EXERCISE 5(A) PAGE NO: 109

Question: 1
What is a lens?
Solution:
A lens is defined as 'a transparent refracting medium bounded by either two spherical surfaces or one surface spherical and other surface plane'.

Question: 2
Name the two kinds of lens? Draw diagrams to illustrate them.
Solution:
There are two types of lenses.
(i) Convex or converging lens and
(ii) Concave or diverging lens

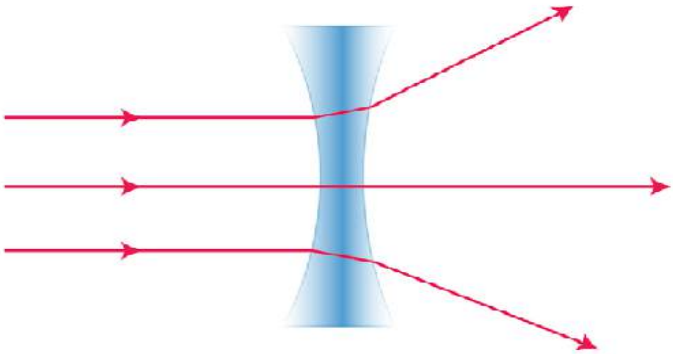
Question: 3
State difference between a convex and a concave lens in their
(a) appearence, and
(b) action on the incident light.
Solution:

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.

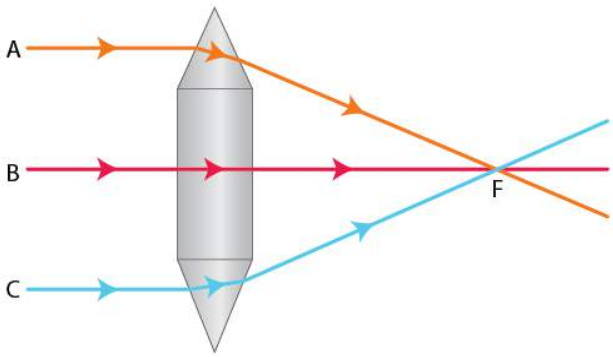
Question: 4
Which lens is converging:
(i) an equiconcave lens or an equiconvex lens?
(ii) a concavo-convex lens or a convexo-concave lens?

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.

Question: 5
Out of the two lenses, one concave and the other convex, state which one will show the divergent action on a light beam. Draw diagram to illustrate your answer.
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:

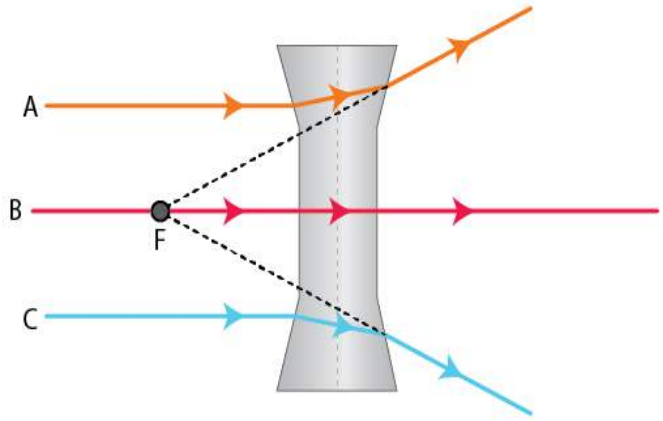


The above figure shows the convex lens which has two glass prisms and one glass slab. One glass prism is situated above the glass slab while the other glass prism is below the glass slab.

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:



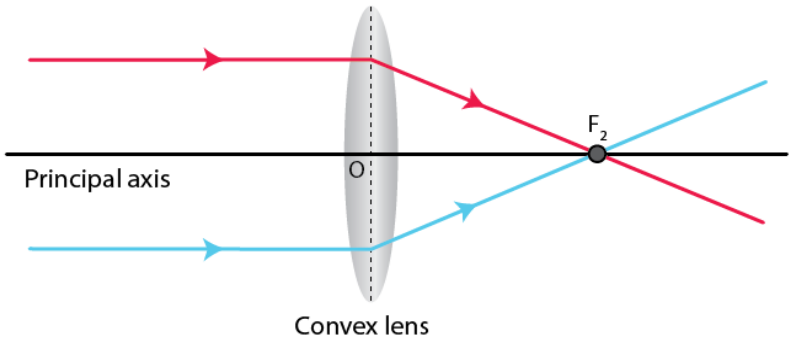
The above figure shows the concave lens which has two glass prisms and one glass slab. One of the glass prism is situated above the glass slab while the other is below the glass slab.

Question: 8

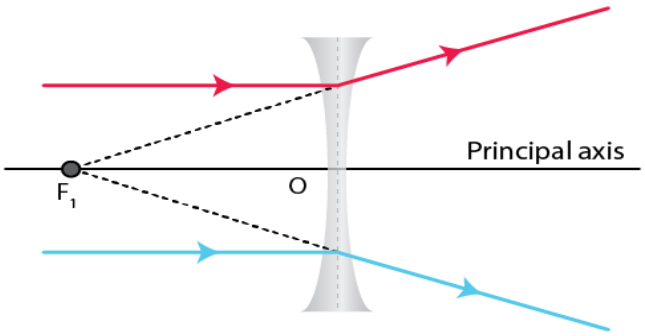
How does the action of convex lens differ from that of a concave lens on a parallel beam of light incident on them? Draw diagrams to illustrate your answer.

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.



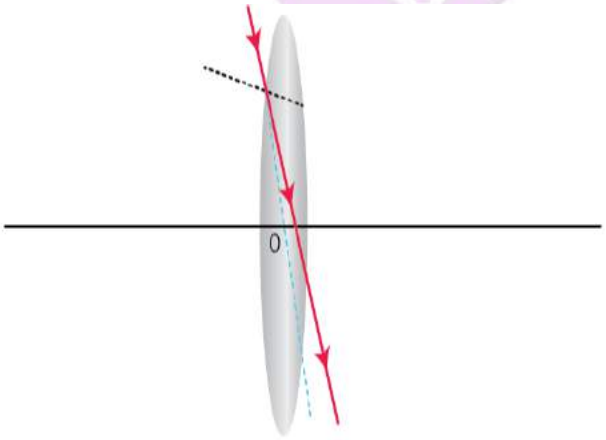
In case of concave lens the upper part of the lens bends the incident ray upwards and lower part bends the incident ray downwards while the central part, which is a parallel sided glass slab, passes the ray undeviated.



Concave lens

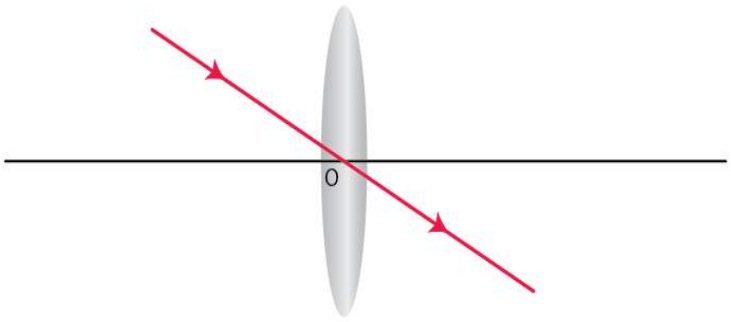
Question: 9
Define the term principal axis of a lens.
Solution:
Principal axis is defined as ‘a line joining the centres of curvature of the two surfaces of the lens’.

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.



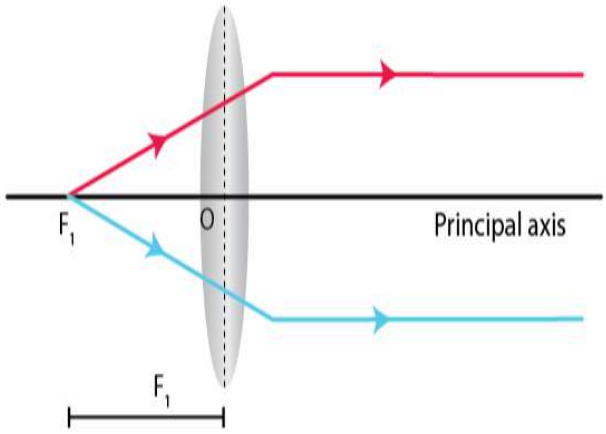
Question: 11
A ray of light incident at a point on the principal axis of a

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)

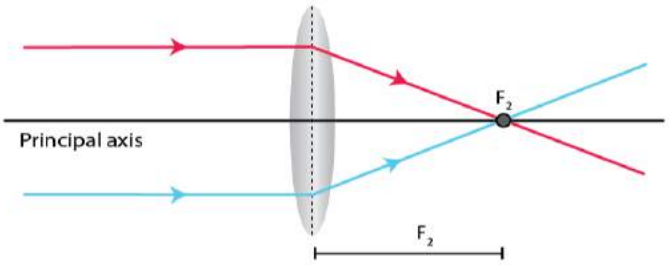


Question: 12
State the condition when a lens is called an equiconvex or equi-concave.
Solution:
When the radii of curvature of both the surfaces are equal then the lens is called an equiconvex or equi-concave lens.

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.

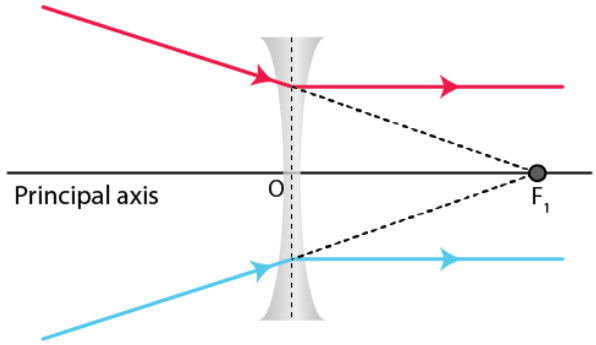


Question: 14

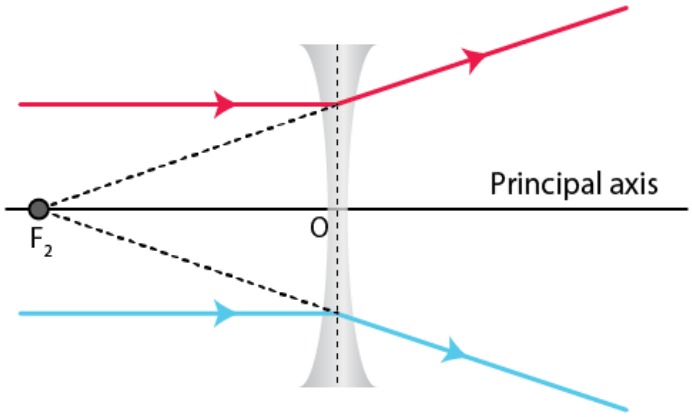
Define the term principal foci of a concave lens and show them with the help of proper diagrams.

