CHAPTER 5 REFRACTION OF LIGHT

Class 10 Solutions

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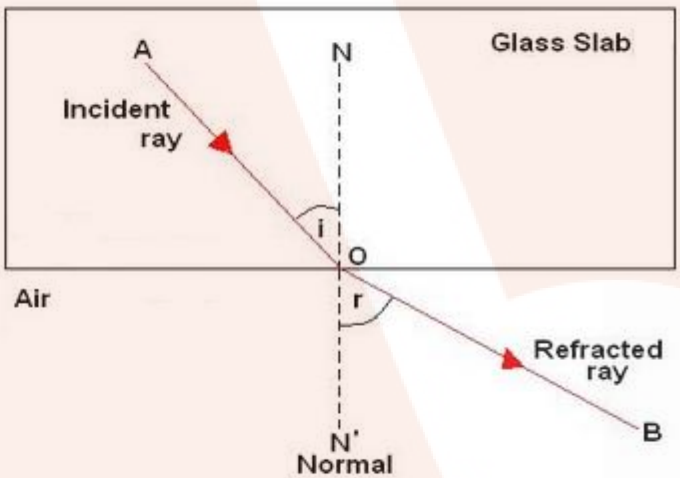
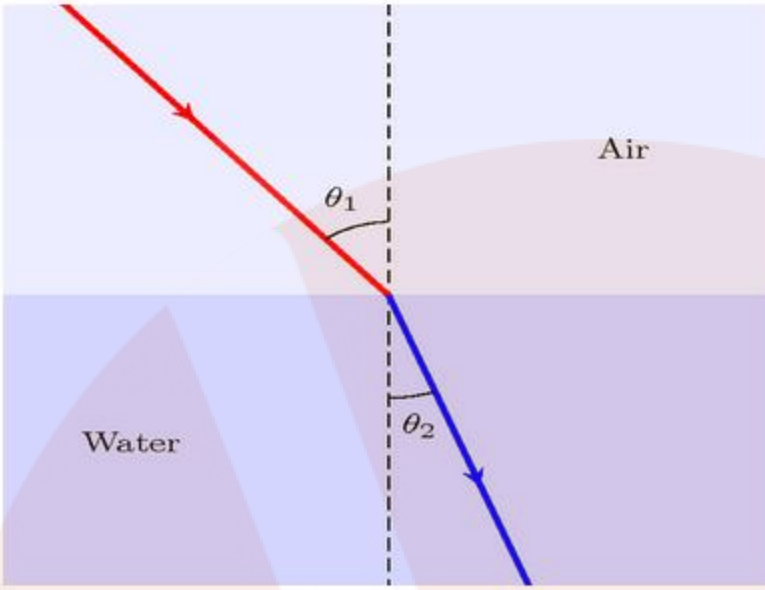
Solution 1:
It will bend towards the normal.

Solution 2:
It will bend away from the normal.

Solution 3:
A ray of light travelling from the glass slabs and emerges into the air.

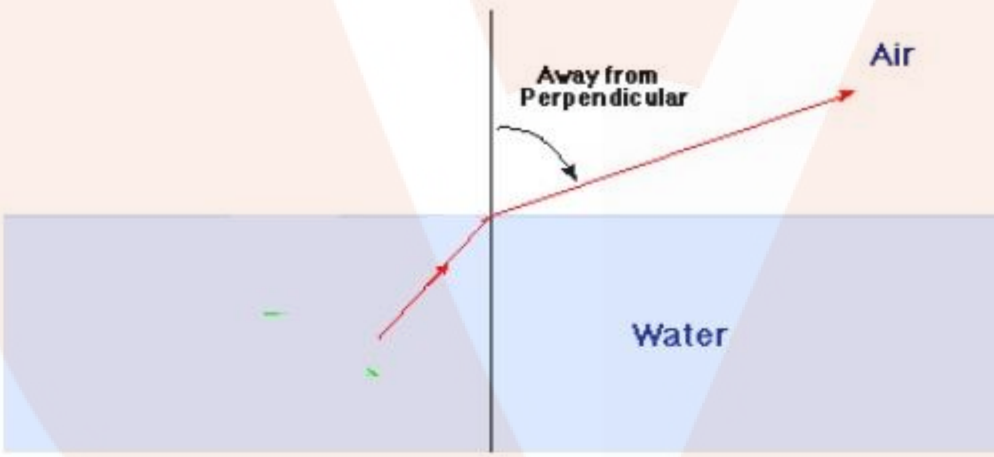


Solution 4:

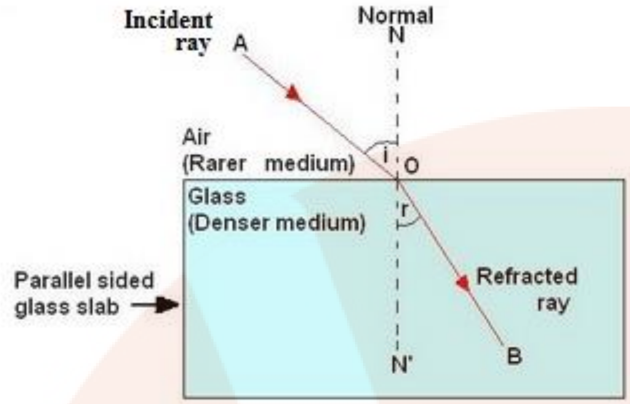


Solution 5:

A ray of light travelling through water to air.



Solution 6:
A ray of light incidence on parallel sided glass slab.



Solution 7:
The ray of light will bend away from the normal.

Solution 8:
The ray of light bends towards the normal. This is because water is an optically denser medium than air.

Solution 9:
It will bend away from the normal.

Solution 10:
Two effects caused by refraction of light are:
– a pool of water appears to be less deep than it actually is.
– an object placed under water appears to be raised.

Solution 11:
This is due to refraction of light.

Solution 12:
Angle of refraction is less than the angle of incidence.

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Solution 13:
A ray of light travelling from air to glass block, will bend towards the normal.

Solution 14:
A ray of light travelling from water into glass will bend towards the normal.

Solution 15:
Light rays travel faster in air.

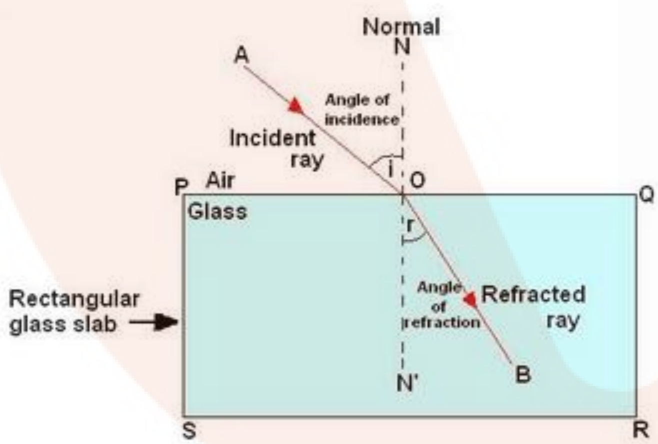
Solution 16:
Refraction of light.

Solution 17:
True.

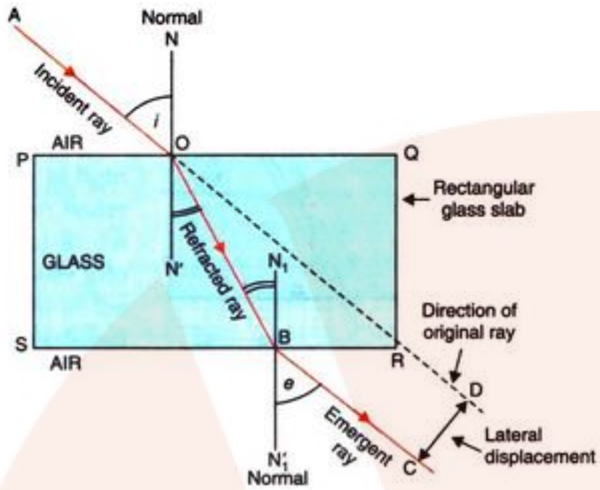
Solution 18:
A ray of light bends when it travels from one medium to another due to the change in the speed of light.

Solution 19:
(a) not.
(b) refracted.

Solution 20:
The change in direction of light when it passes from one medium to another obliquely, is called refraction of light.



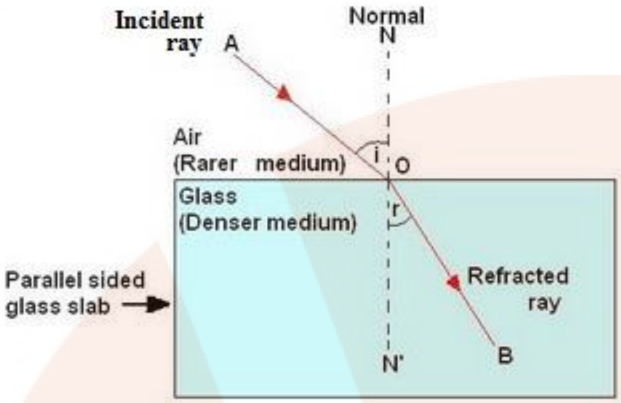
Solution 21:



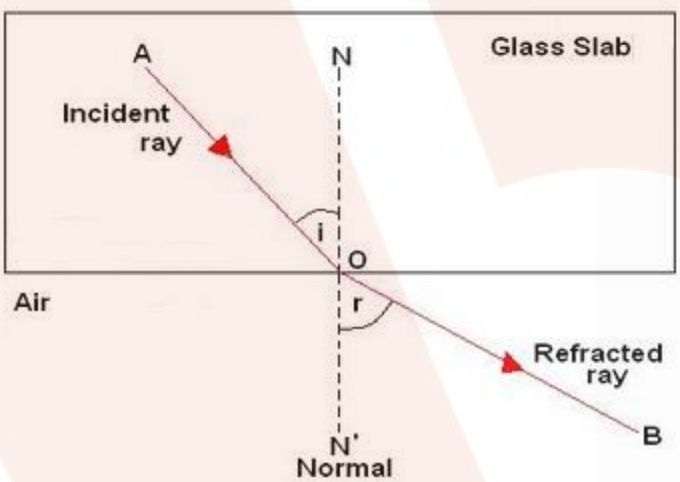
The final direction of the ray of light is same as the incident direction.

Solution 22:

(a) Ray of light travelling from air into an optically denser medium.

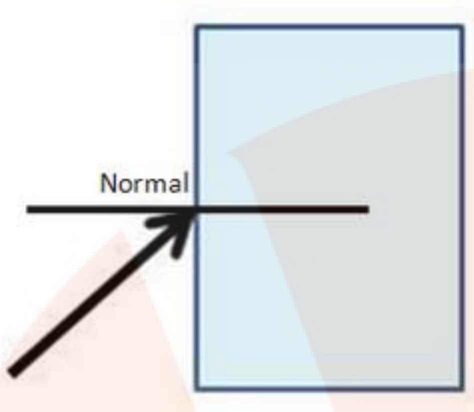


(b) Ray of light travelling from an optically denser medium into air.

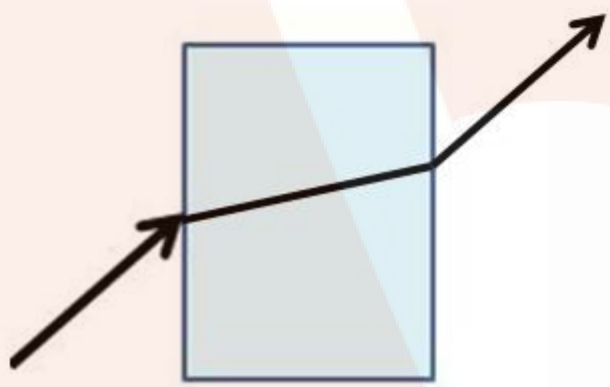


Solution 23:

(a)



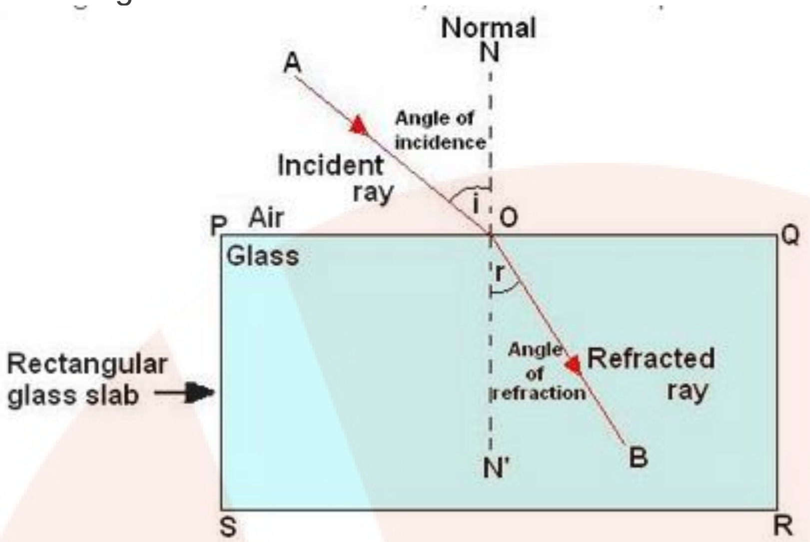
(b)



Solution 24:

The angle between the incident ray and normal at the point of incidence is called angle of incidence.

The angle between the refracted ray and normal at the point of refraction is called angle of refraction.



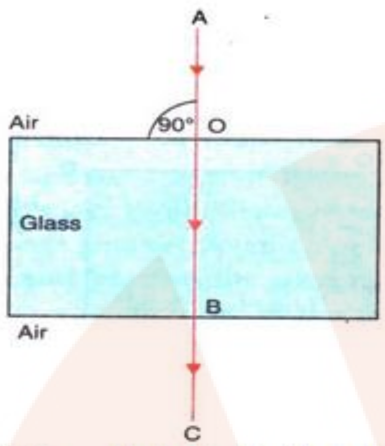
Solution 25:

(a) Glass is optically denser than the water.

