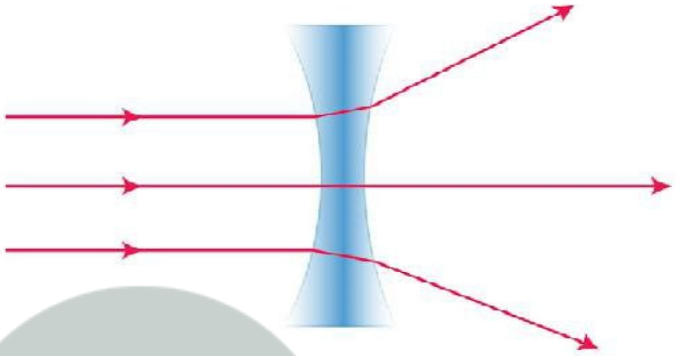


(a) Solution:

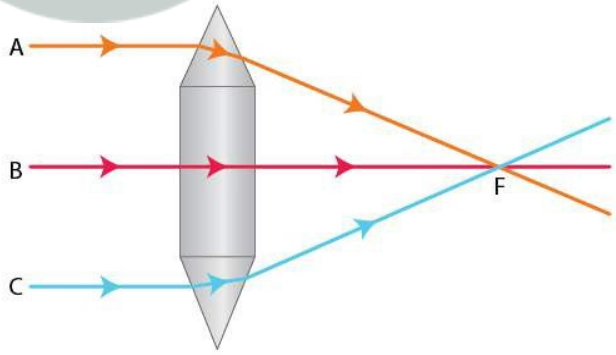
Convex lens	Concave lens
It is thick in the middle and thin at its periphery.	It is thin in the middle and thick at its periphery.
It converges the incident rays towards the principal axis.	It diverges the incident rays away from the principal axis.
It has the real focus.	It has the virtual focus.

Solution:
(i) An equiconvex lens is converging
(ii) A concavo-convex lens is a converging lens. This is because a concavo-convex lens is thicker in the middle and thinner at the edges and has a converging action on a light beam.

Solution:
Concave lens will show the divergent action on a light beam

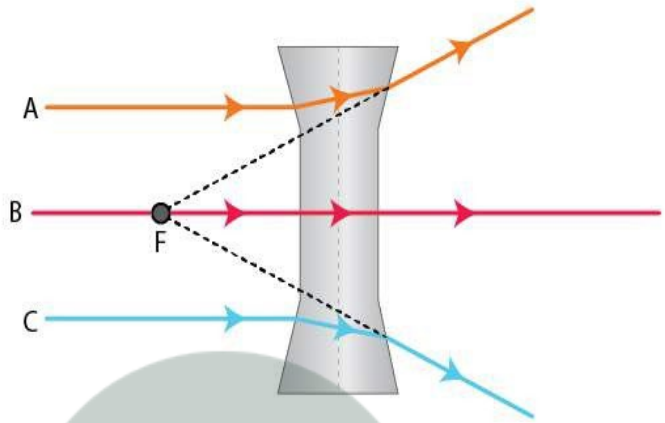


Question: 6
Show by a diagram the refraction of two light rays incident parallel to the principal axis on a convex lens by treating it as a combination of a glass slab and two triangular glass prisms.
Solution:



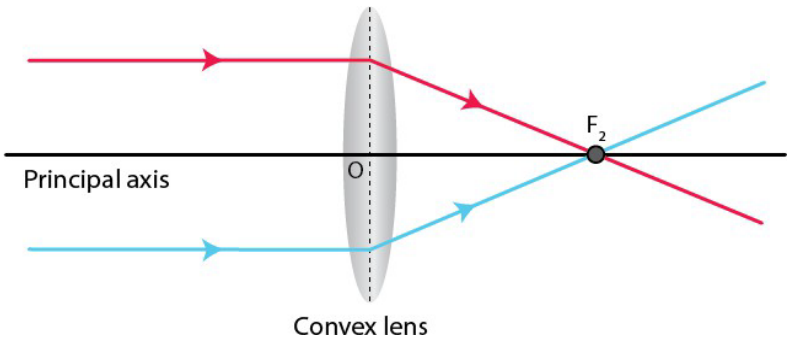
The above figure shows the convex lens which has two glass prisms and one glass slab. One glass prism is situated above the glass slab while the other glass prism is below the glass slab.