Solution:

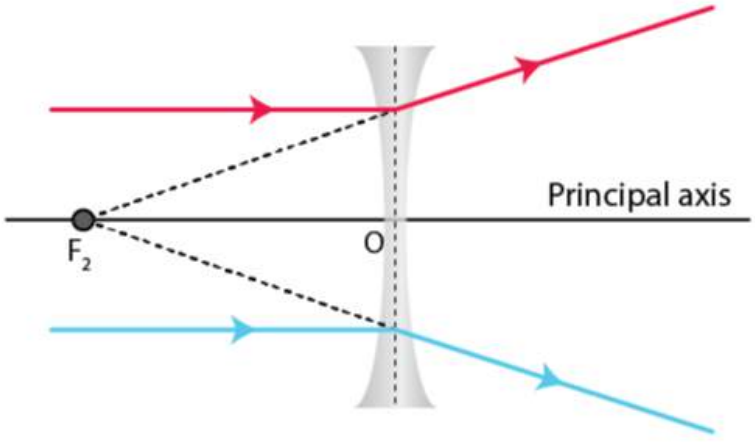
A light ray can pass through a lens from either side. Hence, a lens has two principal foci. For a concave lens, the first focal point is a point F_1 on the principal axis of a lens such that the incident rays of light appearing to meet at it, after refraction from the lens become parallel to the principal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

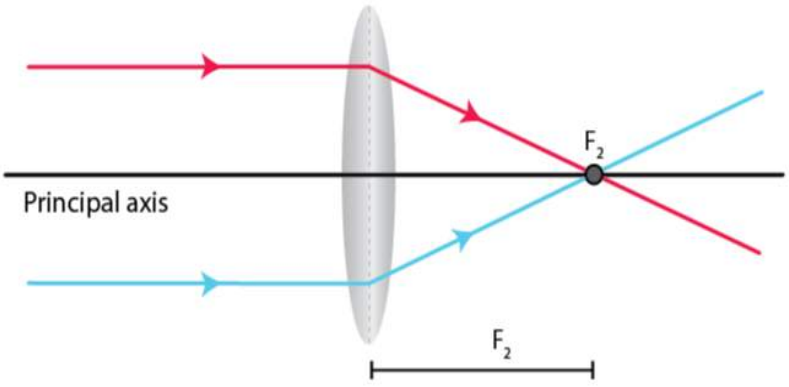


Question: 15
Draw a diagram to represent the second focus of a concave lens.
Solution:



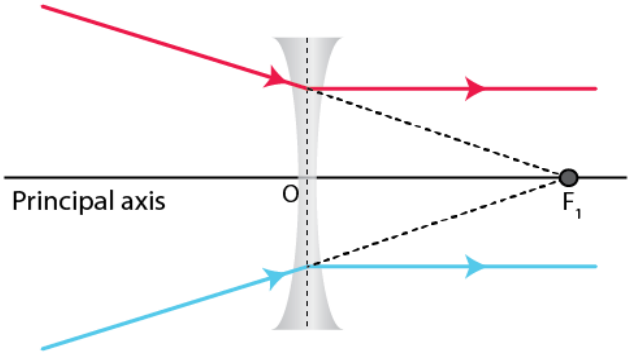
Concave lens representing second focus

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



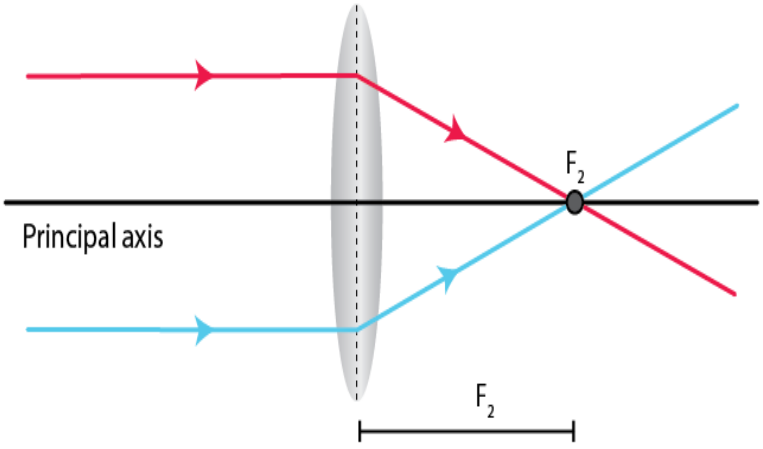
Convex lens representing second focus

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)

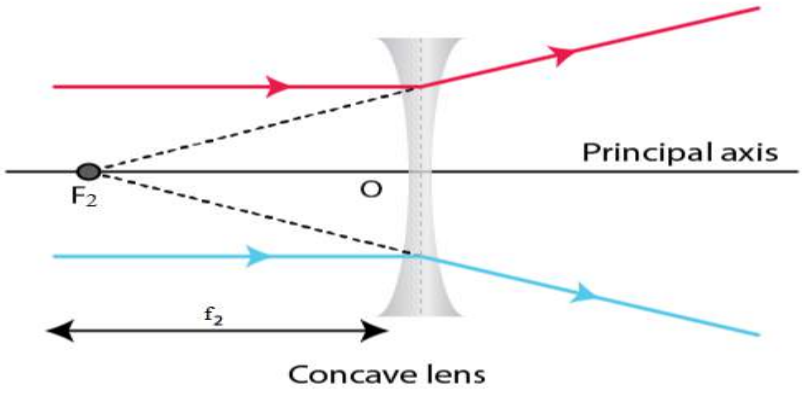


(b) The point F is called first focus when the produced incident ray meets the principal axis at a point F.

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

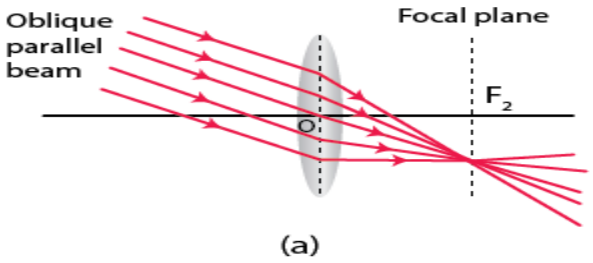


Question: 21
Define the term focal length of a lens.
Solution:
The distance of focus from the optical centre of lens, is called its focal length.

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.

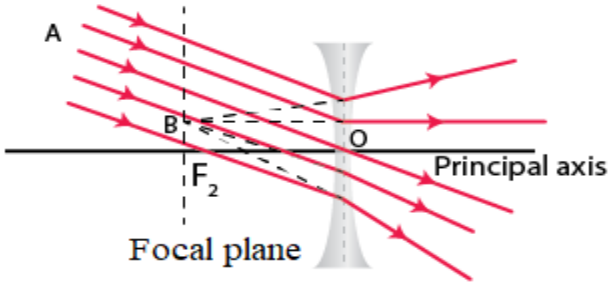
Question: 23
State the condition for each of the following :
(i) a lens has both its focal lengths equal.
(ii) a ray passes undeviated through the lens.
Solution:
(i) Medium is same on either side of lens if it has both its focal lengths equal.
(ii) The ray is incident at the optical centre of the lens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



(a)

Refraction of an oblique parallel beam by a convex lens

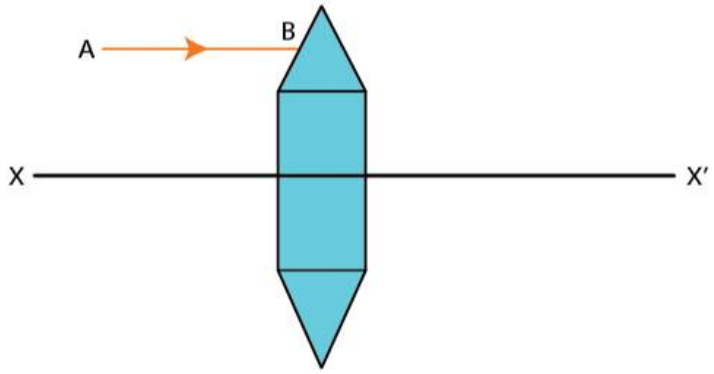


(b)

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.

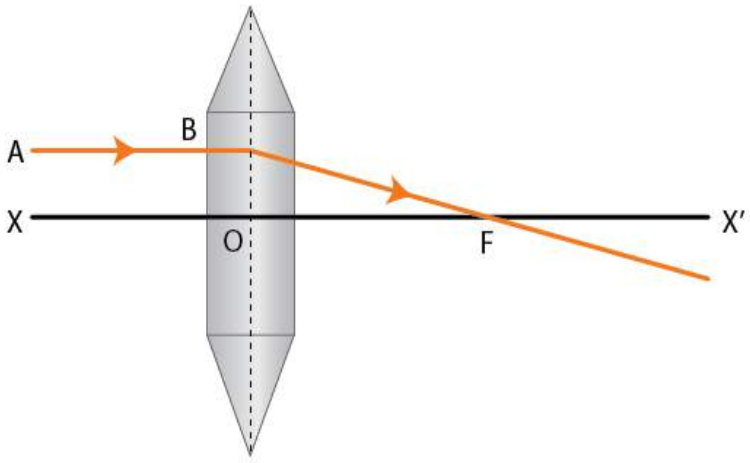
(iv)The final emergent ray will either meet XX' at a point or appear to come from a point on XX'. Label the point as F. What is this point called?

Solution:

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

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

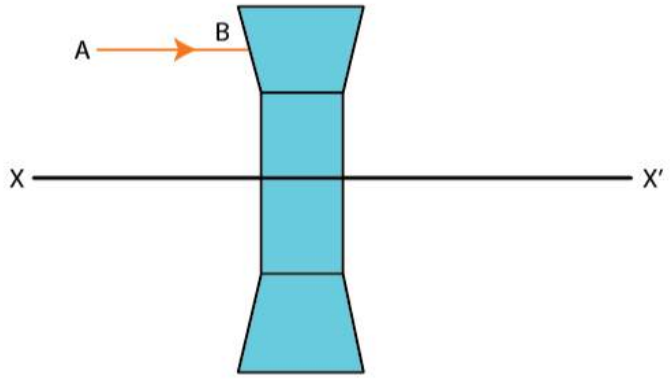
(iii) The complete ray diagram is shown below



(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.

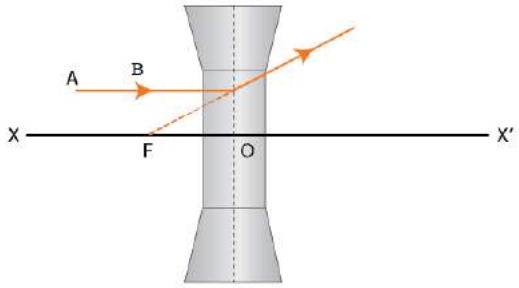
(ii) What is the line XX' called?

(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?

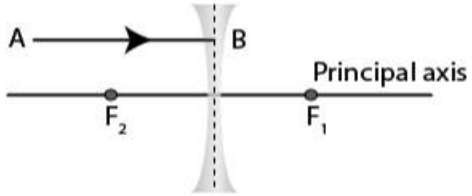
Solution:

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

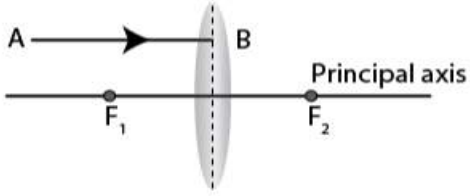


(iv) The point F is called as focal point or focus.

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.

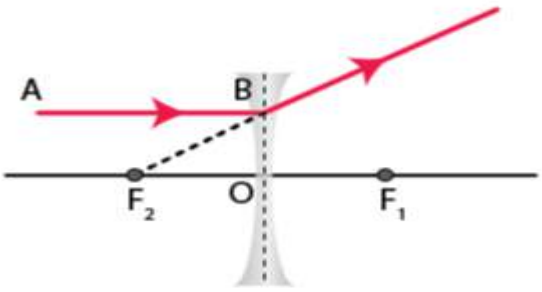


(a)



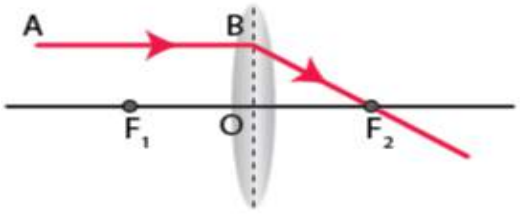
(b)

Solution:
(a)



Concave lens

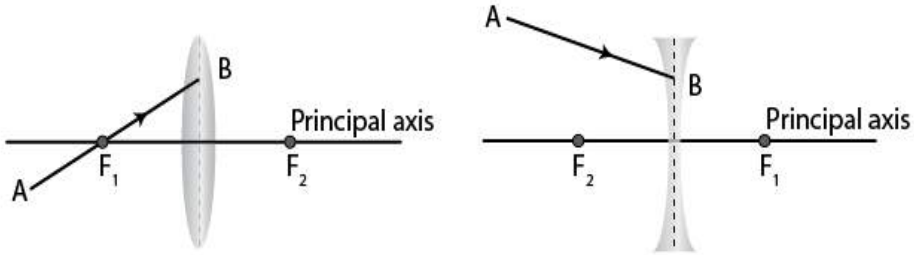
(b)



Convex lens

Question: 28

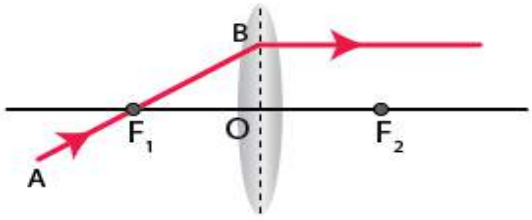
In Fig. (a) and (b), F_1 and F_2 are the two foci of the thin lenses and AB is the incident ray. Complete the diagram to show the path of the ray AB after refraction through the lens.