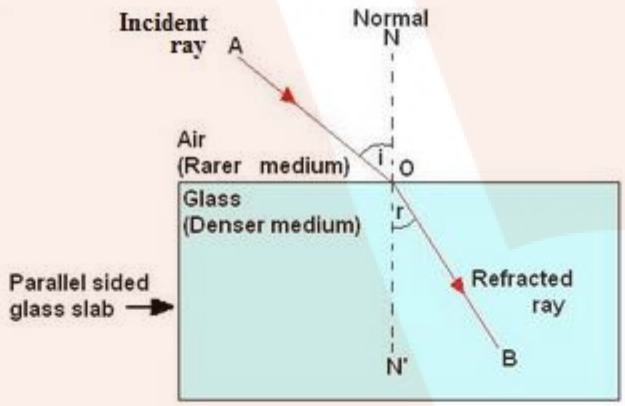
(b) The ray will bend away from the normal.

Solution 26:

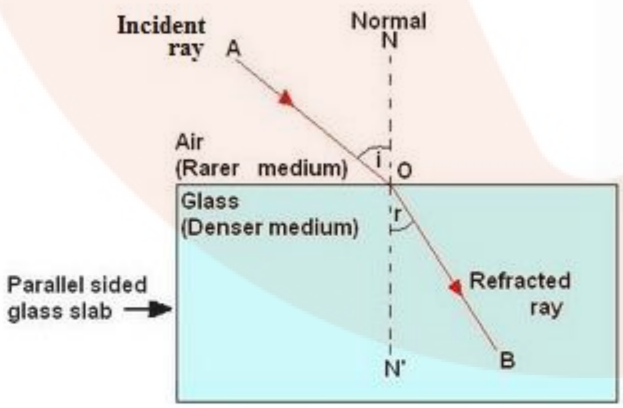
(a) If ray of light hits the block at 90°



(b) If ray of light hits the block other than the 90°

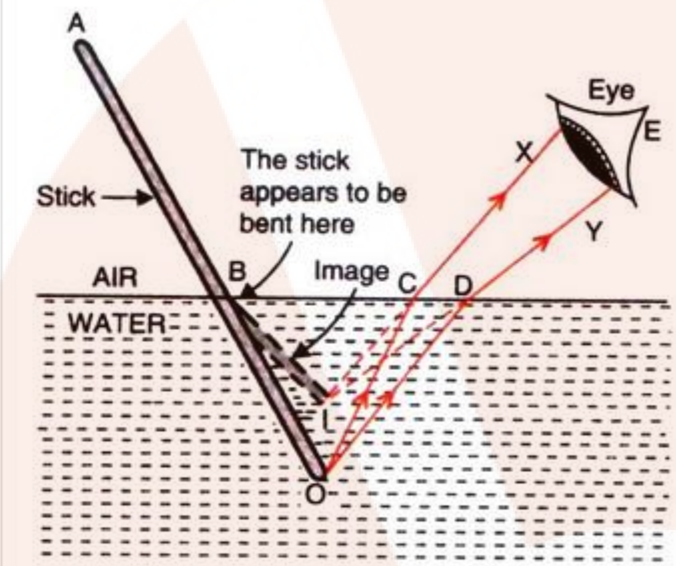


Solution 27:



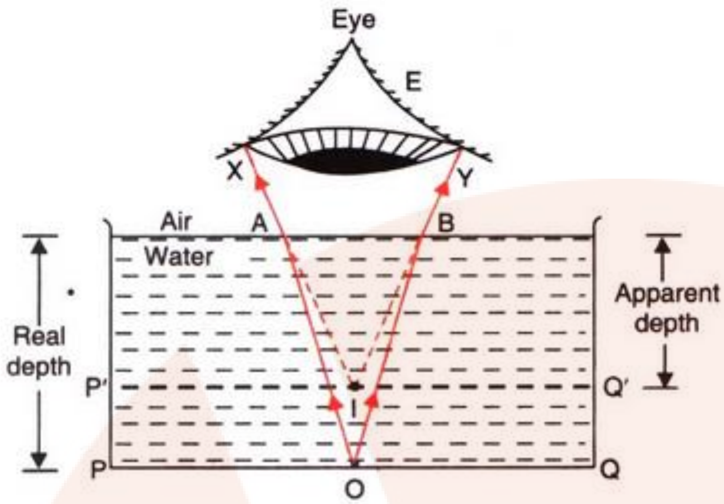
The ray of light bends towards the normal.

Solution 28:
(a) The apparent bending of the stick is due to the refraction of light when it passes from water into air.
A ray of light OC coming from O passes from water into air and gets refracted away from normal (along CX). Another ray OD gets refracted along DY. The two refracted rays CX and DY, when produced backwards, appear to meet at point I. Thus, I is the virtual image of the end O of the stick. So, the stick appears to be bent as shown below.



(b) This phenomenon is due to the refraction of light as it comes out from water into air?

Solution 29:
(a) If we look into a tank of water, it appears to be less deep than it really is. This is due to the refraction of light which takes place when light rays pass from the tank of water into air. When we look into the tank, we do not see the actual bottom of the tank, we see a virtual image of the bottom of the pool which is formed by the refraction of light coming from the water into the air.

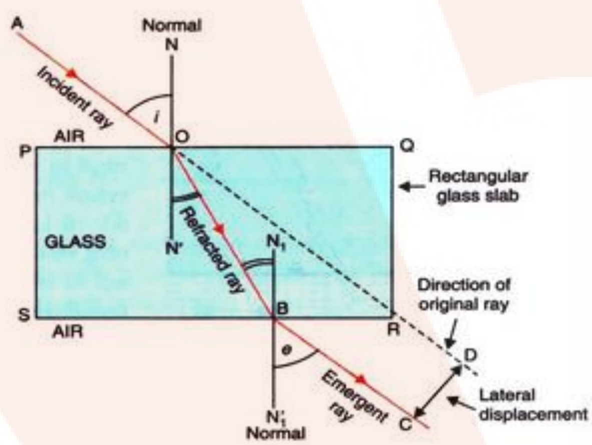


(b) Refraction of light

(b) Refraction of light.

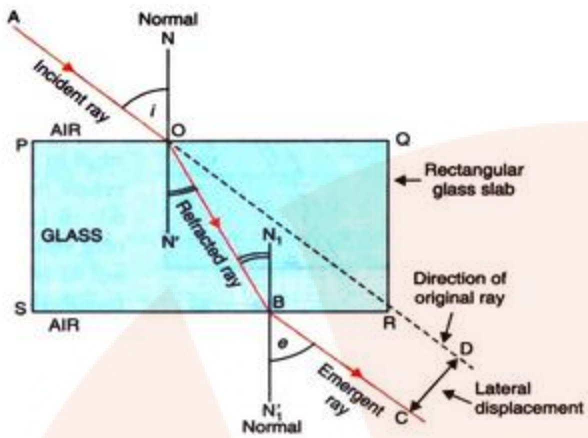
Solution 30:

(a)



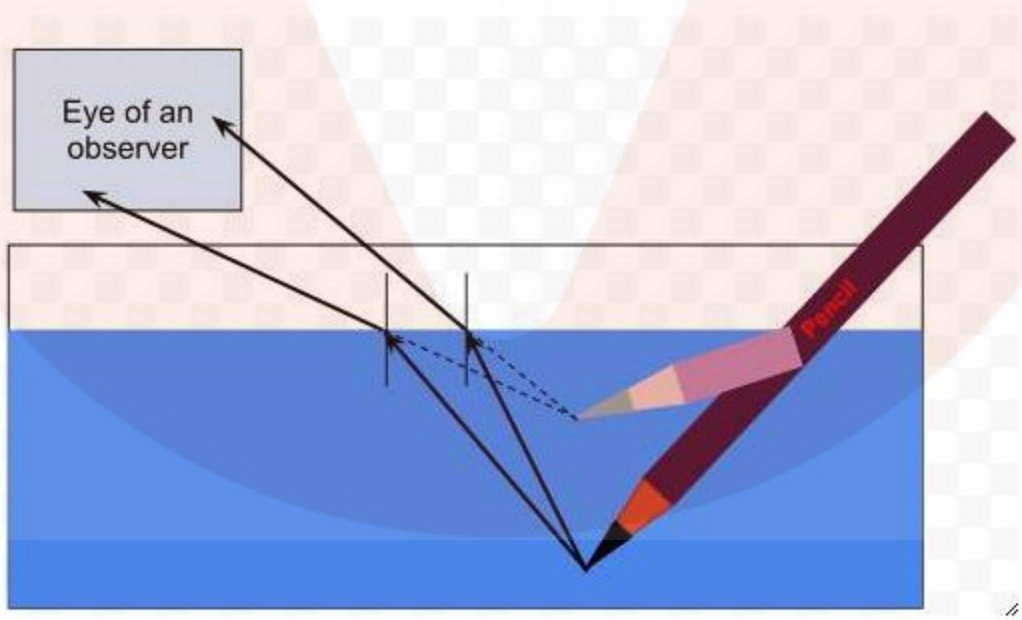
(a)

(a)



(b) The lateral displacement is shown in the above diagram.
(c) Factors on which the lateral displacement depends are:
(i) Angle of incidence
(ii) Thickness of glass slab
(iii) Refractive index of glass slab

Solution 31:
A pencil placed in water appears to be bent because of refraction of light. The refraction causes an apparent shift in the position of the part of the pencil within the water.



If water is replaced by another liquid which is optically more dense than water, then the bending of the pencil will increase. This is because the optically denser medium will cause more refraction of light rays.

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Solution 39:
E.

Solution 40:
(a) 0^0
(b) 0^0

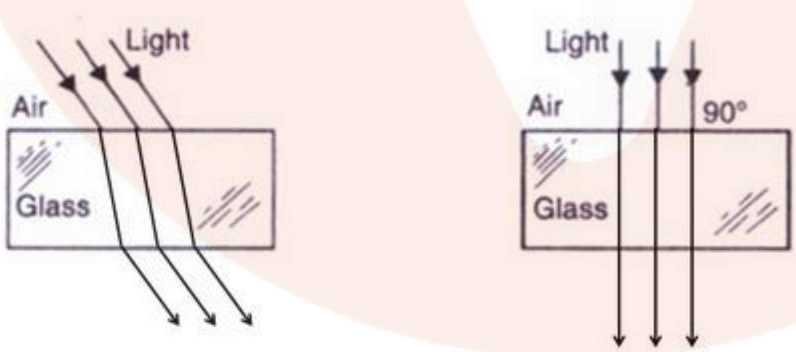
Solution 41:
The angle of reflection is equal to the angle of incidence but the angle of refraction is not equal to the angle of incidence.

Solution 42:
(a) Obliquely; making a large angle of incidence.
(b) Perpendicular to the glass surface.

Solution 43:
(a) By making the light enter from a denser medium to a rarer medium.

(b) Incidence should be at right angle to the surface of substance.

Solution 44:



Solution 45:
A beam of light bends when it enters glass at an angle. This is due to refraction of light. It does not bend if it enters the glass at right angles because no

refraction will occur in this case, the angle of incidence in this case is zero and angle of refraction is also zero.

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Solution 1:
Refractive index.

Solution 2:
Refractive index= sine of the angle of incidence/sine of the angle of refraction.

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Solution 3:
Refractive index has no units.

Solution 4:
Glass has higher refractive index.

Solution 5:
Carbon disulphide is more denser than the ethyl alcohol.

Solution 6:
This means that the ratio of the speed of light in air to the speed of light in diamond is equal to 2.42.

Solution 7:

$$_{diamond}n_{air} = 2.42$$

$$_{air}n_{diamond} = \frac{1}{2.42} = 0.41$$

Solution 8:

$$\text{Refractive index of a material} = \frac{\text{Speed of light in va}}{\text{speed of light in the material}}$$

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Solution 9:
Refractive index.

Solution 10:
Three examples of materials that refract light rays are water, glass and diamond. When light rays (travelling in air) enter these materials, their speed decreases.