Question: 7
Show by a diagram the refraction of two light rays incident parallel to the principal axis on a concave lens by treating it as a combination of a glass slab and two triangular glass prisms.
Solution:

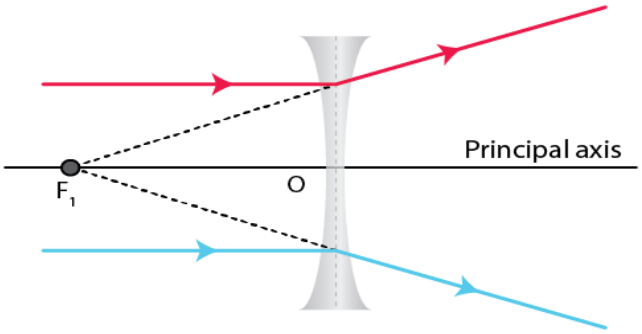


The above figure shows the concave lens which has two glass prisms and one glass slab. One of the glass prism is situated above the glass slab while the other is below the glass slab.

Question: 8
How does the action of convex lens differ from that of a concave lens on a parallel beam of light incident on them? Draw diagrams to illustrate your answer.
Solution:
When a parallel beam of light is incident on a convex lens then the prism in the upper part bends the incident ray downwards while the prism in the lower part bends the incident ray upwards. The central part which is a parallel sided glass slab passes the ray undeviated.



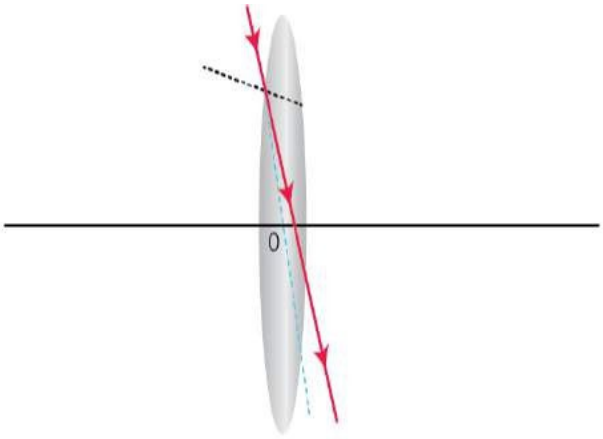
In case of concave lens the upper part of the lens bends the incident ray upwards and lower part bends the incident ray downwards while the central part, which is a parallel sided glass slab, passes the ray undeviated.



Concave lens

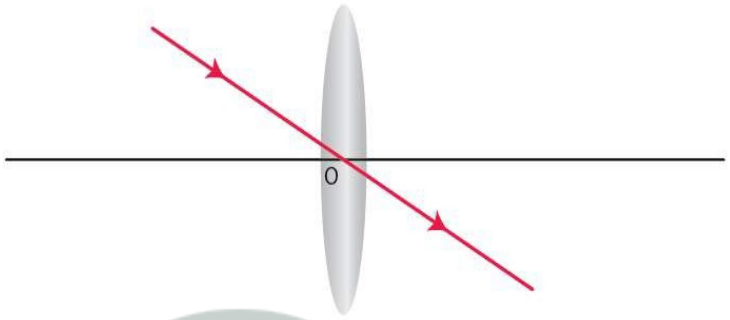
Question: 9
Define the term principal axis of a lens.
Solution:
Principal axis is defined as 'a line joining the centres of curvature of the two surfaces of the lens'.

