Book Name: Selina Concise

EXERCISE - 5 (A)

Solution 1:
A lens is a transparent refracting medium bounded by two curved surfaces which are generally spherical.

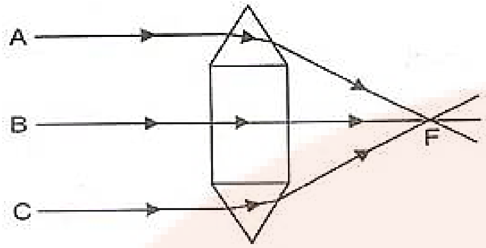
Solution 2:
Lenses are of two types :
(i) Convex or converging lens, and
(ii) Concave or diverging lens.

Solution 3:
Convex lens:
(i) It converge the incident rays towards the principal axis.
(ii) It has a real focus.
Concave lens:
(i) It diverges the incident rays away from the principal axis.
It has a virtual focus.

Solution 4:
Equiconvex lens is converging.

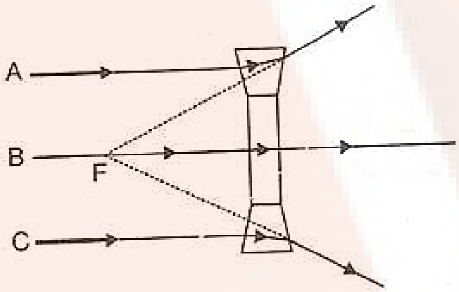
Solution 5:
Concave lens will show the divergent action on a light beam.

Solution 6:



As shown in the figure the convex lens has two glass prisms and one glass block. One of the glass prisms is situated above the glass block and one below the block.

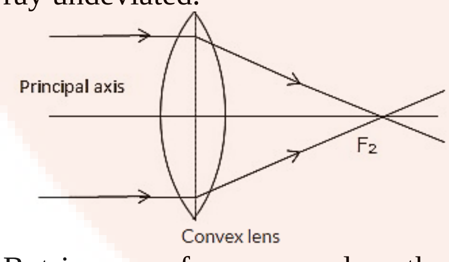
Solution 7:



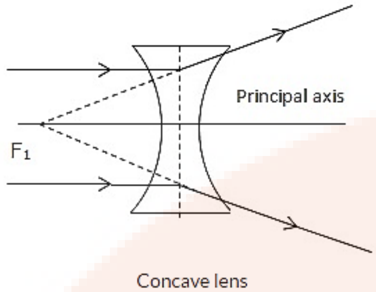
As shown in the figure the concave lens has two glass prisms and one glass block. One of the glass prisms is situated above the glass block and one below the block.

Solution 8:

If a parallel beam of light is incident on a convex lens then the upper part of the lens bends the incident ray downwards. The lower part bens the ray upwards while the central part passes the ray undeviated.

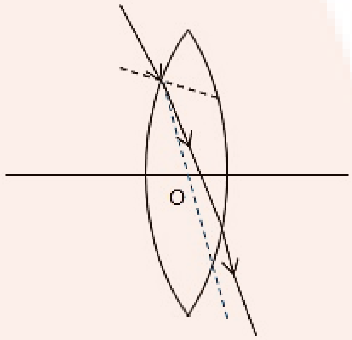


But in case of a concave lens the upper part of the lens bends the incident ray upwards and lower part bends the ray downwards while the central part passes the ray undeviated.

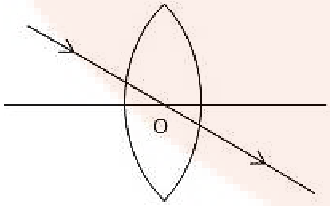


Solution 9:
It is the line joining the centers of curvature of the two surfaces of the lens.

Solution 10:
It is 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 letter O in the figure. The optical centre is thus the centre of the lens.



Solution 11:
(a) This point is known as Optical centre.
(b)

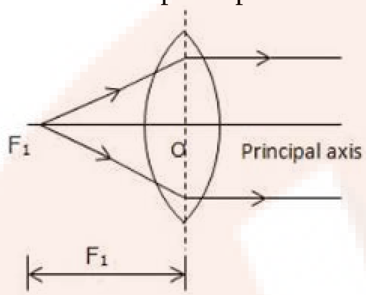


Solution 12:
A lens is called an equiconvex or equiconcave when radii of curvature of the two surfaces of lens are equal.

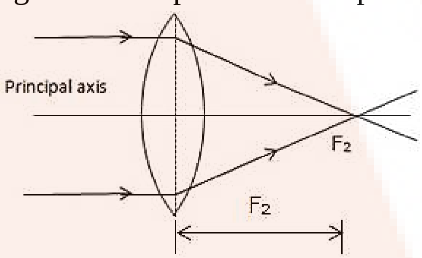
Solution 13:

A light ray can pass through a lens from either direction. Therefore, a lens has two principal foci.

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 starting from it or passing through it, after refraction through lens, become parallel to the principal axis of the lens.



