➤ ***Correcting Myopia (Near-Sightedness)***

Concave lenses are used in spectacles to correct the defect called myopia, where the person is unable to see distant objects clearly.

➤ ***In Optical Instruments (Implied)***

Concave lenses are used in devices like peepholes, binoculars, and telescopes, where they help diverge light rays and control image size or clarity.

➤ ***Laser Flashlights and Beam Expanders (Implied by application)***

Concave lenses are used where diverging rays are needed, such as in some types of flashlights or laser

➤ ***Magnifying Glass***

Convex lenses are used as magnifying glasses. When an object is placed between the optical center and focus, the lens forms a virtual, erect, and enlarged image, allowing closer observation of small objects.

➤ ***Correcting Hypermetropia (Far-Sightedness)***

Convex lenses are used in spectacles to correct the defect of vision called hypermetropia, where the person is unable to see nearby objects clearly.

➤ ***Used in Microscopes and Telescopes (Implied)***

Convex lenses are part of the objective and eyepiece systems in devices like microscopes and telescopes, helping magnify small or distant objects.

Sign conventions are similar to the one used for spheri
mirrors, except that measurements are taken from optical
of the lens.

Focal length of convex lens = Positive
Focal length of concave lens = Negative

Page Number: 168

Question 1

Define the principal focus of a concave mirror.

Answer:

The principal focus of a concave mirror is a point on its principal axis to which all the light rays which are parallel and close to the axis, converge after reflection from the concave mirror.

Question 2

The radius of curvature of a spherical mirror is 20 cm. What is its focal length?

Answer:

Focal length = $\frac{1}{2}$ x Radius of curvature = $\frac{1}{2}$ x 20 cm = 10 cm

Question 3

Name a mirror that can give an erect and enlarged image of an object.

Answer:

Concave mirror.

Question 4

Why do we prefer a convex mirror as a rear-view mirror in vehicles ?

Page Number: 171

Question 1

Find the focal length of a convex mirror whose radius of curvature is 32 cm.

Solution:

R = +32 cm and $f = \frac{R}{2} = +\frac{32}{2} = +16cm$

Question 2

A concave mirror produces three times magnified (enlarged) real image of an object placed at 10 cm in front of it. Where is the image located ?

Solution:

Because the image is real, so magnification m must be negative.

$$m = \frac{h'}{h} = -\frac{v}{u} = -3 \quad \text{or} \quad v = 3u$$

But $u = -10$ cm

Therefore, $m = \frac{-v}{u} \Rightarrow -3 = \frac{-v}{-10}$

$\therefore$ $v = \mathbf{-30\ cm}$.

Thus the image is located at a distance of 30 cm from the mirror on the object side of the mirror.

Page Number: 176

Question 1

A ray of light travelling in air enters obliquely into water. Does the light ray bend towards the normal or away from the normal ? Why ?

Answer:

The light-ray bends towards the normal because the ray of light goes from a rarer medium to a denser medium.

Question 2

Light enters from air to glass having refractive index 1.50. What is the speed of light in the glass ? The speed of light in vacuum is 3 x 10^8 ms^{-1}.

Solution:

Refractive index of glass, n_8 = 1.50

Speed of light in vacuum, $c = 3 \times 10^8\ ms^{-1}$.

$$\text{Speed of light in glass} = \frac{c}{n_g} = \frac{3 \times 10^8\ m/s}{1.5} = 2 \times 10^8\ ms^{-1}$$

Question 3

Find out, from Table 10.3, the medium having highest optical density. Also find the medium with lowest optical density.

Answer:

From table 10.3, diamond has highest refractive index (= 2.42), so it has highest optical density.

Air has lowest refractive index (= 1.0003),
so it has lowest optical density.

Question 4

You are given kerosene, turpentine and water. In which of these does the light travel fastest ? Use the information given in Table 10.3.