(a) (b)

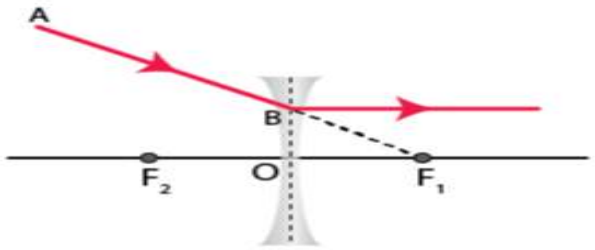
Solution:

(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.

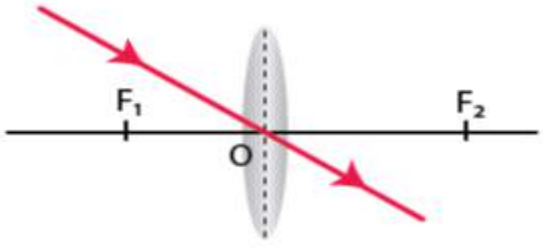
EXERCISE 5(B) PAGE NO: 119

Question: 1

What are the three principal rays that are drawn to construct the ray diagram for the image formed by a lens? Draw diagram to support your answer.

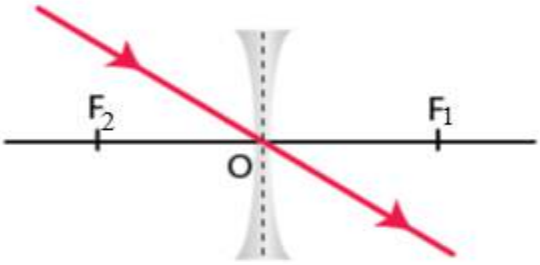
Solution:

(i) A ray of light incident at the optical centre O of the lens passes undeviated through the lens.



Convex lens

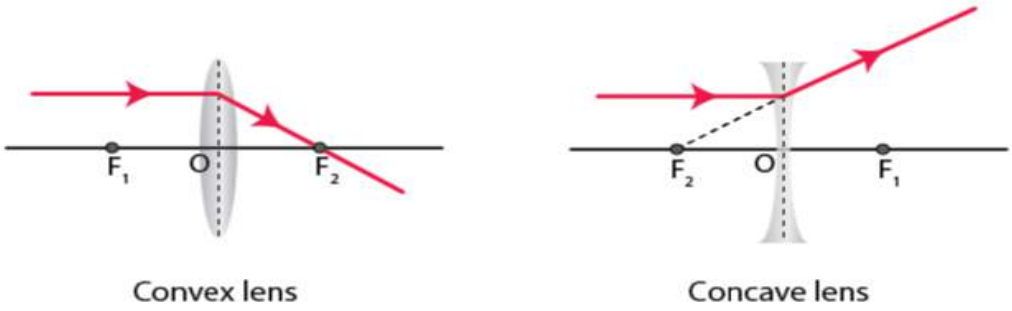
(a)



Concave lens

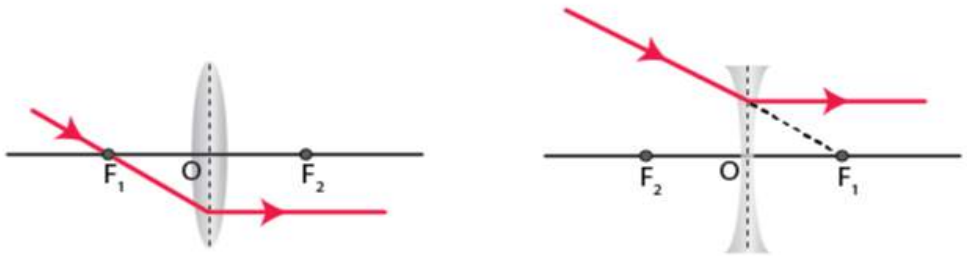
(b)

(ii) A ray of light incident parallel to the principal axis of the lens, after refraction passes through the second focus F_2 (in a convex lens) or appears to come from the second focus F_2 (in a concave lens)



Convex lens Concave lens

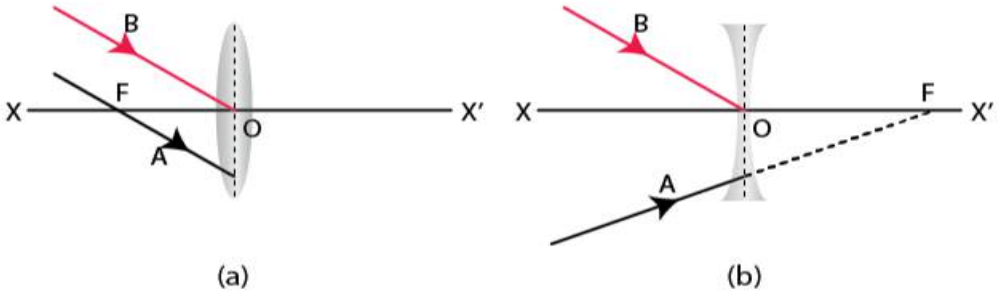
(iii) A ray of light passing through the first focus F_1 (in a convex lens) or directed towards the first focus F_1 (in a concave lens), emerges parallel to the principal axis after refraction



Convex lens Concave lens

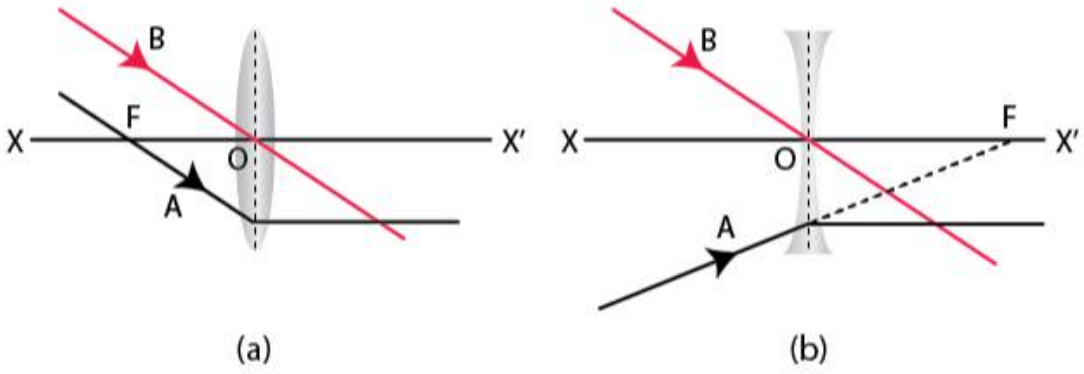
Question: 2

In the diagrams below, XX' represents the principal axis, O the optical centre and F the focus of the lens. Complete the path of the rays A and B as they emerge out of the lens.



(a) (b)

Solution:



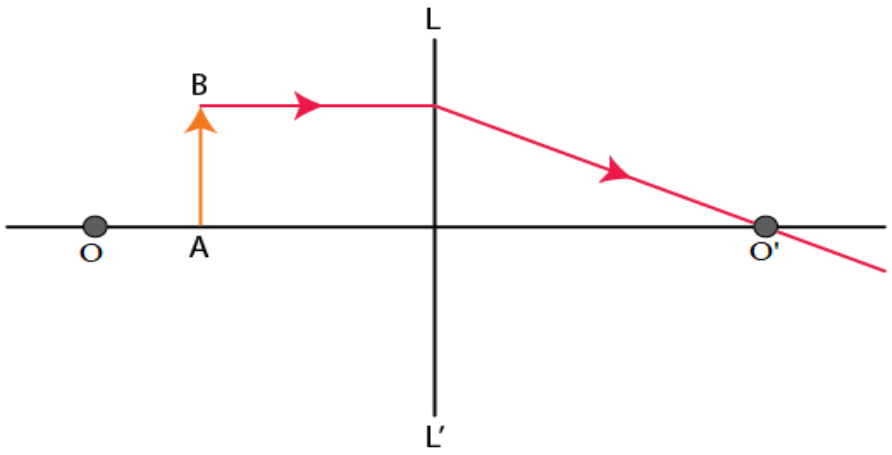
Question: 3
Where must a point source of light be placed in front of a convex lens so as to obtain a parallel beam of light?
Solution:
The rays of light after being refracted through the convex lens obtain a parallel beam of light when a source of light is placed at the first focal point i.e the focal point on the left of the optical centre of the convex lens.

Question: 4
Distinguish between a real and a virtual image.
Solution:

Real image	Virtual image
A real image is formed due to actual intersection of the rays refracted by the lens	A virtual image is formed when the rays refracted by the lens appear to meet if they are produced backwards
A real image can be obtained on a screen	A virtual image cannot be obtained on a screen
A real image is inverted with respect to the object	A virtual image is erect with respect to the object

Question: 5
Study the diagram given below.
(a) Name the lens LL'.
(b) What are the points O and O' called?
(c) Complete the diagram to form the image of the object AB.
(d) State the three characteristics of the image.

(e) Name a device in which this action of lens is used.

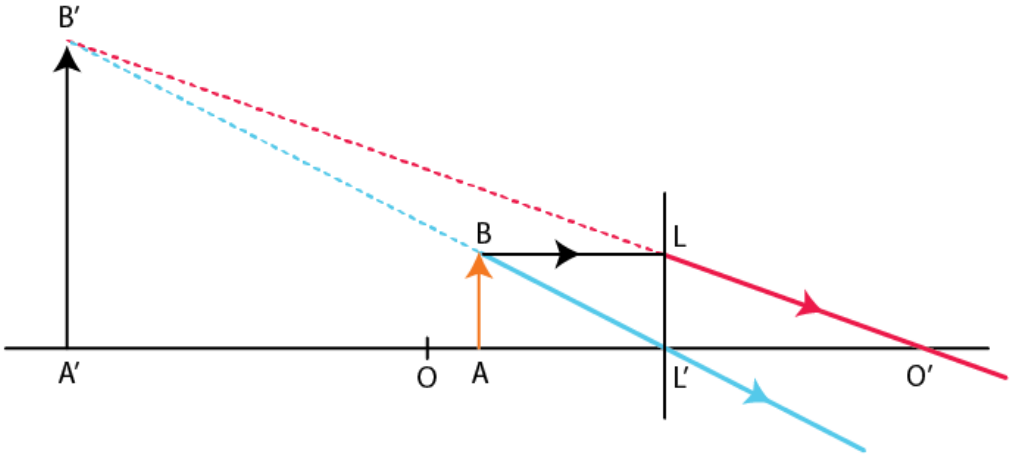


Solution:

(a) LL' is a convex lens

(b) O and O' are called as first and second focal points

(c) The complete diagram is shown below

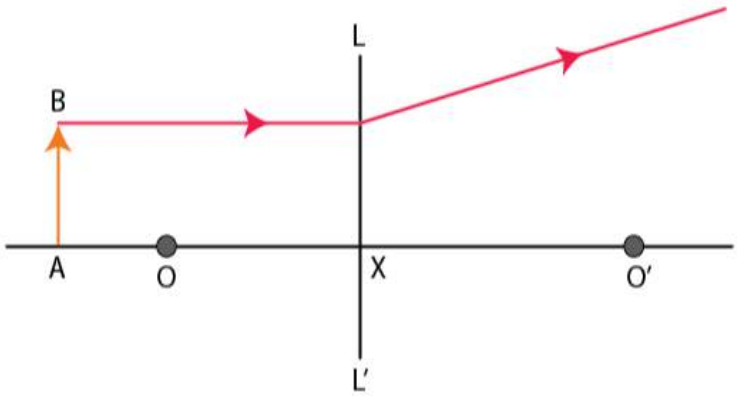


(d) The three characteristics of the image are magnified, virtual and upright.

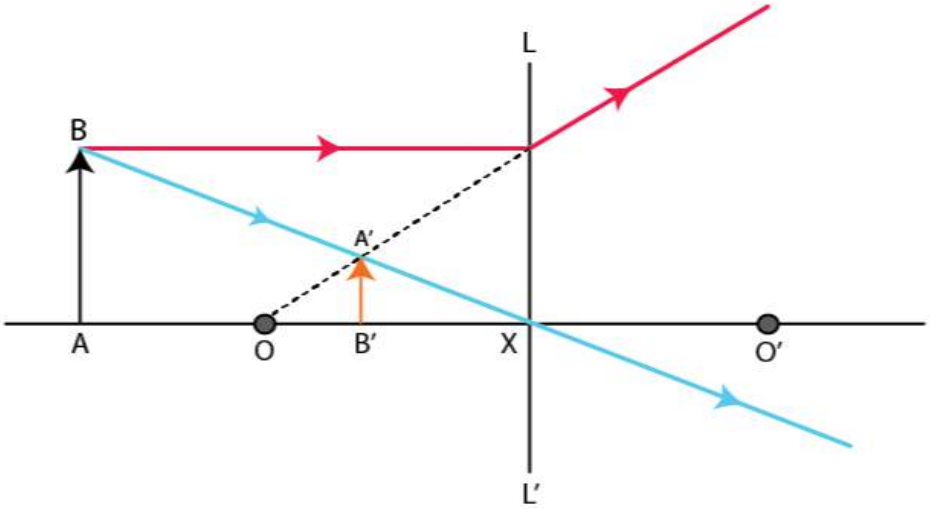
(e) This action of lens is used in magnifying glass

Question: 6

Study the diagram below.