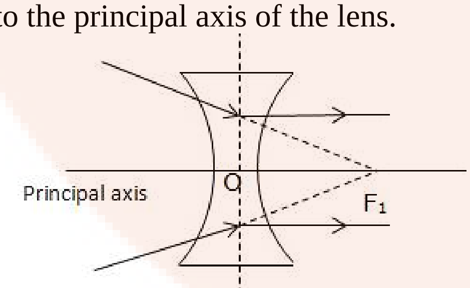
The second focal point for a convex lens is a point F_2 on the principal axis such that the rays of light incident parallel to the principal axis, after refraction from the lens, pass through it.



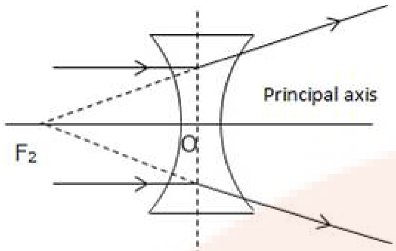
Solution 14:

A light ray can pass through a lens from either direction. Therefore, a lens has two principal foci.

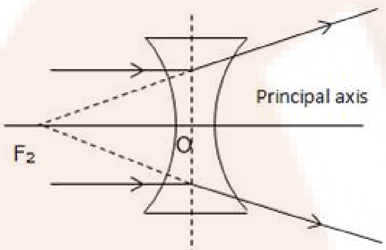
For a concave lens, the first focal point is a point F_1 on the principal axis of the lens such that the incident rays of light appearing to meet at it, after refraction from the lens become parallel to the principal axis of the lens.



The second focal point for a concave lens 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.

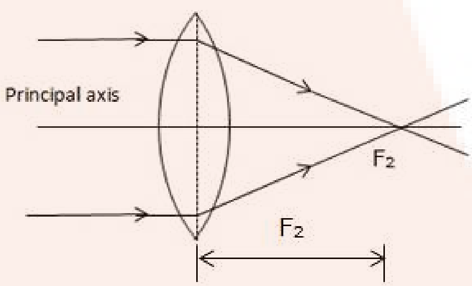


Solution 15:



Concave lens representing second focus

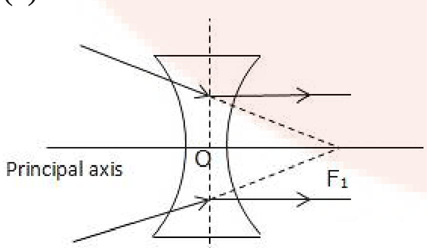
Solution 16:



Convex lens representing second focus

Solution 17:

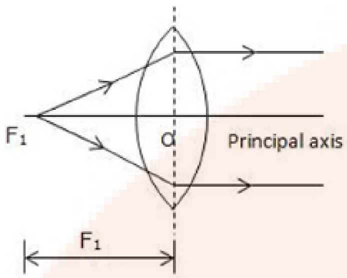
(a)



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

Solution 18:

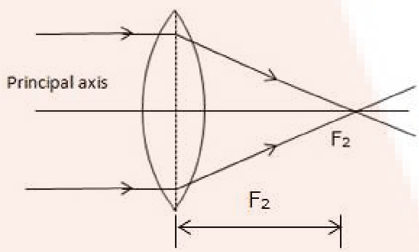
(a)



(b) The point where incident ray passes through a point on the principal axis is called first focus.

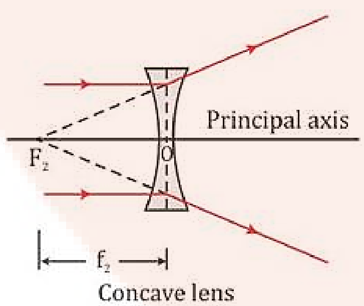
Solution :

Such a point will be second focus.



Solution 20:

It appears to come from 'Second Focus'.



Solution 21:

The distance from the optical centre O of the lens to its second focal point is called the focal length of the lens.

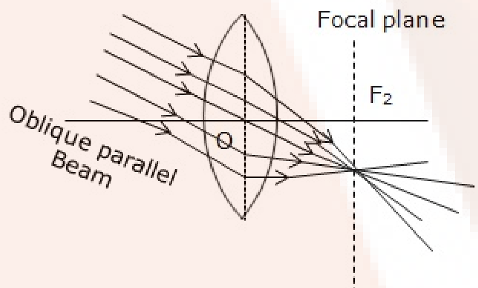
Solution 22:

A plane passing through the focal point and normal to the principal axis of the lens is called the first focal plane.

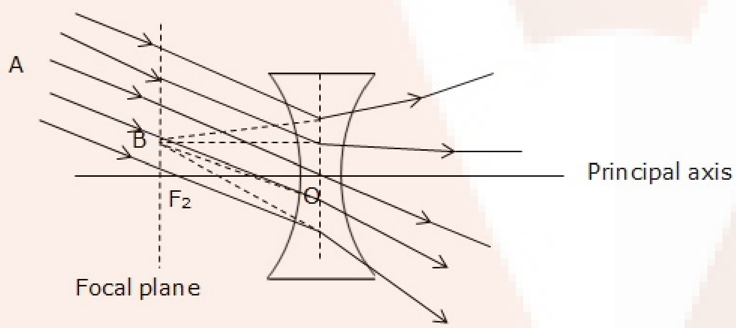
Solution 23:

(i) If a lens has both its focal length equal medium is same on either side of lens.
(ii) If a ray passes undeviated through the lens it is incident at the optical centre of the lens.