Question: 10
Explain optical centre of a lens with the help of proper diagram(s).
Solution:
Optical centre is a point on the principal axis of the lens such that a ray of light passing through this point emerges parallel to its direction of incidence. It is marked by the letter O in below figure. The optical centre is thus the centre of lens.



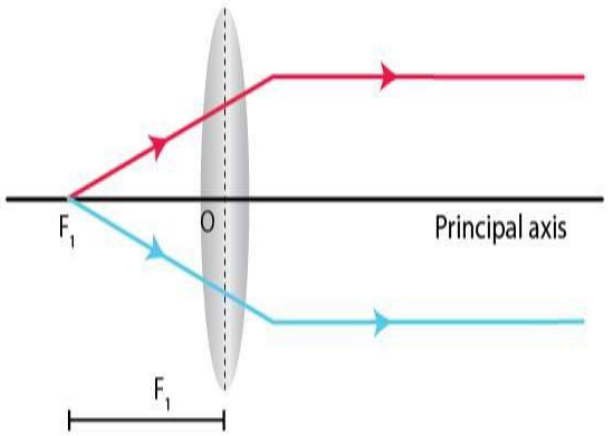
Question: 11
A ray of light incident at a point on the principal axis of a

convex lens passes undeviated through the lens.
(a) What special name is given to this point on the principal axis?
(b) Draw a labelled diagram to support answer in part(a).
Solution:
(a) This point on the principal axis is known as Optical centre.
(b)

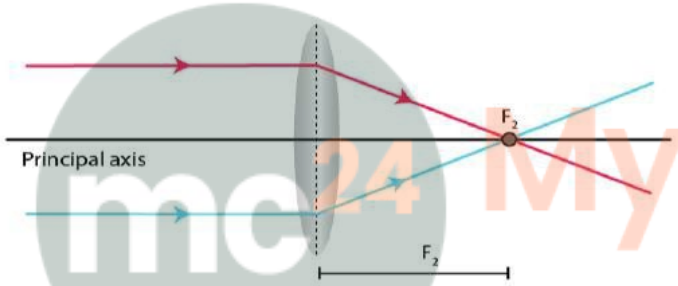


Question: 12
State the condition when a lens is called an equiconvex or equi-concave.
Solution:
When the radii of curvature of both the surfaces are equal then the lens is called an equiconvex or equi-concave lens.

Question: 13
Define the term principal foci of a convex lens and illustrate your answer with the aid of proper diagrams.
Solution:
A light ray can pass through a lens from either side. Hence, a lens has two principal foci, one on either side of the lens.
For a convex lens, the first focal point is a point F_1 on the principal axis of the lens such that the rays of light coming from it, after refraction through lens, become parallel to the principal axis of the lens.



For a convex lens, the second focal point is a point F_2 on the principal axis of the lens such that the rays of light incident parallel to the principal axis, after refraction from the lens, pass through it.