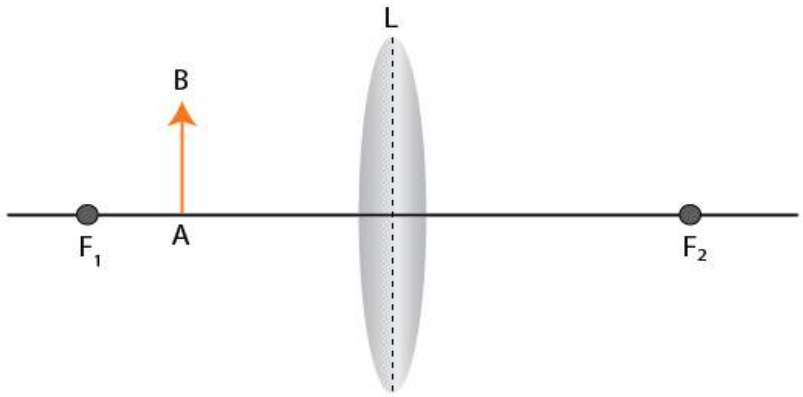


(i)Name the lens LL'.
(ii)What are the points O and O' called?
(iii)Complete the diagram to from the image of the object AB.
(iv)State three characteristics of the image.
Solution:
(i) LL' is a concave lens
(ii) The points O and O' are called second and first focal point.
(iii)



(iv) The three characteristics of the image are virtual, erect and diminished.

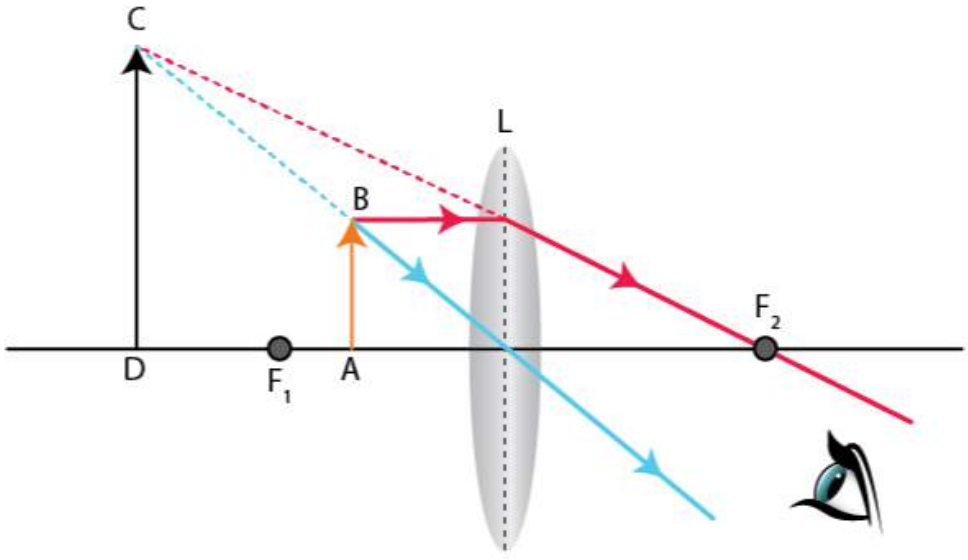
Question: 7
The following diagram in Fig. shows an object AB and a converging lens L with foci F_1 and F_2.
(a) Draw two rays from the object AB and complete the diagram to locate the position of the image CD. Also mark on the diagram the position of eye from where the image can be viewed.



(b) State three characteristics of the image in relation to the object.

Solution:

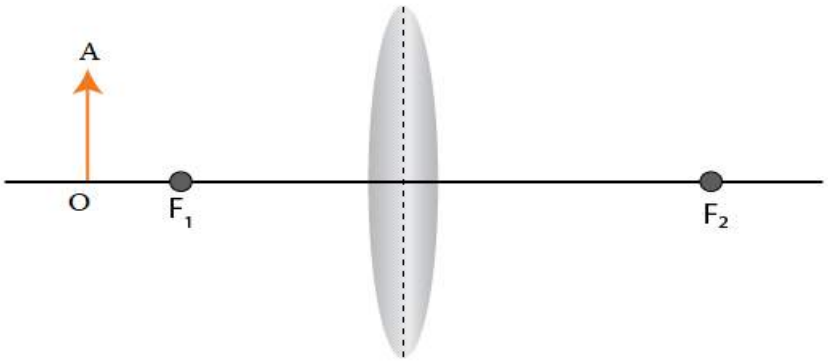
(a) The complete diagram is



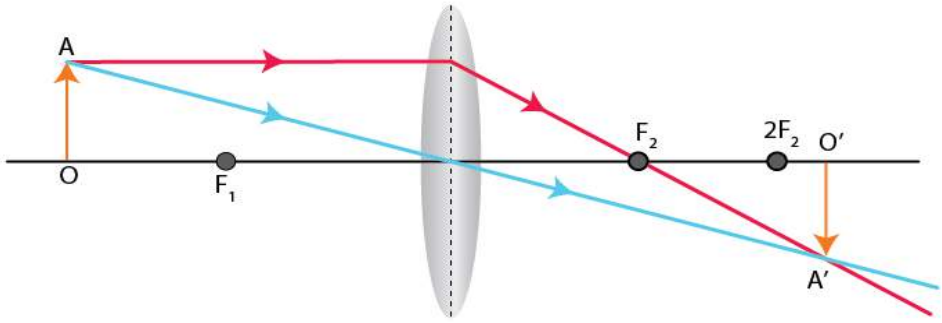
(b) The three characteristics of the image are magnified, virtual and upright.

Question: 8

The diagram given below in fig. shows the position of an object OA in relation to a converging lens L whose foci are at F_1 and F_2.

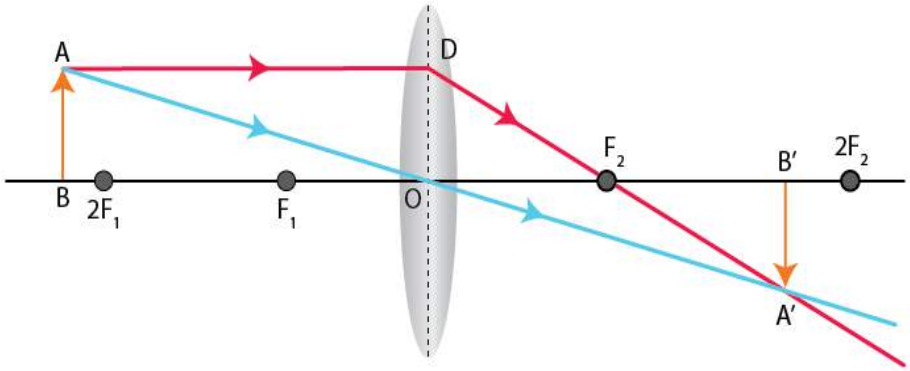


(i) Draw two rays to locate the position of the image.
(ii) State the position of image with reference to the lens.
(iii) Describe the three characteristics of the image.
(iv) Describe how the distance of the image from the lens and the size of the image change as the object move towards F_1.
Solution:
(i)



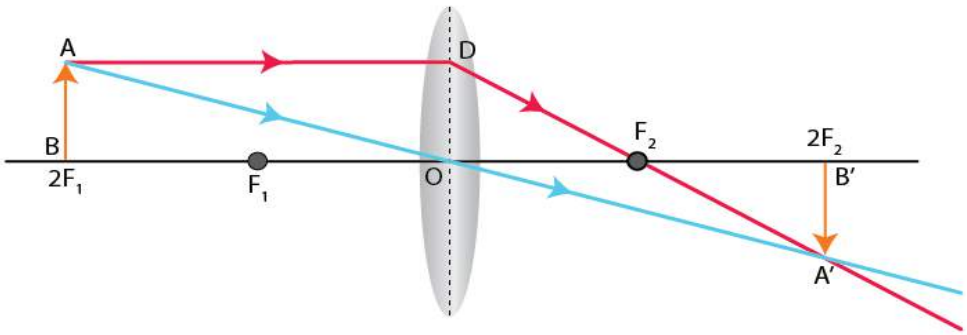
(ii) Images position will be more than twice the focal length of lens
(iii) The three characteristics of this image are magnified, real and inverted.
(iv) The image will shift away from F_2 as the object move towards F_1 and it is magnified. The image will form at infinity and it is highly magnified at F_1. Between F_1 and optical centre, the image will form on the same side of object and will be magnified.

Question: 9
A converging lens forms the image of an object placed in front of it, beyond $2F_2$ of the lens.
(a) Where is the object placed? (b) Draw a ray diagram to show the formation of image. (c) State its three characteristics of the image.
Solution:
(a) The object is placed beyond $2F_1$
(b)



The image is formed beyond $2F_2$
(c) The three characteristics of the image is real, inverted and diminished.

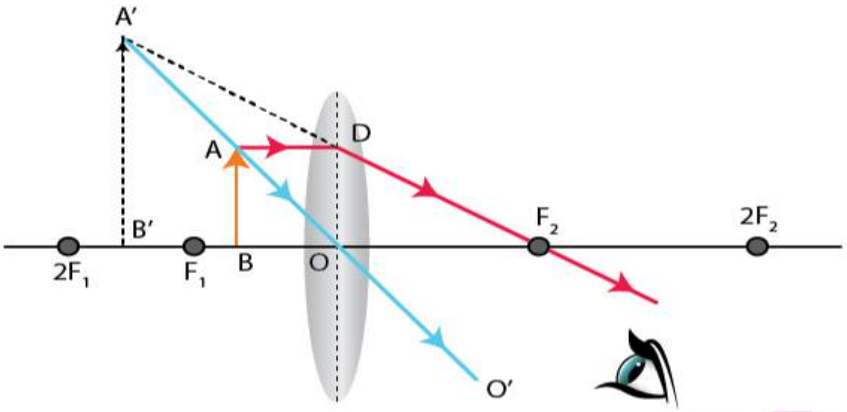
Question: 10
A convex lens forms an image of an object equal to the size of the object. (a) Where is the object placed in front of the lens? (b) Draw a diagram to illustrate it. (c) State two more characteristics of the image.
Solution:
(a) The object is placed at a distance equal to twice the focal length of the lens.
(b)



(c) The image formed is real and inverted

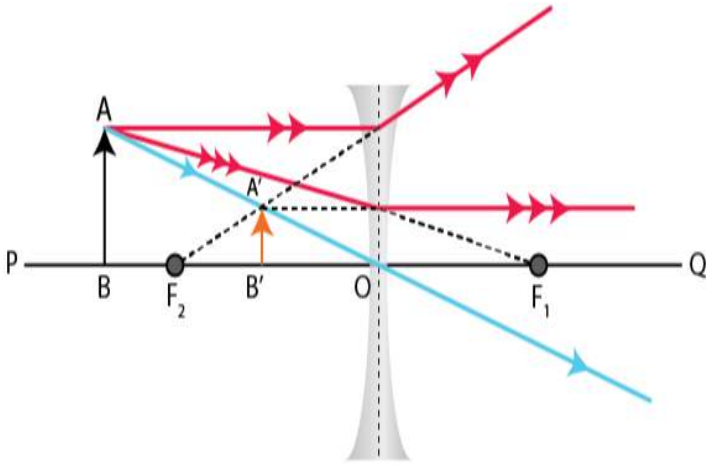
Question: 11
A lens forms an erect, magnified and virtual image of an object.
(a) Name the kind of lens.
(b) Where is the object placed in relation to the lens?
(c) Draw a ray diagram to show the formation of image.
(d) Name the device which uses this principle.
Solution:

(a) Convex lens
(b) The object is placed between the lens and focus (F_1)
(c)



(d) The device which uses this principle is magnifying glass

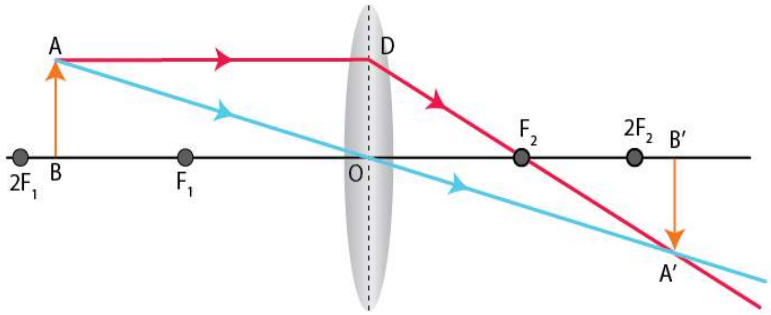
Question: 12
A lens always forms an image between the object and the lens. (a) name the lens. (b) Draw a ray diagram to shown the formation of such image. (c) state three characteristics of the image.
Solution:
(a) The lens that forms the image between the object and itself is concave lens.
(b) The below figure shows the ray diagram



(c) The three characteristics of the image are virtual, erect and diminished.