Solution 24:



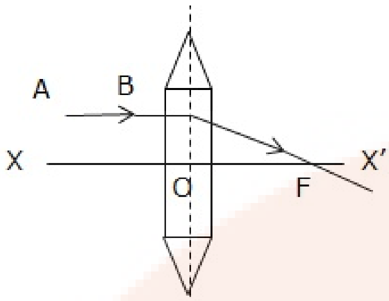
Refraction of an oblique parallel beam by a convex lens.



Refraction of an oblique parallel beam by a concave lens

Solution 25:

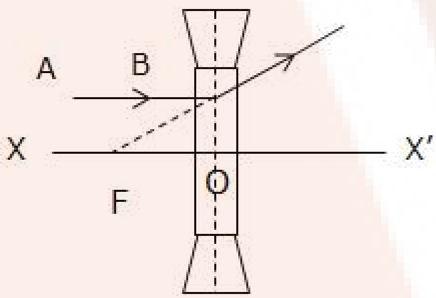
(i) The combination forms convex lens.
(ii) XX' is known as principal axis.
(iii) The complete diagram is



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

Solution 26:

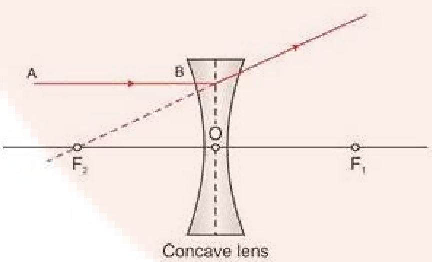
(i) The combination forms concave lens.
(ii) XX' is known as principal axis.
(iii) Complete diagram is drawn as



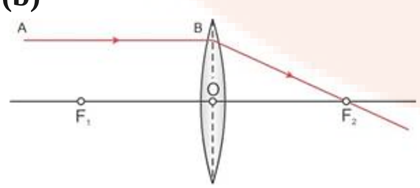
(iv) The point F is called as Focal point or focus.

Solution 27:

(a)

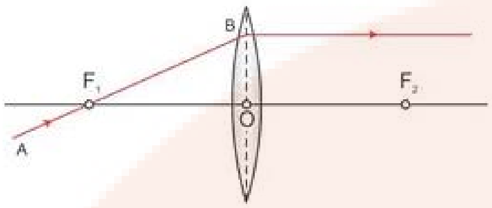


(b)

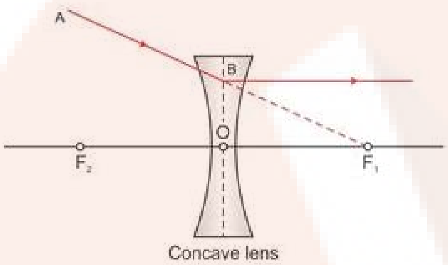


Solution 28:

(a)



(b)



Solution 29:

(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:

Solution 1:

(b) First focus

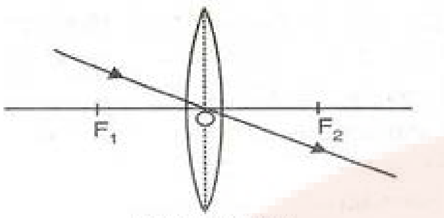
Solution 2:

(d) its second focus

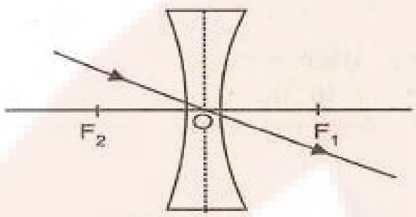
EXERCISE – 5(B)

Solution 1:

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

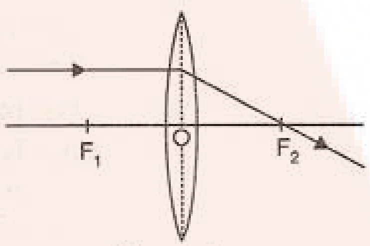


Convex lens

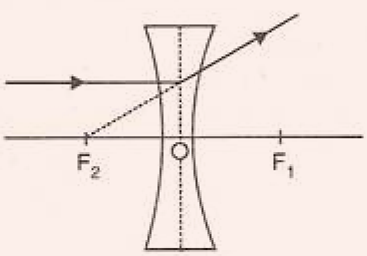


Concave lens

(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).