Solution 11:
Snell's law: According to the Snell's law of refraction, the ratio of sine of angle of incidence to the sine of angle of refraction is constant for a given pair of media.

$$\text{Refractive index} = \frac{\text{sine of the angle of incidence}}{\text{sine of the angle of refraction}}$$

Given: Angle of incidence $= 60^{o}$

Angle of refraction $= 32.4^{o}$

$$\text{Refractive index} = \frac{\text{sine of the angle of incidence}}{\text{sine of the angle of refraction}}$$

$$\text{Refractive index} = \frac{\sin 60^{\circ}}{\sin 32.4^{\circ}}$$

$$\text{Refractive index} = \frac{0.866}{0.540}$$

$$= 1.603$$

Solution 12:

$$\text{(a) } n_{flint} = \frac{\text{speed of light in vacuum}}{\text{speed of light in flint glass}} = \frac{3 \times 10^8}{1.86 \times 10^8} = 1.61$$

$$n_{crown} = \frac{\text{speed of light in vacuum}}{\text{speed of light in crown glass}} = \frac{3 \times 10^8}{1.97 \times 10^8} = 1.52$$

$$\text{(b) } {}_{crown}n_{flint} = \frac{\text{speed of light in crown glass}}{\text{speed of light in flint glass}} = \frac{1.97 \times 10^8}{1.86 \times 10^8} = 1.059$$

Solution 13:

Given:

Speed of light in air=3.0×10^8m/s

Speed of light in medium X=2.0×10^8m/s

Speed of light in medium Y=2.50×10^8m/s

(a) ${}_{air}n_x$=?

$${}_{air}n_x = \frac{\text{speed of light in air}}{\text{speed of light in medium X}}$$

$${}_{air}n_x = \frac{3.0\times10^8 m/s}{2.0\times10^8 m/s}$$

$$= 1.5$$

(b) ${}_{air}n_y$=?

$${}_{air}n_y = \frac{\text{speed of light in air}}{\text{speed of light in medium y}}$$

$${}_{air}n_y = \frac{3.0\times10^8 m/s}{2.50\times10^8 m/s}$$

$$= 1.2$$

(c) ${}_{x}n_y$=?

$${}_{x}n_y = \frac{\text{speed of light in medium X}}{\text{speed of light in medium Y}}$$

$${}_{x}n_y = \frac{2.0\times10^8 m/s}{2.50\times10^8 m/s}$$

$$= 0.8$$

Solution 14:

Refractive index of medium=6/5=1.2
Speed of light in air=3,00,000km/s
We know that

$$\text{Refractive index of the medium} = \frac{\text{Speed of light in air}}{\text{Speed of light in medium}}$$

$$1.2 = \frac{300000}{\text{Speed of light in medium}}$$

Speed of light in medium=250000km/s

Solution 15:

Given:-
Refractive index of glass=1.5
Speed of light in air=3.0×10^8m/s
We know that

$$\text{Refractive index of glass} = \frac{\text{Speed of light in air}}{\text{Speed of light in glass}}$$

$$1.5 = \frac{3 \times 10^8}{\text{Speed of light in glass}}$$

$$\text{Speed of light in glass} = 2 \times 10^8 \text{ m/s}$$

Solution 16:

Speed of light in vacuum=3.0×10^8m/s
Speed of light in water=2.25×10^8m/s

Refractive index of water=?
We know that

$$\text{Refractive index of water} = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in water}}$$

$$\text{Refractive index of water} = \frac{3 \times 10^8}{2.25 \times 10^8} = 1.33$$

Solution 17:

Given:-

Refractive index of diamond=2.42

Speed of light in air=3.0×10^8m/s

We know that

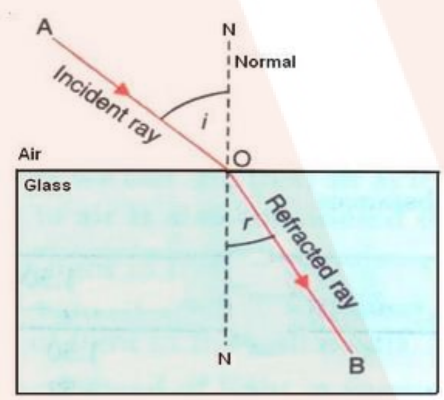
$$\text{Refractive index of diamond}=\frac{\text{Speed of light in air}}{\text{Speed of light in diamond}}$$

$$2.42=\frac{3\times10^8}{\text{Speed of light in diamond}}$$

$$\text{Speed of light in diamond}=1.239\times10^8\ m/s$$

Solution 18:

(a) Laws of refraction:



First law: According to the first law of refraction, the incident ray, the refracted ray and the normal at the point of incidence, all lie in the same plane.

Second law: According to the second law of refraction, the ratio of the sine of angle of incidence to the sine of angle of refraction is constant for a given pair of media.

(b) Refractive index of substance: The ratio of speed of light in vacuum to the speed of light in a medium, is called the refractive index of that medium.

(c) Speed of light in air =300milion m/sec

Speed of light in water=225milion m/sec

We know that

$$\text{Refractive index of water}=\frac{\text{Speed of light in air}}{\text{Speed of light in water}}$$

$$\text{Refractive index of water}=\frac{300\,\text{million}\,m/s}{225\,\text{million}\,m/s}=1.33$$

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Solution 29:
(i) Crown glass to water.
(ii) Water to diamond.

Solution 30:
(i) A (It has least refractive index).
(ii) D (It has highest refractive index).

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Solution 1:
Converging lens.

Solution 2:
Optical center.

Solution 3:
1 cm (same as the height of the object).

Solution 4:
At 2F (At twice the focal length).

Solution 5:
The image is formed at infinity (at very large distance).

Solution 6:
Object should be placed at a distance less than focal length.

Solution 7:
The object should be placed within focus.

Solution 8:
Object should be placed between f and 2f.

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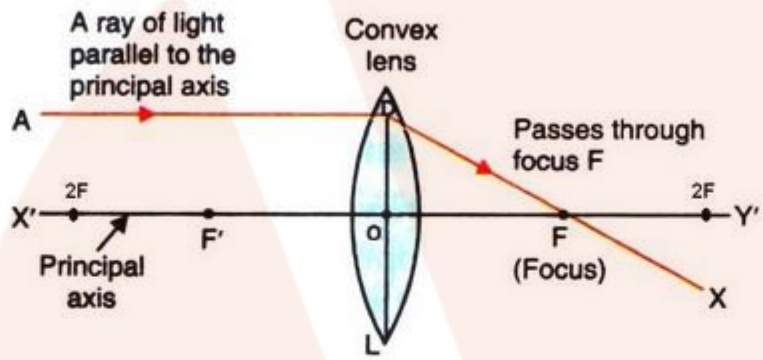
Solution 9:
Beyond 2F.

Solution 10:
At focus F.

Solution 11:



Solution 12:
Convex lens
The object must be withing the focus of the lens.

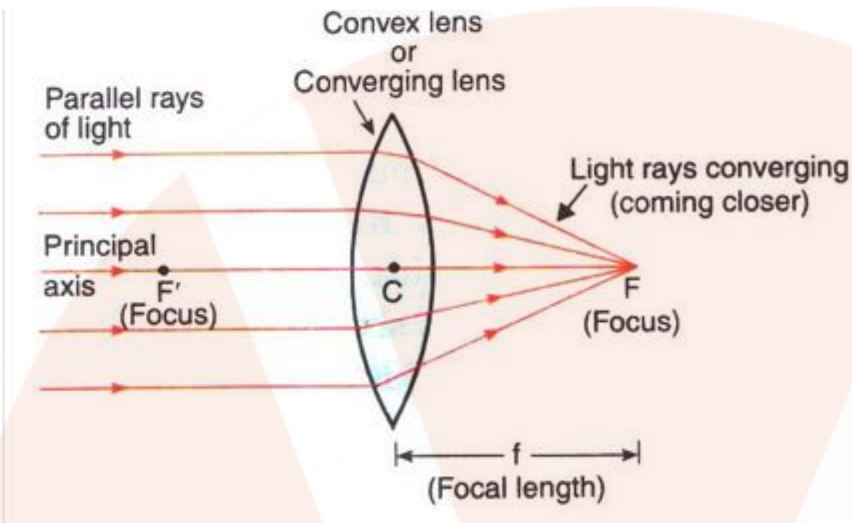
Solution 13:
Focal length of a lens depends on the refractive index of the glass from which it is made, and on the curvature of its two surfaces.

Solution 14:
Two uses of convex lenses:-
1. As a magnifying glass.
2. for making a simple camera.

Solution 15:
a) focus.
b) object.

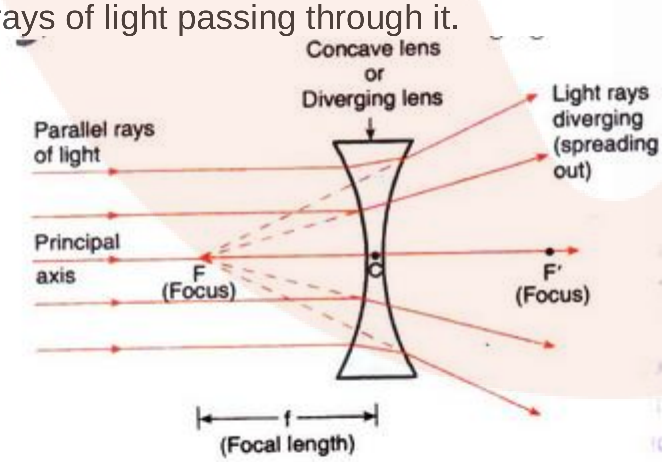
Solution 16:
A lens is a piece of transparent glass bound by two spherical surfaces.
A convex lens is thicker at the middle as compared to the edges; while a concave lens is thicker at the edges as compared to the middle.
Convex lens is converging lens.

Solution 17:
(a) A convex lens also known as converging type because it converges a parallel beam of light rays passing through it.



(b) Principle axis: The principal axis of a lens is a line passing through the optical center of the lens and perpendicular to both the faces of the lens.
Principle focus: The principal focus of a convex lens is a point on its principal axis to which light rays parallel to the principal axis converge after passing through the lens.
Focal length: The distance of the principle focus from the optical center of a lens is called its focal length.

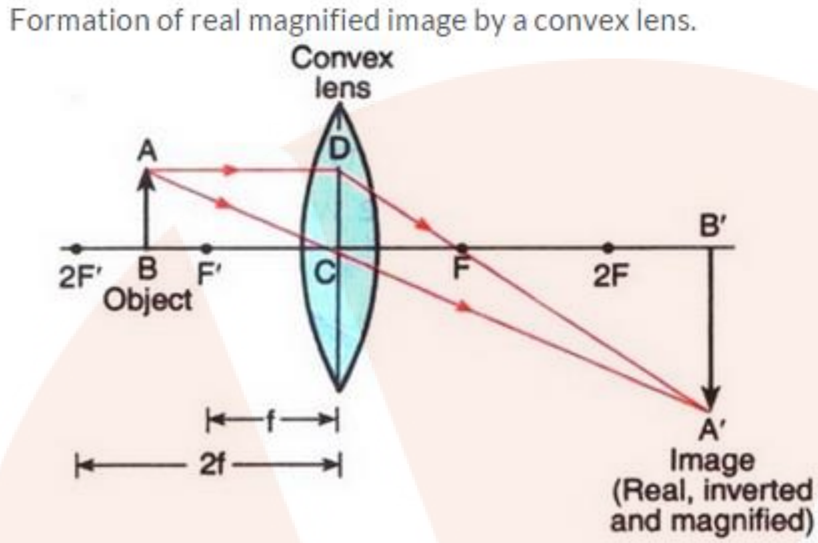
Solution 18:
(a) A concave lens is known as diverging lens because it diverges the parallel rays of light passing through it.



(b) The principal focus of a concave lens is a point on its principal axis from which light rays, originally parallel to the axis, appear to diverge after passing through the lens.

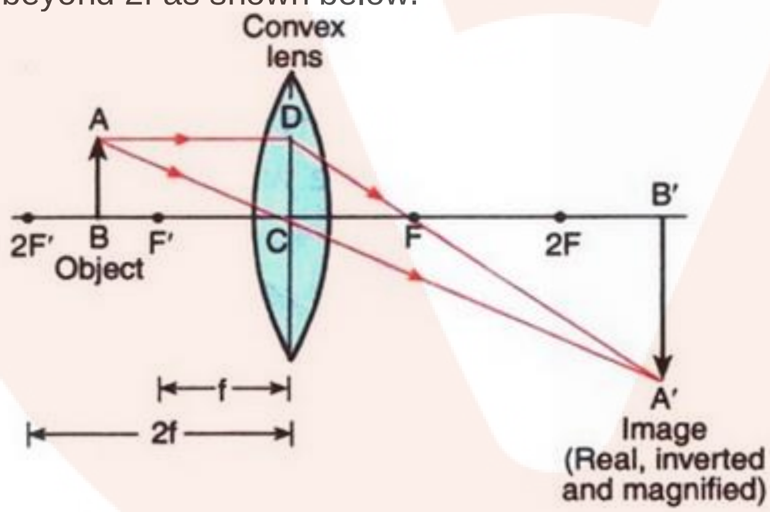
Solution 19:

Formation of real magnified image by a convex lens.



Solution 20:

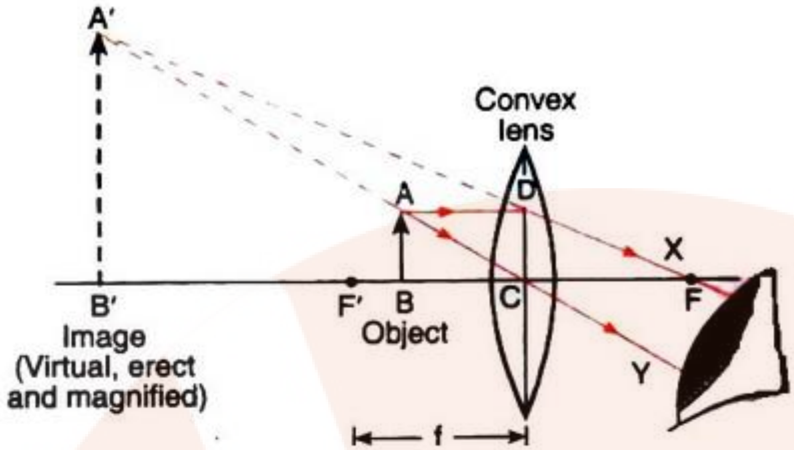
If object is placed in between f and 2f, the image will form on the other side of the lens beyond 2f as shown below.



Characteristics of image formed:
Image formed is real and inverted.
Image formed is magnified.

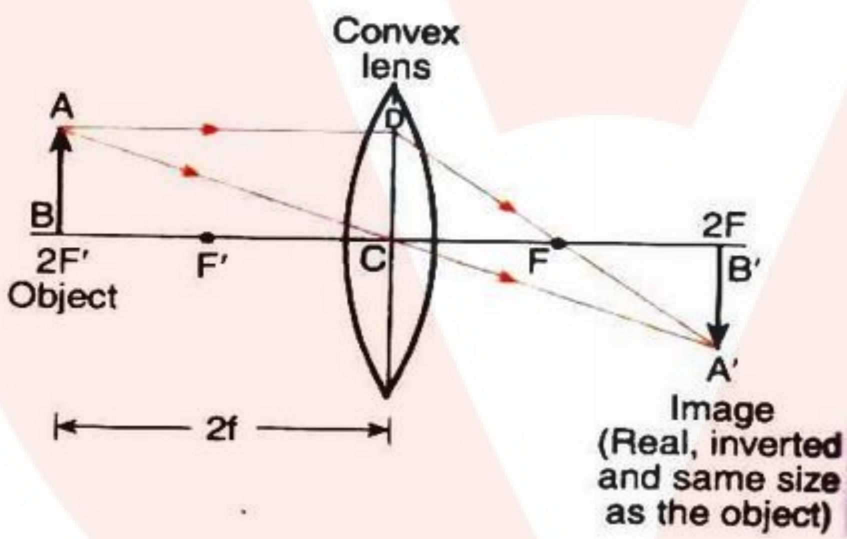
Solution 21:

In the diagram, the object is placed in front of a convex lens between focus and optical center. The image is formed on the same side as the object as shown below.