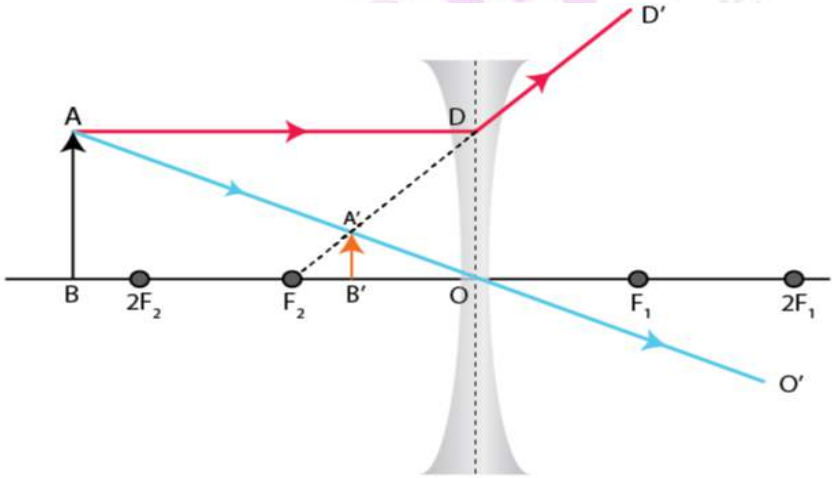
Question: 13
Classify as real or virtual, the image of a candle flame formed on a screen by a

convex lens. Draw a ray diagram to illustrate how the image is formed.
Solution:
Let the object is placed beyond $2F_1$ and its diminished image formed between F_2 and $2F_2$ which is real and inverted.

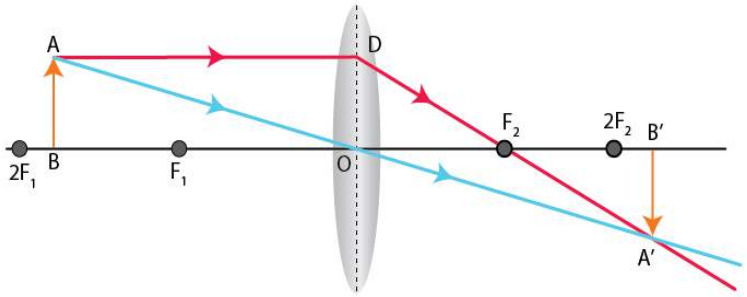


Here the object is AB and its real and inverted image is formed between F_2 and $2F_2$

Question: 14
Show by a ray diagram that a diverging lens cannot form a real image of an object placed anywhere on its principal axis.
Solution:



Question: 15
Draw a ray diagram to show how a converging lens can form a real and enlarged image of an object.
Solution:



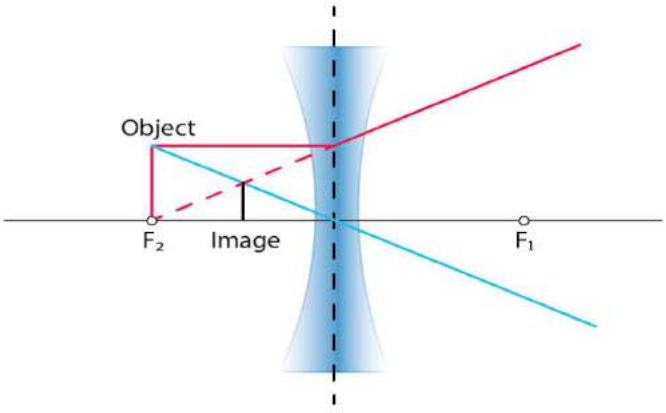
The above figure shows the image formed is real, enlarged and inverted.

Question: 16

A lens forms an upright and diminished image of an object placed at its focal point. Name the lens and draw a ray diagram to show the formation of image.

Solution:

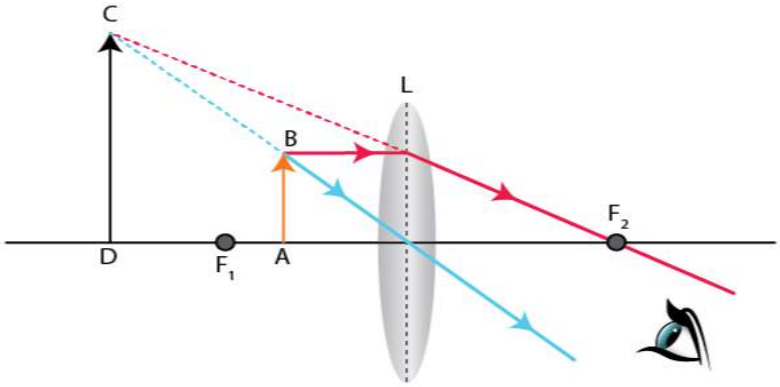
In a concave lens, the lens forms an upright and diminished image of an object placed at its focal point.



Question: 17

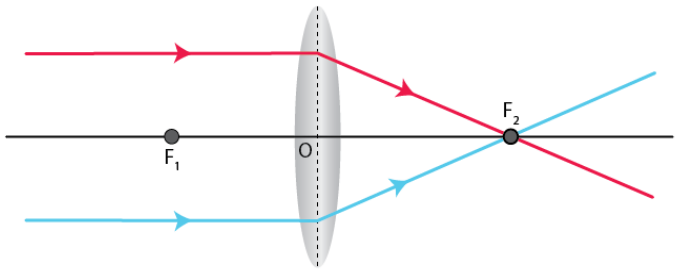
Draw a ray diagram to show how a converging lens is used as a magnifying glass to observe a small object. Mark on your diagram the foci of the lens and the position of the eye.

Solution:



The object is placed between the focal point F_1 and convex lens and its image is formed at the same side of the lens which is enlarged.
Hence, this lens can be used as a magnifying lens.

Question: 18
Draw a ray diagram to show how a converging lens can form an image of the sun. Hence give a reason for the term 'burning glass' for a converging lens used in this manner.
Solution:
The Sun is at infinity so convex lens forms its image at second focal point which is real and very much diminished in size.

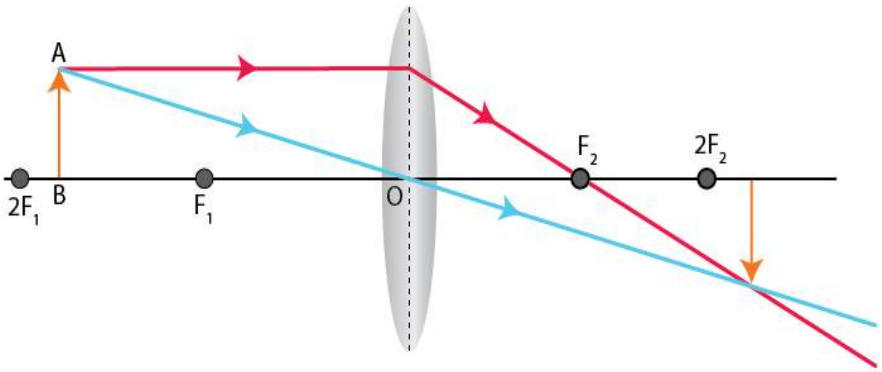


The rays of light from the sun converge to a single point called the focus of the lens. This concentrated image of the Sun burns the paper kept below the lens. Hence, the term burning glass is used for the lens.

Question: 19
A lens forms an inverted image of an object.
(a) Name the kind of lens.
(b) State the nature of the image whether real or virtual?
Solution:
(a) This lens is a convex lens

(b) The nature of the imaged is real

Question: 20
A lens forms an upright and magnified image of an object.
(a)Name the lens.
(b)Draw a labelled ray diagram to show the image formation.
Solution:
(a) The lens used here is a convex lens
(b)



Question: 21
(a)Name the lens which always forms an erect and virtual image.
(b)State whether the image in part (a) is magnified or diminished?
Solution:
(a) The lens used here is concave lens
(b) The image is diminished

Question: 22
Can a concave lens form an image of size two times that of the object? Give reason?
Solution:
No, concave lens cannot form an image of size two times that of the object because it diverges the rays incident on it and only produces a diminished image.

Question: 23
Give two characteristics of the image formed by a concave lens.
Solution:
The image formed by a concave lens is virtual and diminished.

Question: 24
Give two characteristics of the virtual image formed by a convex lens.
Solution:
The virtual image formed by a convex lens will be erect and magnified.

Question: 25
In each of the following cases, where must an object be placed in front of a convex lens so that the image formed is
(a)at infinity,
(b)of same size as the object,
(c)inverted and enlarged,
(d)upright and enlarged?
Solution:
(a) At focus,
(b) At 2F,
(c) Between F and 2F,
(d) Between optical centre and focus.

Question: 26
Complete the following table:

Type of lens	**Position of object**	**Nature of image**	**Size of image**
Convex	**Between optical centre and focus**		
Convex	**At focus**		
Concave	**At infinity**		
Concave	**At any distance**		

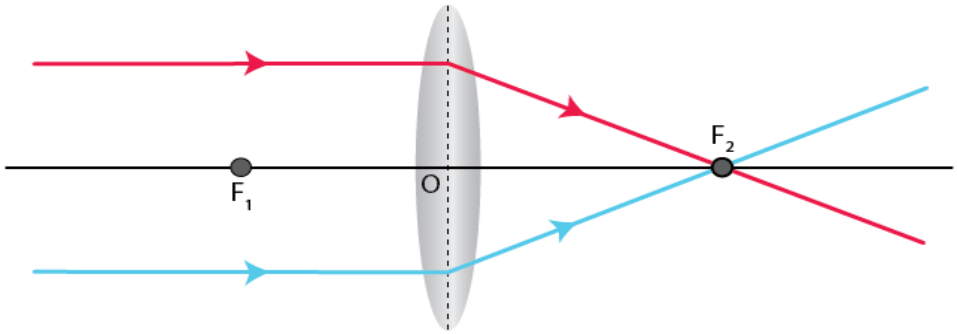
Solution:

Type of lens	Position of object	Nature of image	Size of image
Convex	Between optical centre and focus	Virtual and upright	Magnified
Convex	At focus	Real and inverted	Very much magnified
Concave	At infinity	Virtual and upright	Highly diminished
Concave	At any distance	Virtual and upright	Diminished

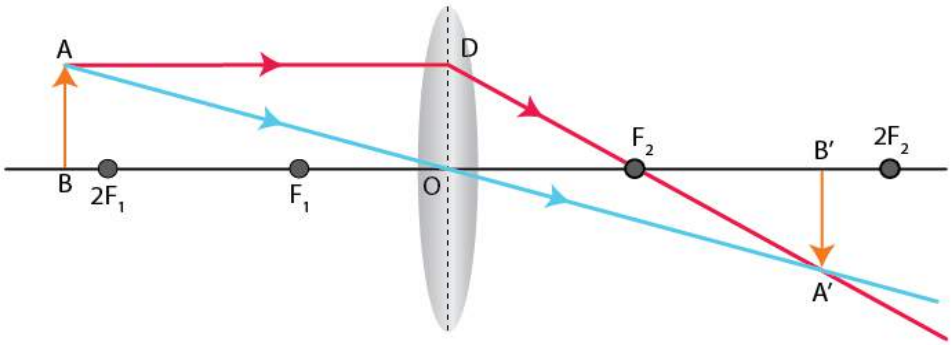
Question: 27
State the changes in the position, size and nature of the image when the object is brought from infinity up to the convex lens. Illustrate your answer by drawing the ray diagrams.