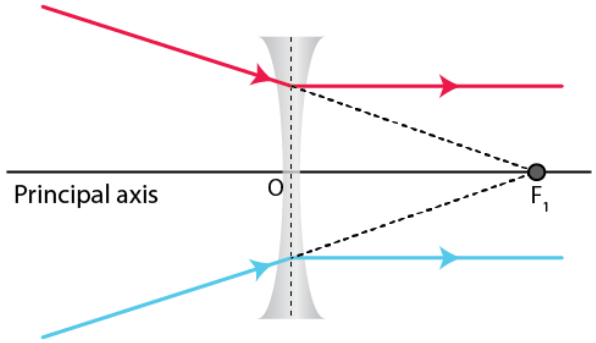


Question: 14

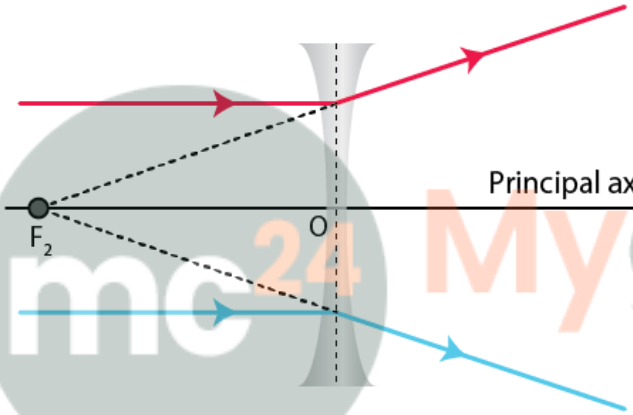
Define the term principal foci of a concave lens and show them with the help of proper diagrams.

Solution:

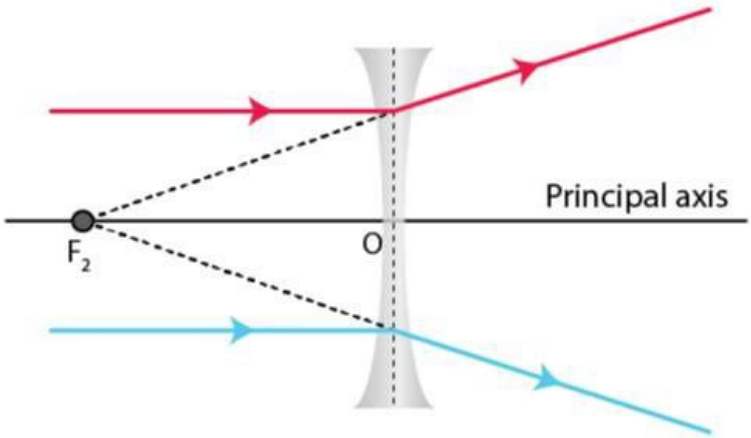
A light ray can pass through a lens from either side. Hence, a lens has two principal foci. For a concave lens, the first focal point is a point F_1 on the principal axis of a lens such that the incident rays of light appearing to meet at it, after refraction from the lens become parallel to the principal axis of the lens.



For a concave lens, the second focal point is a point F_2 on the principal axis of the lens such that the rays of light incident parallel to the principal axis, after refraction from the lens, appear to be diverging from this point.

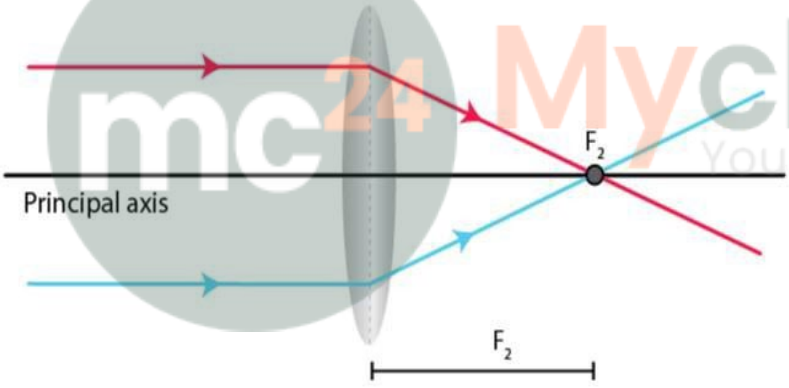


Question: 15
Draw a diagram to represent the second focus of a concave lens.
Solution:



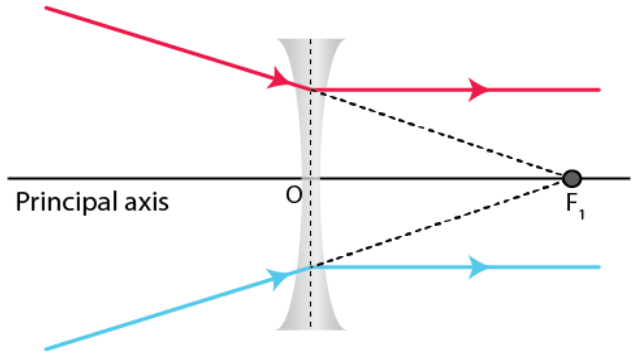
Concave lens representing second focus

Question: 16
Draw a diagram to represent the second focus of a convex lens.
Solution:



Convex lens representing second focus

Question: 17
A ray of light, after refraction trough a concave lens emerges parallel to the principal axis.
(a) Draw a ray diagram to show the incident ray and its corresponding emergent ray.
(b) The incident ray when produced meets the principal axis at a point F. Name the point F.
Solution:
(a)



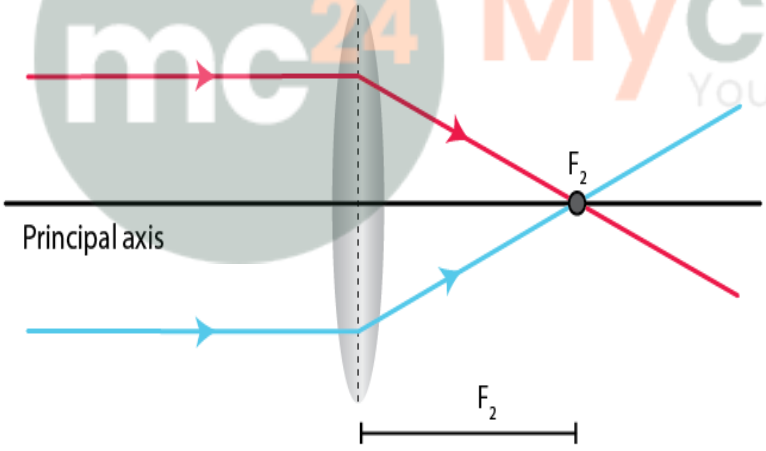
(b) The point F is called first focus when the produced incident ray meets the principal axis at a point F.

Question: 19

A beam of light incident on a convex lens parallel to its principal axis converges at a point F on the principal axis. Name the point F. Draw a ray diagram to show it.

Solution:

This point F is known as second focus.

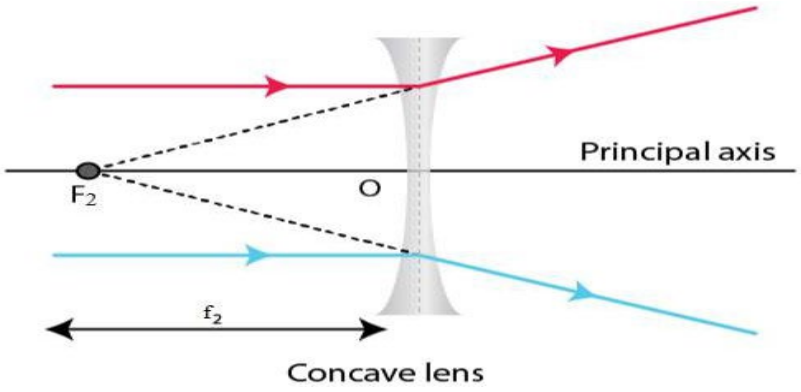


Question: 20

A beam of light incident on a thin concave lens parallel to its principal axis diverges and appears to come from a point F on the principal axis. Name the point F. Draw a ray diagram to show it.

Solution:

This point F appears to come from second focus

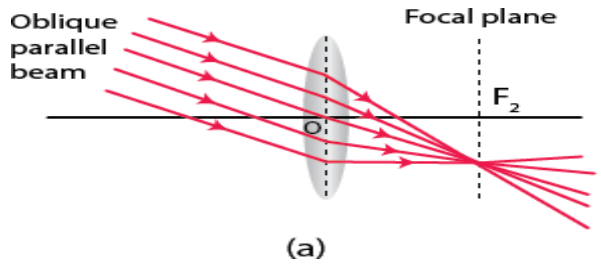


Question: 21
Define the term focal length of a lens.
Solution:
The distance of focus from the optical centre of lens, is called its focal length.