Characteristics of image formed:
Image is virtual and erect.
Image is larger than the object
Image is formed behind the object.

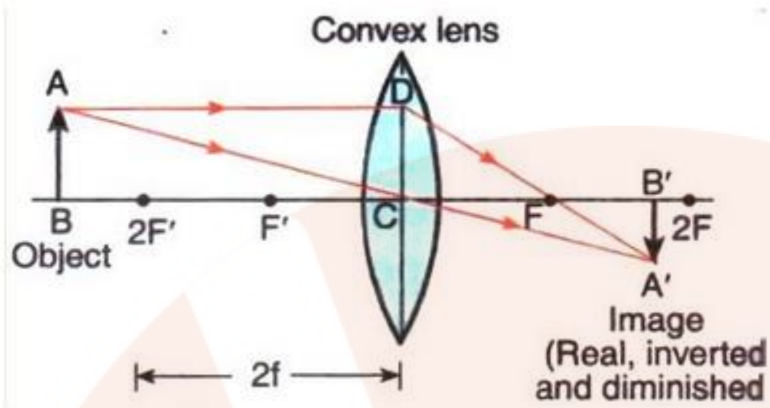
Solution 22:



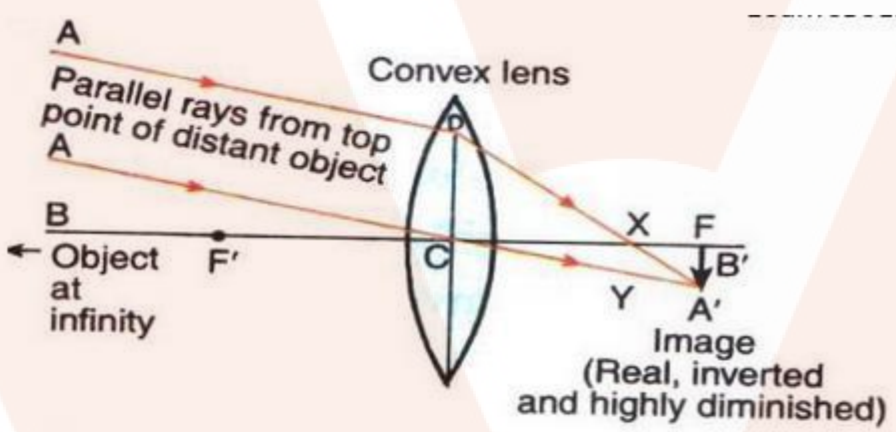
Characteristic of image formed:
Image formed is real and inverted.
Image is of same size as the object

Solution 23:

When an object is placed beyond 2f in front of a convex lens, then the image formed is between f and 2f on the other side of the lens, it is real, inverted and smaller than the object.

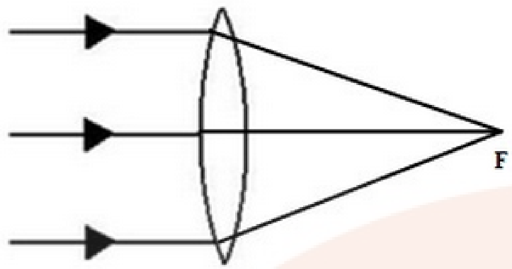


Solution 24:
When an object is placed at infinity in front of a convex lens, the image is formed at the focus on the other side of the lens.



Characteristics of image formed:
Image is real.
Image is inverted.
Image is highly diminished.

Solution 25:
(a) The lens shown in convex. the parallel rays will converge to a point called focus (F).

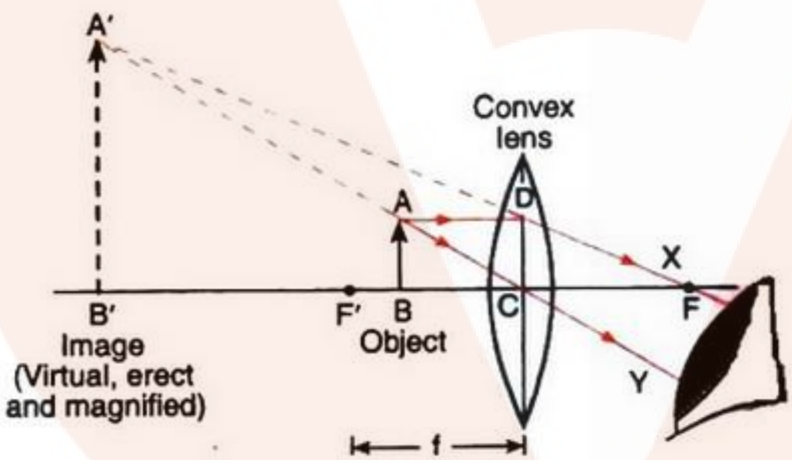


(b) It is unwise to look at the sun because the convex lens focusses a lot of sun rays into our eyes and this may damage them.

(b) It is unwise to look at the sun because the convex lens focusses a lot of sun rays into our eyes and this may damage them.

Solution 26:
a) Beyond 2F
b) At 2F
c) Between F and 2F
d) Between F and optical center

Solution 27:
Converging lens as a magnifying glass:



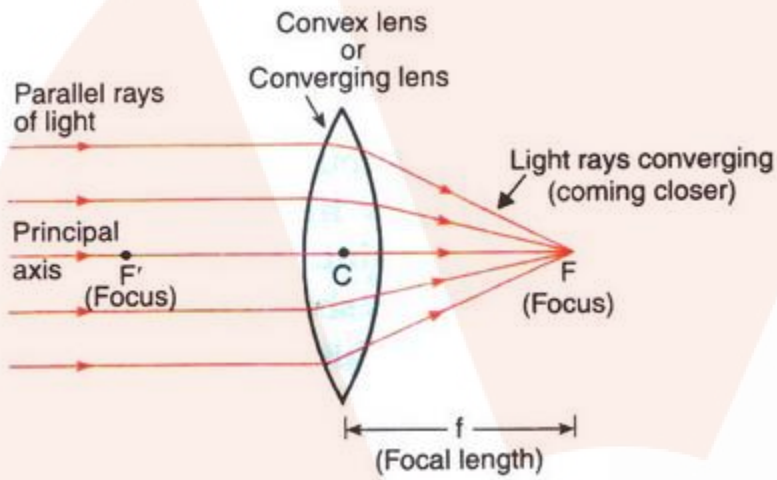
It is usual to choose a lens of short focal length for this purpose rather than one of long focal length because smaller the focal length of a convex lens, greater will be its magnifying power.

Solution 28:
To determine the focal length of a convex lens, we put the convex lens in a holder and keep it in front of a distant object like a window or tree, so that the rays coming from the window pass through it. A cardboard screen is put behind the lens. We change the distance of the screen from the convex lens until a clear

inverted image of the window is formed on the screen. Measure the distance of the screen from the lens with a scale. This distance will be the focal length of convex lens.

Solution 29:

(a) When a beam of light rays parallel to one another and also to the principal axis of the convex lens fall on the lens, the incident rays pass through the lens and get refracted according to the laws of refraction. All the rays, after passing through the lens, converge at the same point F (focus) on the other side of the lens.



(b) A convex lens has a real focus.

(c) Both, convex lens and concave mirror, converge parallel rays of light coming from infinity (parallel to the principal axis) at the focus.

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Solution 30:

(a)

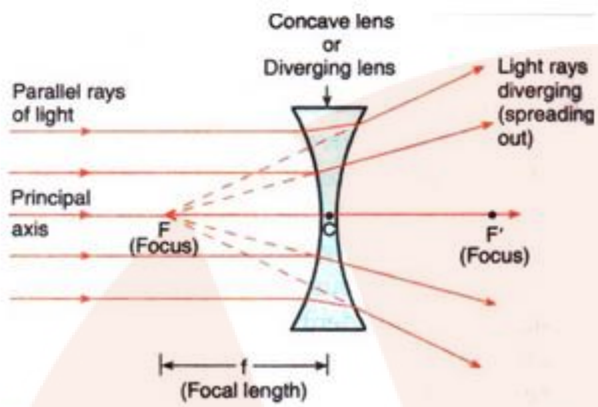


Figure — A concave lens diverges (spreads out) a parallel beam of light rays.

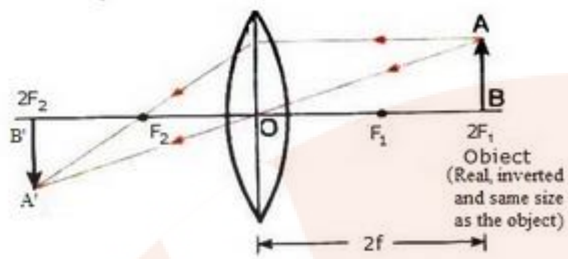
When a beam of light rays parallel to one another and also to the principal axis of the concave lens fall on the lens, the incident rays pass through the lens and get refracted according to the laws of refraction. All the rays spread out after passing through the lens. These diverging rays when produced backwards appear to meet at a point F (focus) on the left side of the lens.

(b) A concave lens has a virtual focus.

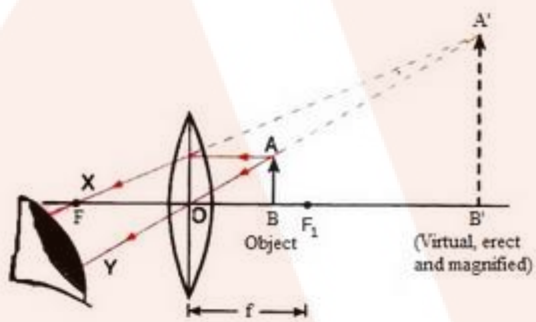
(c) Both, concave lens and convex mirror, diverge parallel rays of light coming from infinity (parallel to the principal axis).

Solution 31:

(a) Object at $2F_1$:



(b) Object between F_1 and the optical centre O of the lens :



The case when object is between F_1 and the optical centre O of the lens shows the use of convex lens as a magnifying glass. This is because here the image formed is erect and magnified.

Solution 32:

(a).

a)

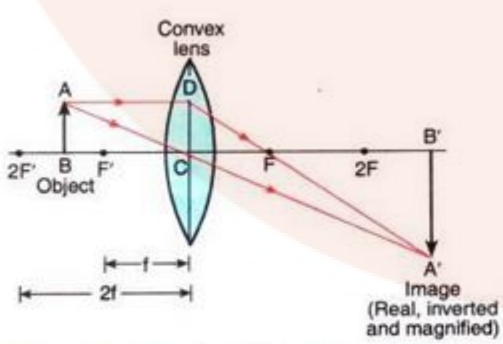


Figure — Formation of image by a convex lens when the object is placed between F′ and 2F′ (or between *f* and 2*f*)

(b)

(i) If object is moved towards the lens, the image size will keep on increasing till the object reaches focus. After that, the size decreases but the image remains magnified. The image keeps moving away from the lens (on the opposite side of the lens) till the object reaches focus; after that the image is formed on the same side of the lens as the object.
(ii) If object is moved away from the lens, the size will keep on decreasing and the image keeps on shifting towards the lens.

Solution 33:
(a) A virtual magnified image is the one which cannot be taken on a screen and whose size is larger than that of the object.
(a) A virtual magnified image is the one which cannot be taken on a screen and whose size is larger than that of the object.

(b)

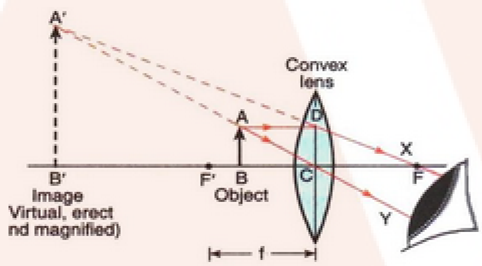


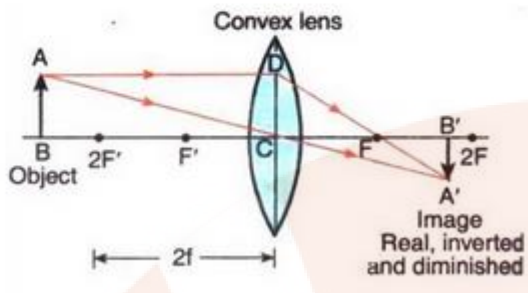
Figure – Formation of image by a convex lens when the object is placed between its optical centre (C) and focus (F').

(c) Convex lens having 4 cm focal length - because it will produce greatest magnification.

Solution 34:
a) A real image can be projected on a screen but a virtual image cannot because a real image is formed when light rays coming from an object actually meet at a point after refraction through a lens while a virtual image is formed when light rays coming from an object only appear to meet at a point when produced

backwards (but do not actually meet) after refraction through a lens.

b)



c) A simple camera

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Solution 46:

(b) 16 cm

Magnification, $m = \frac{v}{u}$

$3 = \frac{v}{u}$

$\Rightarrow v = 3u$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{3u} - \frac{1}{u} = \frac{1}{12}$

$\frac{-2}{3u} = \frac{1}{12}$

$\Rightarrow u = -8\,cm$

$v = 3 \times -8 = -24\,cm$

Distance between object and image=u-v=-8-$(-24) = -8 + 24 = 16\,cm$

Solution 47:

(b) 10 cm

The image is slightly smaller than the object when the object lies beyond 2f; and the image is slightly larger than the object when the object between f and 2f. This means that between 21 cm and 19 cm lies 2f. Out of the given options, 20 cm lies between 21 cm and 19 cm.

So, 2f = 20 cm.

f = 10 cm.

Solution 48:
Here, f=15cm and 2f=30cm
(i) 20 cm (Because a magnified real image is formed when the object is placed between f and 2f).
(ii) 10cm (Because a magnified virtual image is formed when the object is placed between f and the lens).
(iii) 35cm (Because a diminished real image is formed when the object is placed beyonf 2f).
(iv) 30cm (Because an image of same size as the object is formed when the object is placed at 2f).