Solution:

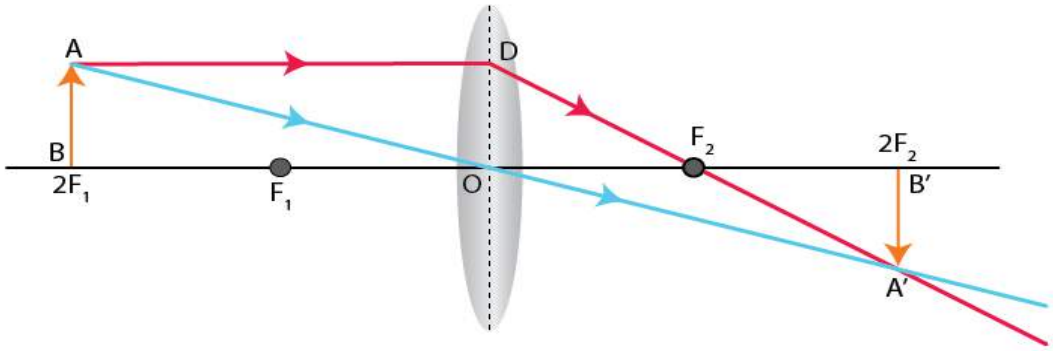
(i) The position of image is at F_2 when the object is situated at infinity. It is very much diminished in size and it is real and inverted.



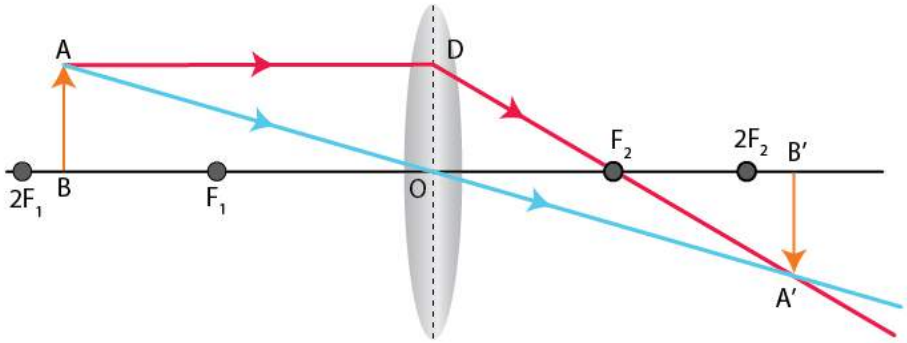
(ii) The position of image (A'B') is between F_2 and $2F_2$ when the object (AB) is situated beyond $2F_1$. It is diminished in size and real and inverted



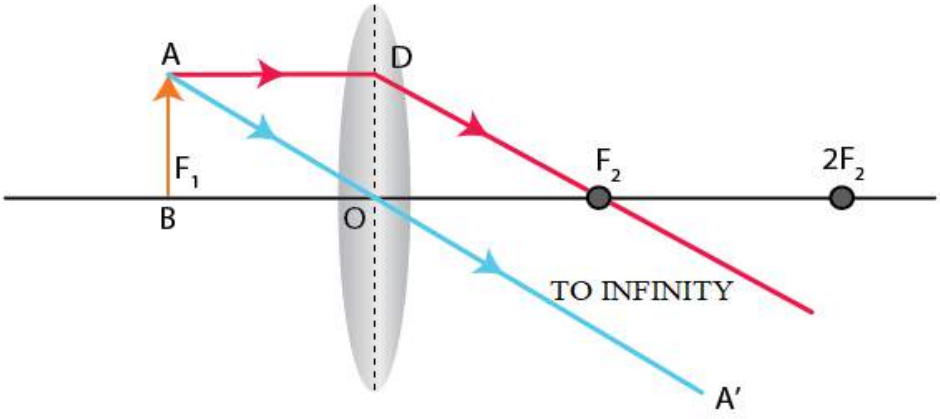
(iii) The position of image (A'B') is at $2F_2$ when the object (AB) is situated at $2F_1$. It is of same size as the object and real and inverted.



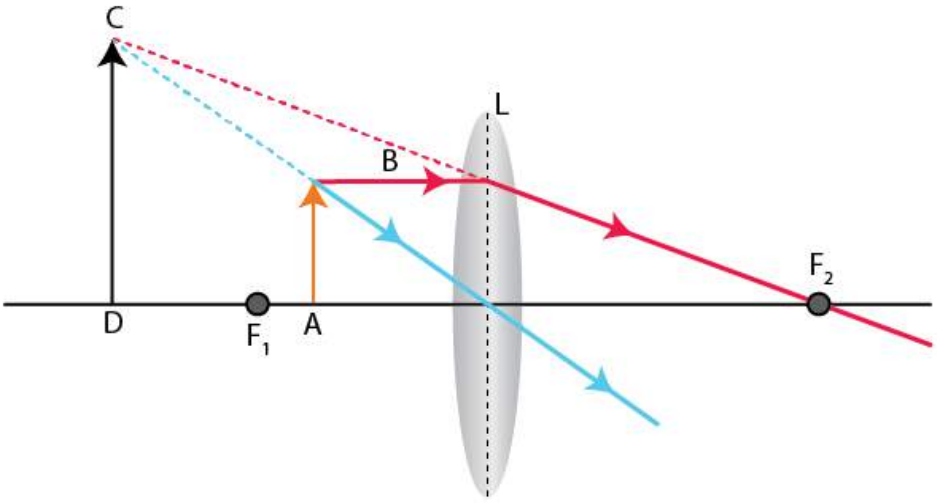
(iv) The position of image (A'B') is beyond $2F_2$ when the object (AB) is situated between $2F_1$ and F_1. It is magnified in size and real and inverted.



(v) The position of image is at infinity when the object (AB) is situated at F_1. It is very much magnified in size and real and inverted.



(vi) The position of (CD) is on the same side when the object (AB) is situated between lens and F_1. It is magnified in size and virtual and upright.

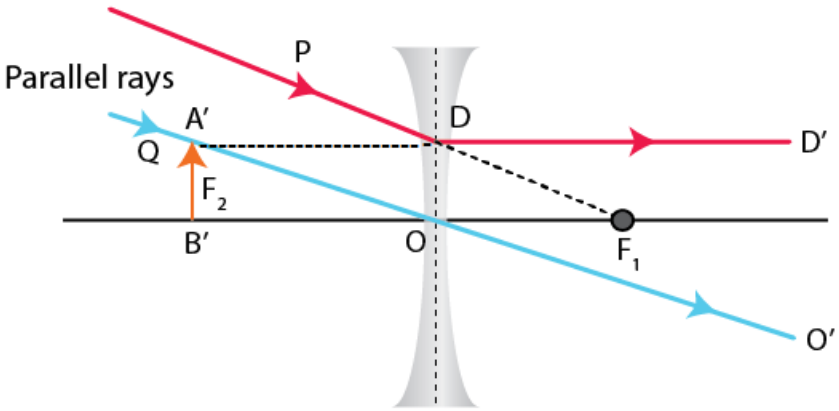


Question: 28

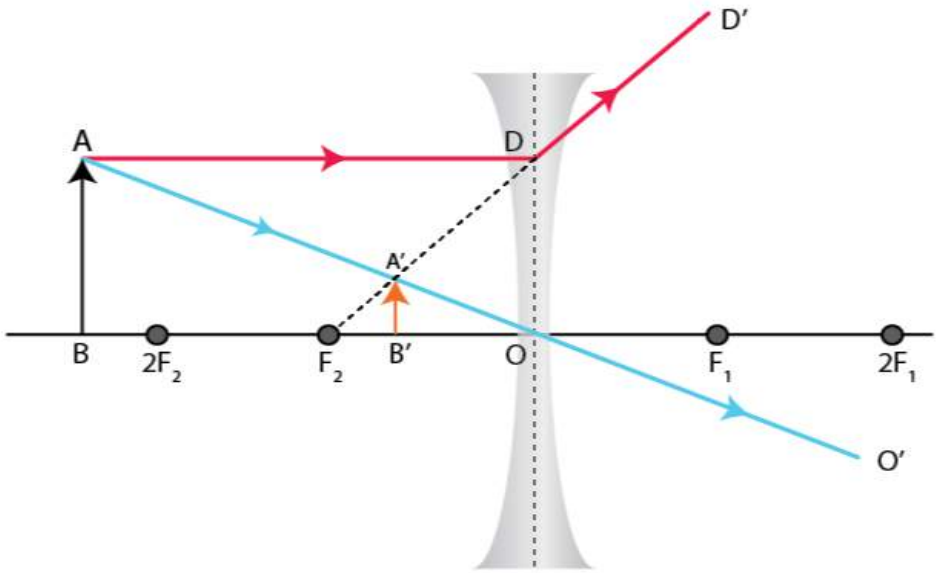
State the changes in the position, size and nature of the image When the object is brought from infinity up to a concave lens. Illustrate your answer by drawing diagrams.

Solution:

(i) The parallel rays from object appears to fall on concave lens due to which image forms at focus when the object (AB) is situated at infinity. This image is highly diminished in size and virtual and upright



(ii) The image forms between focus and optical centre when object (AB) is situated at any point between infinity and optical centre of the lens. This image is diminished in size and virtual and upright.



Question: 29
Complete the following sentence
(a)An object is placed at a distance of more than 40 cm from a convex lens of focal length 20 cm. The image formed is real, inverted and…….
(b)An object is placed at a distance 2f from a convex lens of focal length f. The image formed is…….that of the object
(c)An object is placed at a distance 5 cm from a convex lens of focal length 10 cm. The image formed is virtual, upright and……..
Solution:
(a) An object is placed at a distance of more than 40 cm from a convex lens of focal length 20 cm. The image formed is real, inverted and diminished
(b) An object is placed at a distance 2f from a convex lens of focal length f. The image formed is equal to that of the object
(c) An object is placed at a distance 5 cm from a convex lens of focal length 10 cm. The image formed is virtual, upright and magnified

Question: 30
State whether the following statements are 'true' or 'false' by writing T/F against them.
(a)A convex lens has a divergent action and a concave lens has a convergent action.
(b)A concave lens, if kept at a proper distance from an object, can form its real image
(c)A ray of light incident parallel to the principal axis of a lens, passes undeviated after refraction
(d)A ray of light incident at the optical centre of lens, passes undeviated after

refraction
(e)A concave lens forms a magnified or diminished image depending on the distance of object from it.
Solution:
(a) False
(b) False
(c) False
(d) True
(e) False

MULTIPLE CHOICE TYPE
Question: 1
For an object placed at a distance 20 cm in front of a convex lens, the image is at a distance 20 cm behind the lens. The focal length of convex lens is:
(a) 20 cm
(b) 10 cm
(c) 15 cm
(d) 40 cm
Solution:
The focal length of a convex lens is 10 cm

Question: 2
For the object placed between optical centre and focus of a convex lens, the image is:
(a) Real and enlarged
(b) Real and diminished
(c) Virtual and enlarged
(d) Virtual and diminished.
Solution:
The image is virtual and enlarged

Question: 3
A concave lens forms the image of an object which is:
(a) Virtual, inverted and diminished
(b) Virtual, upright and diminished
(c) Virtual, inverted and enlarged
(d) Virtual, upright and enlarged
Solution:
A concave lens forms the image of an object which is virtual, upright and diminished

EXERCISE 5(C) PAGE NO: 126

Question: 1

State the sign convention to measure the distances for a lens.

Solution:

The axis along which the distances are measured is called as the principal axis. These distances are measured from the optical centre of the lens.

The distances measured in the same direction as that of incident light are taken as positive

The distances measured against the direction of incident light are taken as negative

The distances measured upward and perpendicular to the principal axis are taken as positive

The distances measured downwards and perpendicular to principal axis is taken as negative

The focal length of the convex lens is taken as positive and that of concave lens is taken as negative

Question: 2

The focal length of a lens is (i) positive, (ii) negative.

In each case, state the kind of lens.

Solution:

(i) If the focal length of a lens is positive, then the lens is convex lens

(ii) If the focal length of a lens is negative, then the lens is concave lens

Question: 3

Write the lens formula explaining the meaning of the symbols used.

Solution:

Lens formula

$$1 / v – 1 / u = 1 / f$$

where ‘u’ is the distance of the object from the optical center of the lens

‘v’ is the distance of the image from the optical center while ‘f’ is the focal length, the distance between the optical center and the focus of the lens.