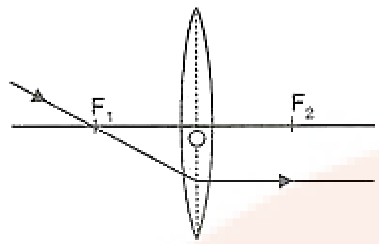


Convex lens

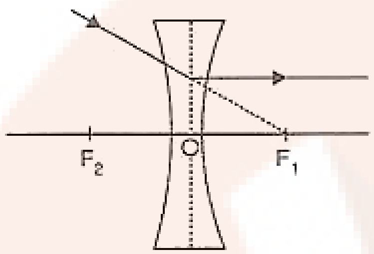


Concave lens

(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.

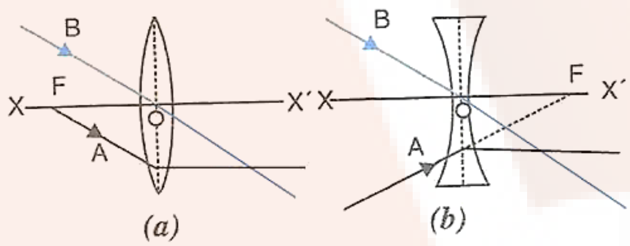


Convex lens



Concave lens

Solution 2:

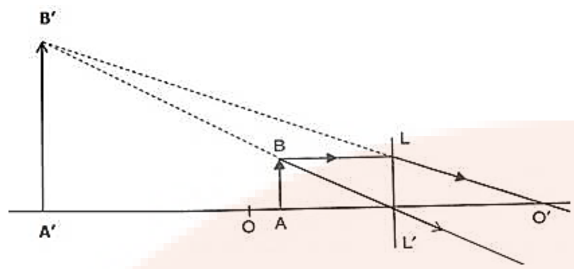


Solution 3:

Real image	Virtual image
1. A real image is formed due to actual intersection of refracted (or reflected) rays.	1. A virtual image is formed when the refracted (or reflected) rays meet if they are produced backwards.
2. 2 A real image can be obtained on a screen.	2. 2. A virtual image cannot be obtained on a screen.
3. 3. A real image is inverted with respect to the object.	3. 3. A virtual image is erect with respect to the object.

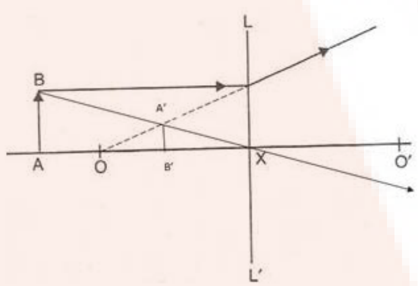
Solution 4:

(a) LL' lens is convex lens.
(b) O and O' are known as first and second focal points respectively.



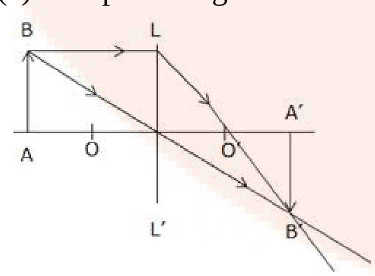
(c) The image formed will be magnified, virtual and upright.
O and
(d) Such action of lens is used in a magnifying glass.

Solution 5:
(i) LL' is concave lens.
(ii)The points O and O' are called second and first focal points respectively.
(iii)

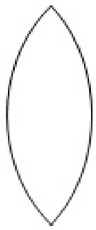


(iv)The three characteristics of the image are:
Virtual
Erect
Diminished

Solution 6:
(a) Complete diagram for the formation of A'B'.



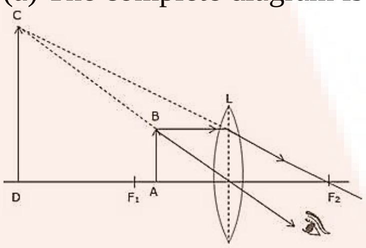
(b) LL' is a convex lens which is drawn as



(c) O and O' are called as first and second focal points respectively.
(d) Object is located at a distance twice of first focal length.
(e) Image is formed at a distance twice of second focal length.
(f) The image formed is real and inverted.

Solution 7:

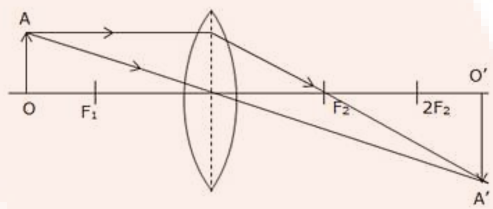
(a) The complete diagram is



(b) The image formed will be magnified, virtual and upright.

Solution 8:

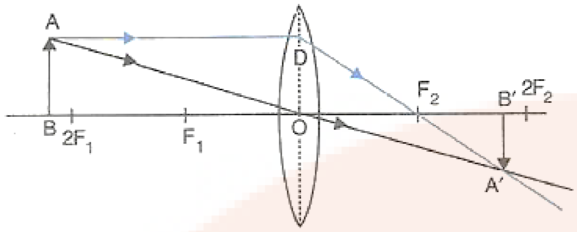
(a)



(b) The position of the images will be more than twice the focal length of lens.
(c) The image will be magnified, real and inverted.
(d) As the object move towards F_1 the image will shift away from F_2 and it is magnified. At F_1 the image will form at infinity and it is highly magnified. Between F_1 and optical centre, the image will form on the same side of object and will be magnified.