Solution 49:
Here, 2f = 36 cm, f = 18 cm.
(a) When the object is placed at a distance of 10 cm from the lens, the object lies within the focus. Hence, the image formed is virtual, erect and magnified.

(b) When the object is placed at a distance of 20 cm from the lens, the object lies between f and 2f. Hence, the image formed is real, inverted and magnified.

Solution 50:
(a) A converging lens focusses parallel ray of light as shown below:

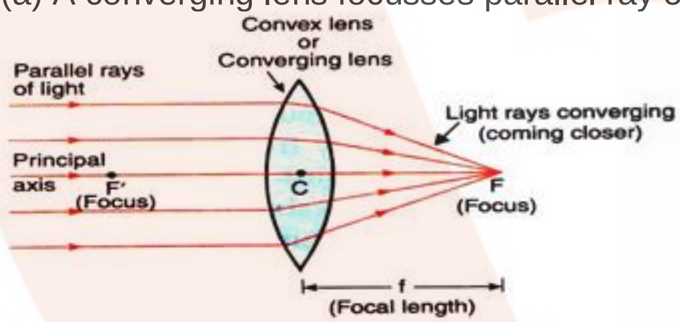

Figure — A convex lens converges (brings closer) a parallel beam of light rays to a point *F* on its other side (right side).

(b) Place a source of light at the focus of the converging lens.

(b) Place a source of light at the focus of the converging lens.

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Solution 1:

Formula for a lens connecting image distance (v), object distance (u) and the focal length (f) is:

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

This is the lens formula.

The lens formula has a minus sign (-) between 1/v and 1/u whereas the mirror formula has a plus sign (+) bet

Mirror formula:

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

Solution 2:

Magnification (m) fomula for a lens is:

$$m = \frac{v(\text{distance of image})}{u(\text{distacne of object})}$$

Magnification formula for a mirror has a minus sign (-) but the magnification formula for a lens has no minus sign.

Magnification formula for a mirror is:

$$m = -\frac{v(\text{distance of image})}{u(\text{distacne of object})}$$

Solution 3:

The image will be virtual and erect, since the magnification has positive value.

Solution 4:

The image will be real and inverted, since the magnification has negative value.

Solution 5:

u = -10 cm, f = 10 cm

We have

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

$$\frac{1}{v} - \frac{1}{-10} = \frac{1}{10}$$

$$\frac{1}{v} = 0$$

$$v = \frac{1}{0} = \infty$$

At infinity

Solution 6:
Since the object is placed at a distance greater than the focal length of the convex lens, so the image formed is real and inverted.

Solution 7:

$f = 12\,cm$

$m = 1$

$m = \frac{v}{u} = 1$

$\Rightarrow v = u$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

Putting the value of v, u and f,

$\frac{1}{u} - \frac{1}{-u} = \frac{1}{12}$ (image distance is negative)

$\frac{2}{u} = \frac{1}{12}$

$u = 24\,cm$

The object should be placed at a distance of 24 cm to from the lens (on the left side).

Solution 8:
New Cartesian Sign Convention for spherical lenses:
(i) All the distances are measured from the optical centre of the lens.
(ii) The distances measured in the same direction as that of incident light are taken as positive.
(iii) The distances measured against the direction of incident light are taken as negative.
(iv) The distances measured upward and perpendicular to the principal axis are taken as positive.
(v) The distances measured downward and perpendicular to the principal axis are taken as negative.

Solution 9:

$u = -10\text{cm}$

$h_1 = 4\text{cm}$

$f = 20\text{cm}$

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

$$\frac{1}{v} - \frac{1}{-10} = \frac{1}{20}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{10} = -\frac{1}{20}$$

$v = -20\text{cm}$ (Image is 20cm in front of the convex lens)

$$m = \frac{v}{u} = \frac{20}{-10} = -2$$

$$m = \frac{h_2}{h_1} = -2$$

$$\frac{h_2}{4} = -2$$

$h_2 = -8\text{cm}$

Image is 8cm in size and is real and inverted.

Solution 10:

$f = 5\text{cm}$

$v = -25\text{cm}$ (Virtual image)

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{-25} - \frac{1}{u} = \frac{1}{5}$$

$$\frac{1}{u} = -\frac{1}{25} - \frac{1}{5} = -\frac{6}{25}$$

$$u = -\frac{25}{6}\text{cm}$$

Magnification, $m = \frac{v}{u} = \frac{-25}{-25/6} = +6$

Solution 11:

$h_1 = 5\text{cm}$

$u = -10\text{cm}$

$f = 6\text{cm}$

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

$$\frac{1}{v} - \frac{1}{-10} = \frac{1}{6}$$

$$\frac{1}{v} = \frac{1}{6} - \frac{1}{10} = \frac{2}{30} = \frac{1}{15}$$

$v = 15\text{cm}$

Image is formed 15cm behind the convex lens and it is real and inverted.

Solution 12:

$v = -50\text{cm}$ (Virtual image)

$u = -20\text{cm}$

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

$$\frac{1}{-50} - \frac{1}{-20} = \frac{1}{f}$$

$$\frac{-2+5}{100} = \frac{1}{f}$$

$$\frac{3}{100} = \frac{1}{f}$$

$f = 33.3\text{cm}$

Solution 13:

(i) Since the object is placed at a distance greater than the focal length of the lens, so the image formed is re

(ii) u = -100cm, f = 40cm

Lens formula: $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

$\frac{1}{v}-\frac{1}{-100}=\frac{1}{40}$

$\frac{1}{v}=\frac{1}{40}-\frac{1}{100}$

$\frac{1}{v}=\frac{5-2}{200}=\frac{3}{200}$

$v=66.6\,cm$

Image is formed 66.6 cm behind the convex lens.

Solution 14:

$m=-3$ (Inverted image)

$u=-15cm$

$m=\frac{v}{u}$

$-3=\frac{v}{-15}$

$v=45cm$

Lens formula: $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

$\frac{1}{45}-\frac{1}{-15}=\frac{1}{f}$

$\frac{1+3}{45}=\frac{1}{f}$

$f=\frac{45}{4}cm$

$f=11.25cm$

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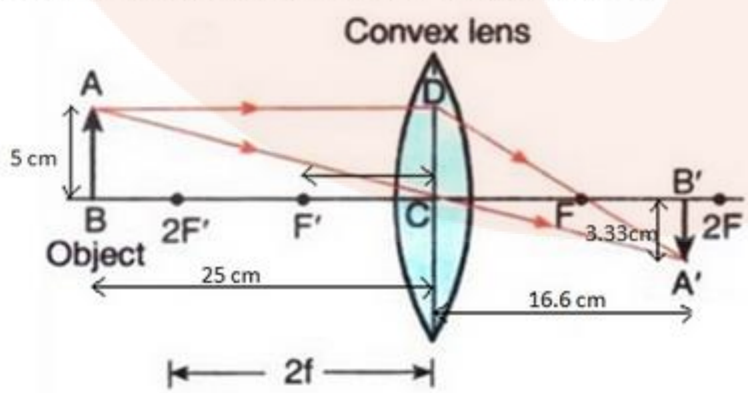
Solution 15:

$f = 5cm$
$u = -20cm$
$v = +v$ (since image is real)
Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$
$\frac{1}{v} - \frac{1}{-20} = \frac{1}{5}$
$\frac{1}{v} = \frac{1}{5} - \frac{1}{20} = \frac{4-1}{20} = \frac{3}{20}$
$v = 6.66$

Solution 16:

$h_1 = 5\,cm$
$u = -25cm$
$f = 10\,cm$
Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$
$\frac{1}{v} - \frac{1}{-25} = \frac{1}{10}$
$\frac{1}{v} = \frac{1}{10} - \frac{1}{25} = \frac{5-2}{50} = \frac{3}{50}$
$v = 16.6$
Image is 16.6 cm behind the convex lens.
$m = \frac{v}{u} = \frac{50/3}{-25} = -\frac{2}{3}$ (Image is real and inverted)
$m = \frac{h_2}{h_1}$
$-\frac{2}{3} = \frac{h_2}{5}$
$h_2 = \frac{-10}{3} = -3.33\,cm$
Image is 3.33 cm in size and is real and inverted.



Solution 17:

$f = 18\,cm$

$v = 24\,cm$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{24} - \frac{1}{u} = \frac{1}{18}$

$\frac{1}{u} = \frac{1}{24} - \frac{1}{18}$

$\frac{1}{u} = \frac{3-4}{72} = \frac{-1}{72}$

$u = -72\,cm$

$m = \frac{v}{u} = \frac{24}{-72} = -\frac{1}{3}$

Solution 18:

$h_1 = 2\,cm$

$f = 5\,cm$

$u = -10\,m = -1000\,cm$

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

$\frac{1}{v} - \frac{1}{-1000} = \frac{1}{5}$

$\frac{1}{v} = \frac{1}{5} - \frac{1}{1000} = \frac{200-1}{1000} = \frac{199}{1000}$

$v = 5.02\,cm$

The image is formed 5.02 cmbehind the convex lens and is real and inverted.

$m = \frac{v}{u} = \frac{5.02}{-1000} = -0.005$

$m = \frac{h_2}{h_1} = -0.005$

$\frac{h_2}{2} = -0.005$

$h_2 = -0.01\,cm$

Since the object distance is much greater than the focal length, this example illustrates the case when the

Solution 19:

$-u+v=80\,cm\ -----(1)$

$m=-3$ (The image is real, since it forms on a screen)

$m=\frac{v}{u}=-3$

$v=-3u$

Put in eq (1),

$-u-3u=80$

$-4u=80$

$u=-20\,cm$

Distance of lens from filament is 20cm.

$v=-3u=60\,cm$

Lens formula: $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

$\frac{1}{60}-\frac{1}{-20}=\frac{1}{f}$

$\frac{1}{f}=\frac{1+3}{60}=\frac{4}{60}$

$f=15\,cm$

Solution 20:

$h_2=2\,cm$ (Erect image)

$v=-12\,cm$ (Erect image)

$h_1=0.5\,cm$

$m=\frac{v}{u}=\frac{h_2}{h_1}$

$\frac{-12}{u}=\frac{2}{0.5}$

$u=-3\,cm$

Lens formula: $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

$\frac{1}{-12}-\frac{1}{-3}=\frac{1}{f}$

$\frac{-1+4}{12}=\frac{1}{f}$

$f=4\,cm$

Solution 21:

$f = 0.10\,m$

$h_1 = 5\,mm = 0.005\,m$

$u = -0.08\,m$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} - \frac{1}{-0.08} = \frac{1}{0.10}$

$\frac{1}{v} = \frac{1}{0.10} - \frac{1}{0.08}$

$v = -0.4\,m$

Image is formed 0.40 m in front of the convex lens.

$m = \frac{v}{u} = \frac{h_2}{h_1}$

$\frac{-0.4}{-0.08} = \frac{h_2}{0.005}$

$h_2 = 0.025\,m = 25\,mm$

Size of image is 25 mm.

Image is virtual and erect.

Solution 22:

$f = 6\,cm$

$u = -4\,cm$

$h_1 = 0.5\,cm$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} - \frac{1}{-4} = \frac{1}{6}$

$\frac{1}{v} = \frac{1}{6} - \frac{1}{4} = \frac{2-3}{12}$

$v = -12\,cm$

$m = \frac{v}{u} = \frac{h_2}{h_1}$

$\frac{-12}{-4} = \frac{h_2}{0.5}$

$h_2 = 1.5\,cm$

Image is 1.5 cm high, virtual, erect and magnified.

Solution 23:

$f = 10\,cm$

$m = +4$ (upright image)

$m = \frac{v}{u} = 4$

$v = 4u$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{4u} - \frac{1}{u} = \frac{1}{10}$

$\frac{-3}{4u} = \frac{1}{10}$

$u = -7.5\,cm$

The object must be placed 7.5 cm in front of the converging lens.

Solution 24:

$f = 20\,cm$

$m = -10$ (Image is real)

$u = ?$

$m = \frac{v}{u} = -10$

$v = -10u$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{-10u} - \frac{1}{u} = \frac{1}{20}$

$\frac{-1-10}{10u} = \frac{1}{20}$

$\frac{-11}{10u} = \frac{1}{20}$

$u = -22\,cm$

$v = -10 \times -22 = 220\,cm$

Solution 25:

$u = -4\text{ cm}$

$v = 12\text{ cm}$ (Real image)

(a) $m = \frac{v}{u} = \frac{12}{-4} = -3$

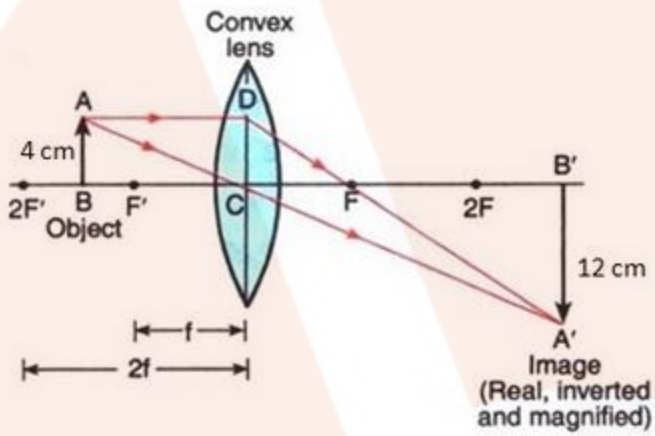
(b) Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{12} - \frac{1}{-4} = \frac{1}{f}$$

$$\frac{1+3}{12} = \frac{1}{f}$$

$f = 3\text{ cm}$

(c)



Solution 26:

(a) $h_1=2cm$
$f=8cm$
(i) $u=-12cm$
Lens formula: $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$
$\frac{1}{v}-\frac{1}{-12}=\frac{1}{8}$
$\frac{1}{v}=\frac{1}{24}$
$v=24cm$
Image is 24 cm behind the lens.
$m=\frac{v}{u}=\frac{h_2}{h_1}$
$\frac{24}{-12}=\frac{h_2}{2}$
$h_2=-4cm$
Image is 4 cm high, real and inverted.
(ii) $u=-6cm$
Lens formula: $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$
$\frac{1}{v}-\frac{1}{-6}=\frac{1}{8}$
$\frac{1}{v}=-\frac{1}{24}$
$v=-24cm$
Image is 24 cm in front of the lens.
$m=\frac{v}{u}=\frac{h_2}{h_1}$
$\frac{-24}{-6}=\frac{h_2}{2}$
$h_2=8cm$
Image is 8 cm high, virtual and erect.