Question: 4

What do you understand by the term magnification? Write expression for it for a lens, explaining the meaning of the symbols used.

Solution:

The term magnification is defined as the ratio of the size of the image to the size of the object. The expression is

$$m = -v / u \text{ or}$$

m =Height of image (h') / Height of object (h) where v means image distance and u means object distance
h' means size of the image or h means size of the object

Question: 5
What information about the nature of image (i) real or virtual, (ii) erect or inverted, do you get from the sign of magnification + or - ?
Solution:
(i) The positive magnification indicates that the image formed is virtual while negative sign indicates that the image formed is real.
(ii) The positive magnification indicates that the image formed is erect while negative sign indicates that the image formed is inverted

Question: 6
Define the term power of a lens. In what unit is it expressed?
Solution:
Power of lens is the ability of the lens to converge the rays of light falling on it or it is defined as P = 1 / f where f is the focal length. The S.I unit of power is Dioptre (D)

Question: 7
How is the power of a lens related to its focal length?
Solution:
The power of a lens is related to its focal length as
P = 1 / f or
Power of lens (in D) = 1 / focal length (in metre)
Therefore its inversely proportional to focal length

Question: 8
How does the power of a lens change if its focal length is doubled?
Solution:
Power is inversely proportional to the focal length. So if the focal length is doubled, the power is reduced by half.

Question: 9
How is the sign (+ or -) of power of a lens related to its divergent or convergent action?
Solution:
The sign of power depends on the direction in which a light ray is deviated by the lens. The power could be positive or negative. If a lens deviates a ray towards its centre

(converges), the power is positive and if it deviates the ray away from its centre (diverges), the power is negative.

Question: 10
The power of a lens is negative. State whether it is convex or concave?
Solution:
It is a concave lens

Question: 11
Which lens has more power: a thick lens or a thin lens?
Solution:
A thick lens has more power than a thin one because it has greater curvature or lesser focal length than a thin lens

MULTIPLE CHOICE TYPE
Question: 1
If the magnification produced by a lens is - 0.5, the correct statement is :
(a) The lens is concave
(b) The image is virtual
(c) The image is magnified
(d) The images is real and diminished formed by a convex
Solution:
The correct statement is the image is real and diminished formed by a convex lens because negative sign of magnification indicates that the image is real while o.5 indicates that the image is diminished.

Question: 2
The correct lens formula is
(a) 1 / u + 1 / v = 1 / f
(b) 1 / u – 1 / v = 1 / f
(c) 1 / v – 1 / u = 1 / f
(d) f = (u + v) / uv
Solution:
The correct lens formula is

$$1 / v – 1 / u = 1 / f$$

Question: 3
On reducing the focal length of a lens, its power:
(a) Decreases
(b) Increases
(c) Does not change
(d) First increases then decreases.
Solution:
On reducing the focal length of a lens, its power increases.

Question: 4
The lens of power + 1.0 D is :
(a) convex of focal length 1.0 cm
(b) convex of focal length 1.0 m
(c) concave of focal length 1.0 cm
(d) concave of focal length 1.0 m
Solution:
Power lens is + 1.0 D. Here positive sign indicates that the focal length of the lens is positive which indicates that it is a convex lens

Power is P = 1 / f (in m)
+1.0 D = 1 / f (in m)
f = 1.0 m

Therefore the lens of power +1.0 D is 1.0 m

NUMERICALS
Question: 1
(a) At what position a candle of length 3 cm be placed in front of a convex lens so that its image of length 6 cm be obtained on a screen placed at distance 30 cm behind the lens?
(b) What is the focal length of lens in part (a)?
Solution:

Given
Height of a candle (object) = 3 cm
Height of the image of the candle = 6 cm
Image distance = 30 cm
(a) The formula for magnification of a lens is
m = h’ / h
m = v / u
6 / 3 = 30 / u
∴ u = 15 cm

(b) Lens formula is
$1 / v – 1 / u = 1 / f$
$\therefore 1 / 30 – 1 / -15 = 1 / f$ [u is negative]
$\therefore 1 / f = 1 / 30 + 1 / 15$
$1 / f = 3 / 30$
$\therefore f = + 10$ cm

Question: 2
A concave lens forms the image of an object kept at a distance 20 cm in front of it, at a distance 10 cm on the side of the object.
(a) What is the nature of the image?
(b) Find the focal length of the lens.
Solution:
Given,
Object distance, u = -20 cm
Image distance, v = - 10 cm
(a) It is a virtual image because the image is formed on the same side as the object. Also, since the lens is a concave lens the image will be erect and diminished.
(b) Lens formula is
$1 / v – 1 / u = 1 / f$
$\therefore 1 / -10 – 1 / -20 = 1 / f$
$\therefore 1 / f = 1 / 20 – 1 / 10$
$\therefore 1 / f = - 1 / 20$
$\therefore f = - 20$ cm

Question: 3
The focal length of a convex lens is 25 cm. At what distance from the optical centre of the lens an object be placed to obtain a virtual image of twice the size?
Solution:
Given,
Focal length, f = +25 cm
Image is virtual and magnified, m = +2
For a lens, magnification is
$m = v / u$
$\therefore +2 = v / u$
$\therefore v = 2u$
Lens formula is,
$1 / v – 1 / u = 1 / f$
$\therefore 1 / 2u – 1 / u = 1 / 25$

∴ - 1 / 2u = 1 / 25
∴ 2u = - 25
∴ u = - 12.5 cm

Question: 4
Where should an object be placed in front of a convex lens of focal length 0.12 m to obtain a real image of size three times the size of the object, on the screen?
Solution:

Given,
Focal length of a convex lens, f = + 0.12 m
m = -3 (real image)
For a lens, magnification is
m = v / u
∴ - 3 = v / u
∴ v = - 3u
Lens formula is,
1 / v – 1 / u = 1 / f
∴ 1 / - 3u – 1 / u = 1 / 0.12
∴ -4 / 3u = 1 / 0.12
∴ 3u = 0.48 m
∴ u = 0.48 / 3
∴ u = - 0.16 m

Question: 5
An illuminated object lies at a distance 1.0 m from a screen. A convex lens is used to form the image of object on a screen placed at distance 75 cm from the lens. Find: (i) the focal length of lens, and (ii) the magnification.
Solution:

Given,
Image distance, v = 75 cm
Object distance, u = -25 cm
Lens formula is,
1 / v – 1 / u = 1 / f
∴ 1 / 75 – 1 / -25 = 1 / f
∴ 1 / f = 1 / 75 + 1 / 25
∴ 1 / f = 4 / 75
∴ f = 75 / 4
∴ f = 18.75 cm

For a lens, magnification is

m = v / u
∴ m = 75 / -25
∴ m = -3

Question: 6

A lens forms the image of an object placed at a distance 15 cm from it, at a distance 60 cm in front of it. Find: (i) the focal length, (ii) the magnification, and (iii) the nature of image.

Solution:

Given,
Object distance, u = - 15 cm
Image distance, v = - 60 cm
(i) Lens formula is,
1 / v – 1 / u = 1 / f
∴ 1 / - 60 – 1 / - 15 = 1 / f
∴ 1 / f = 1 / 15 – 1 / 60
∴ 1 / f = 3 / 60
∴ f = 60 / 3
∴ f = 20 cm

For a lens, magnification is
m = v / u
∴ m = - 60 / - 15
∴ m = +4

(iii) The nature of the image is erect, virtual and magnified.

Question: 7

A lens forms the image of an object placed at a distance of 45 cm from it on a screen placed at a distance 90 cm on other side of it. (a) name the kind of lens. (b) find: (i) the focal length of lens, (ii) the magnification of image.

Solution:

Given,
Object distance, u = - 45 cm
Image distance, v = + 90 cm

(a) The image is real since the image is formed on the other side of the lens. Hence, the lens is a convex lens.
(b)
(i) Lens formula is,
1 / v – 1 / u = 1 / f
∴ 1 / 90 – 1 / - 45 = 1 / f

∴ 1 / f = 1 / 90 + 1 / 45
∴ 1 / f = 3 / 90
∴ f = 30 cm

(ii) For a lens, magnification is

m = v / u
∴ m = 90 / - 45
∴ m = - 2

Question: 8

An object is placed at a distance of 20 cm in front of a concave lens of focal length 20 cm. find: (a) the position of image, and (b) the magnification of image

Solution:

Given,
Object distance, u = - 20 cm
Focal length, f = - 20 cm (concave lens)
(a) Lens formula is,
1 / v – 1 / u = 1 / f
∴ 1 / v = 1 / f + 1 / u
∴ 1 / v = 1 / - 20 + 1 / - 20
∴ 1 / v = - 2 / 20
∴ v = -10 cm

Hence the image is 10 cm in front of the lens on the same side as the object.

(ii) For a lens, magnification is

m = v / u
∴ m = -10 / - 20
∴ m = + 0.5

Question: 9

A convex lens forms an inverted image of size same as that of the object which is placed at a distance 60 cm in front of the lens. Find:
(a) The position of image, and
(b) The focal length of the lens

Solution:

A convex lens forms an inverted, real and an image of the same size as the object when the object is placed at 2f i.e u = 2f

(a) In such cases, the image is formed at the point which is double the focal length on the other side of the lens ($2f_2$)

(b) To find the focal length of this lens, we use the relationship

Object distance (u) = 2f

Object distance = 60 cm (given)
60 = 2f
f = 60 / 2
f = 30
Hence, the focal length of this lens is 30 cm

Question: 10
A concave lens forms an erect image of 1/3rdsize of the object which is placed at a distance 30 cm in front of the lens. Find:
(a) The position of image, and
(b) The focal length of the lens.
Solution:
Given,
Distance of the object u = - 30 cm
Magnification m = h'/ h
= 1 / 3
We know that
The magnification is
m = h' / h
m = v / u
1 / 3 = v / -30
v = -10 cm
Therefore the image is formed at 10 cm from the lens.
Len's formula is
1 / f = 1 / v – 1 / u
1 / f = 1 / - 15
f = -15 cm
Hence, the focal length is 15 cm and the image is formed at 10 cm from the lens.

Question: 11
The power of a lens is +2.0 D. Find its focal length and state what kind of lens it is?
Solution:
Given,
Power of the lens = +2D
Since the power is positive,
∴ The lens is convex
Let focal length be F
Power = 1 / F
2 = 1 / F

F = 1 / 2 m
F = 0.5 m
∴ The focal length is 0.5 m and the lens is convex lens

Question: 12
Express the power (with sign) of a concave lens of focal length 20 cm.
Solution:
P = 1 / F (in metre)
P = 1 / 0.2 m
P = 5D
As it is a concave lens so power is negative
Therefore P = - 5D

Question: 13
The focal length of a convex lens is 25 cm. Express its power with sign.
Solution:
Given,
Focal length, f = +25 cm
= +0.25 m
We need to find the power
P = 1 / f
P = 1 / +0.25
P = +4.0 D

Question: 14
The power of a lens is -2.0 D. Find its focal length and its kind.
Solution:
Given,
The power of a lens = -2.0 D
Power of a lens is
P = 1 / f
-2 = 1 / f
f = 1 / -2
f = -0.5 m
f = - 50 cm
As power is negative it indicates that the lens is a concave lens

Question: 15
The magnification by a lens is -3. Name the lens and state how are u and v related?

Solution:

Here the negative value of magnification indicates that image is real and inverted. The magnitude of magnification is greater than 1, which means the image is enlarged. Hence, the lens should be convex lens.

The relation between u and v is given by

$m = v / u$

$-3 = v / -u$

$v = 3u$

This shows the image distance is 3 times that of object distance.

Question: 16

The magnification by a lens is +0.5. Name the lens and state how are u and v related?

Solution:

The image formed by the concave lens is always virtual, erect and smaller than the object. Hence, the magnification is always positive and less than 1

The relation between u and v is

$m = v / u$

$0.5 = -v / -u$

$1 / 2 = v / u$

$u = 2v$

Hence, the object distance is twice that of image distance.

Question: 17

A concave lens is a focal length 30 cm. Find the position and magnification (m) of image for an object placed in front of it at distance 30 cm. State whether the image is real on virtual?

Solution:

Given,

Object distance, u = -30 cm

Focal length, f = -30 cm

Image distance, v = ?