Answer:

For kerosene, n = 1.44

For turpentine, n = 1.47

For water, n = 1.33

Because water has the lowest refractive index, therefore light travels fastest in this optically rarer medium than kerosene and turpentine oil.

Question 5

The refractive index of diamond is 2.42. What is the meaning of this statement?

Answer:

By saying that the refractive index of diamond is 2.42, we mean that the speed of light in diamond is lower by a factor of 2.42 relative to that in vacuum.

Page Number: 184

Question 1

Define 1 dioptre of power of a lens.

Answer:

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

Page Number: 184

Question 1

Define 1 dioptre of power of a lens.

Answer:

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

Question 2

A convex lens forms a real and inverted image of a needle at a distance of 50 cm from it. Where is the needle placed in front of the convex lens if the image is equal to the size of the object ? Also, find the power of the lens. , Sol. Here, u — +50 cm ..

Solution:

Here v = +50cm

Because the real image is of the same size as the object,

Therefore, $m = \frac{h'}{h} = \frac{v}{u} = -1$

or $u = -v = -50 \text{ cm}$

Now, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{+50} - \frac{1}{-50} = +\frac{2}{50} = +\frac{1}{25}$

or $f = 25 \text{ cm} = 0.25 \text{ m}$

$$P = \frac{1}{f} = +\frac{1}{0.25 \text{ m}} = \mathbf{+4\ D}$$

Question 3

Find the power of a concave lens of focal length 2 m.

Solution:

Because the focal length of a concave lens is negative,

therefore f = -2 m

Therefore, $m = \frac{h'}{h} = \frac{v}{u} = -1$

or $u = -v = -50 \text{ cm}$

Now, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{+50} - \frac{1}{-50} = +\frac{2}{50} = +\frac{1}{25}$

or $f = 25 \text{ cm} = 0.25 \text{ m}$

$$P = \frac{1}{f} = +\frac{1}{0.25 \text{ m}} = \mathbf{+4\ D}$$

Question 1

Which one of the following materials cannot be used to make a lens ?

(a) Water

(b) Glass

(c) Plastic

(d) Clay

Answer:

(d) Clay

Question 2

The image formed by a concave mirror is observed to be virtual, erect and larger than the object. Where should be the position of the object ?

(a) Between the principal focus and the centre of curvature

(b) At the centre of curvature

(c) Beyond the centre of curvature

(d) Between the pole of the mirror and its principal focus.

Answer:

(d) Between the pole of the mirror and its principal focus.

Question 3

Where should an object be placed in front of a convex lens to get a real image of the size of the object ?

(a) At the principal focus of the lens (b) At twice the focal length

(c) At infinity

(d) Between the optical centre of the lens and its principal focus.

Answer:

(b) At twice the focal length.

Question 4

A spherical mirror and a thin spherical lens have each a focal length of -15 cm. The mirror and the lens are likely to be :

(a) Both concave.

(b) Both convex.

(c) the mirror is concave and the lens is convex.

(d) the mirror is convex, but the lens is concave.

Answer:

(a) Both concave

Question 5

No matter how far you stand from mirror, your image appears erect. The mirror is likely to be

(a) plane

(b) concave

(c) convex

(d) either plane or convex.

Answer:

(d) Either plane or convex.

Question 6

Which of the following lenses would you prefer to use while reading small letters found in a dictionary ?

(a) A convex lens of focal length 50 cm.

(b) A concave lens of focal length 50 cm.

(c) A convex lens of focal length 5 cm.

(d) A concave lens of focal length 5 cm.