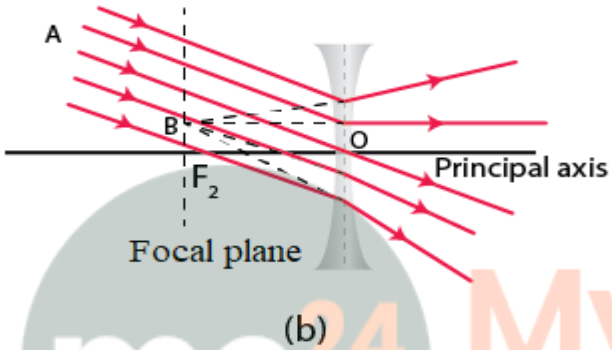
Question: 22
What do you mean by focal plane of a lens?
Solution:
A plane normal to the principal axis, passing through the focus, is called the focal plane of a lens.

Question: 23
State the condition for each of the following :
(i) a lens has both its focal lengths equal.
(ii) a ray passes undeviated through the lens.
Solution:
(i) Medium is same on either side of lens if it has both its focal lengths equal.
(ii) The ray is incident at the optical centre of the lens if it passes undeviated through the lens.

Question: 24
A parallel oblique beam of light falls on a (i) convex lens, (ii) concave lens. Draw a diagram in each case to show the refraction of light through the lens.
Solution:



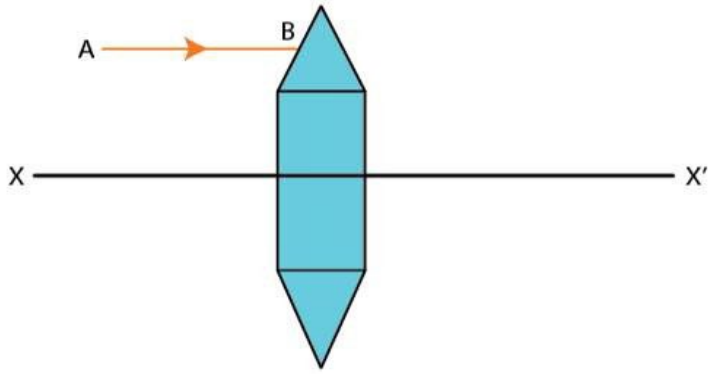
Refraction of an oblique parallel beam by a convex lens



Refraction of an oblique parallel beam by a concave lens

Question: 25

The diagram below shows a lens as a combination of a glass block and two prisms.



(i) Name the lens formed by the combination.

(ii) What is the line XX' called?

(iii) Complete the ray diagram and show the path of the incident ray AB after passing through the lens.

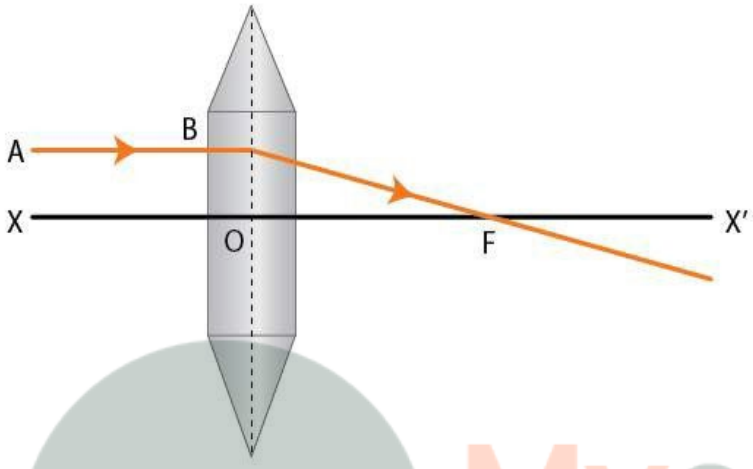
(iv) The final emergent ray will either meet XX' at a point or appear to come from a point on XX'. Label the point as F. What is this point called?