(b) (i) Used in film projector.
(ii) Used as a magnifying glass.

Solution 27:

(a) $h_1 = 3cm$

$u = -24cm$

$f = 8cm$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} - \frac{1}{-24} = \frac{1}{8}$

$\frac{1}{v} = \frac{1}{12}$

$v = 12cm$

Image is formed 12 cm behind the lens.

$m = \frac{v}{u} = \frac{h_2}{h_1}$

$\frac{12}{-24} = \frac{h_2}{3}$

$h_2 = -1.5cm$

Image is 1.5cm high, real and inverted.

(b) $u = -3cm$

$h_1 = 3cm$

$f = 8cm$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} - \frac{1}{-3} = \frac{1}{8}$

$\frac{1}{v} = -\frac{5}{24}$

$v = -4.8cm$

Image is formed 4.8 cm in front of the lens.

$m = \frac{v}{u} = \frac{h_2}{h_1}$

$\frac{-4.8}{-3} = \frac{h_2}{3}$

$h_2 = +4.8cm$

Image is 4.8cm high, virtual and erect.

(c) Case (b)

Solution 28:

(a) f=0.20 m

(i) u=-0.50 m

Lens formula: $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

$\frac{1}{v}-\frac{1}{-0.50}=\frac{1}{0.20}$

$\frac{1}{v}=\frac{1}{0.20}-\frac{1}{0.50}$

$v=0.33\,m$

Image is formed 0.33 m behind the lens.

$m=\frac{v}{u}=\frac{0.33}{-0.50}=-0.66$

Image is real and inverted.

(ii) u=-0.25 m

Lens formula: $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

$\frac{1}{v}-\frac{1}{-0.25}=\frac{1}{0.20}$

$\frac{1}{v}=\frac{1}{0.20}-\frac{1}{0.25}$

$v=1\,m$

Image is formed 1 m behind the lens.

$m=\frac{v}{u}=\frac{1}{-0.25}=-4$

Image is real and inverted.

(iii) u=-0.15 m

Lens formula: $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

$\frac{1}{v}-\frac{1}{-0.15}=\frac{1}{0.20}$

$\frac{1}{v}=\frac{1}{0.20}-\frac{1}{0.15}$

$v=-0.60\,m$

Image is formed 0.60 m in front of the lens.

$m=\frac{v}{u}=\frac{-0.6}{-0.15}=+4$

Image is virtual and erect.

(b) Film projector: Case (ii)

Camera: Case (i)

Magnifying glass: Case (iii)

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Solution 41:

(a) 100 cm; 60 cm; 40 cm; 30 cm; 24 cm

(b) When u=-25 cm, v=100 cm

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

$\frac{1}{100}-\frac{1}{-25}=\frac{1}{f}$

$\frac{1}{f}=\frac{5}{100}$

$f=20\text{cm}$

When u=-90 cm, v=?

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

$\frac{1}{v}-\frac{1}{-90}=\frac{1}{20}$

$\frac{1}{v}=\frac{1}{20}-\frac{1}{90}$

$\frac{1}{v}=\frac{7}{180}$

$v=25.7\text{ cm}$

(c) 25 cm

(d) 20 cm (As calculated in part (b))

Solution 42:

$f=100\text{mm}$

$h_1=16\text{mm}$

$v=-25\text{cm}=-250\text{mm}$

(a) $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

$\frac{1}{-250}-\frac{1}{u}=\frac{1}{100}$

$\frac{1}{u}=-\frac{7}{500}$

$u=-71.4\text{mm}=-7.14\text{cm}$

Distance between object and lens is 7.14 cm.

(b) The object should be placed at the focus so that the image is formed at infinity.

So, u = -100 mm = -10 cm

The object should be placed 10 cm in front of the lens.

Solution 43:

$$h_2 = -3\,cm \text{ (Real image)}$$
$$h_1 = 1\,cm$$
$$-u + v = 15\,cm$$
$$m = \frac{v}{u} = \frac{h_2}{h_1}$$
$$\frac{15+u}{u} = \frac{-3}{1}$$
$$15 + u = -3u$$
$$u = -3.75\,cm$$
$$v = 15 + u = 15 + (-3.75) = 11.25\,cm$$
$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$
$$\frac{1}{11.25} - \frac{1}{-3.75} = \frac{1}{f}$$
$$f = 2.82\,cm$$

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Solution 44:

$$h_1 = 50\,cm$$
$$h_2 = -20\,cm \text{ (Real image)}$$
$$v = 10\,cm$$
$$m = \frac{v}{u} = \frac{h_2}{h_1}$$
$$\frac{10}{u} = \frac{-20}{50}$$
$$u = -25\,cm$$
$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$
$$\frac{1}{10} - \frac{1}{-25} = \frac{1}{f}$$
$$f = \frac{50}{7} = 7.14\,cm$$

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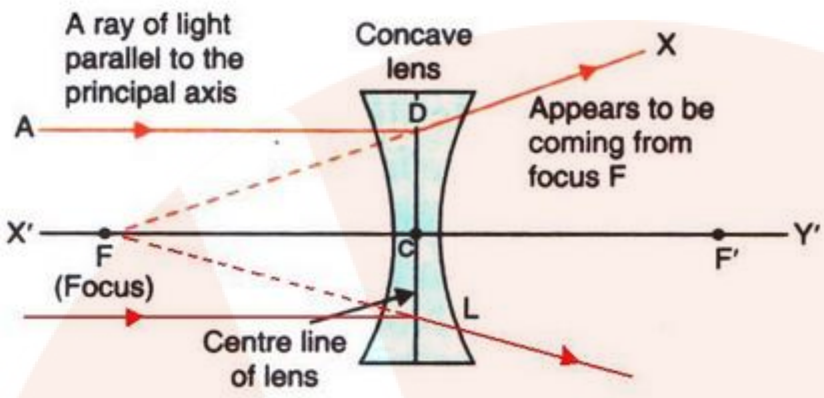
Solution 1:
Concave lens.

Solution 2:



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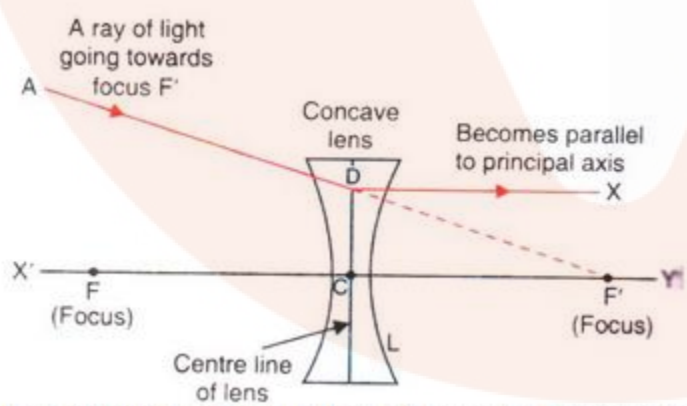
Solution 3:
(a) Concave lenses.
(b) Convex lenses.

Solution 4:



Ray of light going towards the focus of a concave lens.

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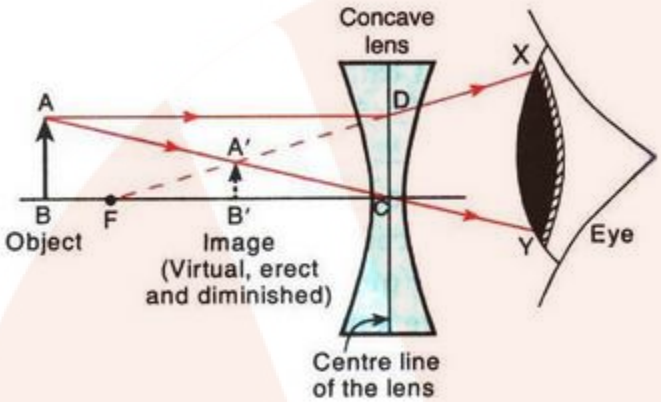
Solution 5:
(a) Real and virtual.
(b) Virtual.

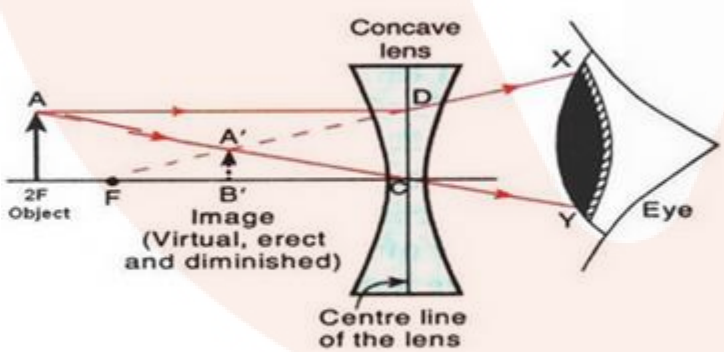
Solution 6:



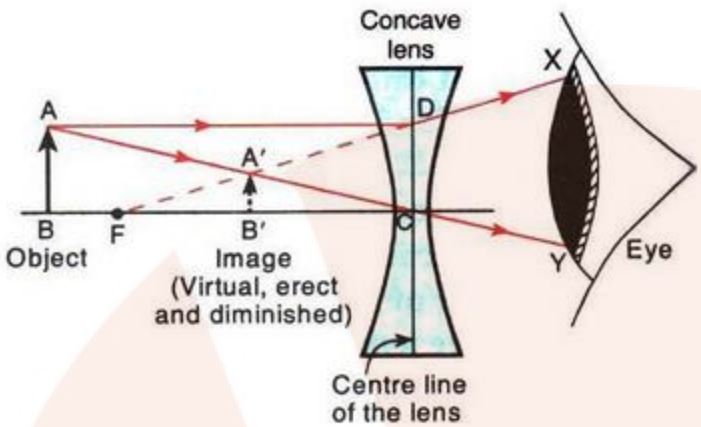
Solution 7:
(a) converges; diverges
(b) converging; virtual

Solution 8:
Concave lens.

Solution 9:



Solution 10:



Solution 11:

(a) When the object is placed anywhere between optical center and infinity, the image is formed between optical center and focus. It is diminished, virtual and erect.
(b) When the object is placed at infinity, the image is formed at focus. It is highly diminished, virtual and erect.

Solution 12:

(a) A convex lens is a converging lens because it converges a parallel beam of light rays passing through it at its focus.

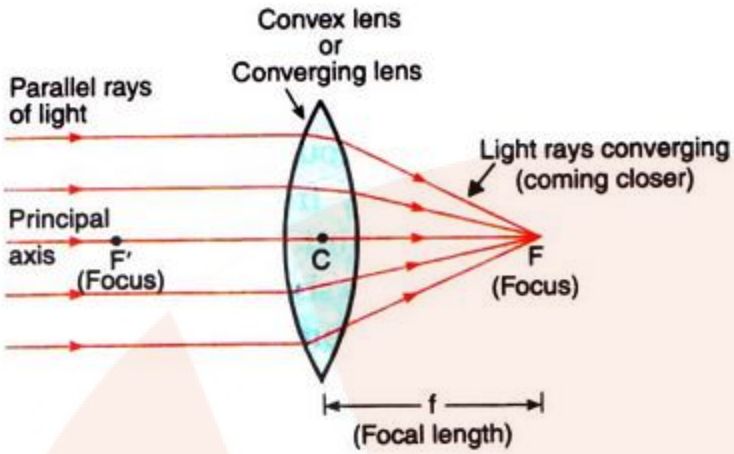


Figure — A convex lens converges (brings closer) a parallel beam of light rays to a point *F* on its other side (right side).

(b) A concave lens is a diverging lens because it diverges the parallel beam of rays passing through it.

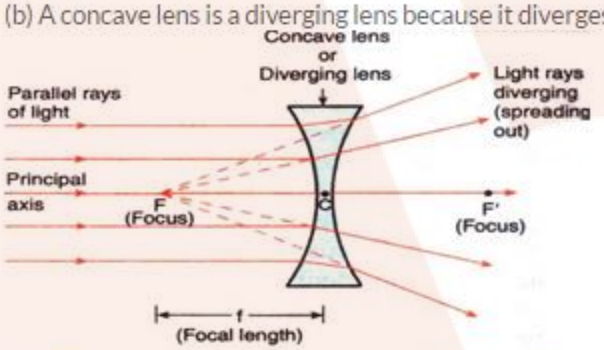


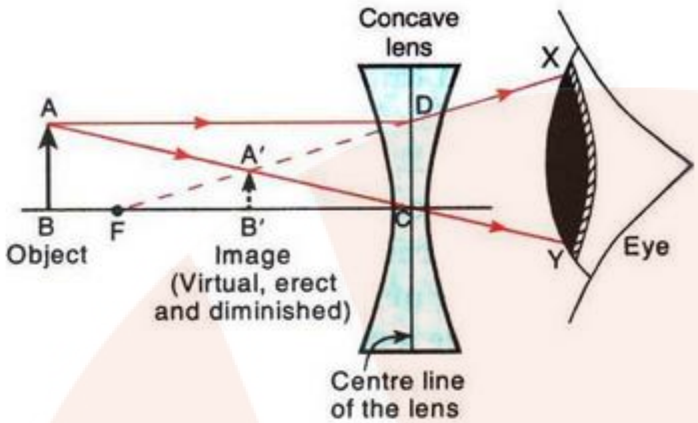
Figure — A concave lens diverges (spreads out) a parallel beam of light rays.