Solution 9:

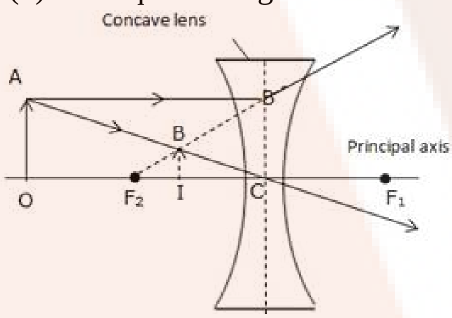
(a) The object is placed beyond $2F_1$.
(b)



(c) The image is formed beyond $2F_2$.
(d) The image will be diminished, real and inverted.

Solution 10:

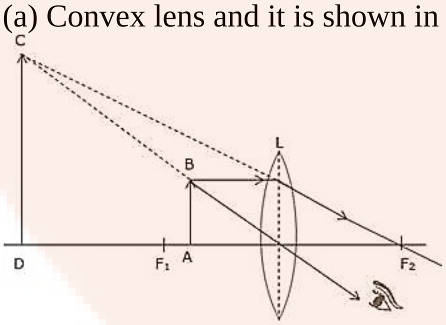
(a)The lens is concave lens.
(b)The required diagram is



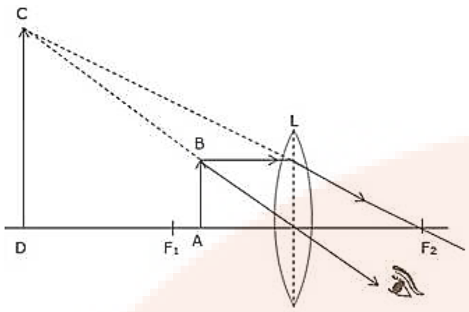
(c)The focal length is measured from optical centre C to F_2.

Solution 11:

(a) Convex lens and it is shown in the diagram below.

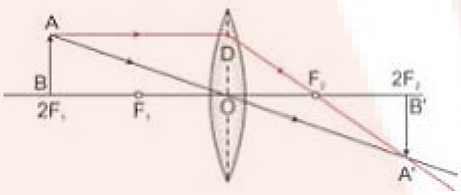


(b)



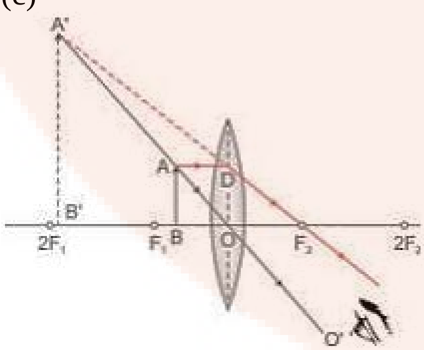
(c) Three characteristics of the image are
(i) Magnified
(ii) Virtual
(iii) Upright

Solution 12:
(a) The object is placed at the centre of curvature.
(b)



(c) The image formed is real and inverted.

Solution 13:
(a) Convex lens
(b) The object is placed between the lens and focus (F_1).
(c)

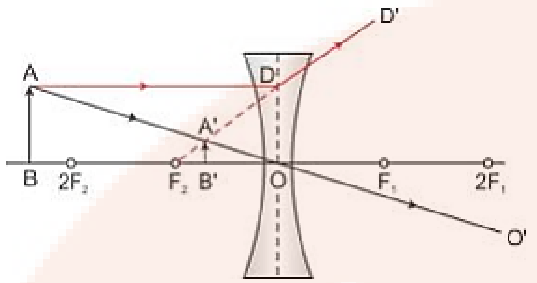


(d) 'Magnifying glass' uses this principle.

Solution 14:

(a) Concave lens

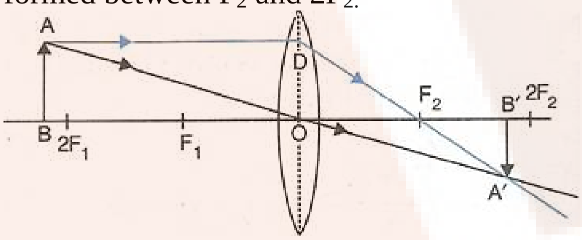
(b)



(c) The image formed is virtual, upright and diminished.

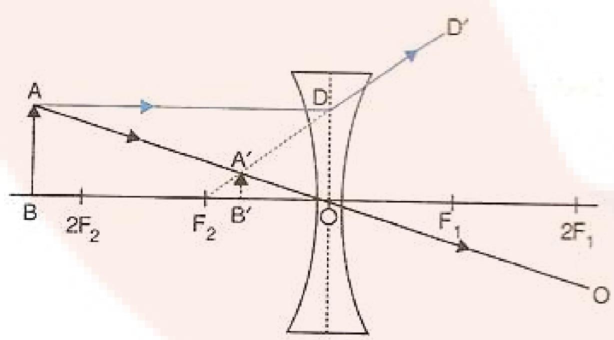
Solution 15:

Let the candle is placed beyond $2F_1$ and its diminished image which is real and inverted is formed between F_2 and $2F_2$.