Solution:

(i) The lens formed by the combination is convex lens

(ii) The line XX' is called principal axis.

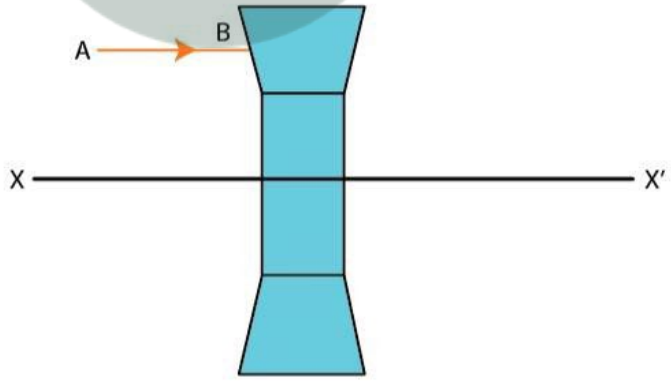
(iii) The complete ray diagram is shown below



(iv) This point F is called as focal point or focus.

Question: 26

The diagram below shows a lens as a combination of a glass slab and two prisms.



(i) Name the lens formed by the combination.

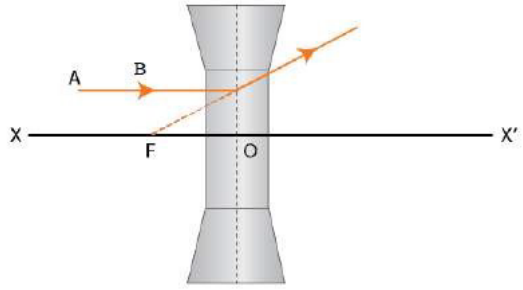
(ii) What is the line XX' called?

(iii) Complete the path of the incident ray AB after passing through the lens.

(iv) The final emergent ray either meets XX' at a point or appears to come from a point on XX'. Label it as F. What is this point called?

Solution:

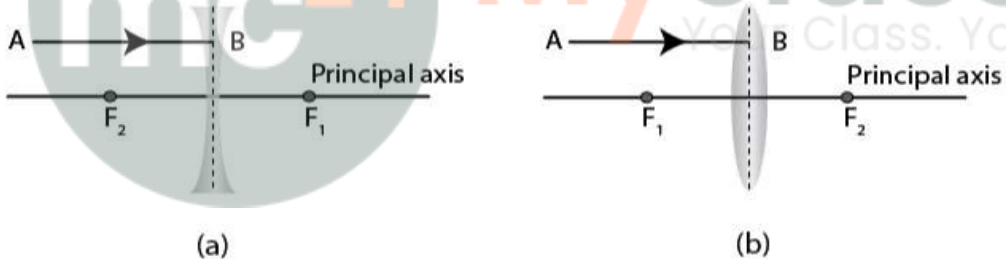
(i) The combination forms concave lens.
(ii) The line XX' is called principal axis.
(iii) Complete diagram is shown below



(iv) The point F is called as focal point or focus.

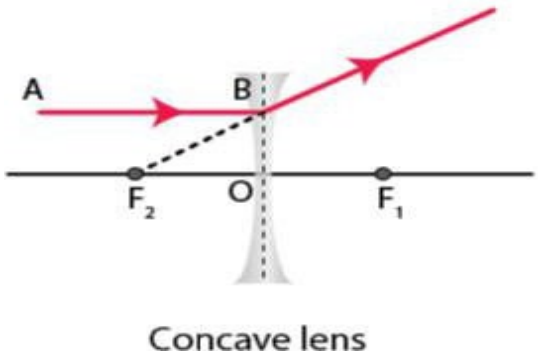
Question: 27

In Fig. (a) and (b), F_1 and F_2 are the positions of the two foci of the thin lenses. Draw the path taken by the light ray AB after it emerges from each lens.