Solution 13:

(a) Smaller.

(b) Bigger.

Image is virtual in both the cases.

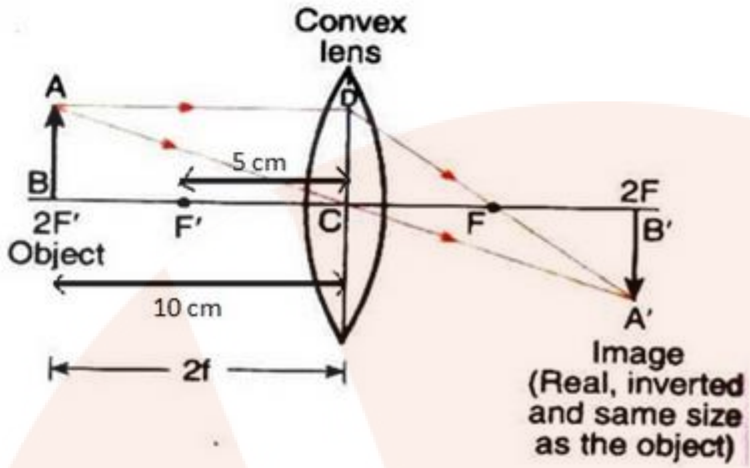


As shown by the diagram, the image of an object viewed through a concave lens appears smaller and closer than the object.

Solution 14:

(a)

(a)
(i)



(ii)

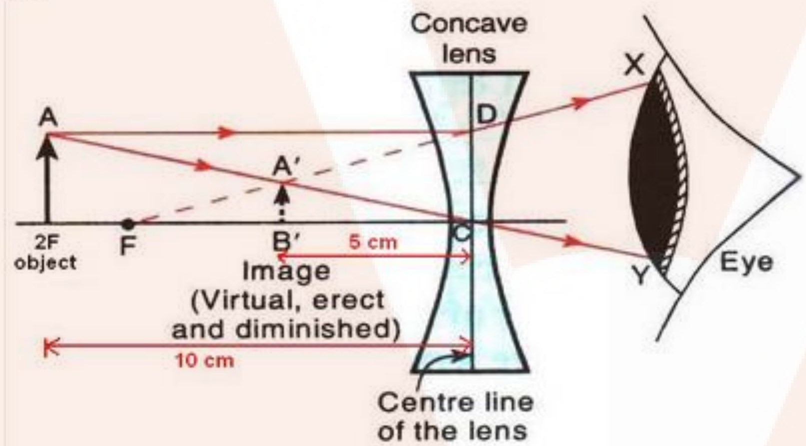
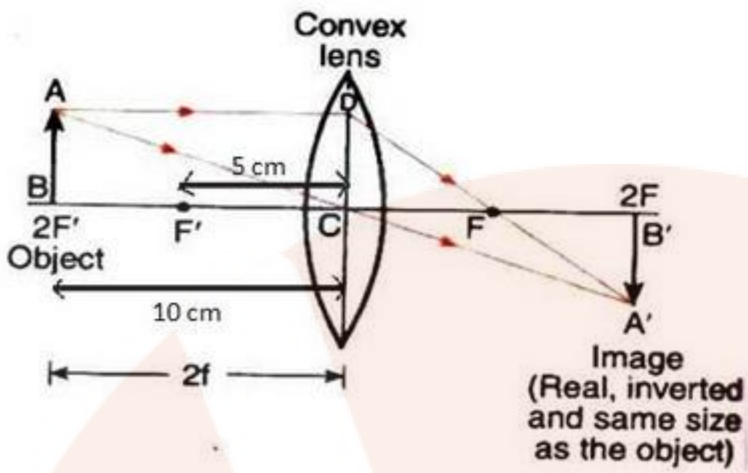


Fig - Formation of image when image is at 2F

(b) Use of convex mirror: As rear-view mirror in vehicles
Use of concave mirror: As shaving mirrors
Use of convex lens: For making simple camera
Use of concave lens: As eye-lens in Galilean telescope

Solution 15:

(i)



(ii)

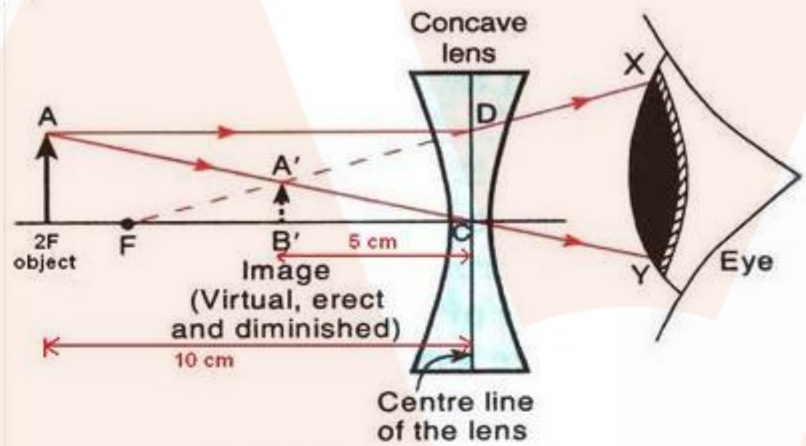


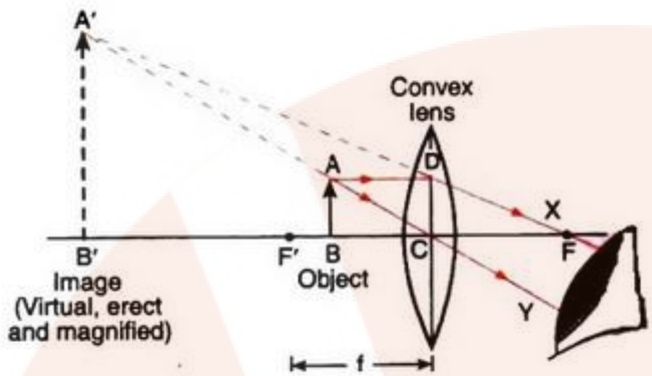
Fig - Formation of image when image is at 2F

(b) Use of convex mirror: As rear-view mirror in vehicles
Use of concave mirror: As shaving mirrors
Use of convex lens: For making simple camera
Use of concave lens: As eye-lens in Galilean telescope

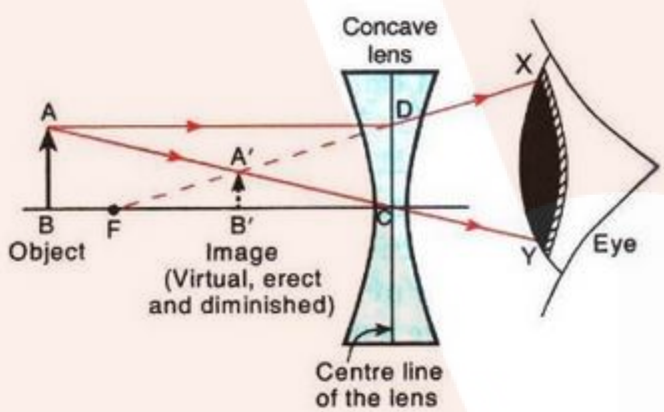
Solution 16:

(a)

(i) Formation of virtual image using a converging lens:



(ii) Formation of virtual image using a diverging lens:



(b) The virtual image formed by a converging lens is magnified whereas that formed by a diverging lens is diminished.

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Solution 23:

(a) The object is placed at focus, so f=10 cm.

(b) the object is placed at a distance twice the focal length, so f=5 cm.

(c) Convex lens (since image is real).

(d) Convex lens (since image is real).

Solution 24:
(i) Concave lens because of negative magnification.
(ii) Convex lens because of positive magnification.

Solution 25:
(a) Convex lens.
(b) Convex lens.
(c) Convex lens.
(d) Concave lens.

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Solution 1:
(a) Convex lens (since image is real, inverted and diminished).
(b) Concave lens (since image is virtual, erect and diminished).

Solution 2:
When an object is placed at a very large distance from a diverging lens, then image is formed at the focus of the lens.
Therefore, the focal length of the lens is 20 cm.

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Solution 3:

$u = -4\,\text{cm}$

$f = -12\,\text{cm}$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} - \frac{1}{-4} = \frac{1}{-12}$$

$$\frac{1}{v} = -\frac{1}{12} - \frac{1}{4}$$

$$\frac{1}{v} = \frac{-4}{12}$$

$v = -3\,\text{cm}$

Image is formed 3 cm infront of the concave lens.

Image is virtual and erect.

Solution 4:

$f = -15\,cm$

$v = -10\,cm$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

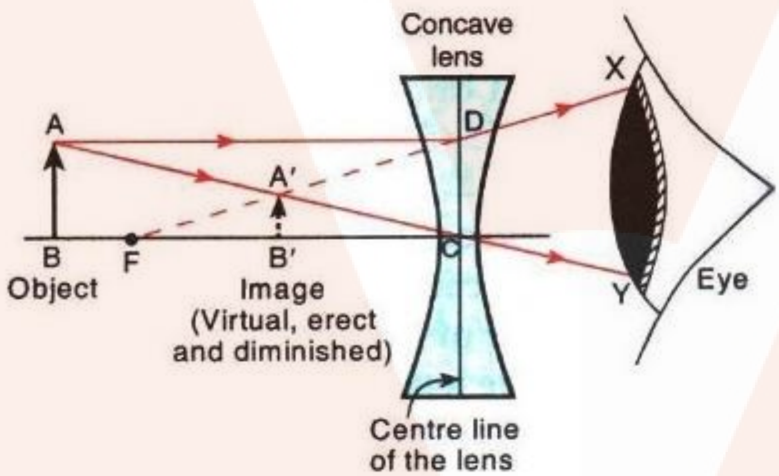
$$\frac{1}{-10} - \frac{1}{u} = \frac{1}{-15}$$

$$\frac{1}{u} = -\frac{1}{10} + \frac{1}{15}$$

$$\frac{1}{u} = \frac{-2}{60}$$

$u = -30\,cm$

Object is at 30 cm from the concave lens (on left side).



Here, OB=30cm
OF=15cm
OB'=10cm

Solution 5:

$u = -60\,cm$

$v = -20\,cm$ (Virtual image)

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

$$\frac{1}{f} = \frac{1}{-20} - \frac{1}{-60}$$

$$= \frac{-2}{60}$$

$f = -30\,cm$

The lens is diverging because the focal length is negative.

Solution 6:

$f = -20\,cm$

$v = -15\,cm$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{-15} - \frac{1}{u} = \frac{1}{-20}$$

$$\frac{1}{u} = -\frac{1}{15} + \frac{1}{20}$$

$$\frac{1}{u} = \frac{-1}{60}$$

$u = -60\,cm$

Object distance is 60 cm towards the left of the lens.

Question 7:

A concave lens has focal length 15 cm. At what distance should the object from the lens be placed so that it forms an image at 10 cm from the lens ? Also find the magnification produced by the lens.

Solution 7:

$f = -15\,cm$

$v = -10\,cm$

Lens formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{-10} - \frac{1}{u} = \frac{1}{-15}$

$\frac{1}{u} = -\frac{1}{10} + \frac{1}{15}$

$\frac{1}{u} = \frac{-1}{30}$

$u = -30\,cm$

Object should be placed at a distance of 60 cm on the left side of the lens.

$m = \frac{v}{u} = \frac{-10}{-30} = +0.33$

Solution 8:

$v = ?$

$h_1 = 12\,mm = 0.012\,m$

$u = -0.20\,m$

$f = -0.30\,m$

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

$\frac{1}{v} - \frac{1}{-0.20} = \frac{1}{-0.30}$

$\frac{1}{v} = \frac{-1}{0.30} - \frac{1}{0.20}$

$v = -0.12\,m$

Image is virtual and erect.

$m = \frac{h_2}{h_1} = \frac{v}{u}$

$\frac{h_2}{0.012} = \frac{-0.12}{-0.20}$

$h_2 = 0.0072\,m = 7.2\,mm$

Image is 7.2 mm high.

Solution 9:

$f = -20\,cm$

$h_1 = 5\,cm$

$v = -15\,cm$ (Concave lens forms virtual image)

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

$$\frac{1}{-15} - \frac{1}{u} = \frac{1}{-20}$$

$$\frac{1}{u} = -\frac{1}{15} + \frac{1}{20}$$

$$\frac{1}{u} = \frac{-1}{60}$$

$u = -60\,cm$

Object should be placed 60 cm to the left of the lens.

$$m = \frac{v}{u} = \frac{h_2}{h_1}$$

$$\frac{-15}{-60} = \frac{h_2}{5}$$

$h_2 = 1.25\,cm$

Image formed is 1.25 cm high.