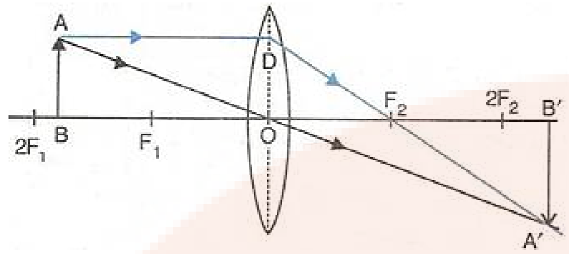


Here the candle is AB and its real and inverted image is formed between F_2 and $2F_2$.

Solution 16:



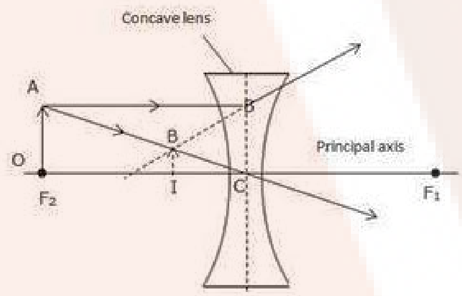
Solution 17:



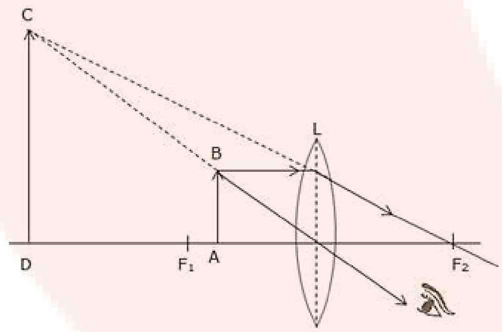
The image formed in above diagram is real, enlarged and inverted.

Solution 18:

The image will form between the focus and optical centre, on the same side of the lens as the object.



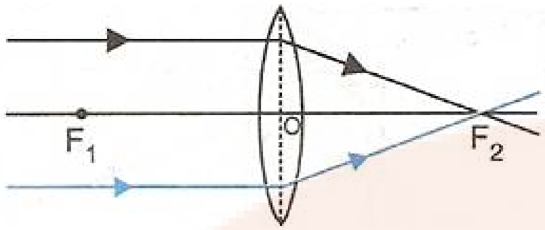
Solution 19:



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

Solution 20:

The sun is at infinity so convex lens forms its image at second focal point which is real and very much diminished in size.



While using the convex lens as burning glass, the rays of light from the sun (at infinity) are brought to focus on a piece of paper kept at the second focal plane of the lens. Due to sufficient heat of the sun rays, the paper burns. Hence this lens is termed as 'burning glass'.

Solution 21:

(a)This is convex lens.
(b)The nature of the image is real.

Solution 22:

(a)Convex lens.
(b)Virtual.

Solution 23:

(a) Concave lens
(b) Image is diminished

Solution 24:

Concave lens

Solution 25:

Image formed by a concave lens is virtual and diminished.

Solution 26:

The virtual image formed by a convex lens will be magnified and upright.

Solution 27:

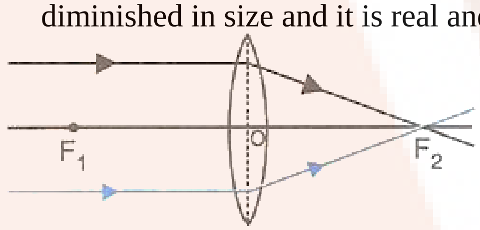
(a) at focus,
(b) at 2F,
(c) between F and 2F,
(d) between optical centre and focus.

Solution 28:

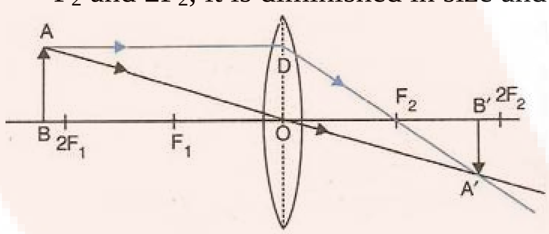
Type of lens	Position of object	Nature of image	Size of image
Convex	Between optic centre and focus	Virtual and upright	Magnified
Convex	At focus	Real and inverted	Very much magnified
Concave	At infinity	Virtual and upright	Highly diminished
Concave	At any distance	Virtual and upright	Diminished

Solution 29:

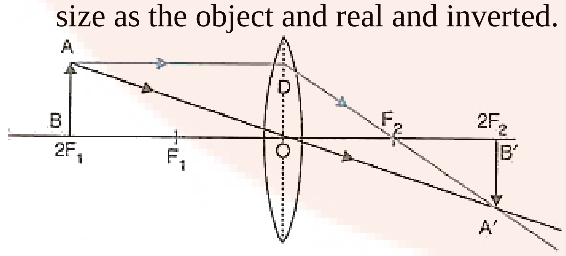
(i) When the object is situated at infinity, the position of image is at F_2, it is very much diminished in size and it is real and inverted.