Answer:

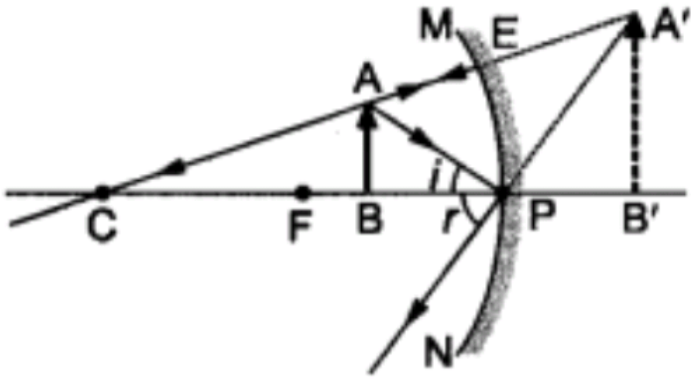
(c) A convex lens of focal length 5 cm.

Question 7

We wish to obtain an erect image of an object, using a concave mirror of focal length 15 cm. What should be the range of distance of the object from the mirror ? What is the nature of the image ? Is the image larger or smaller than the object ? Draw a ray diagram to show the image formation in this case.

Answer:

A concave mirror gives an erect image when the object is placed between the focus F and the pole P of the concave mirror, i.e., between 0 and 15 cm from the mirror. The image thus formed will be virtual, erect and larger than the object.



Question 8

Name the type of mirror used in the following situations.

(a) Headlights of a car.

(b) Side/rear-view mirror of a vehicle.

(c) Solar furnace.

Support your answer with reason.

Answer:

(a) Concave mirrors are used as reflectors in headlights of cars. When a bulb is located at the focus of the concave mirror, the light rays after reflection from the mirror travel over a large distance as a parallel beam of high intensity.

(b) A convex mirror is used as a side/rear-view mirror of a vehicle because

- A convex mirror always forms an erect, virtual and diminished image of an object placed anywhere in front it.
- A convex mirror has a wider field of view than a plane mirror of the same size.

(c) Large concave mirrors are used to concentrate sunlight to produce heat in solar furnaces.

Question 9

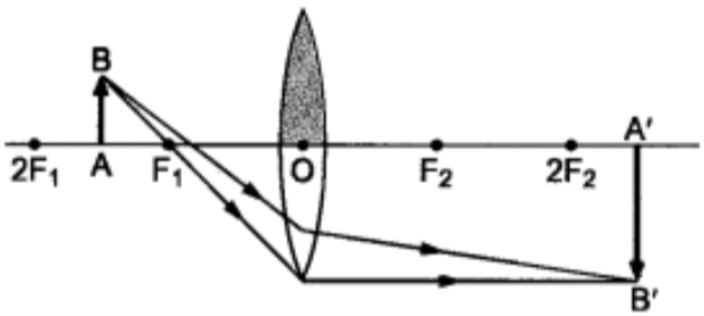
One-half of a convex lens is covered with a black paper. Will this lens produce a complete image of the object ? Verify your answer experimentally. Explain your observations.

Answer:

A convex lens forms complete image of an object, even if its one half is covered with black paper. It can be explained by considering following two cases.

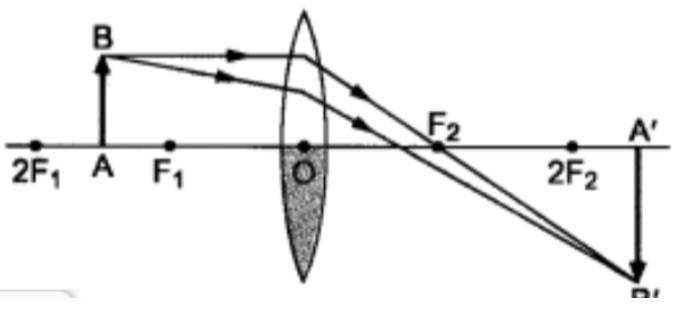
Case I : When the upper half of the lens is covered

In this case, a ray of light coming from the object will be refracted by the lower half of the lens. These rays meet at the other side of the lens to form the image of the given object, as shown in the following figure.



Case II: When the lower half of the lens Is covered

In this case, a ray of light coming from the object is refracted by the upper half of the lens. These rays meet at the other side of the lens to form the image of the given object, as shown in the given figure.