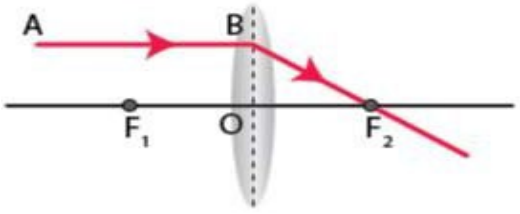


Solution:

(a)



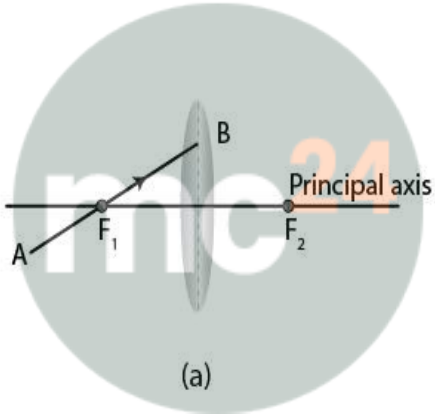
(b)



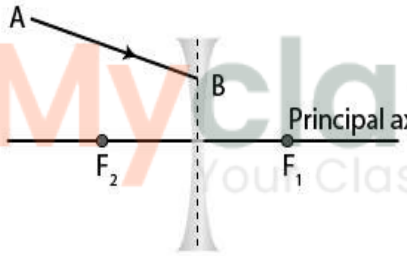
Convex lens

Question: 28

In Fig. (a) and (b), F_1 and F_2 are the two foci of the thin lenses and AB is the incident ray. Complete the diagram to show the path of the ray AB after refraction through the lens.



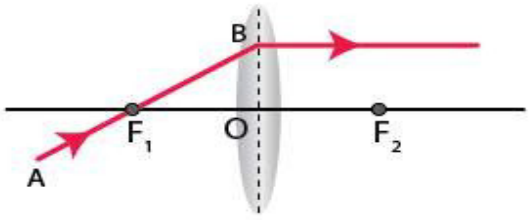
(a)



(b)

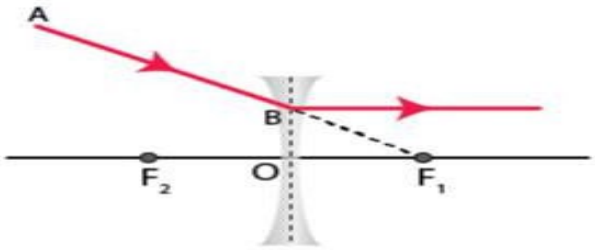
Solution:

(a)



Convex lens

(b)



Concave lens

Question: 29
Complete the following sentences :
(a) If half part of a convex lens is covered, the focal length _____change, but the intensity of image _____.
(b) A convex lens is placed in water. Its focal length will _____.
(c) The focal length of a thin convex lens is _____than that of a thick convex lens.
Solution:
(a) If half part of a convex lens is covered, the focal length does not change, but the intensity of image decreases.
(b) A convex lens is placed in water. Its focal length will increase.
(c) The focal length of a thin convex lens is more than that of a thick convex lens.

MULTIPLE CHOICE TYPE
Question: 1
A ray of light after refraction through a lens emerges parallel to the principal axis of the lens. The incident ray either passes through :
(a) its optical centre
(b) its first focus
(c) its second focus
(d) its centre of curvature of the first surface
Solution:
The incident ray passes through its first focus

Question: 2
A ray of light incident on a lens parallel to its principal axis, after refraction passes through or appears to come from:
(a) Its first focus
(b) Its optical entre
(c) Its second focus

(d) The centre of curvature of its second surface

Solution:

The ray of light after refraction passes through or appears to come from its second focus.