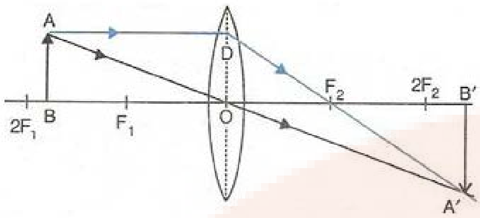
(ii) When the object (AB) is situated beyond $2F_1$, the position of image (A'B') is between F_2 and $2F_2$, it is diminished in size and real and inverted.



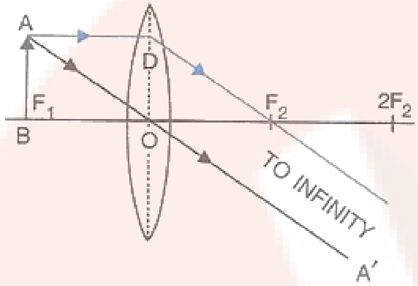
(iii) When the object (AB) is situated at $2F_1$, the position of image (A'B') is at $2F_2$, it is of same size as the object and real and inverted.



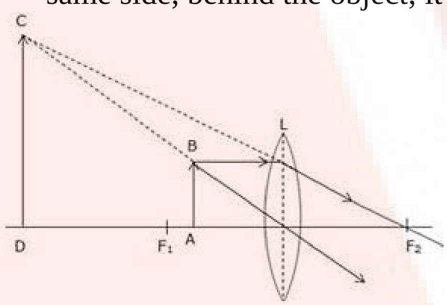
(iv) When the object (AB) is situated between $2F_1$ and F_1, the position of image (A'B') is beyond $2F_2$, it is magnified in size and real and inverted.



(v) When the object (AB) is situated at F_1, the position of image is at infinity; it is very much magnified in size and real and inverted.

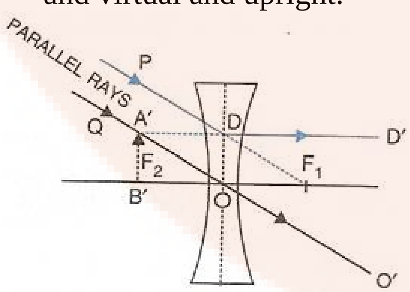


(vi) When the object (AB) is situated between lens and F_1, the position of image (CD) is on the same side, behind the object; it is magnified in size and virtual and upright.

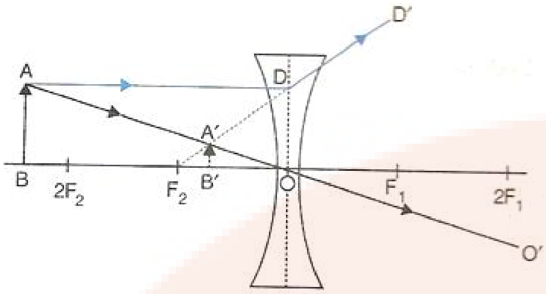


Solution 30:

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



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



Solution 31:

(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.**

Solution 32:

(a) False
(b) False
(c) False
(d) True
(e) False

MULTIPLE CHOICE TYPE:

Solution 1:

The focal length of the convex lens is 10 cm.
Hint: As the object distance = image distance, the object must be kept at 2f.
Therefore, 2f = 20 cm or f = 10 cm.

Solution 2:

Virtual and enlarged.
Explanation: When the object is kept between optical centre and focus of a convex lens, the image is formed on the same side, behind the object. The image thus formed is virtual, enlarged and erect.

Solution 3:

Virtual, upright and diminished

Hint: Concave lens forms virtual, upright and diminished image for all positions of the object.

EXCERSICE. 5 (C)

Solution 1:

The power of a lens is a measure of deviation produced by it in the path of rays refracted through it.

Its unit is Dioptre (D).

Solution 2:

Power of lens (in D) = $\frac{1}{\text{focal length (in metre)}}$

Solution 3:

If focal length of a lens doubled then its power gets halved.

Solution 4:

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.

Solution 5:

It is a concave.

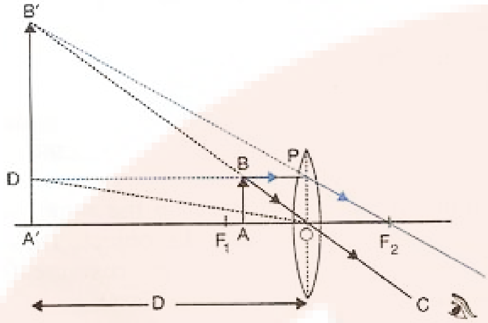
Solution 6:

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. It is used by watch makers to see the small parts and screws of the watch.