Len's formula is

$1 / f = 1 / v – 1 / u$

$1 / -30 = 1 / v – 1 / -30$

$1 / v = -1 / 30 – 1 / 30$

$1 / v = -2 / 30$

$1 / v = - 1 / 15$

$v = -15$

The relation between u and v is
m = v / u
m = -15 / -30
m = 0.5
∴ The image formed is virtual and erect

Question: 18
Find the position and magnification of the image of an object placed at distance of 8.0 cm in front of a convex lens of focal length 10.0 cm. Is the image erect or inverted?
Solution:

Given,
Object distance, u = - 8 cm
Focal length, f = 10 cm
Image distance v = ?
Len's formula is
1 / f = 1 / v – 1 / u
1 / 10 = 1 / v – 1 / -8
1 / v = 1 / 10 – 1 / 8
1 / v = (4 – 5) / 40
1 / v = - 1 / 40
v = - 40 cm

The object is placed between the focus and optical center of the lens. So the image formed is virtual and erect.

EXERCISE 5(D) PAGE NO: 131

Question: 1

What is magnifying glass? State its two uses.

Solution:

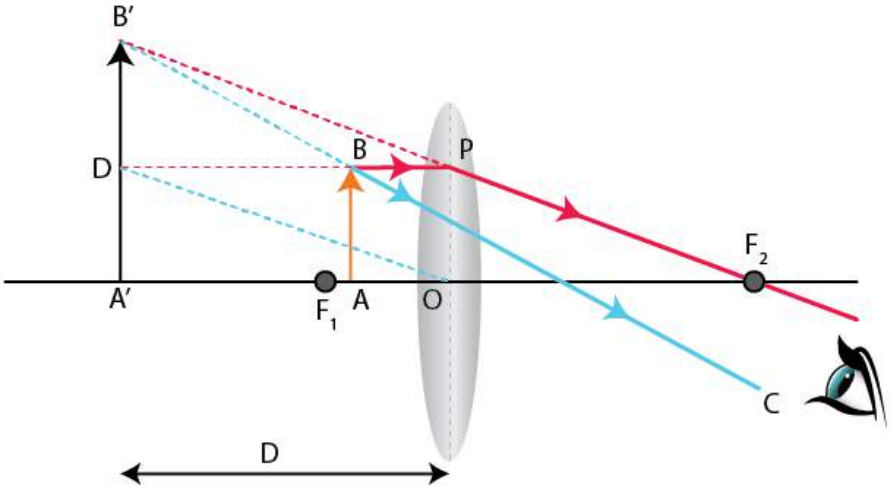
Magnifying glass is a convex lens of short focal length. It is mounted in a lens holder for practical use. It is used to see and read the small letters and figures and also used by watch makers to see the small parts and screws of the watch.

Question: 2

Draw a neat labelled ray diagram to locate the image formed by a magnifying glass. State three characteristics of the image.

Solution:

The image (A'B') of the object (AB) will form on the same side of lens when the object (AB) is situated between focal length and optical centre of a convex lens.



The image formed will be virtual, magnified and erect.

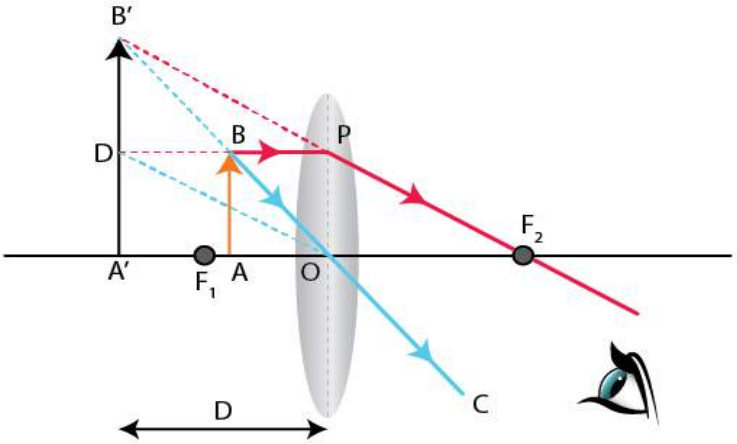
Question: 3

Where is the object placed in reference to the principal focus of a magnifying glass, so as to see its enlarged image? Where is the image obtained?

Solution:

The object is placed between the lens and principal focus

The image is obtained between the lens and principal focus.



Question: 4

Write expression for the magnifying power of a simple microscope. How can it be increased?

Solution:

The magnifying power of the microscope is given as

Magnifying power M = 1 + D / f

Where f is the focal length of the lens and D is the least distance of distinct vision

The magnifying power of the microscope be increased by using the lens of short focal length i.e shorter the focal length, more is the magnifying power. But it cannot be increased indefinitely.

Question: 5

State two applications each of a convex lens and concave lens.

Solution:

Application of a convex lens are

(i) The objective lens of a telescope, camera, slide projector, etc, is a convex lens which forms the real and inverted image of the object.

(ii) Our eye lens is also a convex lens. The eye lens forms the inverted image of the object on retina

Application of concave lens are

(i) A concave lens is used as the eye lens in a Galilean telescope to obtain the final erect image of the object.

(ii) A person suffering from short sightedness or myopia wears spectacles having concave lens.

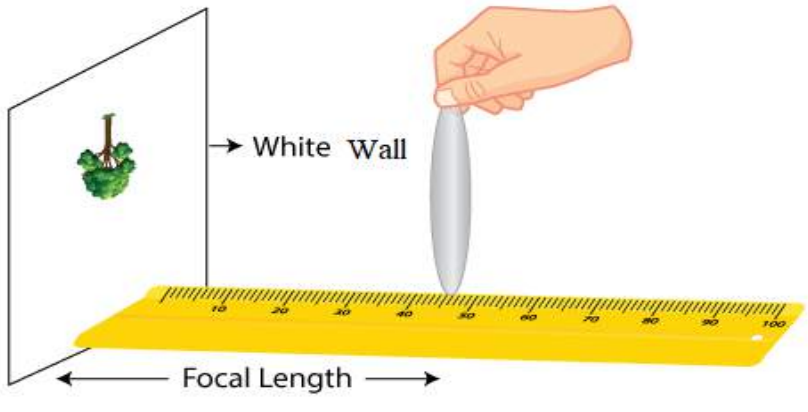
Question: 6

Describe in brief how would you determine the approximate focal length of a convex lens.

Solution:

The approximate focal length of a convex lens can be determined by using the principle that a beam of parallel rays incident from a distant object is converged in the focal plane of the lens.

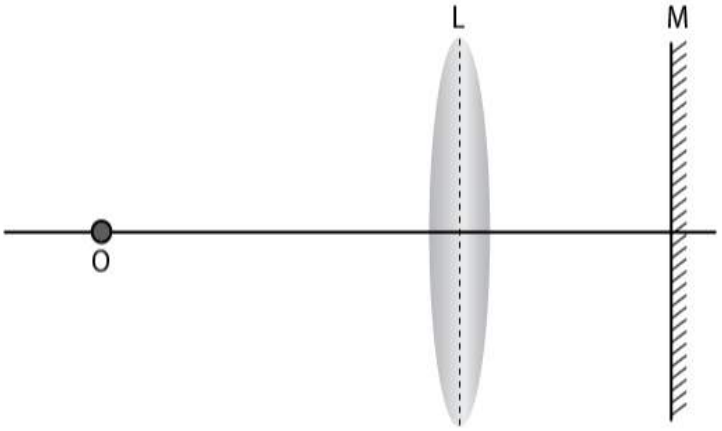
In an open space, against a white wall, a 0 cm end metre scale is placed horizontally touching the wall.



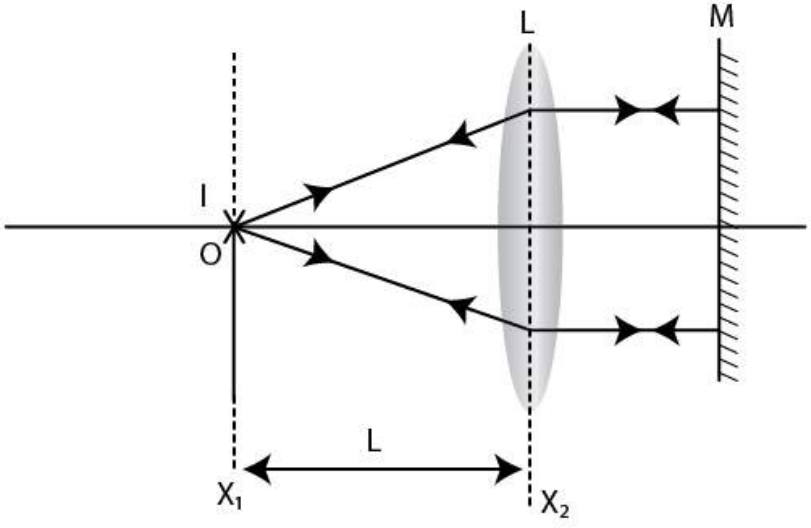
By moving the convex lens to and fro along the length of the metre rule, focus the object on wall. The image formed on the wall is almost at the focus of the lens and from the image, the distance of the lens is read directly by the metre scale. This gives the approximate focal length of the lens.

Question: 7

The diagram in Fig. shows the experimental set up for the determination of focal length of a lens using a plane mirror.



(i)Draw two rays from the point O of the object pin to show the formation of image I at O itself.
(ii)What is the size of the image I?
(iii)State two more characteristics of the image I.
(iv)Name the distance of the object O from the optical centre of the lens.
(v)To what point will the rays return if the mirror is moved away from the lens by a distance equal to the focal length of the lens?
Solution:



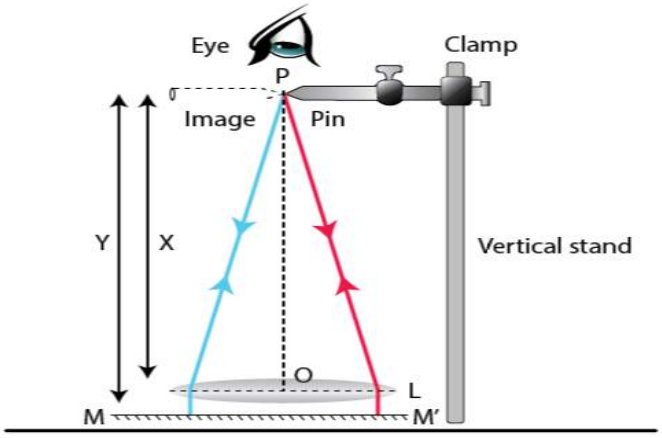
(ii) The size of the image will be same as that of object
(iii) The image formed will be real and inverted.
(iv) The distance of object O from optical lens will be equal to the focal length of the lens
(v) As long as the rays from the lens fall normally on the plane mirror M, the position of the mirror from lens does not affect the formation of image.

Question: 8

Describe how you would determine the focal length of a converging lens, using plane mirror and one pin. Draw a ray diagram to illustrate your answer.

Solution:

In order to determine the focal length by using plane mirror we need a vertical stand, a plane mirror, a lens and a pin. Place the lens L horizontally on a plane mirror MM'. Arrange the pin P in the clamp horizontally in such a way that the tip of pin is vertically above the centre O of the lens.



Adjust the height of the pin till it has no parallax (i.e if the pin and its image shift together) with its inverted image as seen from vertically above the pin.

Measure the distance x of the pin P from the lens and the distance y of the pin from the mirror, using a metre rule and a plumb line. Calculate the average of the two distances. This gives the focal length of the lens, i.e

$$f = (x + y) / 2$$

Question: 9

How will you differentiate between a convex and a concave lens by looking at (i) a distant object and (ii) a printed page?

Solution:

(i) On seeing a distant object through the lens, if its inverted image is seen, the lens is convex and if the upright image is seen, the lens is concave.

(ii) On keeping the lens near a printed page, if letters appear magnified, the lens is convex and if the letters appear diminished, the lens is concave.

MULTIPLE CHOICE TYPE

Question: 1

A magnifying glass forms:

(a) A real and diminished image

(b) A real and magnified image
(c) A virtual and magnified image
(d) A virtual and diminished image
Solution:
A magnifying glass forms a virtual and magnified image

Question: 2
The maximum magnifying power of a convex lens of focal length 5 cm can be:
(a) 25
(b) 10
(c) 1
(d) 6
Solution:

Given,
Focal length of convex lens, f = +5 cm
Magnifying power of convex lens (simple microscope) is
m = 1 + D / f
where D is the distance of the distinct vision, D = 25 cm
m = 1 + 25 / 5
m = 30 / 5
m = 6