Solution 10:

$u = -20\text{cm}$

(a) f=15 cm (for converging lens)

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

$$\frac{1}{v} - \frac{1}{-20} = \frac{1}{15}$$

$$\frac{1}{v} = \frac{1}{15} - \frac{1}{20}$$

$$\frac{1}{v} = \frac{1}{60}$$

$$v = 60\text{cm}$$

$$m = \frac{v}{u} = \frac{60}{-20} = -3$$

(b) f=-15 cm (for diverging lens)

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

$$\frac{1}{v} - \frac{1}{-20} = \frac{1}{-15}$$

$$\frac{1}{v} = -\frac{1}{15} - \frac{1}{20}$$

$$\frac{1}{v} = \frac{-7}{60}$$

$$v = -8.57\text{ cm}$$

$$m = \frac{-v}{u} = \frac{-8.57}{-20} = +0.42$$

Solution 11:

$h_1 = 2\,cm$

$u = -40\,cm$

$f = -15\,cm$

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

$$\frac{1}{v} - \frac{1}{-40} = \frac{1}{-15}$$

$$\frac{1}{v} = -\frac{1}{15} - \frac{1}{40}$$

$$\frac{1}{v} = \frac{-11}{120}$$

$v = -10.90\,cm$

$$m = \frac{v}{u} = \frac{h_2}{h_1}$$

$$\frac{-10.90}{-40} = \frac{h_2}{2}$$

$h_2 = 0.54\,cm$

Solution 12:

(a) $h_1 = 2cm$

$u = -20cm$

(i) f=-40cm (Diverging lens)

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

$$\frac{1}{v} - \frac{1}{-20} = \frac{1}{-40}$$

$$\frac{1}{v} = -\frac{1}{40} - \frac{1}{20}$$

$$\frac{1}{v} = \frac{-3}{40}$$

$v = -13.33cm$

$$m = \frac{v}{u} = \frac{h_2}{h_1}$$

$$\frac{-13.33}{-20} = \frac{h_2}{2}$$

$h_2 = 1.33cm$

(ii) f=40 cm (Diverging lens)

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

$$\frac{1}{v} - \frac{1}{-20} = \frac{1}{40}$$

$$\frac{1}{v} = \frac{1}{40} - \frac{1}{20}$$

$$\frac{1}{v} = \frac{-1}{40}$$

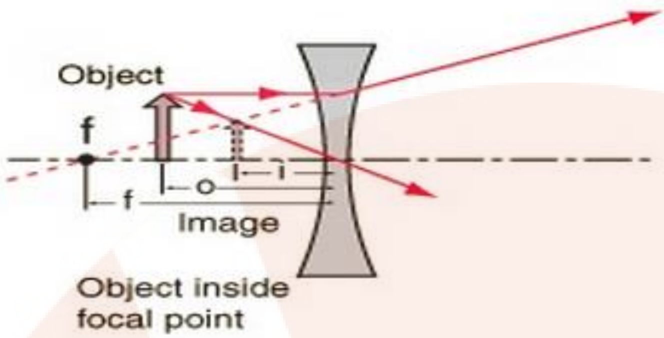
$v = -40cm$

$$m = \frac{v}{u} = \frac{h_2}{h_1}$$

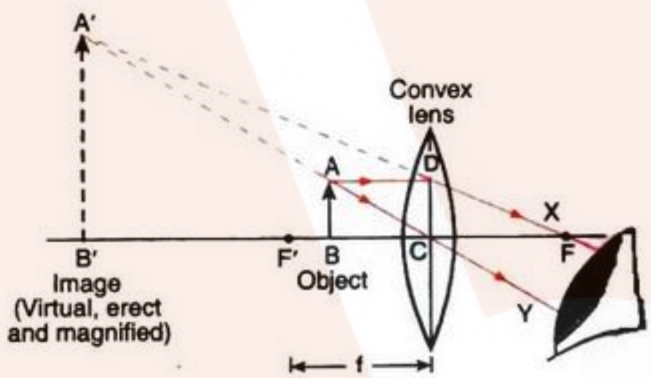
$$\frac{-40}{-20} = \frac{h_2}{2}$$

$h_2 = 4cm$

(b) Formation of image in case (i):



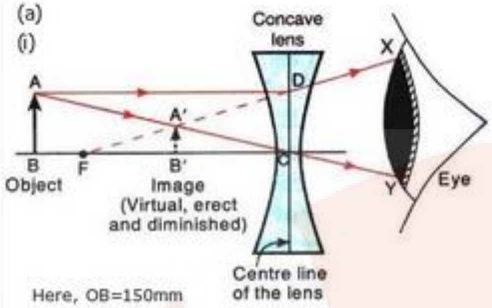
Formation of image in case (ii):



Solution 13:

(a)

(i)



Here, OB=150mm
OF=100mm

(ii) u=-150mm

f=-100mm

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

$$\frac{1}{v}-\frac{1}{-150}=\frac{1}{-100}$$

$$\frac{1}{v}=-\frac{1}{100}-\frac{1}{150}$$

$$\frac{1}{v}=\frac{-5}{300}$$

$$v=-60mm$$

(b) u=-150mm

f=100mm

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

$$\frac{1}{v}-\frac{1}{-150}=\frac{1}{100}$$

$$\frac{1}{v}=\frac{1}{100}-\frac{1}{150}$$

$$\frac{1}{v}=\frac{1}{300}$$

$$v=+300mm$$

The image formed by converging lens is real, inverted and magnified (2 times). It is formed behind the converging lens. On the other hand, the image formed by diverging lens is virtual, erect and diminished. It is formed in front of the diverging lens.

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Solution 18:

(a) u=-20 cm=-200 mm

f=50 mm

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

$$\frac{1}{v}-\frac{1}{-200}=\frac{1}{50}$$

$$\frac{1}{v}=\frac{1}{50}-\frac{1}{200}$$

$$\frac{1}{v}=\frac{3}{200}$$

$v = 66.6\ mm = 6.66\ cm$

The film should be at a distance of 6.66 cm behind the camera lens.

(b) $d_1 = 5 cm = 50\ mm$

$$m=\frac{v}{u}=\frac{d_2}{d_1}$$

$$\frac{66.6}{-200}=\frac{d_2}{50}$$

$d_2 = 16.65\ mm = 1.66\ cm$

(c) It is a convex lens.

Solution 19:

$u = -2\ m$

$m = +\frac{1}{4}$ (Erect image)

$$m=\frac{v}{u}$$

$$\frac{1}{4}=\frac{v}{-2}$$

$v = -0.5\ m$

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

$$\frac{1}{-0.5}-\frac{1}{-2}=\frac{1}{f}$$

$f = -0.666\ m = -66.6\ cm$

It is a concave lens.

Solution 20:

(a) Since the image is formed on a screen, it must be a real image.
Hence, the lens should be a convex lens.
(b) m=-3 (Real and inverted image)

$-u+v=80cm$

$m=\frac{v}{u}$

$-3=\frac{80+u}{u}$

$-3u=80+u$

$u=-20cm$

$v=80+u=80+(-20)=60\,cm$

Lens formula: $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

$\frac{1}{60}-\frac{1}{-20}=\frac{1}{f}$

$\frac{1}{f}=\frac{4}{60}$

$f=+15cm$

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Solution 1:
Lens A has more power because of its shorter focal length.

Solution 2:
Convex lens of short focal length causes more bending of light rays passing through it.

Solution 3:
Power of a lens.

Solution 4:
1 diopter is the power of a lens whose focal length is 1 meter.

Solution 5:
a) Positive power – Convex lens.
b) Negative power – Concave lens.

Solution 6:
Lens of short focal length.

Solution 7:
Power of lens is reciprocal of its focal length in meters.

Solution 8:
Thick convex lens has more power because of its shorter focal length.

Solution 9:
f = 25 cm = 0.25 cm.
P = 1/f = 1/0.25 = +4 D.

Solution 10:
f = 0.5 m
P = 1/f = 1/0.5 = +2 D.

Solution 11:
f = 50 mm = 0.05 m
P = 1/f = 1/0.05 = +20 D.

Solution 12:
f = 80 cm = 0.8 m.
P = 1/f = 1/0.8 = +1.25 D.

Solution 13:
Here, f = -3 cm = -0.03 m (Diverging lens)
P = 1/f = 1/(-0.03) = -33.33 D.

Solution 14:
P = +0.2 D.
P = 1/f.
f = 1/P = 1/0.2 = +5 m.

Solution 15:
P = -2 D.
P = 1/f.
f = 1/P = 1/(-2) = -0.5 m = -50 cm.

Solution 16:
Convex lens.

Solution 17:
Concave lens.

Solution 18:
(a) Convex lens
(b) P = +0.5 D.
P = 1/f.
f = 1/P = 1/0.5 = 2 m.

Solution 19:
P = -1.5 D
P = 1/f.
f = 1/P = 1/(-0.5) = -0.66 m = -66.6 m.
Since focal length is negative, it is a diverging lens.

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Solution 20:
f = -10 cm = -0.1 m
P = 1/f = 1/(-0.1) = -10 D
It is a concave lens.

Solution 21:
f = +150 mm = +0.15 m
It is a convex lens since its focal length is positive.
P = 1/f = 1/0.15 = +6.66 D

Solution 22:
(a) power, diopters.
(b) Positive, negative.

Solution 23:

$h = 4cm$

$u = -15cm$

$P = -10D$

$P = \frac{1}{f}$

$f = \frac{1}{P}$

$= \frac{1}{-10}$

$= -0.1\,m$

$= -10\,cm$

Using Lens formula,

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

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

$= \frac{1}{-10} + \frac{1}{-15}$

$= \frac{-5}{30}$

$v = -6\,cm$

Magnification, $m = \frac{h'}{h} = \frac{v}{u}$

$\frac{h'}{4} = \frac{-6}{-15}$

$h' = 1.6\,cm$

Solution 24:

$h = 4.25\,mm = 42.5\,cm$

$u = -10\,cm$

$P = +5D$

(i) $P = \frac{1}{f}$

$f = \frac{1}{P} = \frac{1}{5} = 0.2\,m = 20\,cm$

(ii) $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

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

$= \frac{1}{20} + \frac{1}{-10}$

$= \frac{-1}{20}$

$v = -20\,cm$

$m = \frac{h'}{h} = \frac{v}{u}$

$\Rightarrow \frac{h'}{42.5} = \frac{-20}{-10}$

$h' = 85\,cm = 8.5\,mm$

Solution 25:

$P_1 = +5D,\ P_2 = -7.5D$

(a) Power of combination:

$P = P_1 + P_2 = +5D + (-7.5D) = -2.5D$

(b) Focal length of the combination:

$f = \frac{1}{P} = \frac{1}{-2.5} = -0.4\,m = -40\,cm$

Solution 26:

$$f_1 = 25\,cm = 0.25\,m$$

$$P_1 = \frac{1}{f_1} = \frac{1}{0.25} = 4D$$

$$f_2 = -10\,cm = -0.1\,m$$

$$P_2 = \frac{1}{f_2} = \frac{1}{-0.1} = -10D$$

(a) Power of the combination:

$$P = P_1 + P_2$$
$$= 4D + (-10D)$$
$$= -6D$$

(b) Focal length of the combination:

$$f = \frac{1}{P} = \frac{1}{-6} = -0.1666\,m = -16.66\,cm$$

(c) The combination has negative focal length, so it is diverging.

Solution 27:

(a) $P = P_X + P_Y$

$$P = \frac{1}{f_X} + \frac{1}{f_Y}$$

$$5 = \frac{100}{15} + \frac{1}{f_Y}$$

$$\frac{1}{f_Y} = 5 - \frac{100}{15}$$

$$= \frac{-25}{15}$$

$$f_Y = -0.6\,m = -60\,cm$$

(b) Lens Y is a concave lens since it has negative focal length.

Solution 28:

$f_A = +20\,cm = +0.2\,m$
$f_B = -10\,cm = -0.1\,m$

(a) Lens A is a convex lens (positive focal length) and lens B is a concave lens (negative focal length).

(b) $P_A = \frac{1}{f_A} = \frac{1}{+0.2} = +5D$

$P_B = \frac{1}{f_B} = \frac{1}{-0.1} = -10D$

(c) Power of combination

$P = P_A + P_B = +5D + (-10D) = -5D$

Solution 29:

(a) Power of a lens is a measure of the degree of convergence or divergence of light rays falling in it.

Power of a lens depends on its focal length.

(b) Unit of power of a lens is dioptre.

One dioptre is the power of a lens whose focal length is 1 metre.

(c) $f_1 = 20\,cm = 0.2\,m$

$$P_1 = \frac{1}{f_1} = \frac{1}{0.2} = +5D$$

$f_2 = 40\,cm = 0.4\,m$

$$P_2 = \frac{1}{f_2} = \frac{1}{0.4} = +2.5D$$

$f_3 = -50\,cm = -0.5\,m$

$$P_3 = \frac{1}{f_3} = \frac{1}{-0.5} = -2D$$

Power of the combination

$$P = P_1 + P_2 + P_3$$
$$= +5D + 2.5D + (-2D)$$
$$= +5.5D$$

Focal length of thr combination

$$f = \frac{1}{P} = \frac{1}{+5.5} = +0.1818\,m = +18.18\,cm$$

Solution 30:

(a) $P_A = +2D$

$$f_A = \frac{1}{P_A} = \frac{1}{2} = +0.5\,m = +50\,cm$$

Lens A is a convex lens.

$P_B = -4D$

$$f_B = \frac{1}{P_B} = \frac{1}{-4} = -0.25\,m = -25\,cm$$

Lens B is a concave lens.

(b) Case 1: For lens A

$f_A = +50\,cm$

$u_A = -100\,cm$

$$\frac{1}{f_A} = \frac{1}{v_A} - \frac{1}{u_A}$$

$$\frac{1}{v_A} = \frac{1}{f_A} + \frac{1}{u_A}$$

$$= \frac{1}{50} + \frac{1}{-100}$$

$$= \frac{1}{100}$$

Image distance, $v_A = 100\,cm$

Magnification, $m_A = \frac{v_A}{u_A} = \frac{100}{-100} = -1$

Case 1: For lens B

$f_B = -25\,cm$

$u_B = -100\,cm$

$$\frac{1}{f_B} = \frac{1}{v_B} - \frac{1}{u_B}$$

$$\frac{1}{v_B} = \frac{1}{f_B} + \frac{1}{u_B}$$

$$= \frac{1}{-25} + \frac{1}{-100}$$

$$= \frac{-5}{100}$$

Image distance, $v_B = -20\,cm$

Magnification, $m_B = \frac{v_B}{u_B} = \frac{-20}{-100} = +0.2$

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Solution 39:

(a) These lenses have negative powers and hence negative focal lengths, so they are concave lenses.

Concave lenses are thinner in the middle.

(b) Lens of lower power has greater focal length.
So, -3.50 D lens has greater focal length.
(c) Left eye is the weaker one because it needs a lens of greater power for its correction.

Solution 40:
(a) These lenses have positive powers and hence positive focal lengths, so they are convex lenses.
Convex lenses are thicker in the middle.
(b) Lens of greater power bends light rays more quickly.
So, +2.50 D lens bends light rays more quickly.
(c) These spectacle lenses will converge the light rays because these are convex lenses