Solution 7:

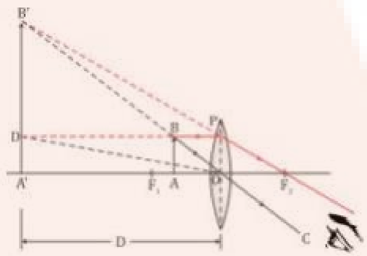
Let the object (AB) is situated between focal length and optical centre of a convex lens then its image (A'B') will form on the same side of lens.



The image formed will be virtual, magnified and erect.

Solution 8:

The object is placed between the lens and principal focus.
The image is obtained between the lens and principal focus.



Solution 9:

The magnifying power of the microscope is defined as the ratio of the angle subtended by the image at the eye to the angle subtended by the object (assumed to be placed at the least distance of distinct vision D = 25 cm) at the eye, i.e.,

Magnifying power = $1 + \frac{D}{F}$

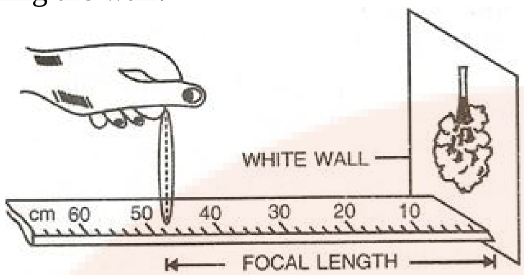
Where F is the focal length of the lens.

The magnifying power of a microscope can be increased by using the lens of short focal length. But it cannot be increased indefinitely.

Solution 10:

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.

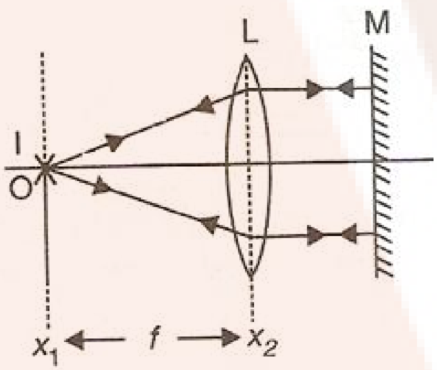
In an open space, against a white wall, a metre scale is placed horizontally with its 0 cm end touching the wall.



By moving the convex lens to and fro along the scale, focus a distant object on wall. The image which forms on the wall is very near to the focus of the lens and the distance of the lens from the image is read directly by the metre scale. This gives the approximate focal length of the lens.

Solution 11:

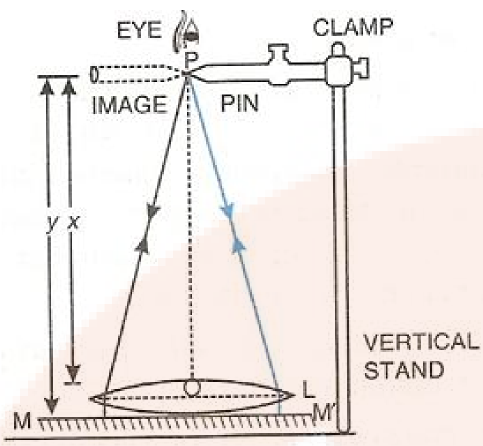
(i)



(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.
(iv) The position of the mirror from lens does not affect the formation of image as long as the rays from the lens fall normally on the plane mirror M.
(v)

Solution 12:

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



Adjust the height of the pin until it has no parallax (i.e., when the pin and its image shift together) with its inverted image as seen from vertically above the pin.
Now measure the distance x of the pin from the lens and the distance y of the pin from the mirror, using a metre scale and a plumb line. Calculate the average of the two distances. This gives the focal length of the lens, i.e.,
$F = \frac{x + y}{2}$

Solution 13:
The two applications of a convex lens are:-
(i) It is used as an objective lens in a telescope, camera, slide projector, etc.
(ii) With its short focal length it is also used as a magnifying glass.

The two applications of a concave lens are:-
(i) A person suffering from short sightedness or myopia wears spectacles having concave lens.
(ii) A concave lens is used as eye lens in a Galilean telescope to obtain an erect final image of the object.

Solution 14:
(i) On seeing a distant object through the lens, if its inverted image is seen, then the lens is convex, and if the upright image is seen, then the lens is concave.
(ii) On keeping the lens near a printed page, if the letters appear magnified, then the lens is convex, and if the letters appear diminished, then the lens is concave.

<u>MULTIPLE CHOICE TYPE:</u>

Solution 1:
Increases
Hint: Power (in Diopter) = $\frac{1}{\text{Focal length (in m)}}$

Solution 2:
A virtual and magnified image
Hint: A magnifying glass forms a virtual, magnified and upright image on the same side as the object.

NUMERICALS:

Solution 1:
P = +2.0D
$P = \frac{1}{F(\text{In metre})}$
$\Rightarrow F = \frac{1}{P} = \frac{1}{2}$
F = 0.5 m or 50 cm

Solution 2:
$P = \frac{1}{F(\text{In metre})}$
$\Rightarrow P = \frac{1}{0.2\ m} = 5\ D$
As it is a concave lens so power is negative
i.e. $P = -5$ D