Question 10

An object 5 cm in length is held 25 cm away from a converging lens of focal length 10 cm. Draw the ray diagram and find the position, size and the nature of the image formed.

Answer:

Here : Object distance, u= -25 cm,

Object height, h = 5 cm,

Focal length, f = +10 cm

According to the lens formula, $\frac{1}{f} = \frac{1}{\nu} - \frac{1}{u}$, we have

$$\Rightarrow \frac{1}{\nu} = \frac{1}{f} - \frac{1}{u} = \frac{1}{10} - \frac{1}{25} = \frac{15}{250} \quad or \quad \nu = \frac{250}{15} = 16.66cm$$

The positive value of v shows that the image is formed at the other side of the lens.

$$\text{Now, magnification, } m = \frac{\text{Image distance}}{\text{Object distance}} = \frac{v}{u} = \frac{16.66}{-25} = -0.66.$$

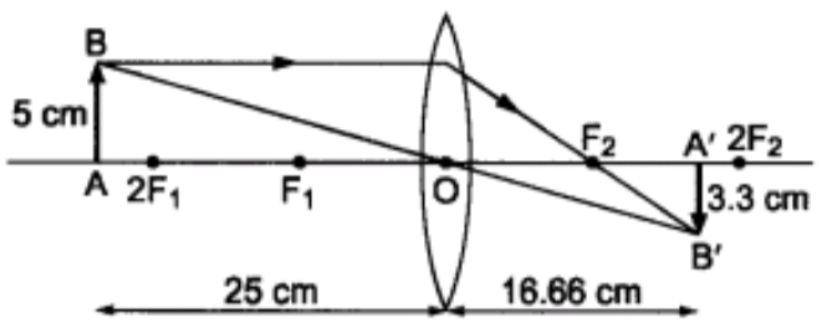
The negative sign shows that the image is inverted.

$$\text{But magnification, } m = \frac{\text{Image height}}{\text{Object height}} = \frac{h'}{5}$$

$$\text{or } h' = -0.66 \times 5 = -3.3 \text{ cm}$$

The negative value of image height indicates that the image formed is inverted.

The position, size, and nature of image are shown alongside in the ray diagram.



Question 11

A concave lens of focal length 15 cm forms an image 10 cm from the lens. How far is the object placed from the lens ? Draw the ray diagram.

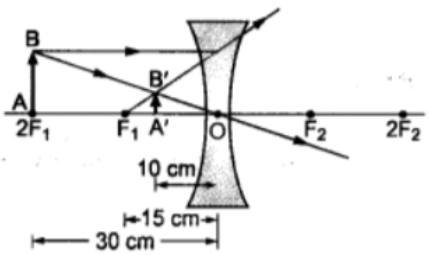
Solution:

Focal length, f = -15 cm, Image distance, v = -10 cm (as concave lens forms the image on the same side of the lens)

From the lens formula $\frac{1}{f} = \frac{1}{\nu} - \frac{1}{u}$, we have

$$\Rightarrow \quad \frac{1}{u} = \frac{1}{v} - \frac{1}{f} = \frac{1}{-10} - \frac{1}{-15}$$

$$= \frac{-3+2}{30} = -\frac{1}{30}$$



Object distance, u = -30 cm

The negative value of u indicates that the object is placed in front of the lens.

Question 12

An object is placed at a distance of 10 cm from a convex mirror of focal length 15 cm. Find the position and nature of the image.

Solution:

Object distance, u = -10 cm, Focal length, f = +15 cm, Image distance, v = ?

From mirror formula, $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$, we have

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{+15}-\frac{1}{-10}=\frac{2+3}{30}=\frac{1}{6} \text{ or } v = \mathbf{6\ cm}$$

Thus, image distance, v = + 6 cm

Because v is +ve, so a virtual image is formed at a distance of 6 cm behind the mirror.

Magnification, $m = \frac{-v}{u} = \frac{-6}{-30} = \frac{1}{5}$ (i.e. < 1)

The positive value of m shows that image erect and its value, which is less than 1, shows that image is smaller than the object. Thus, image is virtual, erect and diminished.

Question 13

The magnification produced by a plane mirror is +1. What does this mean ?

Answer:

Since magnification, $m = \frac{h'}{h} = \frac{-\nu}{u}$. Given, m = +1, so h' = h and v = -u

(i) m = 1 indicates the size of image is same as that of object.

(ii) positive sign of m indicates that an erect image is formed.

The opposite signs of v and u indicate that image is formed on the other side of the mirror from where the object is placed i.e., image is formed behind the mirror and thus image formed is virtual.

Question 14

An object 5.0 cm in length is placed at a distance of 20 cm in front of a convex mirror of radius of curvature 30 cm. Find the position of the image, its nature and size.

Solution:

Since object size, h = +5 cm,

object distance, u = -20 cm

and radius of curvature, R = +30 cm

$$\therefore \quad \text{Focal length, } f = \frac{R}{2} = +\frac{30}{2} = 15 \text{ cm}$$

From mirror formula, $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$, we have $\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$

$$\text{or} \quad \frac{1}{v} = \frac{1}{+15} - \frac{1}{-20} = \frac{4+3}{60} = \frac{7}{60} \quad \text{or} \quad v = \frac{60}{7} = \mathbf{8.6 \text{ cm}}$$

$$\because \quad \text{Magnification, } m = -\frac{v}{u} = \frac{h'}{h}$$

$$\therefore \quad \text{Image size, } h' = -\frac{vh}{u} = -\frac{8.6 \times 5}{-20} = 2.15 \cong \mathbf{2.2 \text{ cm}}$$

A virtual, erect image of height 2.2 cm is formed behind the mirror at a distance of 8.6 cm from the mirror.

Question 15

An object of size 7.0 cm is placed at 27 cm in front of a concave mirror of focal length 18 cm. At what distance from the mirror should a screen be placed, so that a sharp focussed image can be obtained ? Find the size and the nature of the image.

Answer:

Here, object size, h = +7.0 cm,

object distance, u = -27 cm

and focal length, f = -18 cm

Image distance, v = ?

and image size, h' = ?

From the mirror formula, $\frac{1}{f} = \frac{1}{\nu} - \frac{1}{u}$, we have

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} \quad \text{or} \quad \frac{1}{v} = \frac{1}{-18} - \frac{1}{-27} = \frac{-3+2}{54} = -\frac{1}{54} \quad \text{or} \quad v = \mathbf{-54\ cm}$$

The screen should be placed at a distance of 54 cm on the object side of the mirror to obtain a sharp image.

$$\text{Now,} \quad \text{magnification, } m = \frac{h'}{h} = -\frac{v}{u}$$

$$\text{or} \quad \text{image size, } h' = -\frac{vh}{u} = \frac{(-54)\times(+7)}{(-27)} = \mathbf{-14\ cm.}$$

The image is real, inverted and enlarged in size.

Question 16

Find the focal length of a lens of power -2.0 D.

What type of lens is this ?

Answer:

Here, P = -2.0 D

The type of lens is concave because the focal length is negative.

$$\therefore \quad f = \frac{1}{P} = \frac{1}{-2.0D} = \mathbf{-0.5\ m}$$

Question 17

A doctor has prescribed a corrective lens of power +1.5 D. Find the focal length of the lens. Is the prescribed lens diverging or converging ?

Answer:

Here, P = +1.5 D

$$\therefore \quad f = \frac{1}{P} = \frac{1}{+1.5D} = +\frac{10}{15}\ \text{m} = +0.6667\ \text{cm} = \mathbf{+66.67\ cm}$$

Because the focal length is positive, the prescribed lens is converging.